

so that loss of insecticide from the surface may be followed by measuring loss in radioactivity. Different samples of mud were made into blocs under various conditions of humidity, and a homogeneous mixture prepared by dissolving 990 mg. pure  $p,p'$  DDT and 9.8 mg. radioactive  $p,p'$  DDT (specific activity 0.48 mc/g) in carbon tetrachloride, evaporating the solvent, drying the residue over silica gel and grinding it to a fine powder. Each bloc was then dusted with the powder, with about 1 mg DDT particles ranging from 1-25  $\mu$  in diameter, deposited from a stream of nitrogen. An average count of 4220/min was obtained immediately after dusting. The subsequent rate of loss of radioactivity of the bloc in a dry atmosphere was tested, and the percentage of DDT in different layers determined. No DDT was found at a depth below 1.5 mm.

- 482 Morrison, F.O., LeRoux, E.J. HOUSE FLY HEAD AS SITE OF LETHAL ACTION OF DDT. Canad. J. agric. Sci. 34,3 (1954) 316-8.

DDT (2  $\mu$ g per fly) was applied to the labella or to the tibio-femoral membrane of one leg of males of Musca domestica L. that had emerged four days before. Treatment of the labella gave 83% kill in 24 hours, and treatment of the leg gave 68%. When the cervical region of each fly was ligated with cotton thread, the mortality percentages were 91% and only 31% for flies treated on the labella and leg, respectively, and 14 for flies not treated with DDT. When DDT labelled with  $C^{14}$  was used, and the heads and bodies of the flies were separated 24 hours after treatment and tested for radioactivity, all the radioactivity applied was recovered and the percentages of it recovered from the heads of non-ligated and (in brackets) ligated flies were 70 (98) after treatment on the labella and 5 (less than 1) after treatment on the leg. Radioactivity in the hemolymph of flies treated on the leg could be detected 30 seconds after treatment, rose fairly rapidly during the first 5 minutes and then remained at a more or less constant level for 24 hours. It is concluded from these results that DDT is translocated in the hemolymph of the fly, and that the head is probably a critical region for its lethal action. (RAE-B43: 188, 1955)

- 483 Pearce, G.W., Jensen, J.A. SYNTHESIS OF DDT LABELED WITH CARBON-14 IN THE TERTIARY POSITION. Science 118 (1953) 45-6.

A method has been developed for the synthesis of radioactive dichlorophenyl trichloroethane (DDT) of good yield, in which the tertiary carbon is labelled. (For details, see abstract under "Preparation of carbon-14-labeled DDT" in J. agric. Food Chem. 1,12 (1953) 776).

- 484 Pearce, G.W., Jensen, J.A. PREPARATION OF CARBON-14-LABELED DDT. J. agric. Food Chem. 1,12 (1953) 776-8.

The synthesis of DDT labelled with  $C^{14}$  in the tertiary position was carried out in the following steps: barium carbonate to ethyl acetate to ethyl alcohol to chloral to DDT. Starting with 50 mM of barium carbonate containing 20 mc of activity, 15 g of crude DDT were obtained (42% yield based on ethyl alcohol). Two crystallizations from ethyl alcohol yielded 6.11 g of  $p,p'$ -DDT (17% yield) having a melting point of 107-107.5°C. The specific activity was approximately 0.5 mc/g. (auth.)

- 485 Perry, A.S., Jensen, J.A., Pearce, G.W. COLORIMETRIC AND RADIOMETRIC DETERMINATION OF DDT AND ITS METABOLITES IN RESISTANT HOUSEFLIES. J. agric. Food Chem. 3 (1955) 1008-11.

Studies on degradation products of DDT in seven DDT-resistant strains of houseflies, using radioactive DDT ( $C^{14}$ -labelled in the tertiary position), showed that the only significant product of DDT metabolism was DDE. Both DDT and DDE were found in the ether-soluble portion of the excreta, the DDE-DDT ratio increasing with increasing time intervals. Very small amounts of a radioactive product were found in the water-soluble portion of the excreta. Losses of DDT were not consistent and are thought to be within the range of experimental error. No strain specificity was evident. In flies held 10 days after application of the insecticide, small but consistent losses of DDT were experienced, which might be attributed to incomplete recovery of material from excreta. (auth.)

- 486 Perry, A.S., Buckner, A.J. BIOCHEMICAL INVESTIGATIONS ON DDT-RESISTANCE IN THE HUMAN BODY LOUSE PEDICULUS HUMANUS HUMANUS. Amer. J. trop. Med. Hyg. 7 (1958) 620-6.

$C^{14}$ -labelled DDT was incorporated into citrated human blood. This was fed to adult lice through chickens membranes. The DDT-resistant (Korean strain) lice but not the susceptible ones (Orlando strain) could be shown to metabolize DDT to a water-soluble derivative giving a positive test when analysed by the Schechter-Haller method. The metabolite was not ether-extractable following acid hydrolysis but appeared to be in a conjugated form, possibly with a protein fraction.

- 487 Robbins, W.E., Dahm, P.A. ABSORPTION AND EXCRETION, DISTRIBUTION AND METABOLISM OF CARBON-14-LABELLED DDT BY THE AMERICAN COCKROACH. J. agric. Food Chem. 3 (1955) 500-8.
- Radioactive DDT and DDE, topically applied to American cockroaches, are rapidly absorbed and widely distributed internally. As much as 75% of the DDT applied is excreted as metabolite(s) in the faeces over a 24-d period. About 80% of the radioactivity in the faeces is due to metabolites containing the diphenyl-2-carbon moiety of DDT; less than 10% is due to DDT, DDE or DDA. Less than 1% of DDT applied or injected is excreted as  $C^{14}O_2$ . The synergist "piperonyl cyclonene" used with DDT, inhibits absorption of DDT and excretion of metabolites. (auth.)
- 488 Roth, A.R., Lindquist, A.W. EFFECT OF TEMPERATURE AND THE ACTIVITY OF HOUSE FLIES ON THEIR ABSORPTION OF DDT. J. econ. Ent. 46, 1 (1953) 127-30.
- Resistant houseflies, Musca domestica L., treated individually with measured drops of radioactive DDT absorbed 64% more of the toxicant with a lower mortality when held during a 24-h period at 90°F than when held at 70°F. Absorption of the DDT began within the first hour after treatment and gradually increased over several hours. Approximately the same amount of DDT was absorbed irrespectively of whether the fly was immobilized with carbon dioxide or was active. The excrement of treated flies showed some radioactivity. Approximately 15% of the total absorbed was accounted for in the excrement over a 7-d period. No radioactivity could be demonstrated in the carbon dioxide collected from DDT-treated flies. (auth. summary)
- 489 Rothe, C.F., Mattson, A.M., Nueslein, R.M., Hayes, W.J. METABOLISM OF CHLOROPHENOTHANE (DDT). INTESTINAL LYMPHATIC ABSORPTION. Arch. Industr. Health (Amer. Med. Ass.) 16 (July 1957) 82-6.
- Radioactive DDT was used, labelled at the tertiary carbon with  $C^{14}$  (cf. Pearce & Jensen, 1953). Of the intestinally absorbed, radioactive DDT administered orally to rats with their thoracic lymph ducts cannulated, 47-65% was recovered in the chyle. Furthermore, 14-46% of the absorbed DDT-derived materials found in the chyle were dehydrohalogenated into a neutral material (DDE).
- 490 Schmidt, C.H., Weidhaas, D.E. EFFECT OF VARYING CONDITIONS IN A LABORATORY TESTING TECHNIQUE ON THE MORTALITY OF MOSQUITO LARVAE. J. econ. Ent. 52, 5 (1959) 970-9.
- Fourth-instar larvae were used in the tests. The insecticides used were Dieldrin, Lindane, Parathion, Malathion, and radioactive DDT ( $p,p'$ -DDT-4- $C^{14}$  with an activity of 2.1  $\mu$ C/mg). The mortality of mosquito larvae increased as the volume of acetone-water suspensions or solutions of Dieldrin, Lindane, Malathion, and DDT was increased from 100 to 1000 ml. The increase was greater and more consistent with DDT than with the other larvicides and with larvae of Anopheles quadrimaculatus Say and Aedes taeniorhynchus (Wied.) than with Aedes aegypti (L.). No increase in mortality was caused with Parathion. When the diameter of the test containers was increased from 3 to 6 inches but the concentration and volume of the suspensions or solutions were constant, mortality of quadrimaculatus decreased when Dieldrin, Lindane, and DDT were used, but not with Malathion or Parathion. No difference in mortality was observed with the other two species of larvae. (from auth.)
- \* Terriere and Schonbrod 1955 - [728]
- 491 Weidhaas, D.E., Schmidt, C.H. TOXICOLOGICAL ACTION OF DDT ON THREE SPECIES OF MOSQUITO LARVAE. J. econ. Ent. 53, 1 (1960) 106-10.
- The availability of  $C^{14}$ -labelled DDT and of radiometric methods permitted quantitative studies on the toxicological aspects of DDT poisoning in mosquito larvae. In tests by radiometric methods the amount of DDT picked up and its relation to the mortality of fourth-instar larvae of Anopheles quadrimaculatus Say, Aedes taeniorhynchus (Wied.), and Aedes aegypti (L.) varied with the exposure time and the concentration. Larvae did not excrete DDT except when exposed to concentrations above the minimum LC-100. The toxic action of DDT on quadrimaculatus larvae differed from that on aegypti. Resistance to DDT in a strain of taeniorhynchus was not related to the uptake or the excretion. Live quadrimaculatus larvae absorbed three times as much DDT as dead larvae; however, in a 24-h test period the surviving larvae had about the same dose as the nonsurvivors.
- (An abstract of earlier work was published in Bull. ent. Soc. Amer. 4, 3 (1958) 103, abstr. 285)

- 492 Weidhaas, D.E., Schmidt, C.H., Bowman, M.C. EFFECTS OF HETEROGENEOUS DISTRIBUTION AND CODISTILLATION ON THE RESULTS OF TESTS WITH DDT AGAINST MOSQUITO LARVAE. J. econ. Ent. 53 (1960) 121-5.

The concentration of DDT in suspensions was shown to be less than the theoretical, and to vary with the volume of the suspension and the size of the container. This variation resulted from differences in the loss of DDT by codistillation and/or by association with the water interfaces, which explained the resulting differences in mosquito mortality.\* The mortality of Anopheles quadrimaculatus Say was influenced more than that of Aedes aegypti (L.), owing to a difference in the behaviour of the larvae and the dosage-mortality response. Biological data obtained with Parathion, Malathion, Lindane, and Dieldrin indicate that insufficient quantities of these insecticides are lost from the containers to alter mortality under normal test conditions. (auth.)

\*  $C^{14}$ -labelled DDT was used throughout.

- \* Winteringham et al. 1950 - [492]

- 493 Winteringham, F.P.W., Loveday, P.M., Harrison, A. RESISTANCE OF HOUSEFLIES TO DDT. Nature 187 (1951) 106-7.

Since the insecticidal properties of  $DBr^{82}DT$  are similar to normal DDT and there is no reason to expect any fundamental differences in their metabolism, the penetration and metabolism of  $(BrC_6H_4)_2CH.CCl_3$  by susceptible and resistant strains of the housefly Musca domestica were studied by labelling it with  $Br^{82}$ . Preliminary penetration studies indicated that DDT-resistant flies were also resistant to  $DBr^{82}DT$  but their resistance was not associated with decreased absorption of the applied insecticide. Metabolism of  $DBr^{82}DT$  was only observed in DDT-resistant flies. Results suggest that the metabolism is enzymic in nature. Metabolism appears to be insufficiently rapid to account for the successful resistance of the flies used in these experiments. Alternatively, only a small fraction of the applied insecticide is involved at the site of action, but it is this fraction which is metabolized. To check whether the presence of " $DBr^{82}DE$ " metabolite might account for the observed resistance, experiments were performed in which mixtures of  $DBr^{82}DT$  and " $DBr^{82}DE$ " were injected into or applied to susceptible flies. No evidence of protection was observed.

- 494 Winteringham, F.P.W. CONFERENCE ON INSECTICIDE RESISTANCE AND INSECT PHYSIOLOGY. Bull. nat. Res. Council US Publ. 219 (1952) 61-99.

The author used a bromine ( $Br^{82}$ ) analogue of DDT for treating two resistant and two susceptible strains of houseflies (from Italy and Sardinia, and from Italy and England respectively). Both adults and larvae were used for studying the metabolism of  $DBr^{82}DT$ . Both strains were able to metabolize the compound provided the dose absorbed was sufficiently low; the resistant strains degraded the insecticide more rapidly than the susceptible strains did, however. Only the intact, living flies were capable of metabolically degrading the absorbed insecticide. At least two kinds of DDT-resistance were observed, one represented by the Italian strain in which survival appeared to depend upon a mechanism such as enzymatic dehydrohalogenation and the enhanced metabolism was a consequence rather than a cause of survival.

- \* Winteringham et al. 1952 - [786]

- \* Winteringham et al. 1952 - [787]

- 495 Winteringham, F.P.W., Hellyer, G.C., McKay, M.A. EFFECTS OF THE INSECTICIDES DDT AND DIELDRIN ON PHOSPHORUS METABOLISM OF THE ADULT HOUSEFLY MUSCA DOMESTICA L. Biochem. J. 76 (1960) 543-8.

The  $P^{32}$ -labelled-pool technique was used for studying the effects of DDT and Dieldrin. Experimental details are given. The principal soluble phosphorus compounds were uniformly labelled in vivo, extracted and assayed as explained elsewhere (Winteringham, 1960). A significant breakdown of thoracic ADP in DDT-poisoned houseflies was noted at the late prostrate stage. This fall could be reversed by injecting aqueous glucose. A significant breakdown in insects spared the hypermotor activity by cyclopropane anaesthesia. cycloPropane also failed to prevent the enhanced desiccation associated with DDT poisoning. The fall in ATP and respiration rate of DDT-poisoned houseflies is not due to the exhaustion of endogenous reserves or to the hypermotor activity induced by DDT. In both DDT- and Dieldrin-poisoned houseflies there was a fall in the level of thoracic  $\alpha$ -glycerophosphate, which could not be reversed by cyclopropane anaesthesia.

### Endrin and Isodrin

- 496 Brooks, G. T. SYNTHESIS OF CARBON-14-LABELLED 1,2,3,4,11,11-HEXACHLORONAPHTHALENE (ISODRIN) Chem. and Industry (Rev.) (1958) 194.  
Adipic acid-1,6- $C^{14}_2$  (I) pyrolyzed with  $Ba(OH)_2$  gave cyclopentanone-1- $C^{14}$ , which reduced with  $NaBH_4$  gave cyclopentanol-1- $C^{14}$ , dehydration of which with  $H_3PO_4$  gave cyclopentene-1- $C^{14}$ , which brominated gave 1,2-dibromocyclopentane-1- $C^{14}$ , which dehydrobrominated gave cyclopentadiene-1- $C^{14}$ , which condensed with excess 1,2,3,4,7,7-hexachlorobicyclo[2.2.1]hepta-2,5-diene gave 'Isodrin'-6- and 7- $C^{14}$  (II). I containing 0.1 mc  $C^{14}$  gave 7% II. (CA 52: 10986a, 1958)
- 497 Brooks, G. T. THE SYNTHESIS OF  $^{14}C$ -LABELLED 1,2,3,4,10,10-HEXACHLORO-6,7-EPOXY-1,4,4a,5,6,7,8,8a-OCTAHYDRO-EXO-1,4-EXO-5,8-DIMETHANONAPHTHALENE (ENDRIN). J. chem. Soc. (1958) 3693-7.  
A study of the absorption, metabolism, and excretion of insecticides derived from decahydro-1,4,5,8-dimethanonaphthalene required a method for the preparation on a millimolar scale of such compounds labelled with  $C^{14}$ .  $C^{14}$ -labelled Endrin has now been synthesized by peracetic acid oxidation of  $C^{14}$ -labelled Isodrin prepared by Diels-Alder addition of [2- $C^{14}$ ] cyclopentadiene to 1,2,3,4,7,7-hexachlorobicyclo [2,2,1]hepta-2,5-diene.
- 498 Brooks, G. T. MECHANISM OF RESISTANCE OF THE ADULT HOUSEFLY (MUSCA DOMESTICA) TO 'CYCLODIENE' INSECTICIDES. Nature 186 (1960) 96-8.  
Topically applied Isodrin and Endrin ( $C^{14}$ -labelled in the terminal unchlorinated ring) were found to be less toxic than Aldrin and Dieldrin to susceptible houseflies but more toxic to Dieldrin-resistant houseflies. Both strains of houseflies converted Isodrin to the corresponding epoxide Endrin. Small amounts of Endrin also were recovered in the external rinse. The penetration, metabolism and excretion of the insecticides and the presence of residual material in tissues are discussed. Endrin was not formed in the tissues of heat-killed insects, suggesting an enzymic epoxidation. Acetone-extracts of live houseflies treated with Isodrin or Endrin contained small amounts of a nontoxic water-insoluble product, which behaved as a ketone derivative of Endrin. There was no evidence that radioactive material was excreted.

### Miscellaneous

- 499 Bettini, S., Boccacci, M., Rossi, C. DESTINO DELL'ACIDO BROMOACETICO MARCATO CON  $C^{14}$  INOCULATO IN PERIPLANETA AMERICANA (The fate of  $C^{14}$ -labelled bromoacetic acid on injection into Periplaneta americana). Riv. Parasit. 16,2(1955) 103-12. (in Italian)  
Bromoacetic acid disappeared from the blood in 45 minutes. Radioactivity of the tissues varies directly with the dose administered, except in the intestine and the Malpighian tubes where it varies a little. The radioactivity in muscle is slight, and occurs mostly in the most highly pigmented muscles which are richest in succinic dehydrogenase. When the deproteinized extracts are separated by electrophoresis, 5 electro-positive and 2 electronegative compounds may be distinguished by autoradiography. (BS: 17-105748, 1956)
- 500 Bettini, S., Boccacci, M. POISON MECHANISM OF THE ACTION OF IODO-, BROMO-, AND CHLORO-ACETIC ACIDS ON INSECTS AND THE INSECTICIDAL PROPERTIES OF SOME OF THEIR DERIVATIVES. R.C. Ist. sup. Sanit. 21 (1958) 278-95.  
Doses of 90, 180, and 360  $\mu$ g of bromoacetic acid-2- $C^{14}$  ( $\mu$ g) were injected into cockroaches (Periplaneta americana) and their blood was studied. A maximum of activity appeared 5 - 10 minutes after injection, and it disappeared within 60 minutes. Radioactivity rose proportionally to the amount injected in various parts of the roach, but not in the colon and the Malpighian tube. Electrophoresis on paper of deproteinized roach extracts produced 2 electropositive and 5 electronegative radioactive components (after injection of I), the major component resembling  $\delta$ -(carboxymethyl)glutathione in migration rate. Earlier work on the subject is also reviewed. (CA 52: 14874, 1958)
- 501 Foreman, S.E., Gilbert, B.L., Johnson, G.S., Erickson, C.A., Adelman, H. ISOTOPE-LABELLED INSECTICIDE, THIODAN-5a, 9a- $C^{14}_2$ . J. agric. Food Chem. 8, 3 (1960) 193-6.  
The insecticide 6,7,8,9,10-hexachloro-1,5,5a,6,8,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide-5a, 9a- $C^{14}_2$  (Thiodan-5a, 9a- $C^{14}_2$ ) was prepared for use in biological studies which required that quantities as low as 1 part per billion be detectable. Starting with a 411-mc quantity of

barium carbonate-C<sup>14</sup>, the quantity of final product obtained was 210 mc, which represents a radio-chemical yield of 51%.

- 502 Halberstadt, J. SOME EXPERIMENTS WITH RADIOACTIVE PREPARATIONS OF 2,4,5,4'-TETRACHLORO-DIPHENYL SULPHONE, A NEW ACARICIDE. Meded. LandbHoogesch. Gent, 23, 3-4 (1958) 788-94.

A scientific note on the method of preparation of the compound, and on experiments in which it was applied to apple trees. Toxicity tests on rats and their results are reported. S<sup>35</sup> was used for labelling.

- 503 Halberstadt, J. EXPERIMENTS WITH RADIOACTIVE PREPARATIONS OF THE ACARICIDE "TEDION V 18" Philips tech. Rev. 21, 9 (1959/60) 278-9.

Radioactive tracer techniques are applied to investigations into the behaviour in plants and animals of "Tedion V 18" (an acaricide for the control of spider mites). The sulphur in the active ingredient of Tedion, which is 2,4,5,4'-tetrachlorodiphenyl sulphone, is partly replaced by the radioactive isotope S<sup>35</sup>. Apple trees were sprayed with preparations of this radioactive Tedion in two formulations: as a wettable powder and as a miscible oil. Radioactivity measurements showed that an active residue remains on the leaf for a long period, whilst the Tedion taken up in the leaf is subject to conversion and transport within the plant, being continuously supplemented from the surface residue. The miscible oil proves to be more economical in use than the wettable powder. Administered to rats (max. dose 100 mg per kg body weight), about 40 to 45% of the Tedion is found unchanged after 48 h, mainly in the faeces; the remainder is broken down. (auth. summary)

(An earlier abstract "Determination of uptake and loss in plants and animals of 2,4,5,4'-trichlorodiphenyl sulfone, a new acaricide as measured with the aid of S<sup>35</sup>" appeared in Inter. J. appl. Radiation and Isotopes 2 (1957) 217)

## II - D Organophosphates

### Survey Articles

- 504 Heath, D.F. SOME APPLICATIONS OF <sup>32</sup>P TO THE STUDY OF SYSTEMIC INSECTICIDES. p. 136-40 in "Comptes Rendus du 3e Congrès International de Phytopharmacie 1952", Vol. 3, No. 2 Paris. 1954.

- 505 Lüdcke, M. ÜBER DIE AUFNAHME RADIOAKTIVER KONTAKTINSEKTIZIDE BEI PFLANZEN UND TIEREN (Study on the absorption of radioactive contact insecticides by plants and animals). Nachricht. dtsh. PflSchDienst, Berl. 6, (1954) 122-4. (In German)

Relevant work reviewed from 1944 to 1954. With one exception, the radioisotope employed was P<sup>32</sup>.

- 506 Metcalf, R.L. RADIOTRACERS IN STUDY OF SYSTEMIC INSECTICIDES. Agr. Chem. 9, 3 (1954) 33-35, 128-30.

A review article of a general, introductory nature. 8 references.

- 507 Metcalf, R.L., March, R.B., Fukuto, T.R. STUDY OF SYSTEMIC INSECTICIDES. Calif. Agric. 8, 6 (1954) 5-6.

Schradan (octamethyl pyrophosphoramidate) and Demeton or Systox (O,O-diethyl O-ethyl-beta-mercaptoethyl thiophosphate) and their derivatives have shown unusual promise for the control of mites and aphids and other sucking insects on a variety of agricultural crops. These materials are freely transported in the plant and concentrate in certain rapidly growing tissues. It is necessary, therefore, to have detailed knowledge of possible undesirable residues in edible produce. Radio-phosphorus tracers were found to aid basic studies on biochemical behaviour and routine analysis of residues in treated produce. (BA 29: 20080, 1955)

- 508 Mählmann, R., Schrader, G. HYDROLYSE DER INSEKTIZIDEN PHOSPHORSÄUREESTER (Hydrolysis of insecticidal phosphoric acid esters). Z. Naturf. 12 b (1957) 196-208. (In German)

The practical applicability of phosphoric esters depends largely on their hydrolytic stability. The hydrolysis constants in the temperature range 20-70°C and for pH 1-9 were determined. The results are presented in tabulated form. P<sup>32</sup> was used throughout for labelling.

- 509 O'Brien, R.D. COMPARATIVE TOXICOLOGY OF SOME ORGANOPHOSPHORUS COMPOUNDS IN INSECTS AND MAMMALS. Canad. J. Biochem. Physiol. 37 (1959) 1113-22.

A review article. Principles of selective toxicity are discussed. Some unpublished work by Krueger is mentioned who investigated Malathion metabolism in insects employing unusual hot  $P^{32}$ -labelled compounds, and separating the metabolites by column chromatography. Results of chromatographic analysis on an ion-exchange column of metabolites in the bodies of flies 4 h after topical application of radioactive Malathion (150 mg/kg) are shown in a figure. Nine water-soluble degradation products, not the expected 2 were produced. Periplaneta americana, Blattella germanica and Musca domestica all degraded Malathion to the same extent and to the same products but the toxicity, particularly for the roaches, differed widely.

- 510 O'Brien, R.D. TOXIC PHOSPHORUS ESTHERS. New York, Academic Press, 1960.

A section (p.346-53) in chapter 10 (Techniques) is devoted to radiotracer synthesis using  $P^{32}$ . The phases in synthesis are (a) exchange, whereby the initial radioactivity is transferred to the starting material; (b) synthesis of a P intermediate such as  $(RO)_2P(S)SH$ ; (c) coupling the intermediate with the appropriate compound to yield the product; and (d) purification. Almost all currently used organophosphates can be prepared from (1)  $PCl_3$  and  $P(O)Cl_2 \rightarrow$  phosphates or phosphorothiolates; for nearly all subsequent syntheses (except of phosphoramides)  $PCl_3$  gives by far the best yield. (2)  $P(S)Cl_2 \rightarrow$  phosphorothionates. (3)  $P_2S_5 \rightarrow$  phosphorothiolates. Exchange reactions, the preparation of intermediates, activities and yield, coupling and purification are discussed. Numerous references are cited.

- \* Spencer 1958 - [748]

- 511 Spindler, M. INNERTHERAPEUTISCHE INSEKTIZIDE (Insecticides with internal therapeutic action) Z. Pflkrankh. 62 (1955) 98-165. (In German)

The review gives an outline of the development and present state of knowledge in the internal therapy of plants, and deals chiefly with products which have a systemic action. Pyrazoxon [O, O-diethyl O-5-(methylpyrazolyl)phosphate] (water-soluble 10000 ppm) showed good systemic action after trunk application to apples, root absorption in beans and seed treatment of radish. Experiments with  $P^{32}$ -labelled Pyrazoxon showed that it was distributed throughout the entire apple plant following application to roots, stem or a single branch.

- \* Wedding 1953 - [756]

#### Amiton

- 512 Baldit, G.L. AMITON - A NEW ACARICIDE AND SCALICIDE. J. Sci. Food Agric. 9, 8 (1958) 516-24.

Investigation on the behaviour of  $P^{32}$ -labelled Amiton [O, O-diethyl S-2-(diethyl-amino) ethyl phosphorothioate] and its salts in plants showed that Amiton oxalate penetrates the cuticle and is translocated readily through the plant in solutions of pH 7.5 or more but not in acid solutions, probably because dissociation of the salt does not occur in these. Acaricidal concentrations have little effect on insect predators, probably because the oxalate has no fumigant action and only low contact action. At five times the acaricidal concentration, the Amiton oxalate had no effect on Hippodamia quinquesignata ambigua Lec. and killed less than 50% of Stethorus picipes Csy., but it was slightly more harmful to Aphytus (Metaphycus) luteolus Timb. and Orius insidiosus (Say).

#### Co-Ral

- \* Claborn et al. 1960 - [758]

- 513 Kaplanis, J.N., Hopkins, D.E., Treiber, G.H. DERMAL AND ORAL TREATMENTS OF CATTLE WITH PHOSPHOROUS-32-LABELED CO-RAL. J. agric. Food Chem. 7, 7 (1959) 483-6.

Only small amounts of  $P^{32}$  were absorbed through the skin and eliminated in the urine following dermal application of the compound to cattle. High levels of the unchanged toxicant were found on the hair several weeks after treatment. The compound was ineffective as a systemic against stable flies and screwworm larvae but highly effective against these insects by contact. On oral treatments, at 10 and 20 mg per kg, approximately 38% of the dose was excreted in urine as polar degradation products and about 35% in the faeces 7 days after treatment. (auth.)

- 514 Krueger, H. R., Casida, J. E., Niedermeier, R. P. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES. METABOLISM AND RESIDUES ASSOCIATED WITH DERMAL APPLICATION OF CO-RAL TO RATS, A GOAT, AND A COW. J. agric. Food Chem. 7, 3 (1959) 182-8.
- Co-Ral was applied dermally to rats, a cow, and a goat at 30 to 45 mg per kg. The animals were sacrificed at predetermined intervals and the tissues were tested, chromatographically, for residues of the insecticide. Other factors investigated were the *in vitro* and *in vivo* opening of the pyrone ring in Co-Ral and its oxygen analogue, the ease of excretion of Co-Ral and the oxygen analogue from proteinaceous solutions, levels of Co-Ral and metabolites appearing in blood, and the effect on the blood cholinesterase activity, milk residues, and the nature of the products excreted in the urine and faeces.  $P^{32}$  was used for labelling. (auth.)
- 515 Lindquist, D. A., Burns, E. C., Pant, C. P., Dahm, P. A. FATE OF  $P^{32}$ -LABELLED BAYER 21/199 IN THE WHITE RAT. J. econ. Ent. 51, 2 (1958) 204-6.
- The fate of orally administered Bayer 21/199 [ $O$ ,  $O$ -diethyl  $O$ -3-chloro-4-methyl-7-coumarinyl phosphorothioate] which has shown systemic activity against *Hypodermia* in cattle, was studied by administration of the  $P^{32}$ -labelled compound to white rats at an average dosage of 20 mg/kg body weight. The compound was rapidly metabolized and excreted. About 78% of the radioactivity of the original dose was excreted in the urine within 24 h. Paper chromatographic analysis indicated that the radioactivity in the urine was not due to the Bayer 21/199 but was associated with more polar compounds. Smaller amounts of radioactivity were found in the feces, bile, lymph and blood. Among samples of various tissues taken 24 h after dosage, small but significant amounts of radioactivity were found in bone, liver and kidney. (from auth.)
- (See also abstract in Bull. ent. Soc. Amer. 3, 3 (1957) 26, abstr. 34)
- 516 Radeleff, R. D., Claborn, H. V. EXCRETION OF CO-RAL IN THE MILK OF DAIRY CATTLE. J. agric. Food Chem. 8, 6 (1960) 437-9.
- Co-Ral,  $O$ -(3-chloro-4-methylumbelliferone)  $O$ ,  $O$ -diethyl phosphorothioate, also known as Bayer 21/199, is an effective systemic and contact insecticide for livestock use. To determine whether it would be excreted in milk of sprayed cattle, dairy cows were sprayed with 0.5 and 0.75% concentrations. Maximum organo-soluble extractive (Co-Ral plus other organo-soluble compounds) was approximately 0.2 and 0.25 ppm, respectively, for the 0.5 and 0.75% concentrations, reached 5 h after treatment. These levels declined gradually over 7 days, being only a trace at 10 days.  $P^{32}$ -labelled Co-Ral was used.
- 517 Robbins, W. E., Hopkins, T. L., Darrow, D. L. SYNERGISTIC ACTION OF PIPERONYL BUTOXIDE WITH BAYER 21/199 AND ITS CORRESPONDING PHOSPHATE IN MICE. J. econ. Ent. 52, 4 (1959) 660-3.
- The joint oral administration of piperonyl butoxide (1:5) increased the toxicity of both Bayer 21/199 [ $O$ -(3-chloro-4-methylumbelliferone)  $O$ ,  $O$ -diethyl phosphorothioate] and its corresponding phosphate to mice four- to six-fold. This increase in toxicity was also found when synergist and toxicant were administered by different routes. Piperonyl butoxide increased the *in vivo* but not the *in vitro* inhibition of mouse brain cholinesterase by 21/199 or its phosphate. Preliminary studies with  $P^{32}$ -labelled 21/199 demonstrated that the joint administration of piperonyl butoxide inhibited its metabolism to more polar metabolites. (auth.)
- 518 Robbins, W. E., Hopkins, T. L., Darrow, D. L., Eddy, G. W. STUDIES WITH  $P^{32}$ -BAYER 21/199 SPRAYED ON CATTLE. J. econ. Ent. 52, 2 (1959) 214-7.
- The metabolism, excretion, and tissue distribution of  $P^{32}$ -labelled Bayer 21/199 have been studied following spray application of two Hereford bulls. Only low levels of radioactive compounds were found in the blood, and these behaved like polar degradation products. The compound appears to have been sparingly absorbed, about 2.4% (suspension) and 6.3% (emulsion) of the applied dose being accounted for in the urine of the two animals 2 weeks after treatment. At that time only very low levels of organo-soluble compounds which behaved like 21/199 were present in the tissues, but a considerable residue of unchanged 21/199 was present externally. (auth.)
- \* Schmidt and Weidhaas - [737]
- 519 Vickery, D. S., Arthur, B. W. ANIMAL SYSTEMIC ACTIVITY, METABOLISM AND STABILITY OF CO-RAL. J. econ. Ent. 53 (1960) 1037-43.

$P^{32}$ -labelled Co-Ral (Bayer 21/199) (O, O-diethyl O-(3-chloro-4-methylumbelliferone) phosphorothioate) was prepared. The bed bug (*Cimex lectularius* L.) and the Gulf Coast tick (*Amblyomma maculatum* Koch) were utilized to evaluate the animal systemic activity of Co-Ral and Potasan. Rabbits were treated orally, dermally, subcutaneously, or intramuscularly with Co-Ral, and orally or dermally with Potasan. The numbers of animals treated, dosages in mg/kg, numbers of insects tested, and mortality data are given. The relative toxicity of Co-Ral, oxygen analogue of Co-Ral, chloroferon, and Potasan were compared from LD<sub>50</sub> determinations made with adult 3-d old female houseflies (*Musca domestica* L.), adult bed bugs, 4th-instar larvae of the yellow-fever mosquito (*Aedes aegypti* L.) and mixed sexes of white rats. Co-Ral<sup>®</sup> was more stable in several species of insects than in mammals. Metabolites isolated from insects and mammals consisted of the oxygen analogue, O-ethyl and O,O-diethyl phosphoric acid, O,O-diethyl phosphorothioic acid, and possibly "desethyl" Co-Ral. The cumariny ring structure was not opened *in vitro* as was demonstrated by alkaline degradation. The same metabolites were recovered from insects and rats but different quantities of each metabolite were formed. The ability of rats to degrade Co-Ral to water-soluble products more rapidly and completely than insects is probably a significant factor in determining the selective toxicity of Co-Ral.

#### Delnav

- 520 Arthur, B.W., Casida, J.E. BIOLOGICAL ACTIVITY AND METABOLISM OF HERCULES AC-528 COMPONENTS IN RATS AND COCKROACHES. *J. econ. Ent.* 52, 1 (1959) 20-7.

Technical Hercules AC-528 (Delnav) was separated by partition chromatography into 8 different fractions. The major components were the *cis* and *trans* isomers of 2,3-p-dioxanedithiol S, S-bis (O, O-diethyl phosphorodithioate). The structure, toxicity to houseflies and rats, anti-cholinesterase activity and stability to alkaline hydrolysis were studied for these 8 Hercules AC-528 components. Radioactive Hercules AC-528 was prepared and the metabolism in rats and cockroaches studied for the *cis* and *trans* isomers, 2-p-dioxanedithiol S-(O, O-diethyl phosphorodithioate) and bis (diethoxyphosphinothioyl) disulfide. In a wide variety of *in vivo* and *in vitro* biological systems the *cis* and *trans* isomers were the most stable of the radioactive components; the single exception was a study on hydrolysis by human plasma where the dioxene derivative was the most stable. In a sub-acute feeding study with rats, Hercules AC-528 was found to accumulate to a small degree in fat. However, the residues disappeared rapidly when feeding of Hercules AC-528 was discontinued. Other factors in investigating Hercules AC-528 included: cholinesterase depression and recovery in rats following administration of a sub-lethal dose; the effect of sub-acute feeding on rat plasma, red blood corpuscle and brain cholinesterase activity; metabolism of the components of Hercules AC-528 by *Periplaneta americana* L. and rat liver slices; the formation of more polar, non-hydrolyzed metabolites from the radioactive components by rats and cockroaches; and the nature of the hydrolysis products formed from the components in human plasma and following oral administration to rats. (auth.)

- 521 Plapp, F.W., Jr., Bigley, W.S., Darrow, D.L. STUDIES ON THE METABOLISM AND RESIDUES OF  $P^{32}$ -LABELED DELNAV IN A HEREFORD STEER. *J. econ. Ent.* 53 (1960) 60-4.

$P^{32}$ -Delnav<sup>®</sup> (2,3-p-dioxanedithiol S, S-bis(O, O-diethyl phosphorodithioate) was applied as a spray to a Hereford steer and the residues and metabolic pathway were determined. Fatty tissues accumulated small amounts of the insecticide, but 7 d after treatment most of the dose was still on the hair. No residues were found in meat samples. The metabolic degradation of the insecticide in mice was not affected by the route of administration. Paper and alumina chromatography demonstrated the presence of phosphate and/or phosphorothiolate compounds in some of the minor fractions of technical Delnav. (auth.)

Note by the editor: Delnav<sup>®</sup> is also known as Hercules AC-528.

(An abstract of earlier work was published in *Bull. ent. Soc. Amer.* 4,3 (1958) 96, abstr. 196, under "Residues following spray application of  $P^{32}$ -labeled Hercules AC-528 (Delnav) to a Hereford steer")

#### DFP

- 522 Cohen, J.A., Warringa, M.G.P.J. METHODS TO ESTIMATE THE TURNOVER NUMBER OF PREPARATIONS OF OX RED CELL CHOLINESTERASE. *Biochim. biophys. Acta* 11 (1959) 52-8.

Jansen's method (*J. biol. Chem.* 179 (1949) 189) for calculating the initial concentration of enzyme active centres and the turnover number can only be applied to enzyme preparations of a purity which has not been achieved for most esterases known. Such preparations of esterase contain non-enzymic groups



(impurities and perhaps fractions of the esterase molecule itself) which would then also combine with  $\text{DFP}^{32}$ . The combination product thus contains more DFP than enzyme-active groups since groups other than the ones associated with enzyme activity are labelled. The paper presents two methods employed successfully to overcome these difficulties, which result in reliable figures for molar concentrations of active centres and for the turnover number in crude and partly purified preparations of ox red cell cholinesterase.

- 523 Cohen, J. A., Oosterbaan, R. A., Warringa, M. G. P. J. THE TURNOVER NUMBER OF ALI-ESTERASE, PSEUDO- AND TRUE CHOLINESTERASE AND THE COMBINATION OF THESE ENZYMES WITH DIISOPROPYLFLUOROPHOSPHONATE. *Biochim. biophys. Acta* 18 (1956) 228-35.

Bovine red cell stroma was capable of combining with  $\text{DFP}^{32}$ . The combination was found to be mainly due to the ali-esterase present in the stroma. The true cholinesterase of the stroma accounts for only a minor percentage of the  $\text{P}^{32}$  bound. The reaction products of  $\text{DFP}^{32}$  with highly purified preparations of true and pseudo-cholinesterase were prepared by incubation of the enzymes concerned with  $\text{DFP}^{32}$ . For these enzyme preparations turnover numbers could be established. The figure found for true cholinesterase confirmed the value previously reported (295 000). A turnover number of 50 000 was found for pseudo-cholinesterase. The reaction products of DFP with ali-esterase, true and pseudo-cholinesterase were hydrolyzed and subjected to chromatography on Dowex-50. In all three cases the bulk of the radioactivity proved to be associated with the inorganic phosphate and serine phosphate fractions of the chromatogram. The results suggest that the OH groups of serine might be of importance in the combination of DFP with the active centre of the esterases concerned.

- 524 Cohen, J. A., Warringa, M. G. P. J. THE LABELLING OF HUMAN SERUM BY  $^{32}\text{P}$ -DIISOPROPYLPHOSPHOROFUORIDATE ( $\text{DFP}^{32}$ ). *Biochim. biophys. Acta* 25 (1957) 600-7.

On paper electrophoresis the pseudo-cholinesterase activity of human serum is localized between the  $\alpha$ -2 and the  $\beta$ -peak. The same localization is found after electrophoresis on starch columns. Thoroughly dialyzed  $\text{DFP}^{32}$ -treated human sera as well as sera obtained from humans a few days after the injection of  $\text{DFP}^{32}$  were submitted to zone electrophoresis. No radioactivity could be detected on the paper electrophoresis strips, but after column electrophoresis it was possible to localize the radioactivity between the  $\alpha$ -2 and the  $\beta$ -peaks. The conclusion is reached that in human sera, which have been in contact with  $\text{DFP}^{32}$ , only one component, the pseudo-cholinesterase, is irreversibly labelled by  $\text{P}^{32}$ . The values obtained for the turnover of serum proteins by means of  $\text{DFP}^{32}$  therefore clearly reflect the turnover of the pseudo-cholinesterase component.

- 525 Dixon, G. H., Neurath, H. THE REACTION OF DFP (DIISOPROPYLPHOSPHOROFUORIDATE) WITH TRYPSIN. (Short communication) *Biochim. biophys. Acta* 20 (1956) 572-4.

A new technique was developed in order to facilitate the detection of unstable DIP-enzyme derivatives, whereby the phosphorylated enzyme could be rapidly separated from excess DFP and its hydrolysis product DIP. Use was made of a column of Dowex-50  $\times$  2 cation exchange resin, 200-400 mesh, in the  $\text{NH}_4^+$  form. The column was packed in a polyethylene tube and pre-treated with 0.1 M sodium citrate buffer pH 3.0; an aliquot of the reaction mixture of the enzyme with  $\text{DFP}^{32}$  is then applied to the top of the column and forced through under pressure. Upon elution with 0.1 M acetic acid, DIP and DFP were rapidly eluted, with clear separation from each other, while the labelled protein was retained at the top of the resin. It could be located by monitoring the column, and then cutting through column and resin in that region and eluting the labelled protein by suspension of the resin in 1 N NaOH. The results of the above and of dialysis experiments are given in tabulated form. No evidence was found to support the hypothesis that the phosphorylation of imidazole constitutes the initial stage of the combination of DFP with trypsin.

- 526 Goutier, R. ETUDE ÉLECTROPHORÉTIQUE DES ESTÉRASES SÉRIQUES ET DE LA FIXATION DU  $\text{DFP}^{32}$  DANS LE SÉRUM, CHEZ LE LAPIN ET LE COBAYE. *Biochim. biophys. Acta* 19 (1956) 524-34.

Rabbit and guinea-pig sera were submitted to electrophoresis on starch columns and on filter paper, in order to separate the serum esterases and cholinesterase and to determine the nature of serum proteins which are combined with  $\text{P}^{32}$  after intra-muscular injection of  $\text{DFP}^{32}$ . Three days after injection, the radioactivity is located only in one part of the esterase activity (perhaps on B-esterase) in rabbit serum. In guinea-pig serum, it is located mostly on B-esterase and partly on another protein which is very probably cholinesterase. The implications of the results are discussed. (from auth. summary)

- 527 Iyatomi, K., Saito, T., Kanehisa, K., Nishizawa, T., Naruse, H. DISTRIBUTION AND METABOLISM OF  $^{32}\text{P}$ -LABELLED DFP IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA. Boryu Kaga 22 (1957) 192.
- 528 Jansen, E.F., Jang, R., Balls, A.K. THE INHIBITION OF PURIFIED, HUMAN PLASMA CHOLINESTERASE WITH DIISOPROPYLFLUOROPHOSPHATE. J. biol. Chem. 196, 1 (1952) 247-53.
- When a preparation of purified, human plasma cholinesterase was inhibited by radioactive DFP, the phosphorus of the inhibitor was introduced into the inhibited enzyme. Hence the inhibition reaction of this enzyme by DFP was in this respect a similar reaction to the inhibition of the esterolytic proteinases. The amount of phosphorus introduced into the still impure cholinesterase was 0.0023%. (auth. summary)
- 529 Jansz, H.S., Posthumus, C.H., Cohen, J.A. ON THE ACTIVE SITE OF HORSE-LIVER ALI ESTERASE. I. REACTION OF THE ENZYME WITH DIISOPROPYLPHOSPHOROFUORIDATE. Biochim. biophys. Acta 33 (1959) 387-95.
- Horse-liver ali esterase reacts with DFP to form the enzymically inactive DP-enzyme. With isonitrosoacetone diisopropylphosphate is released from the inhibited enzyme; this is accompanied by a recovery of the enzymic activity. In order to investigate the chemical nature of the DFP-binding site of ali esterase the DP-enzyme was digested with pepsin. Essentially one DP-peptide was formed which contained per mole of DP-group the following moles of amino acid residues: alanine (1), glutamic acid or glutamine (2), glycine (3), and serine (2). DFP $^{32}$  of high specific activity (200  $\mu\text{C}/\text{mg}$  DFP) was used.
- 530 Jansz, H.S., Posthumus, C.H., Cohen, J.A. ON THE ACTIVE SITE OF HORSE-LIVER ALI ESTERASE. II. AMINO ACID SEQUENCE IN THE DFP-BINDING SITE OF THE ENZYME. Biochim. biophys. Acta 33 (1959) 396-403.
- The structure of a diisopropylphosphoryl-containing peptide obtained by digestion of DFP-inhibited horse-liver ali esterase by pepsin was established as follows: gly-glu-DP.O. ser-ala-gly-gly-(glu,ser). The DP $^{32}$ -peptide was prepared as described by the authors (ibid. 387-95).
- 531 Michel, H.O., Krop, St. THE REACTION OF CHOLINESTERASE WITH DIISOPROPYL FLUOROPHOSPHATE. J. biol. Chem. 190 (1951) 119-25.
- An investigation into the possibility of a compound being formed between the enzyme cholinesterase and diisopropyl fluorophosphate, the inhibitor, was possible by using  $\text{P}^{32}$ -labelled DFP of 2-10  $\text{mc}/\text{mM}$  activity. It was found that: electric eel cholinesterase 1) reacts with DFP to form a compound which remains undissociated in 10% trichloroacetic acid at room temperature, and 2) combines with  $2.1 \times 10^{-10}$  mole of DFP per unit of activity, unit activity being defined as the amount of cholinesterase which will hydrolyze 1 g of acetylcholine in 1 h at pH 7.4 and 38°C with 0.015 M acetylcholine and an ionic strength of 0.14.
- 532 Oosterbaan, R.A., Kunst, P., Cohen, J.A. THE NATURE OF THE REACTION BETWEEN DIISOPROPYL-FLUOROPHOSPHATE AND CHYMOTRYPSIN (Short Communication). Biochim. biophys. Acta 16 (1955) 299-300.
- The work is aimed at obtaining data on the inhibition of crystalline chymotrypsin by DFP $^{32}$ . It was assumed that this inhibition could serve as a satisfactory model for the corresponding reaction on cholinesterase. Details of the experimental procedure and results are given.
- 533 Oosterbaan, R.A., Kunst, P., Rotterdam, J. van, Cohen, J.A. THE REACTION OF CHYMOTRYPSIN AND DIISOPROPYLPHOSPHOROFUORIDATE. I. ISOLATION AND ANALYSIS OF DIISOPROPYLPHOSPHORYL-PEPTIDES. Biochim. biophys. Acta 27 (1958) 549-55.
- After reaction with DFP $^{32}$ ,  $\alpha$ -chymotrypsin was subjected to a proteolytic digestion. From the digest two related peptides containing the radioactive diisopropylphosphoryl-group were isolated. The amino acid composition of one peptide was established as aspartic acid or asparagine (1), serine (1), glycine (3), and proline (1). In addition to these amino acids, the second peptide contained a leucine residue.
- 534 Oosterbaan, R.A., Rotterdam, J. van. - SYNTHESIS OF  $\text{P}^{32}$  LABELED DIISOPROPYLPHOSPHOROFUORIDATE. J. Amer. chem. Soc. 78 (1956) 5641-3.

A method is described for the preparation of  $P^{32}$ -labelled diisopropylphosphorofluoridate in water or oil solution starting from radioactive phosphoric acid. The specific radioactivity amount to 200 mc/mg. (auth.)

- 535 Saunders, B. C., Worthy, T. S. ESTERS CONTAINING PHOSPHORUS. X. RADIOACTIVE DIISOPROPYL FLUOROPHOSPHONATE (D.F.P.). *J. chem. Soc.* (1950) 1320-2.

The preparation of  $P^{32}$ -labelled DFP is described. Details are given of the preparation of radioactive FPO ( $OCHMe_2$ )<sub>2</sub> (I) on a 1-g scale; a modified apparatus is described which is suitable for the small-scale operation and which takes into account the volatility of the radioactive intermediates and final product. The  $P^{32}$  used had an activity of 28000 cpm/mg and the resulting I an activity of 2200 cpm/mg. The yield of I, prepared according to CA 42: 6740 h, is 62%. (cf. CA 45 (1951) 111f)

- 536 Schaffer, N. K., May, S. C., Jr., Summerson, W. H. SERINE PHOSPHORIC ACID FROM DIISOPROPYL-PHOSPHORYL CHYMOTRYPSIN. *J. biol. Chem.* 202 (1953) 67-75.

The nature of the combination between chymotrypsin and DFP was investigated with  $P^{32}$ -labelled DFP. The reaction product of diisopropyl fluorophosphate (DFP) and chymotrypsin, diisopropylphosphoryl chymotrypsin, was partially hydrolyzed by pepsin, trypsin, and 2 N HCl or directly with 2 N HCl. L-Serine phosphoric acid was obtained in 30% yield from the hydrolysate by fractionation with Dowex 50 chromatography. The product has a nitrogen to phosphorus ratio of 0.9 to 1.1, contained 1 mole of serine per atom of phosphorus, and could not be distinguished from authentic serine phosphoric acid by paper chromatography, Dowex 50 chromatography, or fractional precipitation. (from auth. summary)

- 537 Schaffer, N. K., May, S. C., Jr., Summerson, W. H. SERINE PHOSPHORIC ACID FROM DIISOPROPYL-PHOSPHORYL DERIVATIVE OF EEL CHOLINESTERASE. *J. biol. Chem.* 206 (1954) 201-7.

The reaction product of diisopropyl fluorophosphate and eel cholinesterase, diisopropylphosphoryl cholinesterase, labelled with  $P^{32}$ , was partially hydrolyzed by pepsin, trypsin, and 2 N HCl or directly with 2 N HCl. Serine phosphoric acid was separated from the hydrolysate in approximately a 40% yield (based on phosphorus) by fractionation with Dowex 50 chromatography. Identity was established by comparison with synthetic serine phosphoric acid by fractional alcohol precipitation and Dowex 50 chromatography. (auth. summary)

- 538 Schaffer, N. K., Harshman, S., Engle, R. R. PHOSPHOSERYLGLYCINE FROM DIISOPROPYLPHOSPHORYL CHYMOTRYPSIN AND INVERSION OF ITS PEPTIDE SEQUENCE BY ACID. *J. biol. Chem.* 214 (1955) 799-806.

$P^{32}$ -labelled diisopropylphosphoryl chymotrypsin was partially hydrolyzed with 2 N HCl at 100°C for 2.5 h. Serine phosphoric acid, phosphoseryl glycine, and glycylserine phosphoric acid were separated from the hydrolysate by Dowex 50 chromatography. Phosphoseryl glycine, hydrolyzed under the same conditions, was partly converted to glycylserine phosphoric acid. Evidence is cited that only phosphoseryl glycine represents the normal dipeptide sequence in diisopropylphosphoryl chymotrypsin. (auth. summary)

- 539 Schaffer, N. K., Simet, L., Harshman, S., Engle, R. R., Drisko, R. W. PHOSPHOPEPTIDES FROM ACID-HYDROLYZED  $P^{32}$ -LABELED DIISOPROPYLPHOSPHORYL CHYMOTRYPSIN. *J. biol. Chem.* 225 (1957) 197-205.

$P^{32}$ -labelled diisopropylphosphoryl chymotrypsin was partially hydrolyzed with 12 N HCl at 37°C for 3 d. Dowex 50 chromatography of the hydrolysate resulted in the separation of (1) phosphoserine, (2) aspartylphosphoserine, (3) phosphoseryl glycine, (4) aspartylphosphoseryl glycine, and (5) glycylaspartylphosphoseryl glycine. Two other fractions have the same amino acid composition and sequence as peptides (2) and (4), and are believed to be isopropyl derivatives. Asparagine is not a constituent of these peptides. (auth. summary)

- 540 Schaffer, N. K., Lang, R. P., Simet, L., Drisko, R. W. PHOSPHOPEPTIDES FROM ACID-HYDROLYZED  $P^{32}$ -LABELED ISOPROPYL METHYLPHOSPHONOFUORIDATE-INACTIVATED TRYPSIN. *J. biol. Chem.* 230 (1958) 185-91.

$P^{32}$ -labelled Sarin (isopropyl methylphosphonofluoridate) was used. Sarin is an esterase inhibitor similar to those of DFP (diisopropyl phosphorofluoridate). The isopropyl methylphosphonofluoridate derivative of

trypsin, isopropyl methylphosphonyl trypsin, was partially hydrolyzed with 12 N HCl at 37°C for 3 d. Dowex 50 chromatography of the hydrolysate resulted in the separation of (1) methylphosphonylserine, (2) aspartylmethylphosphonylserine, (3) methylphosphonylserylglycine, and (4) aspartylmethylphosphonylserylglycine. Another peptide with the same amino acid composition and sequence as peptide (4) was separated and is believed to be its isopropyl derivative. Asparagine is not a constituent of these peptides.

\* Winteringham and Harrison 1956 - [782]

\* Winteringham et al. 1957 - [787]

#### Diazinon and Related Compounds

- 541 Krueger, H. R., O'Brien, R. D., Dauterman, W. C. RELATIONSHIP BETWEEN METABOLISM AND DIFFERENTIAL TOXICITY IN INSECTS AND MICE OF DIAZINON, DIMETHOATE, PARATHION, AND ACETHION. J. econ. Ent. 53 (1960) 25-31.

The persistence and metabolism of Diazinon<sup>®</sup>, (O, O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate) Dimethoate, Parathion, and Acethion (O, O-diethyl S-carboethoxymethyl phosphorodithioate) have been studied in the mouse, American cockroach (*Periplaneta americana* (L.)), and housefly (*Musca domestica* L.). The results have been used to explain the selective toxicity of three of these compounds toward insects as compared with mammals. For Diazinon, selectivity is attributed to high levels of oxygen analogue in the susceptible species. For Dimethoate and Acethion, selectivity is attributed to a persistence of unaltered parent compound in the whole body. Small differences were found in Diazinon absorption and metabolism by normal and Diazinon-resistant house flies.

References are quoted for the methods adopted for the preparation of radioactive Dimethoate, Acethion, Diazinon and Parathion.

- 542 Louloudes, S. L., Kaplanis, J. N., Roan, C. C. THE SYNTHESIS OF RADIOACTIVE DIAZINON USING P<sup>32</sup>. J. org. Chem. 21 (1956) 685-6.

Diazinon may be labelled with C<sup>14</sup>, S<sup>35</sup>, or P<sup>32</sup>. Since the last offers an easy synthetic route and is more readily measured radiometrically, elemental red phosphorus was selected as a starting material, after irradiating it to a specific activity of approximately 50 mc/g. The method of synthesizing phosphorus trichloride is described. The two step chlorination and the use of the powdered antimony were utilized to increase the specific activity and yield of phosphorus trichloride. Paper chromatography analyses of the labelled products were made. Experimental details of the methods employed for the synthesis of phosphorus trichloride, triphosphoryl trichloride, O,O-diethyl chlorothiophosphate and Diazinon are given.

\* Mengle and Casida 1960 - [736]

- 543 Robbins, W. E., Hopkins, T. L., Eddy, G. W. METABOLISM AND EXCRETION OF PHOSPHORUS-32-LABELED DIAZINON IN A COW. J. agric. Food Chem. 5, 7 (1957) 509-13.

P<sup>32</sup>-labelled Diazinon, administered orally to a cow at 20 mg/kg, is rapidly metabolized and excreted. Only low levels of unchanged toxicant were found in blood and milk samples. About 74% of the dose, excreted as polar degradation products, was accounted for in the urine 36 h after treatment. (auth.)

- 544 Vigne, J. P., Tabau, R. L., Fondarai, J. CHROMATOGRAPHIE ET DÉTECTION DU DIÉTHYL PHOSPHATE D'ISOPROPYL 2 MÉTHYL 4 OXY 6 PYRIMIDINE ET DU DIÉTHYLTHIONOPHOSPHATE D'ISOPROPYL 2 MÉTHYL 4 OXY 6 PYRIMIDINE. Bull. Soc. chim. France 22 (1955) 1282.

The two compounds were separated by inverse partition chromatography, impregnating the paper with a silicone grease and with H<sub>2</sub>O-EtOH-NH<sub>4</sub>OH as the mobile phase. The spots were located by spraying with I<sub>2</sub> or with iodide-Bi reagent (containing Bi subnitrate, CCl<sub>3</sub>CO<sub>2</sub>H, KI, and H<sub>2</sub>O) or, with radioactive products, by autoradiography. (CA 50: 1530d, 1956)

- 545 Vigne, J. P., Tabau, R. L., Fondarai, J. INSECTICIDES ORGANO-PHOSPHORÉS. I. SYNTHÈSE RADIOACTIVE DU DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL 4-MÉTHYL 6-OXY PYRIMIDINE. Bull. Soc. Pharm. Marseille 5 (1955) 331-8.

Diazinon was labelled with P<sup>32</sup>. A C<sub>6</sub>H<sub>6</sub> solution of the enolic form of 2-isopropyl-4-methyl-6-hydroxypyrimidine and P<sup>32</sup>SCl<sub>3</sub> form the corresponding dichlorothiophosphate ester which, with excess NaOEt, gives

active Diazinon purified by washing with  $K_2CO_3$  solution and azeotropic distribution. Details of the microapparatus employed are given. The product is identified by paper chromatography. The analogous active diethyl phosphate was prepared similarly from  $P^{32}OCl_3$ . Active Diazinon was also prepared from the K enolate of the same 6-hydroxypyrimidine and  $P^{32}SCl(OEt)_2$ , but was contaminated with ethyl bis (2-isopropyl-4-methyl-6-pyrimidinyl) thiophosphate arising from  $P^{32}SCl(OEt)$  present in the  $P^{32}SCl(OEt)_2$ . (CA 50: 17293g, 1956)

- 546 Vigne, J. P., Tabau, R. L. ORGANOPHOSPHOROUS INSECTICIDES. IV. SYNTHESIS OF COMPLEX THIONOPHOSPHORIC RADIOACTIVE ESTERS. APPLICATION TO THE SYNTHESIS OF DIETHYL THIONOPHOSPHATE OF 2-ISOPROPYL-4-METHYL-6-HYDROXYPYRIMIDINE. Bull. Soc. Pharm. Marseille 5 (1956) 321-3.

$P^{32}$  is introduced into  $PSCl_3$  by exchange at  $150^\circ C$  after 24 h by using  $H_3P^{32}O_4$ . The reaction is carried out in a Carius tube. The tube is then cooled in  $CO_2$  snow-acetone mixture. The  $PSCl_3$  is distilled into a solution of 2-isopropyl-4-methyl-6-hydroxypyrimidine in benzene with a special apparatus. The diethyl thionophosphate ester is prepared as previously described (CA 49: 14739e). (CA 51: 13303e, 1957)

- 547 Vigne, J. P., Tabau, R. L., Fondarai, J. SYNTHÈSE DE CERTAINS ESTERS COMPLEXES PHOSPHORIQUES ET THIONOPHOSPHORIQUES MARQUÉS AVEC  $^{32}P$ -APPLICATION À LA SYNTHÈSE DU DIÉTHYLPHOSPHATE DE 2-ISOPROPYL-4 MÉTHYL-6 OXYPYRIMIDINE ET DU DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL-4 MÉTHYL-6 OXYPYRIMIDINE. Bull. Soc. chim. France 23 (1956) 459-60.

Les auteurs décrivent une méthode de préparation d'esters complexes des acides phosphoriques et thionophosphoriques et son application à la préparation du diéthylphosphate de 2-isopropyl-4 méthyl-6 oxyypyrimidine et du diéthylthionophosphate de 2-isopropyl-4 méthyl-6 oxyypyrimidine marqués avec  $^{32}P$ .

(A comprehensive abstract may be found in CA 50: 14769d, 1956)

(Voir 548)

- \* Vigne et al. 1957 - [742]

- 548 Vigne, J. P., Tabau, R. L. PRÉPARATION DE COMPOSÉS HALOGÉNÉS DU PHOSPHORE MARQUÉ AU  $P^{32}$ , PAR UNE RÉACTION D'ÉCHANGE (Note de Laboratoire). Bull. Soc. chim. France 25 (1958) 1194-5.

Dans un précédent mémoire (1) nous avons décrit une méthode de synthèse du  $^{32}P$ , diéthylthionophosphate de isopropyl-2 méthyl-4 hydroxy-6 pyrimidine, dans laquelle nous introduisons le phosphore marqué sous forme de  $^{32}PSCl_3$  préparé à partir du phosphate d'argent radioactif. Cette technique faisant intervenir un certain nombre de réactions délicates à réaliser sur de très petites quantités de composés volatils et radioactifs, nous avons cherché à tourner la difficulté en étudiant une réaction d'échange. Notre nouvelle méthode permet de préparer rapidement et avec un rendement intéressant, de petites quantités de composés halogénés radioactifs du phosphore en réduisant au minimum les manipulations et les dangers de contaminations.

(1) Voir 547

- 549 Vigne, J. P., Tabau, R. L., Chouteau, J., Fondarai, J. SYNTHÈSE RADIOACTIVE, DÉTECTION ET CHROMATOGRAPHIE D'UN INSECTICIDE ORGANO PHOSPHORÉ: LE DIÉTHYLTHIONOPHOSPHATE DE 2-ISOPROPYL 4-MÉTHYL 6-OXY PYRIMIDINE: APPLICATION À SON ÉVALUATION DANS LE LAIT. p. 45-61 in "Proceedings of the International Conference on Radioisotopes in Scientific Research, Paris, Sep. 1957", Vol. 3. Exterman, R. C., ed. London, Pergamon Press, 1958.

Les auteurs, désirant en doser des traces dans des substances alimentaires provenant d'animaux nourris avec des végétaux traités par cet insecticide, ont réalisé: 1. Une nouvelle méthode de synthèse de cette série chimique, avec du  $^{32}P$ . 2. Une nouvelle technique de chromatographie de partition (chromatographie en phase mi-inversée), ainsi qu'une série de méthodes sensibles de détection colorimétrique de ce composé. 3. L'isolement d'une quantité notable de l'insecticide chimiquement pur, ce qui a permis l'étude de son activité anticholinérasique qui s'est révélée importante. 4. L'application de ces deux techniques au dosage dans le lait d'animaux ayant reçu des doses considérables de cet insecticide. Très vite métabolisé, le DTP n'est pratiquement pas retrouvé dans le sang, le lait et les fèces, et n'est présent qu'en quantités minimes dans l'urine de l'animal en expérience (chèvre).

### Dimethoate

- 550 Apple, J. W., Dauterman, W. C., Casida, J. E. DIMETHOATE FOR PEA APHID CONTROL AND CHEMICAL FATE ON THE PEA PLANT. Bull. ent. Soc. Amer. **5**, 3 (1959) 113, abstr. 32.
- Dimethoate was superior to standard and other candidate insecticides against the pea aphid. Residues were determined for whole plants treated with 0.25 pound per acre. Studies with radioactive Dimethoate on and in pea plants showed seven compounds, including Dimethoate, its oxygen analogue, and five hydrolysis products with phosphoric acid predominating.
- 551 Dauterman, W. C., Viado, G. B., Casida, J. E., O'Brien, R. D. PERSISTENCE OF DIMETHOATE AND METABOLITES FOLLOWING FOLIAR APPLICATION TO PLANTS. J. agric. Food Chem. **8**, 2 (1960) 115-9.
- Dimethoate (O, O-dimethyl S-(N-methylcarbamoylmethyl) phosphorodithioate) is known to be effective as a systemic insecticide following foliar application. Analyses were made of surface and absorbed residues following foliar treatment of corn, cotton, pea, and potato plants with Dimethoate. The insecticide was rapidly absorbed and decomposed both on the surface and inside the foliage by phosphorothionate oxidation and hydrolysis. Only trace amounts of Dimethoate and its oxygen analogue were present 32 d after treatment. Of the five identified hydrolysis products, the predominant one from near mature peas was phosphoric acid and from the other plants used as seedlings was O, O-dimethyl S-carboxymethyl phosphorothioate on the surface and O-methyl O-hydrogen S-(N-methylcarbamoylmethyl) phosphorodithioate within the leaf tissue. Limited studies were also made on the persistence of the N-ethyl analogue of Dimethoate. (auth.)
- (An abstract of earlier work was published in Bull. ent. Soc. Amer. **4**, 3 (1958) 84, abstr. 23, under "The metabolism and residues of the systemic insecticide Dimethoate in plants")
- 552 Dauterman, W. C., Casida, J. E., Knaak, J. B., Kowalczyk, T. BOVINE METABOLISM OF ORGANO-PHOSPHORUS INSECTICIDES. METABOLISM AND RESIDUES ASSOCIATED WITH ORAL ADMINISTRATION OF DIMETHOATE TO RATS AND THREE LACTATING COWS. J. agric. Food Chem. **7**, 3 (1959) 188-93.
- Dimethoate is active as a systemic insecticide for cattle. Three lactating cows were treated orally with the  $P^{32}$ -labelled compound and analysis of blood, tissues, excreta, and milk showed Dimethoate to be rapidly metabolized and excreted. Twelve days after treatment, the insecticide was found in trace amounts only in the cow tissues. Hydrolysis of Dimethoate by rats and cows occurred initially at the methyl-phosphate, phosphate-sulfur, sulfur-carbon, and particularly at the carbonyl-nitrogen bonds. Phosphorothioate oxidation occurred with certain of the hydrolysis products and was assumed to occur also with Dimethoate. (auth.)
- 553 Kaplanis, J. N., Robbins, W. E., Darrow, D. I., Hopkins, D. E., Monroe, R. E., Treiber, G. H. THE METABOLISM OF DIMETHOATE IN CATTLE. J. econ. Ent. **52**, 6 (1959) 1190-4.
- The metabolism of  $P^{32}$ -Dimethoate was studied following oral and intramuscular administration (10 mg/kg) to cattle. By both routes high radioactivity was detected in the blood shortly after administration. The radioactivity representing both total and organosoluble compounds, was observed earlier and dissipated faster in the intramuscular treatment. Chromatographic analyses of blood extracts indicated the presence of both Dimethoate and unknown(s), with the latter several times more toxic than the parent compound as determined by enzymic analyses and bioassay. About 87 to 90% of the oral dose was eliminated in the urine at the end of 24 h. The same percentage of intramuscular dose was excreted after 9 h. The major metabolic products were dimethyl phosphate, dimethyl phosphorothioate, and several unknowns. Only 3.7 to 5% of the oral dose and about 1.1% of the intramuscular dose were eliminated in the faeces. Analyses of tissues from an orally treated calf showed only very low levels (0.02 to 0.07  $\mu\text{g/g}$ ) of organoextractable radioactive compounds present in the brain, liver, testes, and lungs. (auth.)

### Dipterex

- 554 Acree, F., Jr., Babers, F. H., Mitlin, N. PREPARATION OF  $P^{32}$ -LABELED BAYER L13/59 AND DDVP, AND THEIR ABSORPTION AND TRANSLOCATION IN THE AMERICAN COCKROACH. J. econ. Ent. **49**, 6 (1956) 808-11
- Details are given of the preparation of  $P^{32}$ -labelled Bayer L13/59 (dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate) from radioactive red phosphorus, and of labelled DDVP (dimethyl 2,2-dichlorovinyl phosphate) by dehydrochlorination of L13/59, and also of studies of their absorption by and translocation in last-instar nymphs of *Periplaneta americana* (L.). The compounds were applied in solution in ethanol to the dorsal cervical membranes, and both were readily absorbed through it. In the case of L13/59, the haemolymph and all tissues became radioactive. After 20 h, most of the internal radioactivity was in the gut, though some remained in all tissues examined, and much activity remained external. The haemolymph of

the cockroaches treated with DDVP did not become demonstrably radioactive, and many tissues became only slightly so. After 2 h, much of the radioactivity was concentrated in the heart. After 22 h, most of it was in the fat-body and only a small amount in the gut. The failure to detect radioactivity in the haemolymph was probably attributable to the low specific activity of DDVP, the small amounts applied in view of its high toxicity, and deposition in the tissues. No radioactivity could be removed from outside two hours after treatment. (RAE-B 46: 22-3, 1958)

- 555 Arthur, B. W., Casida, J. E. METABOLISM AND SELECTIVITY OF O, O-DIMETHYL 2,2,2-TRICHLORO-1-HYDROXYETHYL PHOSPHONATE AND ITS ACETYL AND VINYL DERIVATIVES. J. agric. Food. Chem. 5, 3 (1957) 186-92.

The insecticide, called Bayer L13/59, and its derivatives were investigated with  $P^{32}$  as to metabolism and selective toxicity. The  $LD_{50}$  values in rats, flies, cockroaches, cabbage worms and pea aphids varied widely between compounds and species; the acetyl form was generally least and the vinyl most toxic. Antiesterase activity appeared to be caused by dimethyl phosphorylation of enzymatically active sites. Mammalian toxicity was relatively low. Relations of the latter two observations to chemical structure and mechanisms are discussed. Data are given on detoxification, hydrolysis rates, volatility, and tissue distribution in insects and plants. (BA 31: 26099, 1957)

- 556 Arthur, B. W., Casida, J. E. BIOLOGICAL ACTIVITY OF SEVERAL O, O-DIALKYL ALPHA ACYLOXY-ETHYL PHOSPHONATES. J. agric. Food Chem. 6, 5 (1958) 360-5.

The synthesis and characterization of radioactive ( $P^{32}$ -) Dipterex and butonate are described. Several O, O-dialkyl 2,2,2-trichloro-1-acyloxyethyl phosphonates and related derivatives were compared as to toxicity and anticholinesterase activity. O, O-dimethyl 2,2,2-trichloro-1-n-butyryloxyethyl phosphonate was the most selectively toxic to houseflies of all the phosphonates studied. In vivo and in vitro metabolism studies with insects and rats showed that this phosphonate was hydrolyzed at the acyl group, the phosphorus-carbon bond, and possibly the phosphorus-oxygen-methyl bond. The initial site of in vivo hydrolysis appeared to be a major factor in the selective toxicity of this compound.

- 557 Metcalf, R. L., Fukuto, T. R., March, R. B. TOXIC ACTION OF DIPTEREX AND DDVP TO THE HOUSE FLY. J. econ. Ent. 52, 1 (1959) 44-9.

Dipterex or O, O-dimethyl 1-hydroxy-2,2,2-trichloroethyl phosphonate under mildly alkaline conditions is rapidly degraded to DDVP. The half-life values for this reaction are: pH 8.0 - 63 min, pH 7-336 min, and pH 6.0 - 89 h. The rate of reaction is very slow at pH 5.4. The in vitro inhibition of housefly head cholinesterase by  $10^{-7}$  M Dipterex showed marked pH dependency and ranged from 11% at pH 5.4 to 100% at pH 8.0, thus clearly demonstrating that DDVP formation is necessary for in vitro cholinesterase inhibition. In vivo studies of the mode of action of Dipterex showed that the rate of knock-down of houseflies feeding on Dipterex-treated moist sugar bait was much more rapid at pH 7.0 than pH 5.4. This, together with the 4- to 7-fold greater toxicity of DDVP over Dipterex and the isolation of about 5% of  $P^{32}$  DDVP from the total  $P^{32}$  metabolites in Dipterex-poisoned houseflies, strongly indicates that DDVP is responsible for the in vivo toxic action of Dipterex.

#### Di-Syston

- 558 Carter, W., Gottner, W. A. THE TRANSLLOCATION OF RADIOACTIVE ( $S^{35}$ ) BAYER 19639 IN PINEAPPLE PLANTS. J. econ. Ent. 51, 6 (1958) 905-7.

Radioautographs revealed that the radioactive sulfur in  $S^{35}$ -tagged Bayer 19639 (Di-Syston) is translocated from the soil through the entire pineapple plant. Absorption is greatest in the roots and decreases to barely discernible quantity in the green half-developed fruit. Bioassays revealed that only in the region of greatest absorption, the roots, was the concentration of Bayer 19639 high enough to be toxic to mealybugs. (auth.)

- 559 Metcalf, R. L., Reynolds, H. T., Winton, M., Fukuto, T. R. EFFECTS OF TEMPERATURE AND PLANT SPECIES UPON THE RATES OF METABOLISM OF SYSTEMICALLY APPLIED DI-SYSTON. J. econ. Ent. 52, 3 (1959) 435-9.

The rates of oxidative metabolism and of hydrolytic decomposition of Di-Syston, or O,O-diethyl S-ethyl-2-thioethyl phosphorodithioate (formerly called Bayer 19639) were measured at various temperatures and in several plant species using a  $P^{32}$ -radiotracer. The rates of oxidation of the Di-Syston metabolites in isolated

cotton leaves were accelerated by increased temperatures between 37° and 100°F, and from the Arrhenius energy of activation 10200 cal per mole it was determined that the rate of oxidation of Di-Syston sulfoxide increased about 1.9 times for each 10°C rise in temperature. Metabolism of Di-Syston sulfoxide and hydrolytic decomposition of the toxic products occurred from 2 to 3 times as fast in tomato leaves at 70°F as in cotton leaves. The rates in a number of other plants studied appeared to be intermediate between those in tomato and cotton. (auth.)

(See earlier report by Metcalf, Winton and Reynolds "Comparative rates of metabolism of Di-Syston at various temperatures and in various species of plants" in Bull. ent. Soc. Amer. 3, 3 (1957) 23, abstr. 4)

- 560 Reynolds, H. T., Metcalf, R. L., Winton, M. EFFICIENCY OF PLANT UPTAKE OF DI-SYSTON FOLLOWING VARIOUS METHODS OF TREATMENT. Bull. ent. Soc. Amer. 3, 3 (1957) 23, abstr. 4.

Using  $P^{32}$ -Di-Syston, O, O-diethyl S-ethyl-2-mercaptoethylphosphorodithioate the efficiency of plant uptake was measured after soil treatment with various methods of side dressings. The theoretical and practical applications of this work will be discussed.

#### Guthion (Gusathion)

- 561 Tietz, H., Fukuto, T. R., Metcalf, R. L. UNTERSUCHUNG MIT  $P^{32}$ -MARKIERTEN VERBINDUNGEN ÜBER DAS VERHALTEN DES INSEKTIZIDS GUSATHION BEI BAUMWOLLPFLANZEN UND DAS DAMIT VERBUNDENE RÜCKSTANDSPROBLEM BEI BAUMWOLLSAMEN (Studies, by means of  $P^{32}$ -labelled compounds, of the behaviour of the insecticide Gusathion in cotton plants and of the subsequent residue problem in cotton seeds). Verhandl. d. IV. Intern. Pflanzenschutz-Kongresses, Hamburg 1957, 2 Braunschweig 1960) 1645-8. (In German)

After spraying the plants at intervals of 4 days, and by means of paper chromatography and autoradiography, unchanged Gusathion was found on the leaves plus two lipophilic metabolites and two other fractions. Seed analysis and plant data indicate that Gusathion is unable to diffuse through the capsule into the seed, nor can it penetrate from the leaf into the sap.

- 562 Tietz, H., Metcalf, R. L., Fukuto, T. R. DAS VERHALTEN DES INSEKTIZIDS "GUSATHION" AUF BAUMWOLLPFLANZEN UND DAS RÜCKSTANDSPROBLEM IN BAUMWOLLSAMEN (Action of the insecticide "Gusathion" on cotton plants, and the problem of residues in cotton seed). HöfchenBr. Wiss. 10 (1957) 273-84. English edition 10, 5 (1957) 279-89.

"Gusathion" has proved effective against such cotton pests as Anthonomus grandis, Aphis gossypii, Tetranychus bimaculatus, Alabama argillacea and Thrips spp. In the present studies it was labelled with  $P^{32}$ , and details of concentration and frequency of spraying are given. Leaves were analyzed at different intervals by means of microchemical methods and paper chromatography. Apart from radioactive hydrolysis products,  $P^{32}$  was recovered from the assimilation products of the plant as radioactive phospholipids. Seeds which were still immature at the time of spraying contained much more  $P^{32}$  than mature ones, and much greater quantities of  $P^{32}$ -labelled phosphatide could also be precipitated from their oil. No seed contained any traces of radioactivity in their oil after phosphatide precipitation. No residues were found in the press cakes. "Gusathion" did not have any systemic effect.

#### Malathion

- 563 Darrow, D. L., Plapp, F. W. STUDIES ON RESISTANCE TO MALATHION IN THE MOSQUITO, CULEX TARSALIS. J. econ. Ent. 53 (1960) 777-81.

An investigation was made on the extent of cross-resistance to other insecticides in a Malathion-resistant strain, and on the rate and nature of the detoxification of Malathion by larvae of a resistant and of a susceptible strain of Culex tarsalis.  $P^{32}$ -labelled samples of Malathion and Acethion were used. A colony of Culex tarsalis Coq., 80 times resistant to Malathion, was found to be resistant to Malaoxon (S-[1,2-bis(ethoxycarbonyl)ethyl] O,O-dimethyl phosphorothioate), and the diethyl homologue of Malathion (S-[1,2-bis(ethoxycarbonyl)ethyl] O,O-diethyl phosphorodithioate), although to a lesser degree. Slight resistance to Co-Ral® (O-(3-chloro-4-methylumbelliferone) O,O-diethyl phosphorothioate) was also observed, but no resistance was found to any other of a series of 14 organophosphorus insecticides. Two- to three-fold resistance to DDT and Dieldrin was also found. Larvae of the resistant and a susceptible colony degraded Malathion at about the same rate and in the same manner, largely through the formation of carboxylic acid derivatives.



- 564 Knaak, J. B., O'Brien, R. D. EFFECT OF EPN ON IN VIVO METABOLISM BY THE RAT AND DOG. J. agric. Food Chem. 8, 3 (1960) 198-203.
- The mechanism by which pre-treatment with EPN (O-ethyl O-p-nitrophenyl phenyl-phosphonothionate) increases the subsequent toxicity of Malathion was investigated. P<sup>32</sup>-labelled Malathion was used. In both the rat and dog EPN resulted in a marked shift in the initial detoxification site of the Malathion molecule from the carboxyester to the thiophosphate bond. The percentage of the administered Malathion excreted as metabolites in urine was increased by EPN in the dog but unchanged in the rat. Malathion levels in rat tissues were increased by EPN, whereas Malaoxon levels in rat blood were reduced. Potentiation appears to result from an increased persistence rather than an increased concentration of Malaoxon in the tissues.
- 565 Krueger, H. R., O'Brien, R. D. METABOLISM OF MALATHION BY SEVERAL SPECIES OF INSECTS. Bull. ent. Soc. Amer. 4, 3 (1959) 84, abstr. 22.
- P<sup>32</sup>-labelled Malathion of very high specific activity was topically applied to several species of insects, and the water soluble metabolites extracted and identified by means of ion-exchange chromatography. Considerable variation in metabolism was noted with as many as 9 or more water-soluble degradation products found.
- 566 Krueger, H. R., O'Brien, R. D. RELATIONSHIP BETWEEN METABOLISM AND DIFFERENTIAL TOXICITY OF MALATHION IN INSECTS AND MICE. J. econ. Ent. 52 (1959) 1063-7.
- An attempt has been made to account for the selective toxicity of Malathion on the basis of differences in its metabolism by various species. Eleven metabolites were found in the German cockroach (Blattella germanica (L.)), and American cockroach (Periplaneta americana (L.)), and housefly (Musca domestica L.), seven in the mouse. Most metabolites were identified. Degradation of Malathion is much more extensive in the mouse than in the insect and Malaoxon production is correspondingly lower; these effects account satisfactorily for the low toxicity of Malathion to the mouse. The low toxicity of topically applied Malathion to the German cockroach is attributable to poor penetration through the integument. Technical steps in the preparation of P<sup>32</sup>-labelled Malathion are discussed.
- 567 March, R. B., Fukuto, T. R., Metcalf, R. L., Maxon, M. G. FATE OF P<sup>32</sup>-LABELED MALATHION IN THE LAYING HEN, WHITE MOUSE, AND AMERICAN COCKROACH. J. econ. Ent. 49, 2 (1956) 185-95.
- The fate of P<sup>32</sup>-labelled Malathion has been extensively studied in the laying hen and, for comparative purposes, in the white mouse and in Periplaneta americana L. The experiments also included preparation of expected metabolites of Malathion and tests of their toxicity to various arthropods and their activity in inhibiting cholinesterase of the housefly (Musca domestica L.). The metabolism of Malathion in the cockroach is apparently less extensive and complex than it is in warm-blooded animals. The less effective metabolism in the insect may explain why Malathion is much more toxic to insects than to warm-blooded animals, in which most of the rapidly formed metabolites are apparently of a low order of toxicity. (from auth. summary)
- 568 Mengle, D. C., Casida, J. E., O'Brien, R. D. METABOLISM OF P<sup>32</sup>-LABELED MALATHION, DIAZINON AND METHYL PARATHION IN NORMAL AND PHOSPHATE-RESISTANT STRAINS OF THE HOUSE FLY. Bull. ent. Soc. Amer. 5, 3 (1959) 117, abstr. 73.
- The rate of penetration, hydrolysis and phosphorothionate oxidation was studied in vivo for the insecticides in one normal and three resistant strains. An attempt was made to correlate the degree of resistance with the rate of insecticide metabolism and the extent of in vivo cholinesterase depression.
- 569 Seume, F. W., O'Brien, R. D. METABOLISM OF MALATHION BY RAT TISSUE PREPARATIONS AND ITS MODIFICATION BY EPN. J. agric. Food Chem. 8, 1 (1960) 36-41.
- Homogenates of 11 rat tissues metabolized Malathion at comparable rates, and to similar metabolites. The main hydrolysis occurred at the carboxyester linkage. The hydrolysis at this linkage, the over-all hydrolysis, and the formation of Malaoxon by various tissues in vitro were all inhibited by EPN in vivo. The synergism of EPN and Malathion in vivo is therefore probably not attributable to an increased level of Malaoxon in the body, but to a greater persistence of Malathion and Malaoxon in the tissues. The techniques used are described in some detail, also the synthesis of the P<sup>32</sup>-labelled Malathion used.

- 570 Tomizawa, C., Sato, T. FATE OF ORGANOPHOSPHORUS INSECTICIDES SPRAYED ON RICE PLANT. Boryu Kagaku 25, 3 (1960) 99-105.

A study on the translocation of radioactive Malathion and methyl Parathion.

#### Parathion

- 571 Ahmed, M. K., Casida, J. E., Nichols, R. E. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES: SIGNIFICANCE OF RUMEN FLUID WITH PARTICULAR REFERENCE TO PARATHION. J. agric. Food Chem. 6, 10 (1958) 740-6.

In laboratory tests, rumen fluid from a cow hydrolyzed 16 organophosphorus insecticides to varying degrees. Malathion and TEPP (tetraethyl pyrophosphate) were the most susceptible. Oxidation reactions were of much less importance than reduction reactions in metabolizing the compounds, and phosphorothioates were hydrolyzed much more rapidly than phosphates. The rate of reduction of radioactive Parathion in the rumen fluid of a cow that ingested it was similar to that *in vitro*. Parathion, Paraoxon, and their amino derivatives (O,O-diethyl O-p-aminophenyl phosphorothioate and phosphate) were found circulating in the blood of the animal and were secreted in small amounts in the milk. Amino-Parathion constituted a major excretory metabolite of Parathion, together with diethyl phosphoric and phosphorothioic acids. The toxicological significance of these findings is discussed in relation to the toxicity of the various derivatives. The two amino compounds are much less toxic to houseflies (*Musca domestica* L.) and rats than Parathion and Paraoxon. (from auth. summary)

- 572 Gar, K. A., Mandelbaum, Ya. A., Melnikov, N. N., Chernetsova, V. I., Shevtsova-Shilovskaya, K. D. THE USE OF LABELED ATOMS FOR THE STUDY OF STABILITY OF DUSTS OF ORGANOPHOSPHORUS INSECTICIDES. Dokl. Akad. Nauk. SSSR 94 (1954) 729-32.

$P^{32}$ -labelled Parathion (I) and bis (p-nitrophenyl) ethyl thiophosphate (II) and similarly  $S^{35}$ -labelled specimens were used for stability studies on 1% dusts. In covered dishes in the dark at 16-45° the loss of P is more rapid from I than from II (curves shown); at 45° in 100 h the I specimen lost over 50% of its P content, while II lost that much only in 650 h. At lower temperatures the durability is much higher. Thus the disappearance of insecticidal action 1-2 d after field spraying is not mere evaporation. Similar tests under sunlight (temperature below 37°) show a rapid loss of P with some 50% being lost after 1.5 h exposure of I, the rest being lost in 100 h. In diffuse sunlight some 50% loss of I occurred in 20 h; this is comparable to loss of activity from 30% emulsions of I. The loss of II is much slower in sunlight than that of I; in 70 h a 40% loss occurs. The process appears to be a complex photochemical reaction. Conclusion: fruit surface residues of I after 4 d of weather exposure should not exceed 0.25 mg per kg (apples) (CA 48: 9008d, 1954)

- 573 Gar, K. A., Mandelbaum, Ya. A., Melnikov, N. N., Shvetsova-Shilovskaya, K. D., Chernetsova, V. I. AN APPLICATION OF THE METHOD OF LABELED ATOMS IN THE STUDY OF THE RESISTANCE OF EURYGASTER INTEGRICEPS PUT TO TWO ORGANOPHOSPHORUS INSECTICIDES, AND AN EXPERIMENTAL STUDY OF THEIR PENETRATION INTO PLANTS. Dokl. Akad. Nauk. SSSR 94 (1954) 1189-92.

$P^{32}$ -labelled specimens of (EtO)<sub>2</sub>PS (OC<sub>6</sub>H<sub>4</sub>NO<sub>2</sub>-p) and Et-OPS (OC<sub>6</sub>H<sub>4</sub>NO<sub>2</sub>-p)<sub>2</sub> were used in 1% dusts which were applied to male and female specimens of the insects. Females were generally more resistant to both insecticides than the males. A direct relation was found between the amount of P which penetrated the insect body and the degree of poisoning, within each experimental group. Death occurs with lower level of the di-Et derivative than mono-Et derivative, but this is caused not by a mere difference of diffusion, since in dead specimens the difference in permeability disappears between females and males. Chrysanthemum plants were allowed to absorb through the roots aqueous emulsions of the di-Et derivative (0.05 to 0.2%) and the penetration to the leaves was studied radiometrically. A spraying with even 0.2% emulsion failed to give complete control of Aulacorthum pelargonii although the amount of the insecticide which penetrated the plant mass reached 0.003% of the green mass at room temperature. This corresponds to 20-30 mg/kg. At lower temperature, when this value reached 60 mg/kg a considerable degree of control was attained and the insects contained up to 22 mg/kg of the di-Et derivative. The penetration into chrysanthemum was substantially like that found in beans. However, on cabbage cultures no control was achieved by this method against Brevicoryne brassicae, although withering of leaves was observed at 0.05% concentration of the emulsion, or higher. In cabbage and chrysanthemum expts. considerable hydrolysis of the insecticide took place and after 30 d only the hydrolysis products remained; this process is accelerated by sunlight. Dusting with 1% dust on shaded kidney beans showed 42% hydrolysis after 16 d; in sunlight

almost all was hydrolyzed in 4 d. On wheat the process takes but 2 d. Thus Parathion is not truly a systemic insecticide, owing to its poor penetration and stability in the plant. (CA 48: 9008g, 1954)

- 574 Gar, K. A., Kiplani, R. Y. RESEARCH BY MEANS OF RADIOACTIVE ISOTOPES CONCERNING PENETRATION AND RESIDUES OF PHOSPHO-ORGANIC INSECTICIDES IN PLANTS. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/701. 12 (1956) 185-99.
- The authors summarize Russian research with several radioactive organic phosphorus insecticides including:  $P^{32}$ - and  $S^{35}$ -labelled Parathion, methyl Parathion or  $O,O$ -dimethyl  $O$ - $p$ -nitrophenyl thiophosphate, NIUF-101 or  $O$ -ethyl  $O$ - $O$ -di-( $p$ -nitrophenyl)-thiophosphonate,  $P^{32}$ -labelled Malathion, and Carbophos or  $O,O$ -diethyl- $S$ -(1,2-dicarbethoxymethyl) dithiophosphate. The photochemical stability of formulations of NIUF-101 and Carbophos was greater than that of Parathion and Malathion. Formulations of Parathion and Malathion were about equal in their stability to heat, and NIUF-101 and Carbophos were approximately the same; the latter two were slightly more stable than the former. The plant systemic properties of Parathion and methyl Parathion were slight; hydrolysis of both compounds proceeds rapidly inside plants. Paper chromatographic studies of alkaline hydrolysates and extracts from plants treated with methyl Parathion revealed similar decomposition products; there was no evidence of oxidation and upgrading of toxicity of the insecticide by plants. It was recommended that several of these insecticides could be used on plants shortly before harvesting.
- 575 Hein, R. E., McFarland, R. H. THE SYNTHESIS OF DOUBLY LABELED PARATHION. J. Amer. chem. Soc. 74 (1952) 1856-7.
- The insecticide was labelled with both  $P^{32}$  and  $S^{35}$ . Phosphorus trichloride was used as starting material. Synthesis progressed via  $O,O$ -diethyl-chlorothiophosphate. The various steps in the experimental procedure are described.
- 576 Jäger, A. VERSUCHE MIT RADIOAKTIVEM  $^{32}P$ - $O$ ,  $O$ -DIÄTHYL- $O$ ,  $p$ -NITROPHENYL-MONOTHIO-  
PHOSPHAT AM GOLDHAMSTER (*MESOCRICETUS AURATUS* WATERH.) (Experiments on the golden hamster (*Mesocricetus auratus* Waterh.) with radioactive  $P^{32}$  labelled  $O,O$ -diethyl- $O$ ,  $p$ -nitrophenyl-monothiophosphate) Naturwissenschaften 40 (1953) 534-5. (In German)
- The absorption and distribution of  $P^{32}$ -labelled Parathion or its breakdown products were studied in active and hibernating hamsters. Artificial "hibernation" was obtained by injecting insulin and maintaining the animals at lowered temperatures. The lethal dose in active animals was 7-8 mg/kg of body weight. Cumulative dosage effects were observed. The symptoms and characteristics of Parathion action in active and hibernating animals are described.
- 577 Jensen, J. A., Durham, W. F., Pearce, G. W. STUDIES ON FATE OF PARATHION IN RABBITS, USING RADIOACTIVE ISOTOPE TECHNIQUES. Arch. industr. Hyg. 6 (1952) 326-31.
- A study on the fate of Parathion in rabbits treated dermally and intravenously with radioactive  $S^{35}$ -labelled Parathion has been made. Evidence was obtained that there is very little accumulation of Parathion or a sulfur-bearing portion of the molecule in the blood, organs, or tissues. The compound or sulfur-containing degradation products are rapidly excreted in the urine. The excreted moiety appears to be the inorganic residue of Parathion and is absorbed by anion exchange resins, from which it can be regenerated and precipitated by ammonium molybdate. (auth. summary)
- 578 Jensen, J. A., Pearce, G. W. SYNTHESIS OF RADIOACTIVE PARATHION USING  $S^{35}$ . J. Amer. chem. Soc. 74 (1952) 3184.
- A very brief description of the steps in the preparation of  $S^{35}$ -labelled Parathion is given. The specific activity obtained was 220  $\mu$ C/mM.
- 579 Kiplani, R. Y., Gegenava, G. V. A STUDY OF THE PENETRATION OF THE INSECTICIDE THIOPHOS INTO THE PLANT AND THE EFFECT OF EXTERNAL FACTORS ON ITS STABILITY BY THE METHOD OF MARKED ATOMS. Sobshch. Akad. Nauk. Gruz. SSR 16 (1955) 557-64. (In Russian)
- 580 Lichtenstein, E. P. MOVEMENT OF INSECTICIDES IN SOILS UNDER LEACHING AND NON-LEACHING CONDITIONS. J. econ. Ent. 51, 3 (1958) 380-3.

In 1954 a Miami silt loam and a muck soil were treated with Aldrin, Lindane and DDT. Seventeen months later, testing of the soil showed no noticeable difference in the distribution between individual insecticides, in a vertical sense; Lindane was found to be unequally distributed in a horizontal direction. Distribution was again tested three years after treatment. Experiments, conducted under laboratory conditions, showed that Lindane was leached to some extent from a treated soil into an untreated one. The leaching was most noticeable in Plainfield sand and least noticeable in muck soil. Under non-leaching conditions, Lindane also moved into the untreated layer, but more was retained in a muck soil than in a Plainfield sand. When radioactive Parathion ( $P^{32}$ ) was used, it was found that during a period of 6 d Parathion moved upwards, downwards and sideways as well. The results obtained seem to indicate that the movement of Parathion is more rapid in a Plainfield sand than in a muck soil, as the latter retains the insecticide to a greater extent. Preliminary experiments with Aldrin under non-leaching conditions indicate movement of this insecticide to a considerable extent. (from auth. abstr.)

(Earlier work was reported as abstract in Bull. ent. Soc. Amer. 3,3 (1957) 42, abstr. 36).

- 581 Lockau, S., Lüdicke, M., Weygand, E. DARSTELLUNG VON RADIOAKTIVEM DIÄTHYL-*p*-NITROPHENYL-MONOTHIOPHOSPHAT UND BEISPIELE SEINER BIOLOGISCHEN ANWENDUNG (Preparation of radioactive diethyl-*p*-nitrophenyl-mono thiophosphate, with examples of its biological applications) Naturwissenschaften 38, 15 (1951) 350. (In German)

Parathion was labelled with  $P^{32}$  and used for determining its uptake by insects, and its ability to penetrate into plants. Cuticular applications were made with a water emulsion of the compound, and amounts of Parathion sufficient to produce mortality were determined with the American roach, Periplaneta americana (L.) and Drosophila melanogaster. The penetration of a water emulsion of the radioactive compound into apples was also studied.

- 582 Lockau, S., Lüdicke, M. DIE DARSTELLUNG VON RADIOAKTIVEM  $^{32}P$ -O, O-DIÄTHYL-O, *p*-NITROPHENYL-MONOTHIOPHOSPHAT, SEINE AUFNAHME UND WEITERLEITUNG IM INSEKTENKÖRPER (The synthesis of  $^{32}P$ -O, O-diethyl-O, *p*-nitrophenyl mono thiophosphate, its uptake and distribution in the insect body) Z. Naturf. 7b, 7 (1952) 389-97.

The compound is synthesized from red radioactive phosphorus via  $P^{32}$ -labelled phosphorus pentachloride,  $P^{32}$ -labelled phosphorus sulfochloride and  $P^{32}$ -dichloro-O, *p*-nitrophenyl-thiophosphoric acid. After application to the pronotum, this radioactive phosphoric acid ester penetrates into the body of Periplaneta americana L. and leads to the symptoms typical for Parathion poisoning. The compound or its  $P^{32}$ -containing metabolites are distributed differently in the various organs. The head is highly radioactive, probably due to the lipid-soluble components of the cerebral ganglion. The high radioactivity of the intestine may in part be explained by its excretory function. The total average radiation for the whole insect corresponds to 3,57  $\gamma$  of the compound. The lethal dose is below this value, since part of the poison, on penetration and distribution through the organism may be resorbed in the fore-gut intestine, where it may be suffering breakdown or have been broken down previously.

- 583 Lüdicke, M. ÜBER DAS VERHALTEN VON RADIOAKTIVEM O, O-DIÄTHYL-O, *p*-NITROPHENYL-MONOTHIOPHOSPHAT AUF DER PFLANZE (The behaviour of radioactive O, O-diethyl-O, *p*-nitrophenyl-mono thiophosphate applied to a plant) Z. PflKrankh. 59, 11/12 (1952) 451-9. (In German; Engl. summary.)

$P^{32}$ -labelled Parathion was applied locally to leaves of Ligustrum ovatifolium Hassk and Polystichum falcatum (L.) Diels, to twigs of various ages of Prunus cerasus, wild plums, peaches, and to stored apples. Parathion was used in a concentration of 0,05% in distilled water. Its absorption and conductivity or that of its decomposition products in these plant tissues was studied by a G-M counter and autoradiography. The diffusion capacity in terms of  $P^{32}$ -labelled compounds was studied.

- 584 Lüdicke, M. 16. ÜBER DIE AUFNAHME VON E 605 UND PARATHION BEI PFLANZE UND TIER (On the uptake of E 605 and Parathion by plants and animals) p.139-56 in "Insektizide Heutzutage". Eichler, W. D., ed. Berlin, Volk und Gesundheit. 1954, 579p. (In German)

The author reviews his own and other work done in the field. The first part covers treatment of plants by E 605 (essentially dimethyl-*p*-nitrophenyl-mono thiophosphate, with the addition of a little Parathion, i.e. O, O-diethyl-O, *p*-nitrophenyl-mono thiophosphate) and by Parathion, in order to test their distribution within the plant, and the terms of a possible "internal therapy" against pests from outside, as observed for some phosphoric acid esters. The second part is concerned with the uptake of E 605 and of Parathion by animals. References are numerous but incomplete, i.e. the authors and year are quoted but not the source.

- 585 Mandelbaum, Ya. A., Vladimirova, I. L., Melnikov, N. N. SYNTHESIS OF DIETHYL *p*-NITROPHENYL THIOPHOSPHATE AND ETHYL BIS(*p*-NITROPHENYL) THIOPHOSPHATE, LABELLED WITH RADIOACTIVE PHOSPHORUS AND SULFUR. Dokl. Akad. Nauk. SSSR 100 (1955) 77-9.

Details are given of a study in which Parathion and *O*-ethyl *O*,*O*-di-(*p*-nitrophenyl)-thiophosphonate (NIUF-101) were labelled with  $P^{32}$  and  $S^{35}$ . (Technical details may be found in abstract CA 50: 1650f, 1956).

- 586 Murray, D. H., Spinks, J. W. T. SYNTHESIS OF  $P^{32}$ -LABELED PARATHION. Canad. J. Chem. 30 (1952) 497.

Labelled Parathion (I) was prepared for investigations of insect toxicology. The method used was a modification of a previously reported preparation (CA 43, 1313). Quantitative yields of  $P^{32}OCl_3$  were obtained from  $H_2P^{32}O_4$  and  $PCl_5$ . The oxychloride gave 65%  $P^{32}Cl_3$  when reduced over carbon granules at 1000°; this was converted to 53%  $P^{32}SCl_2$  when heated in a sealed tube with sulphur.  $P^{32}SCl_2$  with NaOEt gave 65%  $(ETO)_2PSCl_2$  which with aqueous  $p-O_2NC_6H_4ONa$  yielded 16% I (on  $PCl_5$  (?)). (CA 47: 2725b, 1953)

- 587 Sato, T., Tomizawa, C. CERTAIN PROPERTIES OF METHYL PARATHION EXAMINED BY TRACER TECHNIQUE (RADIOACTIVE). Botyu Kagaku 25, 3 (1960) 85-90.

- 588 Tomizawa, C., Sato, T., Fukami, J., Mitsuhashi, J. BEHAVIOR OF METHYL PARATHION IN CERTAIN INSECTS. Botyu Kagaku 25, 3 (1960) 91-9

The fate of the labelled insecticide was studied in the rice stem borer Chilo suppressalis (Lepidoptera), Periplaneta americana, and the weevil Callosobruchus chinensis.

#### Phorate (Thimet)

- 589 Bowman, J. S., Casida, J. E. METABOLISM OF THE SYSTEMIC INSECTICIDE *O*, *O*-DIETHYL *S*-ETHYL-THIOMETHYL PHOSPHORODITHIOATE (THIMET) IN PLANTS. J. agric. Food Chem. 5, 3 (1957) 192-7.

Thimet is metabolized by plants to form very potent anticholinesterase agents. When used as a systemic insecticide for seed treatment of cotton, the metabolites within the plant consist of *O*,*O*-diethyl *S*-ethyl-sulfinyl-methyl phosphorodithioate, *O*,*O*-diethyl *S*-ethylsulfinylmethyl phosphorothiolate, and *O*,*O*-diethyl *S*-ethylsulfonylmethyl phosphorothiolate. The last of these metabolites is the most active cholinesterase inhibitor and provides a method of residue analysis. Such analysis is based on chloroform extraction of  $P^{32}$ -labelled compounds and is made on various soluble, insoluble, hydrolyzed and oxidized fractions. Cotton seeds treated with Thimet on charcoal at concentrations as high as 32 pounds of Thimet per 100 pounds of seed showed less than 0.03 ppm of Thimet or metabolites in the seeds maturing from the treated plants. The residual persistence following soil and foliage application was studied with 6 vegetable crops and radioactive Thimet. (from auth.)

- 590 Bowman, J. S., Casida, J. E. FURTHER STUDIES ON THE METABOLISM OF THIMET BY PLANTS, INSECTS, AND MAMMALS. J. econ. Ent. 51, 6 (1958) 338-43.

The oxidative and hydrolytic metabolism of Thimet by plants, insects and mammals were further studied with chromatographic and radiotracer techniques. Bean plants, southern armyworm (Prodenia eridania (Cram.)), albino rats, and a cow were utilized. The proportions of Thimet, oxidized derivatives, and hydrolysis products were determined with bean plants which had absorbed Thimet through their roots, with armyworms which had fed on these plants, and with the faeces of the armyworms. Armyworms were more efficient than bean plants *in vivo* in oxidation of the phosphorothioate group of Thimet and in hydrolysis of the oxidation products. With the mammals, the excretory products and tissue residues were investigated. Extreme difficulty was encountered in extraction of the radioactivity from the tissue of the treated rats and cow. (The Thimet had been synthesized with  $P^{32}$ ). The relative insect and mammalian toxicity and stability to hydrolysis by alkali are reported for Thimet and its oxidation products. (from auth.)

- 591 Bowman, J. S. METABOLISM OF CERTAIN THIOPHOSPHATE SYSTEMIC INSECTICIDES BY PLANTS, INSECTS, AND MAMMALS. Ph.D. Thesis, Wisconsin Univ., Madison. 1958.

$P^{32}$ -labelled organothiophosphate insecticides were used throughout. The work was published in three articles:

Bowman, J. S., Casida, J. E. METABOLISM OF THE SYSTEMIC INSECTICIDE O,O-DIETHYL S-ETHYLTHIOMETHYL PHOSPHORODITHIOATE (THIMET) IN PLANTS. Agric. Food Chem. 5, 3 (1957) 192-7.

Ibid. SYSTEMIC INSECTICIDES FOR THEOBROMA CACAO L., THEIR TRANSLOCATION AND PERSISTENCE IN FOLIAGE AND RESIDUES IN CACAO BEANS. J. econ. Ent. 51, 6 (1958) 773-80.

Ibid. FURTHER STUDIES ON THE METABOLISM ON THIMET BY PLANTS, INSECTS, AND MAMMALS. J. econ. Ent. 51, 6 (1958) 838-43.

- 592 Getzling, L. W., Chapman, R. K. THE FATE OF PHORATE IN SOILS. J. econ. Ent. 53 (1960) 47-51.

Studies were conducted to determine the hydrolysis, oxidation, insecticidal efficiency, persistence, and the degree of binding of Phorate, formerly designated as Thimet (O,O-diethyl S-(ethylthio) methyl phosphorodithioate) in three soils and quartz sand. Phorate applied as a soil treatment in the field was more available to cabbage and potatoes grown in a sandy soil than in a clay-loam soil as indicated by insect-control data and anticholinesterase assay. A measurement of  $P^{32}$ -labelled phosphate uptake by peas from three soils and quartz sand showed that the largest amounts of toxicant were taken from quartz sand and followed by lesser amounts from a sandy soil, clay loam, and muck, in that order. Extraction, column chromatographic and partitioning techniques showed that soil applications of Phorate are partially oxidized, hydrolyzed, and bound to the soil. Chloroform extractions of radioactivity from the soils at 7, 14, and 28 days after treatment were identified as Phorate plus a mixture of the phosphorodithioate sulfoxide and the phosphorodithioate sulfone of Phorate. Only a very small amount of the radioactivity extracted from the soils could be identified as hydrolysis products. A large portion of the radioactivity remained bound to the soil and could not be identified. Radioactive Phorate added to quartz sand was rapidly hydrolyzed, but no oxidation products were detected. A study of Phorate volatilization from the soils showed that within an hour after treatment the sandy soil, silt loam, and muck had lost respectively, 25%, 20%, and 18% of the radioactivity applied. However, after this initial loss, very little or no volatilization occurred. Phorate was lost rapidly from quartz sand and a steel surface with less than 10% of the radioactivity remaining 24 h after treatment. (auth.)

- 593 Hacksaylo, J., Lindquist, D. A., Davich, T. B. ABSORPTION OF PHORATE FROM SOLUTION "CULTURE" AND ITS EFFECT ON PHOSPHORUS UPTAKE BY COTTON PLANTS. Bull. ent. Soc. Amer. 5, 3 (1959) 119, abstr. 81.

Absorption of  $P^{32}$ -labelled Phorate from nutrient solution by cotton plants was linear through 72 h and proportional to the applied level. Subsequent uptake was inversely correlated with plant content. The absorption of inorganic phosphate was reduced by Phorate additions to the solution.

(This work was continued and published in J. econ. Ent. 54, 2 (1961) 379-82, and 54, 3, 411-3, as "LABORATORY AND FIELD INVESTIGATIONS WITH PHORATE-TREATED COTTON SEEDS" and "PHORATE ACCUMULATION BY COTTON PLANTS AND RECOVERY FROM SOIL")

- 594 Lindquist, D. A., Hacksaylo, J., Davich, T. B. ABSORPTION OF PHORATE BY COTTON SEEDS. Bull. ent. Soc. Amer. 5, 3 (1959) 119, abstr. 84.

The uptake of  $P^{32}$ -labelled Phorate by cotton seeds, following seed treatment, was studied in the laboratory, greenhouse and field. Data are presented on the effect of removing cotton seed hulls prior to treatment and the effect of temperature on Phorate uptake by cotton seeds.

- 595 Reynolds, H. T., Fukuto, T. R., Metcalf, R. L., March, R. B. SEED TREATMENT OF FIELD CROPS WITH SYSTEMIC INSECTICIDES. J. econ. Ent. 50, 5 (1957) 527-39.

Tests have shown that systemic insecticides applied to the seeds of cotton, lucerne and sugar-beet at the time of sowing protected the seedling from attack by a wide range of insects. Studies with radioactive Bayer 19639, Thimet and Demeton-S showed that, after seed treatment, the cotyledons contained the highest concentrations of toxicant and that this was not translocated in substantial amounts to other plant parts. The toxicant therefore existed in the plants in a considerable concentration gradient, ranging from the highest value in the oldest leaves to the lowest in the youngest. Effective toxic concentrations of the different insecticides are discussed, as applied to the various plants and their infesting insects.

# Phosdrin

- 596 Gatterdam, P.E., Knaak, J.B., Niedemeter, R.P., Casida, J.E. METABOLISM AND RESIDUES OF PHOSDRIN INSECTICIDE FED TO DAIRY CATTLE. Bull. ent. Soc. Amer. 3, 3(1957) 23, abstr. 10.  
  
Studies with 12 lactating cows were conducted to determine the toxicity and residues in the meat and milk resulting from 90 d feeding of 0, 1, 5, and 20 ppm of Phosdrin in the diet. Further metabolism studies were made with radioactive Phosdrin at 2 mg/kg in a single dose and at 1 mg/kg daily for 7 d.
- 597 Getzin, L.W., Chapman, R.K., EFFECT OF SOILS UPON THE UPTAKE OF SYSTEMIC INSECTICIDES BY PLANTS. J. econ. Ent. 52 (1959) 1180-5.  
  
The effectiveness of insecticide applications to soil often depends upon soil conditions. Experiments were therefore conducted to determine 1) the effect of various soil types upon systemic insecticide absorption by plants from the soil, and 2) the characteristics of soil which bind the insecticides against the leaching action of water. The absorption of some systemic insecticides by peas from four soils and two sands was measured by aphid bioassay and anticholinesterase analysis. The pea aphid (*Macrosiphum pisi* (Harris)) was used in conjunction with Thimet® (O,O-diethyl S-(ethylthio) methyl phosphorodithioate), Schradan, Isolan® (dimethyl 5-(1-isopropyl-3-methyl-pyrazolyl) carbamate), and Phosdrin® (1-methoxycarbonyl-1-propen-2-yl dimethyl phosphate, 80% technical). The binding of an insecticide in soil was studied by leaching radioactive Phosdrin through columns of 12 soils. The amount of Phosdrin bound by the various soils correlated in a positive manner with the base exchange capacity, organic matter content and nitrogen content, but it was concluded that the organic matter content was primarily responsible for insecticide binding. Other chemical and physical properties of the soil did not correlate with the binding of Phosdrin.
- 598 Spencer, E.Y., Robinson, J.R. METABOLISM OF THE SYSTEMIC INSECTICIDE O, O-DIMETHYL 1-CARBOMETHOXY-1-PROPEN-2-YL PHOSPHATE (PHOSDRIN) IN THE PEA PLANT. J. agric. Food Chem. 8, 4(1960) 293-5.  
  
P<sup>32</sup>-labelled Phosdrin and P<sup>32</sup>-labelled cis-Phosdrin acid were used in this study. It was undertaken to define the degradation mechanism of Phosdrin isomers in plants, because alkaline hydrolysis yields different degradation products with the two isomers. The two isomers were found to degrade in the same manner but at different rates in pea plants. By administering one metabolite, Phosdrin acid, to plants it was possible to recover a monodealkylated derivative. The enzymatic degradation of Phosdrin in pea plants differs from the alkaline hydrolysis in that at least two pathways are involved, the major one being via dimethyl phosphate directly. (auth.)
- Ronnel
- 599 Hopkins, T.L. FUNCTIONS OF THE MADEIRA ROACH ALIMENTARY TRACT IN THE ABSORPTION, METABOLISM, AND EXCRETION OF O, O-DIMETHYL O-(2,4,5-TRICHLOROPHENYL) PHOSPHOROTHIOATE (RONNEL). Diss. Abstr. 21, 3 (1960) 707-8.  
  
The role of the alimentary tract of the roach *Leucophaea maderae* (F.) in the in vivo processes of absorption, transport, metabolism and excretion of Ronnel was investigated together with the effect of the compound on the rate of the phosphorus-containing metabolites eliminated. The insecticide was labelled with P<sup>32</sup>.
- 600 Louloudes, S.J. THE SYNTHESIS OF P<sup>32</sup>-LABELLED TROLENE, ITS ABSORPTION, DISTRIBUTION, AND EXCRETION BY THE COCKROACH, *LEUCOPHEA MADERAE* (F.), AND WHITE MOUSE, *MUS MUSCULUS*. Diss. Abstr. 18, 5 (1958) 1601-2.  
  
The synthesis, purification, identification (by chromatographic analyses and the infra red) and the fate of P<sup>32</sup>-labelled insecticide in the organism are described. Oral and topical applications are considered.
- 601 Plapp, F.W., Casida, J.E. BOVINE METABOLISM OF ORGANOPHOSPHORUS INSECTICIDES. METABOLIC FATE OF O, O-DIMETHYL O-(2,4,5-TRICHLOROPHENYL) PHOSPHOROTHIOATE IN RATS AND A COW. J. agric. Food Chem. 6, 9 (1958) 662-7.  
  
O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate is susceptible to hydrolysis at either the methyl-phosphate or phenyl-phosphate bond. Both sites of hydrolysis have been demonstrated with alkali and bovine rumen juice and in rats, houseflies, and a cow. The oxygen analogue of this insecticide undergoes similar hydrolytic cleavage. The excretory metabolites of O,O-dimethyl O-(2,4,5-trichlorophenyl)

phosphorothioate and three derivatives were established for rats. A slower detoxification and excretion of the insecticide metabolites occurred with the cow compared to rats, but the same metabolic pathway was demonstrated for each.  $P^{32}$  was used for labelling.

- 602 Robbins, W.E., Hopkins, T.L., Eddy, G.W. THE FATE OF  $P^{32}$ -LABELED DOW ET-57 IN THE BOVINE BODY. Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 23.

The metabolism and excretion of  $P^{32}$ -labelled Dow ET-57 (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) in a Guernsey bull calf has been studied following its oral administration at the rate of 100 mg/kg. Analysis of the blood sampled at intervals and the quantitatively collected urine and faeces by radiometric assay, partition coefficients, and paper chromatography demonstrated the efficient absorption, degradation, and excretion of the compound. Approximately 50% of the total dose was accounted for in the urine at 30 h and about 90% in the urine and faeces at the end of 10 d. Unchanged Dow ET-57 was present in the extracts of blood and faeces while only metabolic products were found in the urine.

- 603 United States Department of Agriculture. CATTLE-GRUB CONTROL WITH SYSTEMIC INSECTICIDES. ARS 22-37, Agricultural Research Service. 1957, 8p.

A number of compounds were tested against the "warble flies", *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) in cattle as systemic insecticides, prior to 1945. Experiments with Dow ET-57 in 1955 showed it to cause a high mortality in the larvae of both species when they are encysted in the backs. There was no indication that ET-57, administered orally at 100 mg/kg affected the health of the cattle or meat production. It was slightly toxic at 150 mg, but recovery was rapid. The meat of treated animals was eaten without ill effect. Two calves dosed with  $P^{32}$ -labelled ET-57 were found to contain 50 to 70 parts per million in the fat when slaughtered after 3 and 14 d, respectively. Limited tests with Bayer 21/199 [O, O-diethyl O-3-chlor-4-methyl-7-coumarinyl phosphorothioate] showed that this compound also destroys *Hypoderma* larvae before they can damage the hide of the hosts and that, unlike ET-57, it does so when applied as a spray. It is concluded that both show promise for the control of *Hypoderma* but neither can be recommended until more complete toxicological information is available.

#### Schradan

- 604 Arthur, B.W., Casida, J.E. BIOLOGICAL AND CHEMICAL OXIDATION OF TETRAMETHYL PHOSPHORDIAMIDIC FLUORIDE (DIMEFOX). J. econ. Ent. 51, 1 (1958) 49-56.

Comparative radiotracer experiments were carried out on the chemical oxidation and metabolic metabolism of Dimefox [bis(dimethylamino)fluorophosphine oxide], Schradan and hexamethylphosphoramide (containing  $P^{32}$ ) in insects, mammals and plants. Their distribution and absorption is discussed. Within insects, plants and mammals investigated, each of the three compounds was metabolized to oxidized derivatives that decomposed on treatment with acid to yield formaldehyde. With all three compounds, one oxidative derivative was more and another less polar than the original phosphoramidate. Except for the greater instability of Dimefox and its derivatives, the metabolic intermediates appeared to be similar to those of Schradan and hexamethylphosphoramide.

- 605 Batt, R.F., Bennett, S.H., Thomas, W.D.E. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING  $^{32}P$ -LABELLED MATERIAL. I. EXPERIMENTAL TECHNIQUES. Ann. appl. Biol. 41 (1954) 475-83.

Methods for the preparation of radioactive Schradan in solution, and the general experimental technique and procedure adopted throughout are described. This includes the methods for propagation of plant material for experimental use, and the application of the radioactive insecticide to leaves either by dipping or spraying. An account is given of the conditions under which the plants were kept, the procedure adopted at sampling involving leaching of the treated leaves, subdivision of the plant and preparation of samples for determination of "Schradan" and "Schradan equivalent" by liquid counting. The methods of compiling results to determine the distribution and status of the applied Schradan in or on the leaves at harvest, are outlined.

- [Cf. II. "Evaporation and absorption," by Bennett and Thomas, 1954, and  
III. "Translocation and breakdown," by Thomas and Bennett, 1954]



- 606 Bennett, S.H., Thomas, W.D.E. EXPERIMENTS ON THE ABSORPTION AND FATE OF A SYSTEMIC INSECTICIDE BIS(BISDIMETHYLAMINO PHOSPHONOUS) ANHYDRIDE  $[(CH_3)_2N]_2P(O)-O-P(O)[(CH_3)_2N]_2$  IN PLANTS. p. 981-6 in "Transactions of the 9th International Congress on Entomology, Amsterdam 17-24 Aug. 1951", Vol. 1. The Hague, Excelsior Photooffset. 1952.
- Aqueous solutions of  $P^{32}$ -labelled compound were applied at concentrations between 0.6% and 0.025%, usually, between 1 and 2 ml were given to each plant by spraying or dipping. The activity was always below 2.5  $\mu$ Ci/ml. Differences in absorption are observed between plant species, upper and lower leaf surfaces, and the effects of some physical factors on the process are noted. The main translocation is upwards from treated leaves. Decomposition of the insecticide is more rapid in broad and runnerbeans and in apples, than in chrysanthemums and Coleus.
- 607 Bennett, S.H., Thomas, W.D.E. EXPERIMENTS ON THE ABSORPTION AND FATE OF SYSTEMIC INSECTICIDE BIS(BISDIMETHYLAMINO PHOSPHONOUS) ANHYDRIDE IN PLANTS. p. 439-44 (disc. p. 444-5) in "Radioisotope Techniques, Proceedings of the Isotope Techniques Conference, Oxford, July 1951", Vol. 1. London, Her Majesty's Stationary Office, 1953.
- The absorption, translocation and breakdown of Schradan in plants was studied by means of  $P^{32}$ -labelled Schradan. Maximum absorption by the leaves occurred if the leaves were treated when their carbohydrate content was low, but it was more important that the application should be followed by a period of active photosynthesis. The lower leaf surface in chrysanthemum was more absorptive than the upper surface. Translocation of Schradan from sprayed leaves was slow, and only a small amount was absorbed. Translocation was generally found to occur towards the younger leaves and to be closely associated with active physiological processes. Breakdown varied considerably between the plant species tested.
- 608 Bennett, S.H., Thomas, W.D.E. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING  $^{32}P$ -LABELLED MATERIAL. II. EVAPORATION AND ABSORPTION. Ann. appl. Biol. 41, 3 (1954) 484-500.
- When  $P^{32}$ -labelled Schradan was sprayed on the leaves of apple stocks and seedlings, broad and runner beans, Coleus and chrysanthemums, some was absorbed, some evaporated and the rest remained for a considerable time on the leaf surface as a residue removable by aqueous leaching. Some breakdown of Schradan may occur within the cuticular layer. Comparisons of the absorption rates of upper and lower surfaces of leaves support the theory that absorption proceeds through the cuticle in preference to vapour phase entry through the stomata. Temperature and illumination were found to have important effects on absorption. Losses due to evaporation were lower than expected. Young leaves have been shown to be generally more absorptive than the older leaves. Comparisons have also been made of the absorption by different species to be interpreted cautiously. Absorption was found to take place rapidly through detached leaves, in which stomata are closed, and it was also absorbed by the upper and lower surfaces of Coleus leaves at equivalent rates, although the upper surface of this leaf has no stomata. Schradan was decomposed much more rapidly in the bean than in chrysanthemum and Coleus.
- [cf. I. "Experimental techniques," by Batt et al. and III. "Translocation and breakdown," by Thomas and Bennett].
- 609 David, W.A.L. INSECTICIDAL ACTION OF RADIOACTIVE BIS(BISDIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE. Nature 166 (1950) 72-4.
- The toxicity of bis(bisdimethylamino) phosphonous anhydride- $P^{32}$  (I) was detected against Aphis fabae on broad beans, Myzus persicae on cabbage, and Acyrtosiphum onobrychidis on peas with solution equivalent to 10 mc/l. Assays of radioactivity were made in a liquid-type counter after treating plant material with boiling NaOH solutions. The roots, and to a less extent, the leaves of bean plants quickly absorbed I from culture solutions in concentrations which caused aphids to fall from the plant. Culture solutions increased in radioactivity; this indicates preferential absorption on nonradioactive I. Absorption of I was more rapid from sand than from soil with radioactivity being greater in top and bottom leaves. I concentration of 100 mg/kg plant tissue was lethal to aphids. Translocation of I was observed in leaves of the cabbage, peas, strawberry, hops, and, to a lesser extent, broad beans. Leaves of runners became radioactive after application of I to the leaf of the parent plant. Radioactive material was not given off by plants absorbing I through the roots. The honey dew of aphids feeding on I-treated plants was radioactive. (CA 45: 3548i, 1951)

- 610 Gardiner, J.E., Kilby, B.A. SOME OBSERVATIONS OF THE FATE OF BIS(DIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE IN THE RABBIT. *Biochem. J.* **46** (1950) xxxii-xxxiii.
- A dose of 50 mg/kg of Schradan( $\text{Me}_2\text{N}$ )<sub>2</sub> PO.O.PO( $\text{NMe}_2$ )<sub>2</sub>, injected into rabbits leads to death within a few hours with typical symptoms of acetylcholine poisoning (excessive salivation, fibrillary twitchings, etc.) as produced by fluorophosphonates and other anticholinesterases. However, when the action of this anhydride on cholinesterases is measured *in vitro*, surprisingly high concentrations are required to produce 50% inhibition, in contrast with other organic phosphorus compounds which are effective at concentrations of the order of  $10^{-7}$  to  $10^{-8}$  M. This apparent anomaly was investigated by comparing the effects of the anhydride on rabbit blood cholinesterase activity *in vivo* and *in vitro* by means of  $\text{P}^{32}$ -labelled anhydride. The results can be explained by postulating the conversion of the anhydride *in vivo* into some more active inhibitory compound, the liver being one place where this can occur. The formation of the half molecule, ( $\text{NMe}_2$ )<sub>2</sub> PO(OH), is excluded as this is inactive.
- 611 Gardiner, J.E., Kilby, B.A. ORGANIC PHOSPHORUS INSECTICIDES. PART I. SYNTHESIS OF BIS-DIMETHYLAMINOPHOSPHONOUS ANHYDRIDE CONTAINING  $\text{P}^{32}$ . *J. chem. Soc.* (1950) 1769-72.
- A method is described for the conversion of radioactive phosphoric acid into phosphoryl chloride on a small scale, and thence through chlorobisdimethylaminophosphine oxide into bisdimethylaminophosphonous anhydride (cf. preliminary note, *Research*, **2**, (1949) 590). The labelled product is suitable for tracer work in plants (in which the compound acts as a systemic insecticide) and in animals (where it shows anticholinesterase activity). Preparation of the non-radioactive form on a larger scale is also described.
- 612 Gardiner, J.E., Kilby, B.A. BIOCHEMISTRY OF ORGANIC PHOSPHORUS INSECTICIDES I. THE MAMMALIAN METABOLISM OF BIS(DIMETHYLAMINO) PHOSPHONOUS ANHYDRIDE (SCHRADAN). *Biochem. J.* **51** (1952) 78-85.
- A 50% inhibition of whole rabbit blood cholinesterase is caused by incubation for 1 h with  $2.6 \times 10^{-2}$  M-Schradan, bis(dimethylamino) phosphonous anhydride. In spite of this low inhibitory action, injection into rabbits leads to death with the symptoms of acetylcholine poisoning. Using radioactive Schradan, it is shown that the compound is converted *in vivo* into some more active anti-cholinesterase. Incubation of Schradan *in vitro* with rat- or rabbit-liver slices leads to a similar enhancement of activity. The active material after liver-slice incubation can be dialysed into buffer and extracted with chloroform; it is labile and is destroyed by 5 s exposure to 0.033 N-alkali, but is slightly more stable to acid. (auth. summary)
- 613 Glynne Jones, G.D., Thomas, W.D.E. CONTAMINATION OF NECTAR WITH SYSTEMIC INSECTICIDE "SCHRADAN". *Nature* **171** (1953) 263.
- The possible presence of unchanged insecticide in the nectar of flowers and its subsequent appearance in honey was examined. An aqueous solution of "Schradan" containing  $\text{P}^{32}$ -labelled insecticide and a wetter were sprayed on the leaves of white mustard plants (*Sinapis alba*). The sequence followed in spraying and collecting is described. Concentrations of unchanged Schradan in nectar were determined by radio-assay. Another test was made with borage (*Borago officinalis*) for Schradan content in nectar.
- 614 Glynne Jones, G.D., Thomas, W.D.E. THE POSSIBLE CONTAMINATION OF HONEY WITH SCHRADAN. *Ann. appl. Biol.* **40**, 3 (1953) 546-55.
- The reported low toxicity of Schradan to honey bees was confirmed. Using Schradan labelled with  $\text{P}^{32}$ , it was shown that spray applications of this insecticide on mustard and borage plants does result in the contamination of nectar. A series of nectar samples taken over a 4-week period following spraying showed on radio-assay a progressive decrease in total  $\text{P}^{32}$  content and also in the amount of Schradan present in proportion to the decomposition products. The highest figure recorded for the Schradan content of nectar was 21 ppm. Tests on stability of Schradan in contact with the honey stomach of the bee and also in contact with the enzyme invertase, *in vitro*, showed that no appreciable breakdown occurred. Schradan, moreover, was stable in contact with honey over a period of 2.5 months. It is concluded that this systemic insecticide may appear in an unchanged form in the honey obtained from the nectar of plants which have been sprayed less than 4 weeks previously. (auth. summary)
- 615 Hartley, G.S., Heath, D.F., Hume, J.M., Pound, D.W., Whittaker, M. STUDIES ON COMMERCIAL OCTAMETHYLPHOSPHORAMIDE (SCHRADAN). I. COMPOSITION AND ANALYSIS. *J. Sci. Food Agric.* **2** (1951) 303-9.

$P^{32}$  was used for preparing Schradan in the laboratory, following the commercial method of preparation. Commercial OMPA was shown to contain, in addition to octamethylpyrophosphoramidate, a comparable amount of triphosphoric acid pentadimethylamide. This latter compound was apparently as good a systemic insecticide as the former but much less toxic to mammals. A separate synthesis of the triphosphoric acid pentadimethylamide containing  $P^{32}$  was carried out in order to study more thoroughly the behaviour of this compound in biological and analytical tests. A smaller amount of orthophosphoric acid tridimethylamide and minor amounts of perdimethylamides of higher polyphosphoric and cyclic metaphosphoric acids were also found in the commercial material. A method of analysis for OMPA, based upon the various rates of alkaline hydrolysis and differences in the partition coefficients of the compounds listed above, was described.

- 616 Hartley, G.S., Heath, D.F. DECOMPOSITION OF RADIOACTIVE OCTAMETHYL PYROPHOSPHORAMIDE IN LIVING PLANTS. *Nature* 167 (1951) 816.

The systemic insecticide bis(bisdimethylaminophosphonous) anhydride (octamethylpyrophosphoramidate) was synthesized as  $P^{32}$ -labelled OMPA. In order to study the chemical fate of the substance on its uptake by living plants activities of about 400  $\mu\text{C/gm}$  were used in order to obtain the necessary sensitivity in analysis. No preparative details are given in this paper. Within 4 weeks of spraying only about 10% of the toxic product originally present absorbed by the plant remain unchanged; up to 50% is present as decomposition product. By following the fate of hexamethylorthophosphoramidate it is possible to throw some light on the mechanism of decomposition in the plant. It is probably entirely different from that of inanimate hydrolysis.

- 617 Heath, D.F., Lane, D.W.J., Llewellyn, M. STUDIES ON COMMERCIAL OCTAMETHYL PYROPHOSPHORAMIDE. III. DECOMPOSITION OF THE INSECTICIDE IN PLANTS, USING  $P^{32}$  AS A TRACER. *J. Sci. Food. Agric.* 3 (1952) 60-9.

Test plots of strawberries, sugar beets, hops, and Brussels sprouts were sprayed at various times from May to October with radioactive material containing approximately equal proportions of the systemic insecticides octamethylpyrophosphoramidate and its higher homologue, triphosphoric acid pentadimethylamide. On analysing the sprayed crops at various times after spraying, it was found that the concentration of both compounds in the plant fell at much the same rate, and that this rate varied little among the plant species treated providing all were treated at the same time of year. The rate of lowering the concentration slowed as the year progressed from May to September and became very slow in October. It was shown that the plants decomposed the insecticidal compounds, and that the lowering of insecticidal concentration with time was probably due largely to this decomposition within the plants.

- 618 Heath, D.F., Lane, D.W.J., Llewellyn, M. STUDIES ON COMMERCIAL OCTAMETHYL PYROPHOSPHORAMIDE. IV. THE DECOMPOSITION OF PYROPHOSPHORIC ACID TETRA (DIMETHYLAMIDE) AND ORTHOPHOSPHORIC ACID TRI (DIMETHYLAMIDE). *J. Sci. Food. Agric.* 3 (1952) 69-73.

Sugar beets and strawberry plants were treated with octamethylpyrophosphoramidate and orthophosphoric acid tridimethylamide or tri-(dimethylamino) phosphine oxide, both labelled with  $P^{32}$ . Both compounds were decomposed at similar rates in the two species of plants. When sugar beet plants treated with the first compound were analysed 10 to 14 d after treatment, it was shown that the  $P^{32}$  in the beet existed only as the unchanged compound and products not extractable from water by chloroform. When sugar beet plants treated with the second compound were analysed it was found that, besides the unchanged compound and non-chloroform extractable compounds, some material less extractable by chloroform than the tri-(dimethylamino) phosphine oxide was produced. The authors theorized that the plants probably attacked both compounds in the same way, oxidizing them by enzyme action.

- 619 Heath, D.F., Llewellyn, M.V. SYSTEMIC INSECTICIDES ON SPRAYED SURFACES. p. 445-61 (disc. p. 451) in "Radioisotope Techniques. Proceedings of the Isotope Techniques Conference, Oxford, July 1951", Vol. 1. London, Her Majesty's Stationery Office, 1953.

The fate of some systemic insecticides and allied compounds after spraying on foliage was studied using  $P^{32}$  as a trace element in them. The results show that, under certain conditions, a fairly high proportion of the applied material may evaporate before there is time for it to be absorbed. Some crop plants absorb bis(bisdimethylaminophosphonous anhydride and bis-isopropylaminophosphonous fluoride at about the same rate as the insecticides are lost by evaporation under windy conditions. The absorption rates on brassica seedlings vary somewhat with the compound applied, and the results fit in best with a theory of absorption through a semi-permeable membrane. The rate is very sensitive to incident radiation, both

visible and infra-red, an increase in the radiation increasing the uptake. The effect is not, however, completely reversible - once sensitized a plant remains unusually absorptive for several days. (auth. summary)

- 620 Heath, D.F., Lane, D.W.J., Park, P.O. DECOMPOSITION OF SOME ORGANOPHOSPHORUS INSECTICIDES AND RELATED COMPOUNDS IN PLANTS. Phil. Trans. **239B** (1955) 191-214.

Octamethylpyrophosphoramidate (Schradan) containing radioactive  $P^{32}$  was degraded in white clover (Trifolium repens), turnips, Brussels sprouts seedlings, and French beans; heptamethylpyrophosphoramidate, a powerful anticholinesterase (probably either hydroxymethyl heptamethylpyrophosphoramidate or octamethylpyrophosphoramidic oxide), and ionizable compounds were produced. Oxygenated liver slices and oxidation with  $H_2O_2$  produced the same products in similar proportions. Turnips degraded the dimethylamide, monomethylamide, butylamide, isopropylamide, and Et ester of tetramethylphosphorodiamidic acid. The dimethylamide was demethylated to its monomethyl compound; in the other compounds only the dimethylamido groups were attacked.  $O,O$ -diethyl  $O$ -ethylthioethyl phosphorothiolate was converted by plants into at least 3 compounds soluble in  $CHCl_3$  and of unknown structure.  $O,O$ -diethyl  $S$ -ethylthioethyl phosphorothiolate was oxidized in plants rapidly to  $O,O$ -diethyl  $S$ -ethylsulfinyloethyl phosphorothiolate and another compound of unknown structure;  $H_2O_2$  produced the same products. 32 references. (CA 50: 6736f, 1956)

- 621 Heath, D.F., Cleugh, J., Otter, I.K.H., Park, P.O. DETERMINING TRACERS OF OCTAMETHYL-PYROPHOSPHORAMIDE (SCHRADAN) IN CROPS. J. agric. Food. Chem. **4**, 3 (1956) 230-3.

It was desirable to develop a new technique, dependent on microdistillation, for separating the insecticide from natural products in crop extracts. The high efficiency of the initial recovery methods, (a) maceration of the crop sample with water, followed by chloroform extraction of the macerate, and (b) direct solvent extraction by boiling under reflux, is proved. The recovery of Schradan added to untreated crops is proved representative of the recovery from a treated crop. The complete analytical technique is described, and blanks and recoveries are listed. This technique should be generally applicable also to determination of residues of other toxic pest control compounds of volatility similar to or greater than that of Schradan. It is possible to determine the  $P^{32}$ -labelled insecticide and any phosphorus compounds derived therefrom through various operations, regardless of the large amounts of natural phosphorus compounds present. This makes it possible to account for all the relevant material in a way not possible by orthodox analytical technique. (from auth.)

- 622 Kilby, B.A. BIOCHEMISTRY OF SCHRADAN. Chem. and Industry (Rev.) (1953) 856-61.

Review article with 28 references on Schradan. Mention is made of the synthesis of  $P^{32}$ -labelled Schradan and its metabolism in the rabbit following injection.

- 623 March, R.B., Fukuto, T.R., Metcalf, R.L. RADIOTRACERS IN STUDY OF SYSTEMIC INSECTICIDES. Agr. Chem. **9**, 5 (1954) 107.

$P^{32}$ -labelled Schradan and Systox, organic insecticides, were synthesized and used in studies of spray residues and of their metabolism in the plant. Residues were measured to 0.001 ppm and fell between 0.007 and 0.07 ppm on tree fruits, nuts and potatoes after 4 weeks. After 41 d cotton seed oil contained 109 ppm Schradan while the seed cake contained 167 ppm of non-toxic metabolic products, which were separated from the insecticide by solvent partition. Autoradiographs showed deposition in orange peel and cotton seeds. Metabolic products were separated by counter-current distribution and by chromatography on treated filter paper. (BA 29: 22831, 1955)

- 624 Metcalf, R.L., March, R.B. BEHAVIOR OF OCTAMETHYL PYROPHOSPHORAMIDE IN CITRUS PLANTS. J. econ. Ent. **45**, 6 (1953) 988-97.

$P^{32}$ -labelled OMPA was employed in order to study its behaviour in citrus plants, particularly in the lemon, Citrus limon (L.) Burm., the sour orange, C. aurantium L., and the Valencia orange, C. sinensis (L.) Osbeck. Technical details of the methods and materials used are given. The absorption of the labelled insecticide and  $H_3P^{32}O_4$  from water culture by the roots of the lemon was compared. No significant differences could be detected as measured by translocation and storage in the leaves. After 24 h an average of 28% of the activity was found in the basal leaves (on a ppm basis), 41% in the median leaves, and 30% in the terminal leaves. Over a 28-d period, the distribution was: basal leaves 13%, median 22%, terminal 65%. Absorption and translocation of OMPA following application to bark, leaves and peel are

discussed. Lethal dosage levels /g of leaf for adult female citrus red mite (*Paratetranychus citri* (McG.)) and greenhouse thrips (*Heliethrips haemorrhoidalis* (Bch)) are cited. Radioautographs showing the distribution of OMP<sup>32</sup>A in orange and lemon leaves were obtained. (See also AECU-2214, California Univ., Citrus Experiment Station, Riverside, 33p.)

- 625 Metcalf, R.L., Fukuto, T.R., Reynolds, H.T., March, R.E. SCHRADAN RESIDUES IN COTTON AND COTTONSEED PRODUCTS. *J. agric. Food. Chem.* 3, 12 (1955) 1011-3.

P<sup>32</sup>-labelled Schradan was sprayed on cotton at the rate of 1.0 pound per acre and after 41 d the extent of contamination of leaves, seeds, raw and refined oils, cake, cottonseed meal, and soapstock was evaluated. Schradan showed a surprising affinity for the oily seeds, and about 8 to 16 ppm was present in the raw oil. Upon refining, this was decreased to 0.02 ppm and the Schradan was transferred to the soapstock. Ground cottonseed meal and cake contained 70 to 80 ppm of radioactive P<sup>32</sup> calculated as Schradan, but the very low chloroform-1N sodium hydroxide partition ratios indicated that this material was completely metabolized to acidic products. The experiment demonstrates the value of radiotracer studies in evaluating the behaviour of systemic insecticides. (auth.)

- 626 Pietri-Tonelli, P.de, March, R.B. RELATION OF THE ACTIVATION OF SCHRADAN IN PLANT TISSUES TO ITS TOXICITY TO INSECTS AND MITES. *J. econ. Ent.* 47, 5 (1954) 902-8.

The authors describe investigations with insects and a mite to compare the toxicity of unmetabolized Schradan with that of Schradan after contact with plant or mammalian tissue. The highly purified compound proved to be appreciably toxic by direct contact or ingestion to first-instar nymphs of *Aphis medicaginis* Koch, adults of *Paratetranychus* (*Metatetranychus*) *citri* (McG.), and third- or fourth-instar larvae of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), and a comparative test showed that samples of technical Schradan, purified Schradan and Schradan prepared from radioactive phosphorus (P<sup>32</sup>) had median lethal dosages in 48 h for the mosquito larvae 49, 35, and 28 parts per million, respectively, indicating that toxicity is directly related to purity. In tests with the aphid, after introducing Schradan into bean leaves by infiltration or translocation, a much better correlation was found between toxicity and the total content of radioactive compounds in the leaves, than between toxicity and the amount of Schradan metabolized. Observations on mosquito larvae in solutions of radioactive Schradan showed that similar amounts of Schradan were contained in living and dead larvae, proportional to the concentration of the solution and to the mortality caused. Principal mode of entry into larvae may be by ingestion. (RAE-A 43: 321, 1955)

- 627 Stein, L.H., Alper, T., Andersen, E.E. THE MOVEMENT OF A RADIO-PHOSPHORUS-LABELLED INSECTICIDE IN GROUNDNUT PLANTS. *J. Sci. Food Agric.* 3 (1952) 31-7. (See also *Chem. Zbl.* 123 (1952) 5595)

An aphid (*Craccivora* sp.) is known to be the vector for an economically important virus which infects peanut plants in the Transvaal, producing an external or visible foliage and growth symptom locally referred to as "rosette". Tracer-labelled OMPA was used in the field, together with the non-radioactive compound, to study the translocation of the insecticide in the plants. A small plot of the plants was sprayed; samples were taken immediately afterwards and at intervals of a few days, up to 25 d. Roots, nuts, and soil samples were tested for total radioactivity only. It was found that decrease in radioactivity in the parts above ground was due to loss of OMPA as a whole. The heaviest loss was due to evaporation immediately after spraying, and further loss took place by translocation within the roots, nuts, and soil. There was no decomposition of OMPA until more than 18 d after spraying. The radioactivity in the roots and soil samples increased steadily with time.

- 628 Thomas, W.D.E. THE BEHAVIOUR OF SYSTEMIC INSECTICIDES IN PLANTS: A SURVEY OF RESULTS OBTAINED WITH P<sup>32</sup>-LABELLED SCHRADAN AND DEMETON-S. *J. Sci. Food Agric.* 7 (1956) 565-73.

Following application of Schradan (I) to leaves, some was absorbed and some evaporated. Whilst the two surfaces of broad bean and *Coleus* leaves were equally absorptive, the lower surface of apple and chrysanthemum leaves absorbed more than their upper surface. Application of Demeton-S(II) to leaves was followed by 3 processes - evaporation, change into less volatile, toxic derivatives, and absorption, - and the chemical was effectively removed from the leaf surface within a few hours. Translocation of I from treated leaves to other parts of the plant occurred, mainly in an upward direction and in amounts sufficient to kill aphids. I appeared to be translocated in the phloem. Translocation from leaves treated with II was never sufficient to kill aphids feeding elsewhere on the plant. Species differences were found in the rate of breakdown of

I after absorption from leaves. The primary derivatives of II were retained for several weeks, especially within treated leaves. Following root application to broad beans in sand or soil, unchanged II was absorbed and detected in the shoot tip where concentrations of II and its primary derivatives were present in amounts sufficient to kill *Aphis fabae*. Movement in xylem following root application seems to occur freely.

- 629 Wedding, R. T., Metcalf, R. L. TRANSLOCATION OF RADIOACTIVE OCTAMETHYLPYROPHOSPHOR-AMIDE (OMPA) IN BLACK VALENTINE BEAN PLANTS. Bol. Gaz. 114 (1952) 180-9.

The systemic insecticide, OMPA, was labelled with  $P^{32}$ , and supplied to the roots of bean plants (*Phaseolus vulgaris*). After uptake it moved through the stem at approximately 20 cm/h, but <1% of the OMPA supplied had been removed in the above-ground portions after 120 h. OMPA tended to accumulate more rapidly in younger than in older tissues, both in stem and leaf tissues. The  $P^{32}$ -containing compounds detected in the plant were toxic to insects, as determined by bioassay using the two-spotted spider mite, *Tetranychus bimaculatus* Harvey. Insecticidally inactive breakdown products of OMPA were found after 8 d.

(Also published as AECU-2184, California. Univ., Riverside. Citrus Experiment Station. 20 p.) Articles of the same title were also published in Citrus Leaves 33 (1953) 22, 24 and in the Calif. Citrogr. 38 (1953) 138, 140, 142. It was concluded that leaf-spraying or injection into the stem might be better methods of applying OMPA.)

#### Systox (Demeton)

- 630 Ahmed, M. K., Newsom, L. D., Roussel, J. S., Emerson, R. B. TRANSLOCATION OF SYSTOX IN THE COTTON PLANT. J. econ. Ent. 47 (1954) 684-91.

Experimental techniques are described. Some days before the tests the plants were infested with the cotton aphid, *Aphis gossypii* Glov. Reduction in aphid populations was taken as an indication that toxic amounts of the insecticide were present in that portion of the plant on which the insects were feeding. The radioactive Systox had a specific activity of 4.7 mc/mg, and was diluted with water at 1:800. Translocation of Systox in the cotton plant was found to occur only in the xylem tissues. It moved in both directions simultaneously but movement in an upward direction was more rapid. Seed from fruit treated at flowering with Systox tagged with  $S^{35}$  showed measureable amounts of radioactivity 35 d after treatment, with a progressive decrease during this period of time. The insecticide was found to be concentrated in the more rapidly growing young tissues.

- 631 Chatters, R. M. A SUMMARY OF RESEARCH ON A  $P^{32}$  AND  $S^{35}$  LABELED TRIALKYL THIOPHOSPHATE SYSTEMIC INSECTICIDE, SYSTOX. Oklahoma Agricultural and Mechanical Coll., Stillwater, 1953, 5p. (mimeographed)

The labelled sulphur was apparently on the phosphorus in the Systox, O,O-diethyl-O-2-(ethylmercapto)-ethyl thiophosphate. Among the studies carried out with this insecticide are translocation experiments, seed treatments, volatilization studies, vapour pressure studies, and phytotoxicity studies.

- 632 David, W. A. L. INSECTICIDAL ACTION STUDIES WITH DEMETON-O AND DEMETON-S. Bull. ent. Res. 48, 1 (1957) 91-107.

The two isomers Demeton-O and Demeton-S occur as a mixture in the commercial insecticide Systox, and act on *Aphis fabae* Scop. as contact and systemic insecticides and as fumigants. When applied in the experiments described, as a contact insecticide or systemically through the roots from solution or from soil, Demeton-S was about ten times as toxic to *A. fabae* on broad beans (*Vicia faba*) as Demeton-O. Using Demeton-S containing  $P^{32}$ , it was shown that, when applied to the roots, radioactive material passed to all parts of the plants and that the concentration in the aerial parts was higher than in the roots. Leaf samples were more active than stem samples. By radioassay and by the cut-taproot technique, it appeared that the lethal dose of Demeton-S was equivalent to about 1 mg/kg fresh plant tissue. The lethal dose of Demeton-O, by the taproot technique was 3 mg/kg. From solutions of Demeton-S, the plants first absorbed Demeton-S preferentially, then water preferentially. Demeton-S was more rapidly absorbed from sand than from soil. Both isomers were translocated from older to younger leaves of broad beans, usually in sufficient quantities to kill aphids, but the results were more consistent with Demeton-S. The quantity translocated downwards was small. A low light intensity before and after treatment reduced the quantity of Demeton-S translocated. There was also a reduction in the quantity translocated when the plants were shaded only before treatment. One day of shading was sufficient to cause the maximum reduction. Solutions of the two

isomers gave off toxic vapours, and plants treated through the roots gave off toxic vapours from the foliage. (RAE-A 45: 218, 1957)

- 633 Eldefrawi, M. E., Gordon, H. T. METABOLISM OF  $C^{14}$ -LABELED SYSTOX IN THE GERMAN COCKROACH, *BLATTELA GERMANICA* L. Bull. ent. Soc. Amer. 4, 3 (1959) 84, abstr. 27.

$C^{14}$ -Systox and phosphate analogue were synthesized from 2-ethylmercaptoethanol-1,2- $C^{14}$ , through ethyl mercaptan and 2-bromoethanol-1,2- $C^{14}$ . Isomerization of Systox gave isosystox. Sulfoxides and sulfones of the ethylmercaptoethanol and sulfoxides of the insecticides were prepared by peroxide oxidation and characterized by paper chromatography. Systox in the cockroach is converted to sulfoxide and polar compounds.

- 634 Fukuto, T. R., Metcalf, R. L. ISOMERIZATION OF  $\beta$ -ETHYLMERCAPTOETHYL DIETHYL THIONO-PHOSPHATE (SYSTOX) J. Amer. chem. Soc. 76 (1954) 5103-6.

The rearrangement of  $\beta$ -ethylmercaptoethyl diethyl thionophosphate to its isomer  $\beta$ -ethylmercaptoethyl diethyl thiophosphate has been investigated using  $P^{32}$ -labelled phosphate and paper chromatography and found to show first-order kinetics. The effect of solvents also has been investigated. Ethyl alcohol markedly increases the isomerization rate, chloroform to a lesser degree, while ethyl acetate, dioxane, methyl ethyl ketone, benzene and 2,2,4-trimethylpentane have little or no effect. (auth.)

Preparative details are given.

- 635 Fukuto, T. R., Metcalf, R. L., March, R. B., Maxon, M. G. CHEMICAL BEHAVIOR OF SYSTOX ISOMERS IN BIOLOGICAL SYSTEMS. J. econ. Ent. 43, 4 (1955) 347-54.

The seven oxidation products of the thiono and thiol isomers,  $O,O$ -diethyl  $O$ -ethyl-2-sulfinylethyl phosphorothionate (thionophosphate sulfoxide),  $O,O$ -diethyl  $S$ -ethyl-2-sulfinylethyl phosphorothiolate (thiolphosphate sulfoxide),  $O,O$ -diethyl  $O$ -ethyl-2-mercaptoethyl phosphate (phosphate),  $O,O$ -diethyl  $O$ -ethyl-2-sulfinylethyl phosphate (phosphate sulfoxide),  $O,O$ -diethyl  $O$ -ethyl-2-sulfonylethyl phosphate (phosphate sulfone),  $O,O$ -diethyl  $S$ -ethyl-2-sulfonylethyl phosphorothiolate (thiolphosphate sulfone), and  $O,O$ -diethyl  $O$ -ethyl-2-sulfonylethyl phosphorothionate (thionophosphate sulfone) have been synthesized and some of their properties were compared with the metabolic products of the Systox isomers obtained after topical applications to the base of the cotton plant. The comparison of the results obtained from paper chromatography, cholinesterase activity, systemic activity, mammalian and insect toxicities of the oxidation and metabolic products indicates that the thiono isomer of Systox is converted to the thionophosphate sulfoxide, which is then converted to the thionophosphate sulfone or phosphate sulfoxide, or to both. A similar comparison of the oxidation and metabolic products of the thiol isomer indicates that it is converted to the thiolphosphate sulfoxide and then possibly to the thiolphosphate sulfone.  $P^{32}$ -labelled  $O,O$ -diethyl  $O$ -ethyl-2-ethyl-2-mercaptoethyl phosphorothionate and  $O,O$ -diethyl  $S$ -ethyl-2-mercaptoethyl phosphorothiolate were used. Toxicity tests were made on *Metatetranychus citri* (McG.), *Heliothrips haemorrhoidalis* (Bch.), *Musca domestica* L., *Tetranychus telarius* (L.) and *Aphis gossypii* Glover. (Includes auth. summary)

- 636 Fukuto, T. R., Wolf, J. P., III., Metcalf, R. L., March, R. B. IDENTIFICATION OF THE SULFOXIDE AND SULFONE PLANT METABOLISM OF THE THIOL ISOMER OF SYSTOX. J. econ. Ent. 49, 2 (1956) 147-51.

In this fifth paper of a series, an account is given of further investigations on the chemical behaviour of  $O,O$ -diethyl  $S$ -2-(ethylthio) phosphorothioate (Demeton-S), one of the two isomers present in Systox, in which the infra-red spectra of its metabolic products were compared with those of the synthetic oxidation products, in order to confirm the suspected identity of the metabolites. Demeton-S labelled with  $P^{32}$  was applied to the bases of young cotton plants and its metabolites were recovered from the leaves and isolated by the methods that are described. The results showed that the major metabolic product in the plant 4-6 d after application was identical with  $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorothioate (the thiolphosphate sulfoxide). When this compound labelled with  $P^{32}$  was applied to plants in the same way, the spectrum from the metabolite isolated after two weeks proved that subsequent oxidation of  $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorothioate (the thiolphosphate sulfone) occurs at a somewhat slower rate than the conversion of Demeton-S to the thiolphosphate sulfoxide. (RAE-A 45: 181, 1957)

- 637 Gardner, K., Heath, D.F. QUANTITATIVE DETERMINATION OF ISOMERS OF O, O-DIETHYL ETHYL-MERCAPTOETHYL THIOPHOSPHATE. Analyt. Chem. 25, 12 (1953) 1849-53.
- Pure O,O-diethyl O-ethylmercaptoethyl thiophosphate (I) prepared in the laboratory showed different physical and toxicological characteristics from those of the active constituent of the insecticide Systox, which is started to be this compound. In view of the fact that many compounds of the S = P - O type - e.g., Parathion - are known to be thermally unstable, it was presumed that the discrepancies were due to partial isomerization of the commercial product. Concurrent partition chromatography of a mixture of radioactive preparations ( $P^{32}$ ) of pure O,O-diethyl O-ethylmercaptoethyl thiophosphate and O,O-diethyl S-ethylmercaptoethyl thiophosphate (II), with the active ingredient isolated from Systox demonstrates the presence of both I and II in Systox. It is also shown that I isomerizes to II on heating. A chromatographic method of analysis is described for determination of the two active ingredients in O,O-diethyl (O,S)-ethylmercaptoethyl thiophosphate preparations. The analytical identification technique described - concurrent partition chromatography of the unknown sample with radioactive components of established structure and purity - may find more general application, particularly to preparations of the S = P - O and O = P - S types. (auth.)
- 638 Hartley, G.S. RESEARCH DEVELOPMENTS. THE ANOMALY OF SYSTOX. World Crops 4 (1952) 397.
- The anomaly of Systox lies in the fact that it acts as a systemic insecticide while only soluble to the extent of 1 part in 15 000 of water. Systox contains 2 active ingredients, the S-P-O-C and the O-P-S-C compounds.  $P^{32}$ -labelled O-P-S-C compound when applied to roots of brassica seedlings could be shown to be rapidly converted into a more water-soluble compound within the living plant, a derivative being responsible for the systemic insecticidal action. The derivatives were separated and concentrated. A third, even more water-favourable compound was also discovered, and shown to possess anti-cholinesterase activity. The original compounds may thus be seen to be rapidly and completely converted into the derivatives, which persist for several weeks. This may explain why it has been reported that toxic residues disappear very rapidly with Systox treatment, despite its persistence as an insecticide.
- 639 March, R.B., Metcalf, R.L., Fukuto, T.R. PAPER CHROMATOGRAPHY OF THE SYSTEMIC INSECTICIDES DEMETON AND SCHRADAN. J. agric. Food Chem. 2 (1954) 732-5.
- The components of technical Demeton and related compounds have been separated by means of 2 paper chromatographic techniques, and of technical Schradan and related phosphoramidate esters by means of a 3rd paper chromatographic technique.  $P^{32}$  or  $S^{35}$  were used for labelling. The above techniques have materially aided in investigations on systemic insecticides, for the preparation and determination of purity of  $P^{32}$ -labelled Demeton and its isomerization to the thiol isomer (see Fukuto & Metcalf, J. Amer. Chem. Soc. 76 (1954) 5103); the translocation and biochemistry of Systox (Demeton) in plants; the determination and characterization of residues of Systox in citrus, walnut, apples, pears, potatoes and sugar beets; the preparation and the determination of purity of  $P^{32}$ -labelled Schradan, determination of its residues in cotton, and some studies in comparative biochemistry.
- 640 March, R.B., Metcalf, R.L., Fukuto, T.R., Maxon, M.G. METABOLISM OF SYSTOX IN THE WHITE MOUSE AND AMERICAN COCKROACH. J. econ. Ent. 48, 4 (1955) 355-63.
- $P^{32}$ -labelled thiono and thiol isomers of Systox were found to be rapidly metabolized, degraded, and eliminated in the white mouse and the American cockroach. Metabolism, degradation and elimination are somewhat slower in the cockroach than in the mouse, but in gross aspects they are the same. The foregut exhibits a marked selective absorption of the isomers, and the gut is the principal avenue of elimination. Although the gut appears to be the most active tissue in the role of metabolism and degradation, other tissues such as nerve and muscle are more active in the roach than in the mouse. The principal pathway of metabolism to toxic metabolites for both isomers is the oxidation of the mercapto sulfur of the ethylmercaptoethyl moiety to the sulfoxide and sulfone. A secondary pathway in the case of the thiono isomer involves the oxidation of the thiono sulfur to produce the phosphate and its sulfoxide and sulfone. Both isomers and their toxic metabolites are degraded by hydrolysis and of the P-O- or P-S-bond to form the alcohol and acid. The routes of metabolism and the toxic metabolites formed are the same in plants and animals. Thus toxic residues in edible products present no peculiar hazard as a result of biochemical activity in the plant. (from auth. summary)
- 641 Metcalf, R.L., March, R.B., Fukuto, T.R., Maxon, M. THE BEHAVIOR OF SYSTOX-ISOMERS IN BEAN AND CITRUS PLANTS. J. econ. Ent. 47, 6 (1954) 1045-55.



The  $P^{32}$ -labelled isomers were readily absorbed by the roots and stems of the lemon seedlings and translocated to the leaves in amounts toxic to *Paratetranychus* (*Metatetranychus*) *citri* (McG.), and *Heliothrips haemorrhoidalis* (Bch.). The translocated materials were present in greater quantity in the peripheral growing areas of the upper leaves, and the systemic behaviour closely resembled that of Schradan. After topical application to the stems, radioactivity accumulated in the upper leaves of bean and lemon 5-10 times as fast for Demeton-S as for Demeton-O. Studies of the quantitative metabolism of the two isomers in bean and lemon leaves by paper chromatography indicated a rapid metabolism of both. Contact toxicity studies in which oranges were dipped in standard solutions and the dry residues tested showed that Demeton-S is 3-5 times as toxic as Demeton-O to *P. citri* and *H. haemorrhoidalis*; the metabolite of the former caused total mortality at an estimated concentration of less than 40  $\mu\text{g/g}$  leaf, and the metabolite of the latter at about 300  $\mu\text{g/g}$ . Pure Demeton-O was a poor inhibitor of fly-brain cholinesterase, but Demeton-S and the principal metabolites of both isomers were highly active. No radioactive vapours were recovered from the leaves of plants of which the stems had been treated with the radioactive isomers. (RAE-A 43: 421, 1955)

- 642 Mercalf, R. L., Fukuto, T. R., March, R. B., Stafford, E. M. THE SYSTEMIC BEHAVIOUR OF SYSTOX THIOL ISOMER SULFOXIDE AND METHOSULFATE IN PLANTS. *J. econ. Ent.* 49, 6 (1956) 738-41.

The systemic behaviour of Demeton-S and its methosulfate and sulfoxide ( $O,O$ -diethyl  $S$ -ethyl-2-sulfinyl-ethyl phosphorothioate) applied topically to the stems of young cotton plants was studied by means of  $P^{32}$  radiotracers and paper chromatography. Demeton-S was absorbed and translocated much more rapidly than the sulfoxide for up to 7 d after application. At 14 d, the amounts were nearly equal, and at 30 d the sulfoxide was present in appreciably greater amounts. The methosulfate accumulated much more slowly, indicating a lower degree of penetration of this strongly polar compound through the plant cuticle. The rates of metabolism and decomposition of Demeton-S and its sulfoxide were approximately the same, and small amounts of the sulfone were formed from both. Radioautography after topical application to young lemon leaves showed that the penetration and spread in the leaf interior was most rapid for Demeton-S and least so for its methosulfate, but more rapid for  $O,O$ -diethyl  $O$ -2-(ethyl-thio)ethyl phosphorothioate [Demeton-O] than for Demeton-S sulfoxide. (from auth. summary)

- 643 Mercalf, R. L., March, R. B., Fukuto, T. R., Maxon, M. G. THE NATURE AND SIGNIFICANCE OF SYSTOX RESIDUES IN PLANT MATERIALS. *J. econ. Ent.* 48 (1955) 364-9.

The investigations were largely carried out by means of  $P^{32}$ -labelled Systox isomers,  $O,O$ -diethyl  $O$ -ethyl-2-mercaptoethyl phosphorothioate (thiono isomer) and  $O,O$ -diethyl  $S$ -ethyl-2-mercaptoethyl phosphorothioate (thiol isomer), and paper chromatography. Samples of apples, pears, oranges, walnuts, potatoes, and sugar beets were processed for analysis. The metabolism of the isomers and their residue products, and the action of air and sunlight on surface residues are discussed. In addition to activation within the plant tissues to oxidative metabolites, these are subsequently hydrolyzed to nontoxic, diethyl phosphoric acids and alcohols. The thiol isomer metabolites persist in leaf and fruit tissues about twice as long as the thiono isomer metabolites. The hydrolysis of the toxic metabolites in plant materials to non-toxic phosphoric acid derivatives is a further safeguard against the retention or accumulation of the toxic esters over a long period of time. Average residue values of toxic Systox metabolites 2 and 4 weeks after application were substantially below 0.1 ppm, i.e., so that they could not have been determined precisely by other (non-tracer) methods.

- 644 Metcalf, R. L., Stafford, E. M., Fukuto, T. R., March, R. B. THE SYSTEMIC BEHAVIOR OF  $O,O$ -DIETHYL  $S$ -2-(DIETHYLAMINO)ETHYL PHOSPHOROTHIOATE AND ITS SALTS. *J. econ. Ent.* 50, 2 (1957) 205-10.

The translocation of  $O,O$ -diethyl  $S$ -2-(diethylamino)ethyl phosphorothioate (thiol isomer) and its salts, particularly the hydrogen oxalate, in plants was investigated by the use of compounds labelled with  $P^{32}$  and compared, in some cases, with that of its thiono isomer ( $O,O$ -diethyl  $O$ -2-(diethylamino)ethyl phosphorothioate) and Demeton-S [ $O,O$ -diethyl  $S$ -2-(ethylthio)ethyl phosphorothioate]. Cotton, lemon and orange plants were used in experiments, and the distribution and metabolism of thiol isomer and its oxalate discussed. (from RAE-A 46, 5: 182-3, 1958)

- 645 Mühimann, R., Tietz, H. THE CHEMICAL BEHAVIOUR OF METHYLISOSYSTOX IN THE LIVING PLANT AND THE PROBLEM OF RESIDUES. *HöfchenBr., Wiss. (English edition)* 9 (1956) 116-40.

The chemical behaviour of Methylisoxystox,  $O,O$ -dimethyl  $S$ -(2-ethyl-mercaptoethyl)-thiophosphate, Methylisoxystoxsulfoxide and Methylisoxystox-sulphone was examined in the plant in the mammalian

organism by means of  $P^{32}$ -labelled compounds. Two toxic transformation products were found in the plant. In addition to sulphoxide, Methylisoxystoxsulphone was also identified in plants treated with Methylisoxystox. Both Methylisoxystox and its oxidation products, sulphoxide and sulphone are exposed to the normal hydrolytic decomposition to non-toxic compounds in the living plant. The first decomposition product is dimethyl phosphoric acid, the end product orthophosphoric acid. It could be proved that the phosphoric acid formed by complete decomposition of the "Systox" active substances is largely used by the plant for the synthesis of phosphatides (particularly lecithin). True residual values were found considerably below those calculated at random on the basis of the total  $P^{32}$ -content. The sulphoxide primarily formed in the plant is excreted quantitatively from the organism of warm-blooded animals within a short time. Cases of chronic poisoning cannot be caused following the consumption of such small quantities as represented by the residues in the harvest crops.

- 646 Stein, L.H., Smith, A.J. UPTAKE AND DEGRADATION OF LABELED SYSTEMIC INSECTICIDES. II. TREATMENTS OF TOBACCO AND POTATOES WITH SYSTOX. J. S. Afr. chem. Inst. 7 (1954) 114-9.

A 0.05% Systox spray was used in which the thiol isomer of Demeton, Demeton-S, was labelled with  $P^{32}$ , and used in a determination of the dissipation of residues in tobacco and potatoes at various times after application. A soil application of 0.05% at the rate of 2 gal/yd<sup>2</sup> resulted in 566.5 to 425.9 ppm in tobacco leaves 53 d later, and 83.6 ppm (wet weight) in potatoes.

- 647 Stein, L.H., Smith, A.J. UPTAKE AND DEGRADATION OF LABELED SYSTEMIC INSECTICIDES. III. ESTIMATION OF THE MORE TOXIC DEGRADATION PRODUCTS OF SYSTOX. J. S. Afr. chem. Inst. 7 (1954) 120-4.

Sprays were used where the Systox ingredients were present in their normal proportion but the Demeton-S was labelled with  $P^{32}$ . The method of spraying and sampling as applied to tobacco and potato plants is described, and was also used to determine how much of the insecticide or of its more toxic degradation products is present in potatoes and tobacco at various intervals after treatment (cf. Stein and Smith, 1954). The  $CHCl_3$  extract which contains the toxic portions of Systox degradation products was found to be 5 ppm (dry weight) in tobacco leaves and 1.2 ppm (wet weight) in potato tubers 53 d after soil applications of 0.05% at the rate of 2 gal/yd<sup>2</sup>.

- 648 Thomas, W.D.E., Glynn Jones, D.G. THE SYSTEMIC PROPERTIES OF DIETHYL S-(2-(ETHYLTHIO)ETHYL) PHOSPHOROTHIOATE (DEMETON-S) WITH REFERENCE TO THE CONTAMINATION OF NECTAR. Ann. appl. Biol. 43, 2 (1955) 182-91.

The systemic insecticide Systox normally contains a mixture of the two isomers, diethyl 2-(ethylthio) ethyl phosphorothionate and diethyl S-(2-(ethylthio) ethyl) phosphorothiolate, or Demeton-O and Demeton-S, respectively. Demeton-O is toxic to honey bees, and sublethal amounts may possibly be transported in nectar by them and contaminate the honey. Demeton-S has been shown to be about ten times as toxic as Demeton-O to mammals and insects, and investigations were therefore carried out to ascertain whether it, or any derivative, appears in the nectar of sprayed plants; also, its rate of translocation and breakdown in the plant.  $P^{32}$ -Demeton-S was used. The fate of Demeton-S in white mustard (Brassica alba), borage (Borago officinalis) and field beans (Vicia faba) was followed over several weeks by means of the radioactive tracer technique. Radioassay of nectar samples from flowers that opened a few days after spraying showed no unchanged Demeton-S, but degradation products were present in small amounts. The highest value for total radioactivity found in the nectar corresponds to 2.7 parts per million expressed as Demeton-S. Radioassay of treated leaves and new growth after spraying confirmed that Demeton-S is rapidly converted in the plant into two primary degradation products extractable by chloroform. Further breakdown occurs and is still more rapid in new growth, but appreciable quantities of the two primary degradation products are retained by treated leaves for several weeks after spraying. Chrysanthemum cuttings which had absorbed an extract of them proved toxic to Macrosiphum (Macrosiphoniella) sanborni (Gill.). It is concluded that the extent to which Demeton-S appears in the nectar is negligible, but that some contamination by degradation products, possibly toxic to man, occurs. (RAE-A 43: 406, 1955)

- 649 Thomas, W.D.E., Bennett, S.H., Lloyd-Jones, C.P. THE ABSORPTION, BREAKDOWN, AND SYSTEMIC BEHAVIOR IN PLANTS OF  $P^{32}$ -LABELED DEMETON-S. Ann. appl. Biol. 43 (1955) 569-93.

Following leaf application of diethyl S-(2-(ethylthio) ethyl) phosphorothiolate (Demeton-S) (I), labelled with  $P^{32}$ , to beans, apples, and coleus, evaporation, breakdown into toxic non-volatile compounds, and absorption occurred concurrently and effectively removed unchanged I from the leaf surface within a few

hours. Evaporation gave rise to a fumigant action on *Aphis fabae*. Both I and its degradation products were absorbed, I degrading rapidly within the tissue. Translocation from treated leaves was insufficient to kill aphids feeding on untreated foliage, and no unchanged I could be found in the plant other than in the leaves. Following root application to bean plants in soil or sand, aphids feeding on the shoot tips were killed after 2 d; unchanged I was translocated following root application. I and its toxic derivatives appeared to move much more freely in xylem than in phloem tissue. (CA 50: 6737c, 1956)

- 650 Tietz, H. "METASYSTOX" RÜCKSTANDSUNTERSUCHUNGEN 1956 (1956-Studies on "Metasystox" residues). *HöfchenBr. Wiss.* 9, 2 (1956) 286-8. (in German)

A brief note is added to an earlier communication (Mühlmann and Tietz, *HöfchenBr. Wiss.* 9, 2 (1956) 116). Whereas the previous study described data under conditions designed to obtain maximum residue, normal spraying with  $P^{32}$ -labelled insecticide in early summer instead of autumn was applied. Results show that fruit and vegetables are perfectly safe for human consumption after 8-10 d from the last spraying.

- 651 Tietz, H. DER MIT  $^{32}P$  MARKIERTE DIÄTHYLTHIONOPHOSPHORSÄUREESTER DES  $\beta$ -OXYÄTHYL-THIOÄTHYLÄTERS (WIRKSTOFF DES SYSTEMISCHEN INSEKTIZIDES "SYSTOX"), SEINE AUFNAHME IN DIE HÖHERE PFLANZE UND SEIN WANDERUNGSVERMÖGEN (The  $P^{32}$ -labelled diethylthionophosphoric acid ester of  $\beta$ -oxyethylthioethyl ether, the active substance of the systemic insecticide Systox, its uptake by higher plants and its translocation) *HöfchenBr. Wiss.* 7, 1 (1954) 1-56. (in German)

E 1059 (the active substance of Systox) was labelled with  $P^{32}$  (supplied by G. Schrader, Farbenfabriken Bayer) and applied to roots or leaves, in order to study its absorption through roots, its upward movement, and its accumulation in the leaves. Penetration and movement were traced after leaf application, and residual effects, including storage and detoxification by plants were studied. The insecticide was absorbed freely from solution by the intact root. The quality of treated soil was found to influence uptake and concentration limit. The permeability of the root for water increased over a long period, then dropped below the normal value, and finally adjusted to it. After absorption by the root, the insecticide was translocated to shoot organs above the ground. Temporary storage, particularly peripherally, was observed in leaves. Spraying or brushing of the leaf with Systox solution allowed greater inward penetration, the degree depending on several factors. Treatment of individual leaves resulted in a displacement towards untreated parts of the plant, particularly apically. Once within the leaf, the insecticide did not appear to diffuse widely. Autoradiographs of leaf cross-sections indicated temporary storage by living cells, particularly in the epidermis and in cells of the connecting bundle parenchyma. Loss from the plant occurred chiefly through exudation via cuticle pores, translocation after treatment of the shoot part above the ground primarily via the phloem. Evaporation or rain remove the eliminated toxic parts from the surface.

- 652 Tietz, H. METABOLISME DES INSECTICIDES ET ACARICIDES DU GROUPE DEMETON-MÉTHYL. *Phytiatrie-Phytopharmacie* 9 (1960) 167-80.

Le Méthylsystox (marqué au  $P^{32}$ ) est transformé en composés toxiques conformément aux observations de Heath. Les sulfoxydes et les sulfones des matières actives, du "Systox" sont identiques aux dérivés  $D_1$  et  $D_2$ . On a pu prouver que les acides phosphoriques résultant de la décomposition complète de la matière active se transforment dans une large mesure en phosphatides végétaux (surtout en lécithine). Le sulfoxyde que se produit en premier lieu dans la plante est éliminé quantitativement en peu de temps de l'organisme des animaux à sang chaud. En cas d'intoxication aiguë chez la souris blanche, 97% du sulfoxyde sont éliminés (15 h); il en résulte que l'absorption de faibles quantités du produit comme p. e. des résidus se trouvant dans les produits de récolte ne peut conduire à des intoxications chroniques.

#### Tepp

- 653 Roan, C.C., Fernando, H.E., Keams, C.W. A RADIOBIOLOGICAL STUDY OF FOUR ORGANIC PHOSPHATES. *J. econ. Ent.* 43, 3 (1950) 319-25.

TEPP (tetraethyl pyrophosphate), tetraisopropyl pyrophosphate, tetra-n-butyl pyrophosphate and O,O-diethyl O-paranitrophenyl phosphate were synthesized with  $P^{32}$  and used in studies employing the techniques of radiobiological assays. Among others, experiments were made to determine the tissue concentration of radioactive TEPP or its metabolite after topical application which showed that the highest concentration occurred in the fore gut, with the concentration in the body fluid rising rapidly at first and then falling sharply; slight increases were noted in muscle tissue during the first hour after treatment. After both sublethal and lethal administrations, the fore gut showed a marked selective absorption of TEPP in the tissues of surviving and prostrate cockroaches (*Periplaneta americana* (L.)) showed considerably higher concentrations

of radioactive material in the fore gut of surviving than of prostrate cockroaches, and higher concentrations in the muscles of prostrate than of surviving ones. Although no radioactive materials were detected in the central nervous system, the authors do not consider that this necessarily indicates a complete absence of such materials from this region, since the specific activity of the tracer compound employed had deteriorated to a rather low level when the experiment was performed.

- 654 Robinson, J. R. TETRAETHYL PYROPHOSPHATE LABELED WITH PHOSPHORUS-32. Canad. J. Chem. **33** (1955) 722-3.

A method for the synthesis of  $P^{32}$ -labelled tetraethyl pyrophosphate (TEPP) is described. The corresponding specific activity of the product is  $65 \mu\text{C/g}$  but this could be increased by altering the ratio of active to inactive P and no major modification of the technique would be required. The over-all chemical yield based on  $\text{H}_3\text{PO}_4$  is 49%. (CA 49: 939a, 1955)

#### Thiodan

- 655 Klee, O. ÜBER DEN EINFLUSS DER TEMPERATUR UND LUFTFEUCHTIGKEIT AUF DIE TOXISCHE WIRKUNG ORGANISCH-SYNTHEISCHER INSEKTIZIDE. (Study on the influence of temperature and humidity on the toxic effects of organically synthesized insecticides) Z. angew. Zool. **47** (1960) 183-229. (In German)

Insects were exposed to the vapour phase of the  $S^{35}$ -labelled insecticide Thiodan®. Contamination of any one part of the body which might be in contact with precipitated material could thus be avoided. By measuring the radioactivity taken up from the vapour at different temperatures and levels of humidity it was possible to determine the extent to which insecticide efficacy was a function of these factors, and to demonstrate the great importance of the vapour phase.

#### Miscellaneous

- 656 Benjamin, E., Metcalf, R. L., Fukuto, T. R. THE CHEMISTRY AND MODE OF ACTION OF THE INSECTICIDE O, O-DIETHYL O-P-METHYLSULFINYLPHENYL PHOSPHOROTHIONATE AND ITS ANALOGUES. J. econ. Ent. **52** (1959) 94-8.

The insecticide (Bayer 25141) was studied with regard to its chemical instability to heat, hydrolysis, and oxidation and to the effect of the products formed upon insect toxicity. The compound is readily oxidized to the sulfone and upon heating undergoes internal oxidation-reduction to also form the sulfide. Additionally, the compound apparently isomerizes very readily to form the S-ethyl-isomer. The oxidation and isomerization products also form in aqueous systems such as the insects body and as they possess enhanced anticholinesterase activity apparently contribute to the mechanism of toxic action which appears to be that of inhibition of cholinesterase. The bimolecular rate constant for reaction with cholinesterase and the hydroxide-ion catalyzed hydrolysis constant for p-substituted methylthio-, methylsulfinyl-, and methylsulfonylphenyl diethyl phosphates and phosphorothionates can be satisfactorily correlated with the electron-withdrawing capacities of the aryl substituents. A  $P^{32}$ -labelled form was used, the insect studied being Periplaneta americana. The techniques for paper chromatography, quantitative evaluation of  $P^{32}$ -labelled compounds and identification of the various metabolites are given.

- 657 Benjamin, E., Metcalf, R. L., Fukuto, T. R. CONTACT AND SYSTEMIC INSECTICIDAL PROPERTIES OF O, O-DIETHYL O-P-METHYLSULFINYLPHENYL PHOSPHOROTHIONATE AND ITS ANALOGUES. J. econ. Ent. **52** (1959) 99-102.

The above insecticide (Bayer 25141), its dimethyl analogue, and several reduced and oxidized derivatives were investigated as contact and systemic insecticides. The more active compounds studied were of the same order of contact toxicity as Parathion and were also effective systemic insecticides. In plant tissue, the sulfoxides are oxidized to sulfones and also appear to isomerize to S-ethyl-isomers. Compounds  $p\text{-CH}_3\text{SOC}_2\text{H}_4\text{OP(S)(OEt)}_2$  and  $p\text{-CH}_3\text{SOC}_2\text{H}_4\text{OP(S)(OMe)}_2$  were available in highly purified and in  $P^{32}$ -labelled preparations. Experiments were carried out on Musca domestica Linn., Periplaneta americana (Linn.), Metatetranychus citri (McGregor), Tribolium confusum (Duval), Laphygma frugiperda (J.E. Smith), and Brevicoryne brassicae (L.), and contact toxicity of p-substituted phenyl dialkyl phosphorothionates and phosphates determined. Results on contact toxicity, systemic toxicity, rates of absorption and translocation are discussed.

- 658 Bowman, J. S., Casida, J. E. SYSTEMIC INSECTICIDES FOR THEOBROMA CACAO L., THEIR TRANSLOCATION AND PERSISTENCE IN FOLIAGE AND RESIDUES IN CACAO BEANS. J. econ. Ent. **51**, 6 (1958) 773-80.

From preliminary screening of 14 systemic compounds with cacao seedlings in Costa Rica, Thimet, Chipman R-6200 (O,O-diethyl S-(2-diethylamino)ethyl phosphorothioate), Demeton, Isolan and Dimefox were selected for further study. These five systemics were compared on the basis of their translocation and persistence in the foliar parts of mature cacao trees after trunk implantation, their effect on the flavour of chocolate produced from beans from the treated trees, and the level and nature of residues in the beans using radiotracer and anticholinesterase methods of analysis. Thimet and Chipman R-6200 were readily translocated into the foliar portions of cacao trees and persisted for as long as 20 months after a single implantation treatment. Little or no residues were found in the cacao beans at any time after treatment regardless of the position on the trees in relation to the site of implantation. Studies with radioactive R-6200 (labelled with  $P^{32}$ ) demonstrated a high concentration of phosphorus-containing residues in the cotyledons of the cacao beans but these materials did not partition into chloroform and did not inhibit cholinesterase, and therefore cannot be considered as hazardous residues. No off-flavours were detected in chocolate from beans harvested from any of the systemic treatments but definite off-flavours were obtained when BHC was used as a foliar spray. (auth.)

- 659 Casida, J. E. ISOMERIC SUBSTITUTED-VINYL PHOSPHATE AS SYSTEMIC INSECTICIDES. Science 122 (1955) 597-8.

The biological distribution and fate of the *cis* isomer of compound 2046, O,O-dimethyl 1-carbo-methoxy-1-propen-2-yl phosphate, was studied after being labelled with  $P^{32}$ , since substituted-vinyl phosphates are noted for frequently high insecticidal activity. It was found that in contrast to other systemic insecticides currently available, compound 2046 does not require preliminary "metabolic activation" within the plant to produce the effective toxicant. The substituted-vinyl phosphates had the shortest residual period of 20 organo-phosphates studied on carrots, potatoes and cabbage. Distribution and detoxification were studied. Accumulation seemed to occur in the mid- and hindgut; detoxification appeared to take place in the gastric caeca and nerve cord of the roach, *Periplaneta americana*.

- 660 Casida, J. E., Gatterdam, P. E., Getzin, L. W., Jr., Chapman, R. K. RESIDUAL PROPERTIES OF THE SYSTEMIC INSECTICIDE O, O-DIMETHYL 1-CARBO-METHOXY-1-PROPEN-2-YL PHOSPHATE. J. agric. Food Chem. 4, 3 (1956) 236-43.

O,O-dimethyl 1-carbomethoxy-1-propen-2-yl phosphate (compound 2046) offers considerable promise as a short-residual systemic insecticide. The potential hazard of residues in crop plants was investigated. Compound 2046 consists of about  $\frac{2}{3}$  *cis* and  $\frac{1}{3}$  *trans* isomers. The *cis* is about 100 times more toxic than the *trans* to insects and mammals. Despite the greater residual persistence of the *trans* isomer within the plant, its residual hazard was negligible compared to the less stable but more toxic *cis* material. The initial enzymatic attack on both isomers within the plant appeared to be on the carboxylic ester group, followed by hydrolysis of the vinyl phosphate bond. Foliage application to vegetable crops in the field resulted in a 90% residual loss in less than 2 d and over 99% loss in 4 d based on anticholinesterase determinations. The toxic 2046-residues in crop plants treated at dosage levels used for insect control were essentially dissipated within 2 d following insecticide application. The residual properties of compound 2046 were determined by several different techniques, amongst them radioactive insecticide, using  $P^{32}$  as tracer. Its synthesis is described. (auth.)

- 661 Heath, D. F., Casapieri, P. HYDROLYSIS OF DIMETHYLAMIDES OF PHOSPHORIC ACIDS. Trans. Faraday Soc. 47 (1951) 1093-101.

Some phosphoramides show remarkable toxic properties towards mammals and insects. The study was undertaken to measure the hydrolysis rates of some dimethylamides of phosphoric acids in acids, alkalis and water. It was found that the P-N link is about as easily broken by acids as the C-N link in organic amides, but is extremely stable to alkalis. Only in acid amides, containing the group N-P-OH, is the P-N group broken by water at a measurable rate. Other modes of hydrolysis of some of these compounds are described, and all the results considered in relation to the behaviour of organic amides. A radioactive,  $P^{32}$ -labelled form of  $R_4P_2O_5$  was used in the study. (auth.)

- 662 Heath, D. F. THE EFFECTS OF SUBSTITUENTS ON THE RATES OF HYDROLYSIS OF SOME ORGANO-PHOSPHORUS COMPOUNDS. PART II. RATES IN ALKALINE SOLUTION. J. chem. Soc. (1956) 8796-804.

The rates of hydrolysis, in alkaline solution, of compounds of the types  $RR^*P(O)X$  and  $RR^*P(S)X$ , where R and  $R^*$  are alkoxy- or alkylamino-groups and X is an acidic group, are summarized, and more results are given. The mechanism is of type  $S_N2$ . The electromeric and inductive effects of substituents are usually very

similar to those found in carbon chemistry for reactions of this type. However, ethyl NN-dimethylphosphoramidocyanidate and compounds containing P-S-C bonding are hydrolyzed exceptionally rapidly, perhaps because the cyanide group and the sulphur atom are very readily polarized relatively to the other substituents considered. In the phosphorodiamidic fluoride series, those compounds containing four alkyl substituents are hydrolyzed markedly more slowly than those containing only three, owing to a steric effect. For the same reason diisopropyl phosphorofluoridate is hydrolyzed more slowly than would be expected from its structure. All rates of reaction in neutral solution and several of the slower ones in alkaline solution were determined on compounds labelled with  $P^{32}$ . This is the most accurate of the methods used.

- 663 Heath, D.F. THE EFFECTS OF SUBSTITUENTS ON THE RATES OF HYDROLYSIS OF SOME ORGANO-PHOSPHORUS COMPOUNDS. PART II. RATES IN NEUTRAL SOLUTION. J. chem. Soc. (1956) 3804-9.

The approach used in the preceding paper is extended to cover rates of hydrolysis in compounds under conditions such that catalysis by hydroxyl ions can be neglected. Hydrolysis rates were obtained using very dilute solutions of  $P^{32}$ -labelled compounds. Salts catalyses hydrolysis of NN'-diisopropyl- and NN-dimethyl-N'-iso-propyl-phosphorodiamidic fluoride.  $k_w$  for the first compound is probably composite, water acting as both an anionoid and a cationoid reagent. Generally, however, water acts as an anion by an  $S_N2$  mechanism. Substituents have similar effects to those described in Part I, except that in the tetra-alkyl pyrophosphates steric effects are more important than inductive effects, and that P-S-C groups accelerate the rates less in neutral than in alkaline solution.

- 664 Kossobutsky, V.I. STUDY OF THE ACTION OF ORGANOPHOSPHORUS INSECTICIDES ON THE GRAIN BUG (EURYGASTER INTEGRICEPS PUT.) WITH THE AID OF TAGGED ATOMS. Zool. Zh. 34 (1955) 800-5. (In Russian)

- 665 Plapp, F.W., Casida, J.E. HYDROLYSIS OF THE ALKYL-PHOSPHATE BOND IN CERTAIN DIALKYL ARYL PHOSPHOROTHIOATE INSECTICIDES BY RATS, COCKROACHES, AND ALKALI. J. econ. Ent. 51, 6 (1958) 800-3.

The nature of the products formed by *in vitro* and *in vivo* hydrolysis of Parathion, methyl Parathion, Diazinon, Dow ET-57, Chlorthion, and Dicapthon was studied. All these dialkyl aryl phosphorothioates were hydrolyzed at both the alkyl-phosphate and the aryl-phosphate bonds. Alkyl-phosphate hydrolysis was proportionately greater with the dimethyl than with the diethyl phosphorothioates in rats and under the alkaline conditions employed. Very little alkyl-phosphate hydrolysis occurred with cockroaches with five of the six compounds studied. The lower alkyl-phosphate hydrolysis with cockroaches as compared to rats may contribute to the lower relative toxicity of the dimethyl aryl phosphorothioates to mammals. Differences were also noted in the rate of oxidation of the various hydrolytic metabolites between rats and cockroaches. Six phosphorothioate insecticides (Dow ET-57, Dicapthon, Chlorthion, methyl Parathion, Parathion, and Diazinon) used in the study were synthesized from  $P^{32}$  pentasulfide prepared by isotope exchange. Subsequent treatments are described. (from auth.)

## II - E Pyrethrins and related Compounds

- 666 Acree, F., Jr., Babers, F.H. SEPARATION OF dl-cis FROM dl-trans LABELED AND UNLABELED CHRYSANTHEMUMIC ACID ON PAPER. Science 120 (1954) 948-9.

$C^{14}$ -labelled dl-cis, trans-Allethrin has been synthesized. The procedure for a successful paper separation of the dl-cis from the dl-trans chrysanthemumic acid is described. A comparison of the 8 isomeric labelled Allethrins was of interest. Some attempts were made to analyse certain zones of impurities also obtained, but present data do not permit an interpretation of their nature and origin.

- 667 Acree, F., Jr., Roan, C.C., Babers, F.H. THE SYNTHESIS AND CHROMATOGRAPHIC PURIFICATION OF RADIOACTIVE ALLETHRIN. J. econ. Ent. 47, 6 (1954) 1066-70.

Radioactive Allethrin has been synthesized to facilitate a study of the metabolic fate of toxic esters of chrysanthemumic acid after their application to houseflies and cockroaches. After having been purified by chromatography, the radioactive Allethrin appeared to be approximately 98% pure. (auth. summary)

- 668 Acree, F., Jr., Babers, F.H. CONTAMINANTS IN RADIOACTIVE ALLETHRIN DETERMINED BY PAPER CHROMATOGRAPHY. A SCIENTIFIC NOTE. J. econ. Ent. 49, 1 (1956) 135.

Traces of five contaminants were found in the reversed-phase chromatogram of  $C^{14}$ -Allethrin with respect to ammoniacal ethanol: one (A) at  $R_f$  0.0 and a mixture of four (C) at  $R_f$  0.84. This mixture, with respect to ammoniacal isopropyl acetate, consisted of an unknown D at  $R_f$  0.0, both *dl-cis* and *trans-2-C^{14}*-chrysanthemic acids, and a mixture at  $R_f$  0.98. The last mixture consisted, with respect to ammoniacal Skellysolve B, of an unknown E at  $R_f$  0.0 and dimerized allethrolone at  $R_f$  0.89. At present, the most logical explanation for the presence of chrysanthemic acid and dimerized allethrolone is that traces of Allethrin are hydrolyzed during reversed-phase chromatography by the ammoniacal solvent. However, those products may be produced by some other reaction, such as photo-decomposition, because zones A and C also have been observed on chromatograms prepared in the absence of ammonia.

- 669 Blum, M.S., Kearns, C.W. TEMPERATURE AND THE ACTION OF PYRETHRUM IN THE AMERICAN COCKROACH. J. econ. Ent. 49, 6 (1956) 862-5.

Increased toxicity at lower temperatures has been reported for various insecticides, including pyrethrum. This phenomenon was investigated for a possible correlation between toxicity and penetration, and for the relationship between toxic materials in the blood and symptomatic reaction. Pyrethrin solutions labelled with  $C^{14}$  were used. The symptoms of poisoning manifested by pyrethrum-treated cockroaches were correlated with the concentration of a toxin in the hemolymph as determined by bioassay from the duration of paralysis of adults of Sarcophaga crassipalpis Macq. into which 3 or 6  $\mu$ l blood was injected. Blood from treated cockroaches kept at 15°C was toxic to the flies when the same amount from flies kept at 35°C was not. Absence of radioactivity in the blood of cockroaches treated with  $C^{14}$ -labelled pyrethrins indicated that the toxin was not a pyrethrin or metabolite. If cockroaches were treated with a high concentration of pyrethrins and became paralyzed almost immediately, the toxicity to flies of blood removed several hours later was about the same as that of blood removed as soon as prostration had occurred. Piperonyl butoxide applied with the pyrethrum extract increased the susceptibility of the cockroach to it at higher temperatures, as indicated by observation of paralysis and by demonstration of the existence of the toxin by bioassay. Analysis showed that the synergist was present in the fat-body and the central nerve cord of the cockroach and absent in the blood. The toxic agent in blood lost almost all its activity when the blood was stored for 3 h at room temperature (26-27°C). (from RAE-B 46:24-25, 1958)

- 670 Bridges, P.M. ABSORPTION AND METABOLISM OF  $[^{14}C]$  ALLETHRIN BY THE ADULT HOUSEFLY. Biochem. J. 66, 2 (1957) 316-20.

Allethrin (I) labelled with  $C^{14}$  was incubated with enzyme extracts or homogenates or it was injected into adult houseflies. After a metabolism period any unchanged I and its metabolites were extracted, resolved by paper chromatography, and determined radiometrically. A considerable fraction of the I injected into female houseflies was metabolized in a period of 24 h. The proportion of the metabolism occurring in the 1st h of this period was 80%. The net weights of I metabolized by a male lipase extract and a female abdomen homogenate were small and of doubtful significance. Metabolism of I by female thoracic homogenates could not be detected. A sublethal exposure to MeBr inhibited the metabolism of I. There was some evidence that benzaldehyde, a lipase inhibitor, reduced the metabolism of I *in vivo* at the higher concentrations used. Absorption of topically applied I- $C^{14}$  was rapid during the 1st 5-10 h after application. The fraction of the dose absorbed in 24 h approached unity at lower doses but fell off significantly at higher doses. (CA 51:16971g, 1957)

- 671 Earle, N.W. MODE OF ACTION OF PIPERONYL BUTOXIDE AS A SYNERGIST FOR PYRETHRUM. Ph.D. Thesis, Illinois, Univ., Urbana. 1952.

The following insects were used in these experiments: a normal, or non-resistant strain of houseflies, Musca domestica L., a pyrethrum-piperonyl butoxide-resistant strain of houseflies; adult flesh flies, Sarcophaga crassipalpis; and adult American cockroaches, Periplaneta americana L. When piperonyl butoxide and Allethrin in the ratio of 1:1 are applied to the housefly there is a resultant slight decrease in the rate of Allethrin penetration and initial lag in knock-down time.  $C^{14}$ -labelled pyrethrins and cinerins were found useful in this investigation. In general, the various experiments showed that piperonyl butoxide reduces the rate of detoxication of pyrethrins and cinerins *in vivo*.

- 672 Hopkins, T.L., Robbins, W.E. THE ABSORPTION, METABOLISM, AND EXCRETION OF  $C^{14}$ -LABELED ALLETHRIN BY HOUSE FLIES. J. econ. Ent. 50, 5 (1957) 684-7.

The fate of pyrethroid insecticide in female DDT-resistant houseflies (Musca domestica L.) has been studied, using Allethrin labelled with  $C^{14}$  on the chrysanthemum monocarboxylic acid moiety. To study the

absorption and excretion of Allethrin or its degradation products quantitatively, a method was devised for attaching house flies in stationary positions throughout the experimental period. Allethrin was rapidly absorbed, metabolized, and excreted. The synergist piperonyl butoxide applied jointly with Allethrin at a 1:1 ratio retarded both absorption and excretion of the labelled insecticide. Almost all the absorbed dose of Allethrin was metabolized by houseflies in 24 h. The bulk of the radioactivity present in the homogenates and excreta behaved as an unknown metabolite, only trace amounts of unchanged Allethrin or free acids being detected. No qualitative differences in the metabolism of Allethrin applied alone or jointly with piperonyl butoxide were found in these experiments. (auth. summary)

- 673 Levy, L. W., Usubillaga, A. BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS. Bol. Inform. scient. nac., Quito 9, 82 (1957) 42-9.

Young pyrethrum plants having numerous buds were grown for 12 d in an atmosphere containing  $68 \mu\text{C}$  of  $\text{C}^{14}\text{O}_2$ /mg total C. The ligroin extract from the flowers was strongly radioactive. (CA 52: 8445a, 1958)

- 674 Levy, L. W., Usubillaga, A. EXPERIMENTS ON BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS. p. 577-86 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D. C., Pan American Union, 1960.

Pyrethrins are obtained from pyrethrum flowers (Chrysanthemum cinerariaefolium). Although the plants will grow in any part of the world, it has been observed that the flowers contain an appreciable amount of pyrethrins only when cultivated at high altitudes with temperate climates. Pyrethrins are substances of strong insecticidal actions but are completely non-toxic to warm-blooded animals and to man. The use of pyrethrins as insecticides is growing since insects develop no resistance to pyrethrins as they do to synthetic insecticides. The preparation of radioactive pyrethrum extract is reported following exposure of plants to an atmosphere containing carbon dioxide labelled with  $\text{C}^{14}$ . (NSA 13: 8537, 1959)

- 675 Pellegrini, J. P., Jr., Miller, A. C., Sharpless, R. V. BIOSYNTHESIS OF RADIOACTIVE PYRETHRINS USING  $\text{C}^{14}\text{O}_2$ . J. econ. Ent. 45, 3 (1952) 532-6.

A method is described for obtaining radioactive pyrethrins by growing pyrethrum plants (Chrysanthemum cinerariaefolium) for a prolonged period in an atmosphere containing radioactive carbon dioxide ( $\text{C}^{14}\text{O}_2$ ) and isolating and purifying the pyrethrine from the  $\text{C}^{14}$ -labelled flowers. A mixture of  $\text{C}^{14}\text{O}_2$  and normal carbon dioxide ( $\text{C}^{12}\text{O}_2$ ) was generated from a mixture of radioactive and normal barium carbonates ( $\text{BaC}^{14}\text{O}_3$  and  $\text{BaC}^{12}\text{O}_3$ ) and their utilization by the plant described. The method is given in some detail. About 400mg pure pyrethrins were extracted from the flowers. Tests showed that the pyrethrins had the expected insecticidal activity against houseflies (Musca domestica L.) and cockroaches, and that they were labelled with  $\text{C}^{14}$  in both alcohol and acid portions of the molecules at levels high enough for qualitative and quantitative determinations. Detailed observations made throughout the work, precautions taken and improvements that could be made in the method are discussed. (from RAE-A 40: 349, 1952)

- 676 Schmidt, C. H., Dahm, P. A. THE SYNTHESIS OF  $\text{C}^{14}$ -LABELED PIPERONYL BUTOXIDE AND ITS FATE IN THE MADEIRA ROACH. J. econ. Ent. 49, 6 (1956) 729-35.

As an aid to study of the mode of action of piperonyl butoxide, a pyrethrum synergist, radioactive piperonyl butoxide was prepared. A study was made of the absorption and excretion of radioactive piperonyl butoxide after its topical application to the ventral thoracic area of males and females of Leucophaea maderae (F.). About 88% was absorbed in 3 d. About half the radioactivity in the applied dose was recovered from the faeces in 7 d. Paper chromatographic analysis of faecal extracts showed that less than half of the radioactivity was from piperonyl butoxide; the remainder consisted of unidentified, water soluble metabolites. The internal distribution of radioactivity in female cockroaches showed that the brain and thoracic ganglia, fore-gut, and hind-gut and Malpighian tubules contained the greatest amounts of radioactivity per unit weight. Since little radioactivity was found in the other tissues, it is postulated that the nervous tissue, fore-gut, and hind-gut and Malpighian tubules are involved in the breakdown of radioactive piperonyl butoxide in females of L. maderae. (from auth. summary)

(An abstract of this paper was published in Iowa State Coll. J. Sci. 32, 2 (1957) 159-60. See also Bull. ent. Soc. Amer. 2, 3 (1956) 17, abstr. 22)

- 677 Schmidt, C. H. SYNTHESIS OF RADIOACTIVE PIPERONYL BUTOXIDE AND ITS METABOLISM IN THE MADEIRA ROACH, LEUCOPHAEA MADERAE (F.) Iowa State Coll. J. Sci. 32, 2 (1957) 259-60.



- 678 Winteringham, F.P.W. SEPARATION AND DETECTION OF THE PYRETHRIN-TYPE INSECTICIDES AND THEIR DERIVATIVES BY REVERSED PAPER CHROMATOGRAPHY. Science 116 (1952) 452-3.
- For the purpose of studying the metabolic fate of  $C^{14}$ -labelled insecticides of the pyrethrin type a method was applied which separated the esters and their acid and alcohol products of hydrolysis. These had to be separated under conditions unfavourable to their further decomposition after extraction from insect tissue or other, on unidimensional paper chromatograms so that they could be assayed radiometrically by scanning techniques. The method of reversed phase paper chromatography developed for the separation of bromine analogues of DDT and its derivatives was found to be applicable, with minor modifications.
- 679 Winteringham, F.P.W., Harrison, A., Bridges, P.M. ABSORPTION AND METABOLISM OF  $^{14}C$  PYRETHROIDS BY THE ADULT HOUSEFLY, MUSCA DOMESTICA L., IN VIVO, Biochem. J. 61 (1955) 359-67.
- A natural mixture of (biosynthetically)  $C^{14}$ -labelled pyrethroids were resolved by reversed-phase paper chromatography into chrysanthemic and pyrethric esters, and unidentified non-insecticidal impurities. Allethrin, labelled with  $C^{14}$  in the alcohol portion of the molecule, was prepared on the millimole scale at a specific activity of about 60  $\mu$ C/g of pure esters and purified by means of reversed-phase paper chromatography. Allethrin, the natural mixture of pyrethroids, or the chrysanthemic esters separated chromatographically was injected into or applied topically to adult houseflies. After a metabolism period the unchanged esters and their metabolites were extracted, resolved by paper chromatography and determined by radioactivity assay. Significant and comparable fractions of all the applied pyrethroids were metabolized to relatively non-insecticidal substances within 24 h. When the synergist piperonyl cyclonene was applied simultaneously with the pyrethroid, the metabolism was substantially inhibited, but least effectively in the case of Allethrin. Absorption of the pyrethroids applied topically was almost complete within 24 h and was apparently non-selective from an applied mixture of esters. The presence of piperonyl cyclonene invariably retarded absorption in 24 h, presumably by dilution of the pyrethroid on the insect integument. (from auth. summary)
- 680 Zeid, M.M.I., Dahm, P.A., Hein, R.E., McFarland, R.H. TISSUE DISTRIBUTION, EXCRETION OF  $C^{14}O_2$  AND DEGRADATION OF RADIOACTIVE PYRETHRINS ADMINISTERED TO THE AMERICAN COCK-ROACH, J. econ. Ent. 46 (1953) 324-36.
- The tissue distribution and metabolism of  $C^{14}$ -labelled pyrethrins and cinerins in the American cockroach, Periplaneta americana (L.), were determined in male and female roaches, and the data summarized in tabular form. A rather extensive distribution of the insecticides or their metabolites is implied. A comparison was also made of the conversion of pyrethrins and cinerins to  $C^{14}O_2$  following administration to both sexes by several routes. The highest percentage of excreted  $C^{14}O_2$  (measured as  $BaC^{14}O_3$ ) occurred after inter-spiracular perfusion. Results are presented as tables and graphs. A large portion of the radioactive pyrethrins and cinerins may be taken to have undergone hydrolysis in the insect to corresponding keto-alcohols and chrysanthemum acids, plus unchanged esters, and several unidentified metabolites. Eight to 12% of the radioactivity was excreted as  $C^{14}O_2$ .
- (Also published as AECU-2411, Kansas Agricultural experimental Station, 43 p.)

## II - F Nicotine, Carbamates and other Compounds

### Nicotine

- 681 Bennett, D.R., Tedeschi, R.E., Lason, P.S. STUDIES ON THE FATE OF NICOTINE IN THE BODY. VII. OBSERVATIONS ON THE EXCRETION OF NICOTINE AND ITS METABOLITES BY THE DOG. Arch. int. Pharmacodyn. 98 (1954) 221-7.
- Isotopically labelled nicotine was obtained from tobacco plants grown in an atmosphere containing  $C^{14}O_2$ . The nicotine isolated had a specific activity of 0.187  $\mu$ C/mg. After the intravenous injection of 1-10 mg/kg of  $C^{14}$ -labelled nicotine into dogs, 95% appeared in the urine within 36 h. There appears to be no prolonged storage of nicotine or its metabolites in body tissues. No radioactivity was detected in the expired air.
- 682 Bowden, K. BIOGENESIS OF NICOTINE. Nature 172 (1953) 763.

DL-Tryptophane, containing  $C^{14}$  in the 8-position, was fed as its acetate to young tobacco plants via the roots. The leaves became radioactive. The nicotine from the plant was separated from other products. The spots obtained chromatographically were found to exhibit no radioactivity, the results so far obtained lending no support to the theory that the tryptophane molecule in toto is converted into nicotine.

- 683 Brown, S.A. Byerrum, R.U. THE ORIGIN OF THE METHYL CARBON OF NICOTINE FORMED BY NICOTIANA RUSTICA L. J. Amer. chem. Soc. 74 (1952) 1523-6.

Tracer experiments with  $C^{14}$  have established that the methyl carbon of methionine can act as a precursor of the nicotine methyl carbon in intact Nicotiana rustica plants. A lesser incorporation of formate carbon into the methyl group of nicotine was observed. It is considered probable that formate is employed by the plant in the synthesis of labile methyl groups, which then undergo transmethylation to nicotine. (auth.)

- 684 Byerrum, R.U., Wing, R.E., THE ROLE OF CHOLINE IN SOME METABOLIC REACTIONS OF NICOTIANA RUSTICA. J. Biol. Chem. 205 (1953) 637-42.

Tracer studies with  $C^{14}$  showed that the methyl carbons of choline can be transferred to give the methyl group of nicotine in N. rustica. The methyl carbons of choline and methionine were donated to nicotine at about the same rate. No phospholipides could be isolated from the growing tobacco plants by the method employed, and it was concluded, therefore, that no significant amount of choline was involved in the synthesis of phospholipides. (auth, summary)

- 685 Byerrum, R.U., Hamill, R.L., Ball, C.D. INCORPORATION OF GLYCINE INTO NICOTINE FORMED BY TOBACCO PLANTS. Fed. Proc. 13 (1954) 188, abstr. 626.

In order to ascertain the possible metabolic origin of the N-methyl group of nicotine, each of 30 tobacco plants, 3 months old, was fed  $1.34 \times 10^{-5}$  moles of glycine labelled with  $C^{14}$  in the alpha-carbon and having a radioactivity of  $1.0 \times 10^5$  cpm. After the desired feeding period, the plants were dried and nicotine isolated from them as the dipicrate. From a group of plants supplied glycine for 10 d nicotine dipicrate having a specific activity of  $11.6 \times 10^3$  cpm/mM was obtained whereas another group of plants to which glycine was fed for 7 d yielded nicotine dipicrate with a specific activity of  $8.5 \times 10^3$  cpm/mM. The nicotine from both groups of plants was demethylated using hydriodic acid to discover how much of the radioactivity was in the N-methyl carbon. The methyl iodide formed upon demethylation of the nicotine was reacted with triethylamine to give methyltriethylammonium iodide which was counted for radioactivity. About 75% of the radioactivity of the nicotine from plants fed glycine for 10 d was recovered in the quaternary iodide whereas the nicotine from plants fed glycine for 7 d yielded about 100% of the radioactive carbon on demethylation. Glycine labelled with  $C^{14}$  in the carboxyl carbon when fed to tobacco plants under the same conditions did not give rise to radioactive nicotine. (auth)

- 686 Byerrum, R.U., Ringle, R.L., Hamill, R.L. BIOSYNTHESIS OF THE N-METHYL GROUP OF NICOTINE FROM FORMALDEHYDE AND BETA-CARBON OF SERINE. (abstr.) Fed. Proc. 14 (1955) 188.

Previous studies in our laboratory have indicated that in tobacco plant metabolism an N-methyl group of nicotine may arise by transmethylation from methionine or by reduction of either formate or the alpha-carbon of glycine. In a comparative study it was found that, in one week, the alpha-carbon of glycine was incorporated to a greater extent than any of the other methyl group precursors used. In the present work  $C^{14}$  formaldehyde and serine labelled with  $C^{14}$  in the beta-position have been administered to tobacco plants in an effort to ascertain other precursors of the nicotine methyl group. Nicotine isolated from plants fed these compounds was radioactive, and demethylation showed that the radioactivity was located almost entirely in the N-methyl group. It was further demonstrated that formaldehyde was incorporated into methyl groups to a greater extent than to alpha-carbon of glycine in one week, whereas the beta-carbon of serine was introduced to a lesser extent. These results suggest that the alpha-carbon of glycine and the beta-carbon of serine may be converted either to formaldehyde or an 'active' formaldehyde which is then reduced to the methyl group of nicotine.

- 687 Dawson, R.F., Christman, D.R., Anderson, R.C. ALKALOID BIOGENESIS. IV. THE NON-AVAILABILITY OF NICOTINIC ACID-CARBOXYL- $C^{14}$  AND ITS ETHYL ESTER FOR NICOTINE BIOSYNTHESIS. J. Amer. chem. Soc. 75 (1953) 5114-5.

Nicotinic acid had (elsewhere) been regarded as a possible precursor of the pyridine moiety of the Nicotiana alkaloids. An isotopic test was devised for checking on the availability of nicotinic acid and its ethyl esters as precursors for nicotine biosynthesis. Carboxyl-labelled nicotinic acid was prepared from 3-bromopyridine,

$n$ -butyllithium and  $C^{14}O_2$ , giving an activity of  $3.59 \mu\text{C}/\text{mg}$  C. Ethyl- $C^{14}$  nicotinate with a radioactivity of about  $0.1 \mu\text{C}/\text{mg}$  C was also prepared. Tobacco roots (*Nicotiana tabacum*, var. Turkish) were grown in culture and in due course given aqueous solutions of the acid or of its ester. A table gives data on nicotine from  $C^{14}$  feeding experiments. The negligible activity of the carbonate samples indicates that neither nicotinic acid nor its ethyl ester had been incorporated into nicotine during the culture period. The results are discussed. It appears that whatever the relationship between nicotinic acid and nicotine in the living plant it is confined to the catabolic side of metabolism and is unconcerned with nicotine biosynthesis.

- 688 Dawson, R.F., Christman, D.R., D'Adamo, A. INTERMEDIATES IN THE BIOSYNTHESIS OF NICOTINE. *Plant Physiol.* 31, 1 (1956) xxxvii.

Ring-labelled  $H^3$ - and  $C^{14}$ -nicotinic acids were prepared by recoil reactions accompanying neutron bombardment in the Brookhaven pile. These acids were supplied to sterile excised root cultures of Turkish tobacco. The nicotine produced by these cultures contained  $C^{14}$  and  $H^3$  in significant ranges of specific activity. Degradation experiments demonstrated that the isotopes were confined to the pyridine ring of nicotine. Nicotine is thus produced from nicotinic acid and ornithine (data of Byernum et al. and of Leete). Specifically labelled nicotinic acids were employed to clarify details of the pathway of nicotinic acid utilization.

(Abstract of paper presented at the meetings of the American Society of Plant Physiologists and the Physiological Section, Botanical Society of America, Univ. of Connecticut, Storrs, Connecticut, 26-30 Aug. 1956)

- 689 Dawson, R.F., Christman, D.R., Anderson, R.C., Solt, M.L., D'Adamo, A.F., Weiss, U. BIOSYNTHESIS OF THE PYRIDINE RING OF NICOTINE. *J. Amer. chem. Soc.* 78 (1956) 2498-9.

Ring-labelled T-nicotinic acid and nicotinic acid containing  $C^{14}$  in both ring and carboxyl positions were supplied to sterile cultures of excised roots of Turkish tobacco. Substantial amounts of radioactivity were found in the nicotine produced by the roots during their growth. Oxidation of the T-labelled nicotine with  $HNO_3$  or  $KMnO_4$  indicated an almost complete recovery of the T from the nicotine in the nicotinic acid. Conclusion: the pyridine ring of nicotinic acid is the biosynthetic precursor of the pyridine ring of nicotine and related alkaloids. (CA 50: 11447d, 1956)

- 690 Dawson, R.F., Christman, D.R., D'Adamo, A., Solt, M.L., Wolf, A.P. THE BIOSYNTHESIS OF NICOTINE FROM ISOTOPICALLY LABELLED NICOTINIC ACIDS. *J. Amer. chem. Soc.* 82 (1960) 2628-33.

The four specific ring hydrogen-labelled nicotinic acids were prepared and fed to tobacco root cultures in sterile media, then the nicotine produced by the roots was isolated and analysed. Recoil tritium and carbon-14 labelled nicotinic acid were similarly employed. The nicotine from all of these except nicotinic acid-6-t show similar and substantial incorporation into the nicotine. Oxidation of nicotinic acid, obtained from the nicotine, to the corresponding 2- and 6-pyridones indicate that the position of hydrogen label is conserved during the conversion to nicotine. The 6-labelled acid gave less than 10% of the amount of incorporation shown by the other acids, indicating the probability of enzymatic attack on the 6-position of nicotinic acid during its conversion to nicotine by the tobacco roots. The conversion probably does not proceed via oxidation at the 6-position, since both 6-hydroxynicotinic acid- $N^{15}$  and 1-methyl-6-oxo-nicotinamide-2-t failed to be incorporated. The possibility that the acid is incorporated into nicotine via a 1,6-dihydro intermediate is being investigated. Nicotinamide is incorporated to at least as great an extent as is the corresponding labelled acid. (auth.) (NSA 14: 16518, 1960)

- 691 Dawson, R.F. BIOSYNTHESIS OF THE NICOTIANA ALKALOIDS. *Amer. Scient.* 48 (1960) 321-40.

The author discusses the tobacco alkaloids, biosynthetic intermediates, the rate stability of alkaloid production and the possible nature of the rate-limiting steps, the dependency of nicotine production rate upon growth rate, and possible botanical correlations. Ring-labelled nicotinic acid ( $C^{14}$  and  $H^3$ ) and specifically synthesized nicotinic acid ( $-2-H^3$ ) were supplied to root cultures (Turkish variety and *N. glauca*), and radioactivity was found to be incorporated to different degrees into nicotine and anabasine. This and other results indicate that nicotine and anabasine, respectively, may be synthesized in the plant from the universal metabolites nicotinic acid and ornithine, and nicotinic acid and lysine. Nicotinic acid may undergo some modification prior to reaction with the corresponding amino acid derivative. There is no indication in these experiments of the nature of the circumstances which compel the plant to synthesize apparently terminal products from such metabolically useful intermediates.

- 692 Dewey, L.J., Byerrum, R.U., Ball, C.D. THE ORIGIN OF THE METHYL GROUP OF NICOTINE THROUGH TRANSMETHYLATION. J. Amer. chem. Soc. **76**, 15 (1954) 3997-9.
- A study in which methionine, doubly labelled in the methyl group with  $C^{14}$  and deuterium, was administered to intact tobacco plants has established that the methyl group of methionine can give rise to the methyl group of nicotine through transmethylation. (auth.)
- 693 Dewey, L.J., Byerrum, R.U., Ball, C.D. BIOSYNTHESIS OF THE PYRROLIDINE RING OF NICOTINE. Biochim. biophys. Acta **18** (1955) 141-2.
- By the use of ornithine-2- $C^{14}$  it was shown that part of the ornithine (I) is incorporated into the pyrrolidine ring of nicotine (II) in *Nicotiana rustica*. Approximately half of the II synthesized by plants fed radioactive I was recovered in the nicotinic acid (III) obtained by permanganate oxidation of II. All of the radioactivity in the III was located in the carboxyl group, and none was present in the pyridine ring. Therefore, about half of the  $C^{14}$  in the original II was located in the 2-position of the pyrrolidine ring. The remaining half of the radioactivity was somewhere in the 3, 4, and 5 positions of the ring. The  $\alpha$ -C atom of I is a very inefficient precursor of the N-Me group of II. (CA 49: 18089b, 1955)
- 694 Ganz, A., Kelsey, F.E., Gelling, E.M.K. BIOSYNTHESIS OF RADIOACTIVE NICOTINE. Bot. Gaz. **113** (1951) 195-203.
- Descriptions are given of the incorporation of  $C^{14}O_2$  in the tobacco plant and isolation of radioactive nicotine (I). The identity of the extracted and purified compound as nicotine was evidenced by spectrophotometric data, precipitation with silicotungstic acid, solubility in alkali, ether, and acid, and the melting point of the picrate. A spectrophotometric method was developed with readings at 260 m $\mu$ . The highest activity of I obtained was 501 000 cpm (0.3503  $\mu$ c/mg). The value of the specific radioactivity of extracted I per unit of radioactivity administered to the plant is roughly constant when different amounts of radioactivity are given. This value averaged 529 cpm/mg  $1/\mu$ c of  $C^{14}$  injected. (CA 46: 4178g, 1952)
- 695 Ganz, A., Kelsey, F.E., Gelling, E.M.K. EXCRETION AND TISSUE DISTRIBUTION STUDIES ON RADIOACTIVE NICOTINE. J. Pharmacol. **103** (1951) 209-14.
- Radioactive nicotine (I) obtained from *Nicotiana rustica* plants grown in the presence of  $C^{14}O_2$  was used. In mice the main excretion route of I is via the urine and approximately 50% of the radioactivity is recovered in the urine within 6 h after injection. The liver showed the highest radioactivity of the tissues examined. No radioactivity was found in the expired air; this indicates no metabolic breakdown of I to  $CO_2$ . In rats the urinary excretion of I begins almost immediately after injection; about 40% is excreted in 3 h, 85% in 6 h, and practically all in 16 h. When the isolated guinea-pig is perfused with a radioactive I solution an appreciable uptake of I occurs only during the initial period of heart block. Almost all of the radioactivity taken up by the heart is released during subsequent perfusion with fresh Ringer-Locke solution. No appreciable amount of I is metabolized by the heart tissue. (CA 46: 184c, 1952)
- 696 Larson, P.S., Harlow, E.S. SOME CURRENT APPLICATIONS OF CARBON-14 TO ANIMAL AND HUMAN PHYSIOLOGICAL RESEARCH; STUDIES WITH TOBACCO AND ITS CONSTITUENTS. p. 62-78 in "Proceedings of the International Conference on Radioisotopes in Scientific Research, Paris, Sep. 1957". Vol. 3. Exterman, R.C., ed. 1958.
- Greenhouse preparation of randomly labelled plant materials through photosynthesis in an atmosphere containing  $C^{14}O_2$  is described. Some aspects of the metabolism of nicotine in the body were studied.
- 697 Leete, E. BIOGENESIS OF NICOTINE. Chem. and Industry (Rev.) (1955) 537.
- Ornithine (I) has been shown to be an indirect precursor of nicotine (II). DL-1 ( $\alpha$ - $C^{14}$ ) was administered to *Nicotiana tabacum* and the II, purified by distillation and conversion to the dipchlorate, had only one-half the original activity. The MeI evolved by demethylation of a portion of the II, isolated as  $Et_3MeNI$ , was inactive. The activity was shown to be in the  $\alpha$ -carbon of the pyrrolidine ring by oxidation of the II perchlorate and decarboxylation of the nicotinic acid to give  $CO_2$  containing one-fourth of the original activity. A scheme is suggested for the biogenesis of II. (CA 50: 439c, 1956)
- 698 Leete, E. THE BIOGENESIS OF NICOTINE AND ANABASINE. J. Amer. chem. Soc. **78** (1956) 3520-3.

The metabolism of lysine-2-C<sup>14</sup> in nicotine-producing Nicotiana tabacum and in anabasine-producing Nicotiana glauca has been studied. The nicotine isolated from the plant was inactive, but the anabasine was radioactive. Systematic degradation of the anabasine (2-(3-pyridyl)-piperidine) indicated that all the radioactivity resided in the  $\alpha$ -carbon atom of the piperidine ring attached to the pyridine ring. The significance of these results is discussed. (auth.)

Leete, E., Siegfried, K.J. THE BIOGENESIS OF NICOTINE. III. FURTHER OBSERVATIONS ON THE INCORPORATION OF ORNITHINE INTO THE PYRROLIDINE RING. J. Amer. chem. Soc. 79(1957) 4529-31.

Radioactive nicotine was isolated from two groups of Nicotiana tabacum plants, which were harvested one and three weeks after the administration of equal counts of ornithine-2-C<sup>14</sup>. The nicotine from the two experiments had almost the same specific activity, indicating that little or no metabolic breakdown of nicotine had occurred during the last two weeks of the second experiment. The nicotine from both experiments was degraded unambiguously and all the activity in the alkaloid was shown to be equally divided between the two  $\alpha$ -carbons of the pyrrolidine ring. (auth.)

Leete, E. BIOGENESIS OF NICOTINE. V. NEW PRECURSORS OF THE PYRROLIDINE RING. J. Amer. chem. Soc. 80 (1958) 2162-4.

Nicotiana tabacum plants were grown for varying lengths of time up to 9 weeks after feeding ornithine-2-C<sup>14</sup> to the roots of the plant. The activity of the nicotine reached a maximum after 3 weeks and then slowly decreased. When glutamic acid-2-C<sup>14</sup>, uniformly labelled proline-C<sup>14</sup>, and putrescine-1,4-C<sup>14</sup> were fed to the plant, radioactive nicotine was obtained in each case. Degradation of the nicotine from these experiments showed that all the activity occurred in the pyrrolidine ring. Under similar conditions the incorporation of ornithine, putrescine, proline, and glutamic acid into nicotine was 0.43, 0.12, 0.032, and 0.0078%, respectively. The significance of the results is discussed. (CA 52: 13022a, 1958)

Toczko, K. BIOSYNTHESIS AND DEGRADATION OF NICOTINE. UCRL-tr.-626, 17p. tr. from Postępy Biochem. No. 6 (1960) 43-58. (In Polish)

Isolated root cultures of tobacco were fed with compounds labelled with C<sup>14</sup>. Chemical transformations involved in the biosynthesis and degradation of nicotine were studied. Reaction mechanisms are discussed. Results are compared with those previously reported. (NSA 15: 5891, 1961)

### Carbamates

Baldwin, R.E., Freed, V.H., Fang, S.C. ABSORPTION AND TRANSLOCATION OF CARBON-14 APPLIED AS O-ISOPROPYL-N-PHENYL CARBAMATE IN AVENA AND ZEA. J. agric. Food Chem. 2 (1954) 428-30.

The compound was absorbed through the cut surface of leaves, cut surfaces of roots, and intact roots (in descending order of absorption rate). Intact leaf surfaces did not absorb it in appreciable amounts. The absorption through roots was greater in corn plants than in oat plants. (CA 48: 7708b, 1954)

Eldefrawi, M.E., Hoskins, W.M. THE METABOLISM OF C<sup>14</sup>-SEVIN BY SUSCEPTIBLE AND PARATHION-RESISTANT HOUSE FLIES. Bull. ent. Soc. Amer. 5, 3 (1959) 123, abstr. 119.

Topical application of C<sup>14</sup>-Sevin results in rapid absorption and excretion. By use of paper chromatography and paper electrophoresis, at least three metabolites are demonstrated in both tissues and excreta after four hours. Susceptible and resistant strains show differences in amount and proportion of the metabolites.

Eldefrawi, M.E. ABSORPTION AND METABOLISM OF C<sup>14</sup>-SEVIN BY THE SUSCEPTIBLE AND RESISTANT HOUSE FLY, THE GERMAN COCKROACH, AND THE MILKWEED BUG AND THE INHIBITORY EFFECT OF SYNERGIST. Doctoral Thesis. California, Univ., Berkeley. 1960.

Fang, S.C., Theisen, P. UPTAKE OF RADIOACTIVE ETHYL-N, N-di-n-PROPYLTHIO CARBAMATE (EPTC-S<sup>35</sup>) AND TRANSLOCATION OF SULFUR-35 IN VARIOUS CROPS. J. agric. Food Chem. 8, 4 (1960) 295-8.

A study of the absorption of radioactive EPTC by crops in pre-emergence application indicated an uptake of this chemical from soil. By use of a radioautographic technique the differences in accumulation patterns of S<sup>35</sup> from EPTC-S<sup>35</sup> among crops were demonstrated; above-ground portions of beans, peas, and corn

contained slightly more sulfur-35 than the roots, while above-ground portions of radishes, carrots, and other plants contained 70 to 94% of the  $S^{35}$  from the absorbed EPTC- $S^{35}$ . Total absorption by individual crops at various stages of growth was determined. Generally, an increase in applied EPTC- $S^{35}$  increased absorption, but not in proportion to the increase in the rate of application. (auth.)

- 706 Skrab, W.J., Young, F.G. RADIOACTIVE SEVIN (1-NAPHTHYL-1-CARBON-14 N-METHYLCARBAMATE), A CONVENIENT SYNTHESIS. J. agric. Food Chem. 7,9 (1959) 612-3.

The commercial introduction of Sevin as a broad spectrum insecticide of low mammalian toxicity has created interest in the study of the mechanism of its insecticidal action and its metabolism in insects. A convenient synthesis of  $C^{14}$ -labelled material is described to provide a tool for these studies at normal dose levels. (auth.)

#### Other Compounds

- 707 Fletscher, M. L., King, R. C., Harby, M. H. THE EFFECT OF 2,4 DINITROPHENOL UPON THE UPTAKE, LOCALIZATION AND TURNOVER OF  $P^{32}$  IN ADULT DROSOPHILA PSEUDOOBSCURA FEMALES. Genetics 42 (1957) 381

Newly emerged flies were placed on standard corn meal-molasses food to which tracer amounts of  $P^{32}$  and 2,4 dinitrophenol (0.0001 M, 0.0005 M and 0.001 M) were added. Females were dissected after varying intervals; the amount of  $P^{32}$  taken up by various tissues was determined. Initially, most of the phosphorus is found in the gut and haemolymph; later, the ovaries and thorax have the highest percentage. Although females fed 0.0005 M and 0.001 M DNP incorporate less phosphorus, the distribution of phosphorus within the body appears normal if ovarian growth is comparable to that of the controls. However, ovaries from flies fed DNP seem to mature more slowly than ovaries from controls. Upon being removed to unlabelled food, control females excrete phosphorus more rapidly. Thus, it is concluded that both phosphorus uptake and turnover are reduced in the presence of 0.0005 M and 0.001 M DNP.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

- 708 Levy, L.W., Munoz, R.A. BIOSYNTHESIS OF RADIOACTIVE ROTENONE. p. 225-8 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union, 1960.

Acetate labelled with  $C^{14}$  in position one ( $CH_3 C^{14}OONa$ ), two ( $C^{14}H_3 COONa$ ) and in both was used as precursor of Rotenone. It could be shown that both carbon atoms are incorporated in Rotenone in barbasco plants, that the acetate can be administered by means of foliar absorption, and that the method described is an easy way of preparing radioactive Rotenone.

- 709 Sacks, J., Marott Sinex, F. THE EFFECT OF 2,4-DINITROPHENOL ON THE TURNOVER OF THE ACID-SOLUBLE PHOSPHORUS OF RAT DIAPHRAGM. Arch. Biochem. Biophys. 39 (1952) 205-18.

The effects of dinitrophenol (DNP) on phosphorylation have been studied in the isolated rat diaphragm. Three concentrations of DNP were used; one which stimulated respiration, a higher one which gave initial stimulation followed by depression, and a still higher one which gave principally profound depression. With all concentrations of DNP phosphocreatine was completely hydrolyzed and the concentration of adenosine triphosphate (ATP) was reduced markedly. The concentration of hexose monophosphate (HMP) was reduced when respiration was depressed. The turnover rate of ATP was not affected by a concentration of DNP which stimulated respiration, but was decreased by the higher concentrations which depressed respiration. The turnover of HMP was increased by the stimulating concentration and not reduced below the control level by the higher concentrations of DNP. This suggests that there are pathways for the formation of HMP in the intact cell which are resistant to DNP and therefore different from those found in particulate fractions.  $P^{32}$  was used as tracer element throughout. (from auth.)

- 710 Turrell, F. M. PHYSIOLOGICAL EFFECTS OF ELEMENTAL SULFUR DUST ON CITRUS FRUITS. Plant Physiol. 25 (1950) 13-62.

Rate of volatilization of elemental S increased logarithmically with temperature.  $S^{35}$  dusted on lemon fruit penetrated the peel to a depth of 240  $\mu$  when the fruit was incubated 6 h at 15.6°C. The release of gases, and specifically of  $H_2S$  and  $SO_2$  under different conditions (aerobic, anaerobic, while incubated at different temperatures) is discussed. Catalase of the peel was inactivated by dust treatment and incubation. S-dusted fruits in comparison with non-dusted had higher  $SO_4^{--}$  in the peel and sap; there was more  $SO_4^{--}$  in the peel of fruits burned on the tree; there was more on the burned side than on the unburned.

- 711 Turrell, F.M., Chervenak, M.B. METABOLIC PRODUCTS OF ELEMENTAL SULFUR  $S^{35}$  APPLIED TO LEMONS AS AN INSECTICIDE. Advanc. Chem. Ser. 1 (1959) 250-9.

When lemon fruit is dusted with sulfur containing  $S^{35}$  and incubated (41.  $^{\circ}C$  for 68 h), a large proportion of the S in the  $H_2S$  formed is derived from the S applied. The sulfate formed in the fruit peel can also be derived similarly provided large amounts of S are applied, whereas the  $SO_2$  formed is derived largely from a source within the plant. Elemental S-vapour penetrates lemons producing compounds similar to those produced by topical dust. The quantity of S-products formed is influenced by the area of the S-layer from which vaporization occurs and the duration of the exposure at 41.  $^{\circ}C$ . Radioautographs of the peel of dusted lemons suggest that the S has been incorporated into the tissue proteins.

- 712 Wilson, L.P., King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. VI. THE EFFECT OF DNP ON PHOSPHORUS INCORPORATION BY ADULT DROSOPHILA MELANOGASTER. J. exp. Zool. 130 (1955) 341-52.

A study was made of the effect of dinitrophenol upon viability, growth, and phosphorus incorporation by adult Drosophila melanogaster. Results are tabulated and presented graphically. Data are included on normal phosphorus metabolism in Drosophila. Adult females were found less susceptible to toxic effects of 0.001 M DNP than males. The minimum value for the ingested amount of DNP toxic to male and female flies is  $1 \times 10^{-4}$  mg DNP/mg wet weight fly. DNP reduces the rate at which exogenous P is incorporated into male and female flies; the reduction is more marked in females. The general action of DNP in females is to reduce the rate at which exogenous phosphorus is incorporated into the haemolymph, thorax, head, legs, gut, Malpighian tubes, wings, and abdominal residue. DNP acts specifically on the ovary to completely block exogenous phosphorus uptake after an exogenous P-concentration 30% the control value is reached. Cessation of P incorporation is accompanied by a cessation of ovarian growth, which partially accounts for the fact that DNP-treated females do not increase in weight at the control rate. Per unit weight the ovary of control females incorporates 1.7 times as much exogenous phosphorus as the testis of control males in a 30 h period. Per unit weight there is no sexual dimorphism in exogenous P incorporation by control heads and thoraxes. It was found that over a wide range of incorporated exogenous P-concentrations 75-80% of the phosphorus entering the haemolymph is withdrawn rapidly by the various tissues. (from BA 30: 28374, 1959)

## II - G Repellents

### Diethyltoluamide

- 713 Bar-Zeev, M., Schmidt, C.H. ACTION OF A REPELLENT AS INDICATED BY A RADIOACTIVE TRACER. J. econ. Ent. 52, 2 (1958) 268-9.

$P^{32}$ -phosphoric acid was used as a tracer in experiments with Aedes aegypti (L.) feeding through a membrane on citrated blood. When diethyltoluamide was present in the blood at a concentration that prevented the mosquitoes from engorging, the mosquitoes barely touched the membrane and did not insert their proboscises into the blood. When the concentration was lowered to one that allowed about half the mosquitoes to become engorged, those that did not feed spent slightly more time in contact with the membrane, and about a third of them inserted their proboscises into the blood but did not imbibe. It was concluded that most of the repellency was due to vapour action, but at a low concentration contact chemoreceptors on the labella may have been involved. (auth.)

- 714 Green, N. SYNTHESIS OF CARBOXY-LABELED  $C^{14}$ -N, N-DIETHYL-m-TOLUAMIDE, AN INSECT REPELLENT. J. econ. Ent. 51, 5 (1958) 707-10.

For studies of the various properties of N, N-diethyl-m-toluamide, an outstanding all-purpose insect repellent, this compound was prepared in radioactive form. The molecule was labelled in the carboxy position by carbonating m-toluene magnesium bromide with  $C^{14}O_2$  to give  $C^{14}$ -m-toluic acid. The m-toluic acid chloride was then combined with diethyltoluamide to give the final product, of which the specific activity was  $5.7 \times 10^7$  disintegrations per second per gram. (auth.)

- 715 Schmidt, C.H., Acree, F., Jr., Bowman, M.C. FATE OF  $C^{14}$ -DIETHYLTOLUAMIDE APPLIED TO GUINEA PIGS. J. econ. Ent. 52, 5 (1958) 928-30.

Little information is available as to why certain compounds act as insect repellents, and why they are effective for such short periods of time. Diethyltoluamide labelled with  $C^{14}$  was applied to the skin of guinea pigs at 6.97 - 7.11 mg/in<sup>2</sup>. After 6 h 0.96 - 0.98 mg/in<sup>2</sup> had been lost by evaporation and 1.32 - 3.40 mg/in<sup>2</sup> by absorption. The remaining repellent was removed. The radioactivity in the urine reached a peak within 12 h after application, and over 80% of the absorbed dose was excreted in 24 h. However, diethyltoluamide as such was not found in the urine. Only 0.75% of the absorbed dose was excreted in the faeces during 8 d, whereas 93% appeared in the urine. Very small amounts of radioactivity were found in the blood, skin, and hair. (from auth.)

(An abstract of earlier work was published in Bull. ent. Soc. Amer. **4**, 3 (1958) 95, abstr. 188)

#### Dimethyl Phthalate

- 716 Barker, D. Y., Christian, J. E. THE SYNTHESIS OF CARBON<sup>14</sup>-CARBONYL LABELED DIMETHYL PHTHALATE. J. Amer. pharm. Ass., Sci. Ed. **44** (1955) 105-7.

$C^{14}$ -labelled dimethyl phthalate was prepared by treating  $o$ -MeC<sub>6</sub>H<sub>4</sub>MgBr with  $C^{14}O_2$  (obtained from BaC<sup>14</sup>O<sub>3</sub>), oxidizing the resulting  $o$ -toluic acid to phthalic acid, and esterifying by the acid chloride. The over-all yield, calculated on BaC<sup>14</sup>O<sub>3</sub>, was 80.4%. (CA 49: 7195c, 1955)

- 717 Gerding, P. W., Sperandio, G. J., Christian, J. E. THE RETENTION OF AN INSECT REPELLENT IN EMULSIFIED BASES AT THE SITE OF APPLICATION. J. Amer. pharm. Ass., Sci. Ed. **44** (1955) 574-7.

The retention of NaI, MeI, and dimethyl phthalate (I) on the skin in various ointment bases was studied under 3 experimental conditions (normal, exposure to a fine spray of H<sub>2</sub>O, and conditions of sensible perspiration) with radioactive tracer techniques. Under normal conditions, an oil/water base gave better retention for NaI and MeI than a water/oil base, but the reverse held true when the bases were subjected to fine H<sub>2</sub>O sprayings. Under conditions of perspiration, NaI was retained well in water/oil base but MeI was retained better in the oil/water base. A water/oil emulsion containing 40% I provided better retention under all conditions. On the basis of the data obtained, an improved cream for I containing 15% of acetostearin was evaluated and found superior to 7 other bases. (CA 49: 16310i, 1955)

## II - H Insecticide Metabolism in

### II-H-1 INSECTS

#### Surveys

- 718 Brown, A. W. A. MECHANISM OF RESISTANCE AGAINST INSECTICIDES. Annu. Rev. Ent. **5** (1960) 301-26.

Review article dealing with resistance to DDT, Prolan, Dieldrin, BHC, organophosphorus insecticides, pyrethrin, cyanide, and arsenic. 229 references. Work with radioisotopes is included but not emphasized.

- 719 Casida, J. E. THE METABOLISM OF INSECTICIDES BY INSECTS. p. 216-36 (disc. p. 236-8) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.

After sketching the main lines of interest in insecticide research, the author considers general detoxication mechanisms. A section on chlorinated hydrocarbons is divided into DDT metabolism in houseflies, DDT-dehydrochlorinase of resistant houseflies, synergists for DDT-resistant flies, DDT metabolism in insects other than houseflies, hexachlorocyclohexane (BHC) metabolism in houseflies, and insect metabolism of cyclodiene insecticides. A shorter section deals with pyrethroids and miscellaneous insecticides. Organophosphorus insecticides are discussed in terms of their oxidation reactions, reactions other than oxidation and phosphoryl or alkyl phosphate hydrolysis, phosphoryl and alkyl phosphate hydrolysis, their selectivity in relation to the metabolism of organophosphorus insecticides and acquired resistance to them. Relevant work with radioisotopes is cited throughout.

- 720 Fay, R. W. USE OF RADIOACTIVE COMPOUNDS IN THE STUDY OF INSECTICIDE METABOLISM. Annu. Mtg. Amer. Ass. chem. Specialties Mfrs. **43** (1957) 153-5.



Some of the advances in insecticide metabolism studies that have occurred through the use of radioactively tagged insecticides, e.g., DDT, are reviewed. The advantages of such methods as well as the limitations are indicated. (18 references).

- 721 Kearns, C. W. BIOCHEMICAL ASPECTS OF RESISTANCE. p. 113-7 in "Research Progress on Insect Resistance, Symposium", Vol. 2, No. 1, College Park, Md., Entomological Society of America. 1959, 175p.  
  
A review of recent advances in the biochemistry of the action of toxicants in insects and of their enzymatic detoxification, and of knowledge gained concerning the metabolism of both resistant and susceptible insects.
- 722 Metcalf, R. L. PHYSIOLOGICAL BASIS FOR INSECT RESISTANCE TO INSECTICIDES. Physiol. Rev. **35** (1955) 197-232.  
  
A general survey paper, with some mention of how the use of radioisotopes in specific cases has given new insight into some of the problems involved.
- \* Metcalf 1960 - [413]
- \* O'Brien 1959 - [509]
- \* Perry 1958 - [430]
- \* Perry 1960 - [431]
- 723 Perry, A. S. METABOLISM OF INSECTICIDES BY VARIOUS INSECT SPECIES. J. agric. Food Chem. **8**, 4 (1960) 266-72.  
  
Review article with 78 references. Most chlorinated hydrocarbon insecticides and many organophosphorus compounds are metabolized by insect species, the metabolic processes which bring about these chemical changes being classifiable as "activating" and "detoxifying". Activating mechanisms usually involve epoxidation reactions, such as conversion of heptachlor to heptachlor epoxide and Aldrin to Dieldrin; or oxidation reactions, such as conversion of thionophosphates to phosphates, oxidation of thiol ethers to sulfoxides and sulfones, and oxidation of phosphoramides to more potent cholinesterase inhibitors. Detoxifying processes may convert insecticide to nontoxic metabolites, which are retained in the tissues or rapidly excreted. Detoxication of organophosphorus compounds in most cases involves hydrolytic reactions. The type of change is dependent on the chemical structure of the compound and the insect species - DDT is metabolized by the housefly, body louse, certain mosquitoes, American roach, Mexican bean beetle, boll weevil, milkweed bug, fruit fly, etc., - but this process follows four or five metabolic pathways. Many of these reactions are enzymatically catalyzed. Work with radioisotopes is discussed in connection with C<sup>14</sup>, Cl<sup>36</sup>- and S<sup>35</sup>-labelled Dieldrin, a Br<sup>81</sup> analogue of Dieldrin, C<sup>14</sup>-labelled Isodrin, Pyrethrins, Allethrin and labelled  $\alpha$ -,  $\beta$ - and  $\delta$ -BHC, and P<sup>32</sup>-labelled Malathion, Dipterex, DDVP and Delnav.
- \* Winteringham and Barnes 1955 - [433]
- 724 Winteringham, F. P. W. COMPARATIVE BIOCHEMICAL ASPECTS OF INSECTICIDAL ACTION. Chem. and Industry (Rev.) **36** (1957) 1195-1202.  
  
The complexity of selective insecticidal action and biochemical selectivity is reviewed. Glycolysis, oxidative and amino acid metabolism in insects and mammals, the metabolism of acetate (traced in the insect by the injection of acetate-2-C<sup>14</sup>), and the chemical identity of the metabolites are discussed. In considering the biochemical differences between insects and mammals, variations in enzyme vulnerability under different conditions must be taken into account (e.g., insect enzymes at different stages of insect development). Resistance, physiological differences between insects and mammals, and comparative mechanisms of insecticidal action are discussed.
- 725 Winteringham, F. P. W. BIOCHEMICAL MECHANISMS OF INSECT RESISTANCE. WHO/Insecticides/76 (1958) 92-106.  
  
(Presented at the Seminar on "The Resistance of Insects to Insecticides" New Delhi, India Feb. 27-March 7, 1958)

Review article. The author discusses identification of the resistance mechanism (reduced uptake or absorption of the insecticide, detoxication or excretion of the insecticide so that the rate of arrival at the sites of action is below the tolerance threshold, abnormal biochemistry or physiology at the sites of action) and possible countermeasures based on biochemical studies. (52 references, including numerous refs. on application of radioisotopes)

#### Aldrin and Dieldrin

- \* Chang and Kearns 1959 - [434]
- \* Winteringham and Harrison 1959 - [436],[437]

#### Bayer 22408

- 726 Boyd, N.R., Jr., Arthur, B.W. BIOLOGICAL DEGRADATION OF O,O-DIETHYL O-NAPHTHALIMIDO PHOSPHOROTHIOATE (BAYER 22408). J. econ. Ent. 53 (1960) 848-53.
- P<sup>32</sup>-labelled Bayer 22408 (O,O-diethyl O-naphthalimido phosphorothioate) was converted to the oxygen analogue, O-ethyl phosphoric, O,O-diethyl phosphoric, O,O-diethyl phosphorothioic acid and at least three other metabolites by rats, several species of insects, and cotton plants. Differences in the degradation of Bayer 22408 by the three biological systems were not the result of the number of metabolites but of the amount of each metabolite formed. Bayer 22408 was stable in insects and most of the absorbed material was recovered as administered; the oxygen analogue was formed to a limited extent. Rats degraded Bayer 22408 rapidly to water-soluble phosphoric acids, which were eliminated primarily in the urine. Some Bayer 22408 escaped degradation and was eliminated intact in the feces. Bayer 22408 was not effective as an animal systemic against several ectoparasites feeding on treated rabbits. Bayer 22408 was quite stable on the foliage of cotton plants but was not translocated to untreated portions of plants. (auth.)

#### BHC

- \* Bradbury et al. 1953 - [440]
- \* Bradbury and Standen 1955 - [441]
- \* " " 1956 - [442],[443]
- \* Bradbury 1957 - [439]
- \* Bradbury and Standen 1958 - [444]
- \* " " 1958 - [445]
- \* Bridges 1959 - [448]
- \* Perlowagora-Szumlewieca 1953 - [456]

#### Chlorobenzene

- \* Gessner and Smith 1960 - [457],[458]
- \* Kikal and Smith 1958 - [459]

#### Co-Ral

- \* Vickery and Arthur 1960 - [519]

#### Delnav

- \* Arthur and Casida 1959 - [520]

#### Diazinon

- \* Krueger et al. 1960 - [541]

### DFP

\* Iyatomi et al. 1957 - [527]

727 Winteringham, F.P.W., Harrison, A., McKay, M.A., Weatherley, A. BIOCHEMISTRY OF DIISOPROPYL-PHOSPHOROFLOURIDATE POISONING IN THE ADULT HOUSEFLY. Biochem. J. 66 (1957) 49P-50P.

A considerable reduction in the rate of [ $C^{14}$ ] acetylation of choline by the insect in vivo as the result of DFP is reported. The stimulated respiration and glutamine accumulation indicate possibly fatal biochemical lesions in addition to that of cholinesterase inhibition in the DFP-poisoned insect. This view is supported by the fact that massive doses of pyridine-2-aldoxime methiodide (PAM) failed to protect the DFP-treated fly from the stimulated respiration and some delayed lethal effect, although it protected the insect from the typical paralysis. The same dose of PAM alone did not have toxic effects on the insect. It is a potent reactivator of inhibited mammalian cholinesterase in vitro and in vivo, and will protect mammals from otherwise lethal doses of DFP.

### DDT

\* Butts et al. 1953 - [464]

\* Gjullin et al. 1952 - [466]

\* Hagley and Morrison 1958 - [467]

\* Hoffman et al. 1951 - [469]

\* " 1952 - [470]

\* Hoskins and Witt 1958 - [471]

\* LeRoux and Morrison 1954 - [474],[475]

\* Lindquist et al. 1951 - [478],[479]

\* Lindquist and Dahm 1956 - [477]

\* Morrison and LeRoux 1954 - [482]

\* Perry et al. 1955 - [485]

\* Perry and Buckner 1958 - [486]

\* Robbins and Dahm 1955 - [487]

\* Roth and Lindquist 1953 - [488]

\* Schmidt and Weidhaas 1959 - [490]

728 Terriere, L.C., Schonbrod, R.D. THE EXCRETION OF RADIOACTIVE METABOLITE BY HOUSE FLIES TREATED WITH CARBON $^{14}$  LABELED DDT. J. econ. Ent. 48, 6 (1955) 736-9.

The study was aimed at investigating the fate of DDT in resistant and susceptible flies. The observations of previous authors concerning the production of a metabolite other than DDE have been confirmed. Resistant and susceptible houseflies have been examined for evidence of metabolism of DDT up to 14 days after treatment with radioactive insecticide. Susceptible flies, given sublethal doses, have been shown to excrete up to 88% of the dose in the form of a water-soluble conjugate. Resistant flies show a similar detoxification and excretion capacity. The excretion begins during the first day after treatment and appears to continue until all of the absorbed dose has been metabolized. The conjugate is hydrolyzable with acid to produce a compound weakly acidic in nature. Attempts to identify this compound have met with no success although several possible structures have been eliminated.

\* Weidhaas and Schmidt 1960 - [491]

- \* Weidhaas et al. 1960 - [492]
- \* Winteringham et al. 1951 - [493]
- \* Winteringham 1952 - [494]

#### Dipterex

- \* Acree et al. 1956 - [554]
- \* Arthur and Casida 1957 - [555]
- \* Arthur and Casida 1958 - [556]
- \* Metcalf et al. 1959 - [557]

#### DNP

- \* Fleischer et al. 1957 - [707]

#### Endrin & Isodrin

- \* Brooks 1960 - [498]

#### Fumigants

- 729 Winteringham, F. P. W., Hellyer, G. C. EFFECTS OF METHYL BROMIDE, ETHYLENE DIBROMIDE, AND ETHYLENE DICHLORIDE ON THE PHOSPHORUS METABOLISM OF MUSCA DOMESTICA L. Biochem. J. **58** (1954) xlv-xlvi.

A comparison was made of the effects of methyl bromide, ethylene dibromide, and ethylene dichloride on  $P^{32}$ -labelled intermediates extracted from the thoracic muscles of houseflies. The slow depletion of phosphoglycerate by the first two chemicals suggested a common inhibition of triose phosphate dehydrogenase; they thus resembled iodoacetate in their action. Depletion of ATP and arginine phosphoric acid by methyl bromide indicated a rapid blocking of the phosphorylation of nucleotide acceptors.

- 730 Winteringham, F. P. W., Hellyer, G. C., McKay, M. A. EFFECTS OF METHYL BROMIDE ON PHOSPHORUS METABOLISM IN THE ADULT HOUSEFLY. Biochem. J. **69** (1958) 640-8.

A quantitative study is described (see preliminary communication by Winteringham and Hellyer, 1954). Techniques described earlier (Winteringham, Bridges and Hellyer, 1955) were used with only minor modifications for  $P^{32}$ -labelling of the soluble intermediates of the adult insect *in vivo*, and for their extraction. The paper-radiochromatographic techniques used were also very similar to the previous ones. The chemical identity of the labelled fractions is discussed, and details are given of the ages and conditions of the insects used, and of their treatment. Tabulated data are presented on the distribution of soluble phosphorus in tissues of the adult insect; the effects of methyl bromide on the distribution of soluble  $P \dots$ , *in vivo*; of the effects of ethylene dichloride vapour and injected iodoacetic acid on the distribution of soluble  $P \dots$ , *in vivo* and of the effect of methyl bromide on tissue nucleotides of the adult housefly *in vivo*. The significance of the results are discussed, particularly with regard to changes in ATP-levels.

#### Malathion

- \* Darrow and Plapp 1960 - [563]
- \* March et al. 1956 - [567]
- \* Mengle et al. 1959 - [568]
- \* Krueger and O'Brien 1959 - [565]
- \* Krueger and O'Brien 1959 - [566]

#### Paraoxon

- 731 Mengle, D.C., Lewallen, L.L. METABOLISM OF P<sup>32</sup>-LABELED PARAOXON IN NORMAL AND PHOSPHATE-RESISTANT STRAINS OF THE MOSQUITO Aedes nigromaculis LUDLOW. Bull. ent. Soc. Amer. 6, 3 (1960) 153, abstr. 72.

The nature and quantity of hydrolysis products were determined following administration of Paraoxon to mosquito larvae. Chromatographic results indicate differences in detoxification rate between the resistant and normal strains. Additional studies were made with P<sup>32</sup>-labelled material attempting to correlate resistance with rate of hydrolysis.

#### Parathion

- \* Gar et al. 1954 - [573]
- \* Lockau et al. 1951 - [581]
- \* Lockau and Lüddecke 1952 - [582]
- \* Tomizawa et al. 1960 - [588]

#### Phorate

- \* Bowman and Casida 1958 - [590], [591]

#### Pyrethrins

- \* Blum and Kearns 1956 - [669]
- \* Bridges 1957 - [670]
- \* Earle 1952 - [671]
- \* Hopkins and Robbins 1957 - [672]
- \* Pellegrini et al. 1952 - [675]
- \* Schmidt and Dahm 1956 - [676]
- \* Winteringham 1952 - [678]
- \* Winteringham et al. 1955 - [679]
- \* Zeid et al. 1953 - [680]

#### Ronnel

- \* Hopkins 1960 - [599]
- \* Louloudes 1958 - [600]

#### Schradan

- \* Arthur and Casida 1958 - [604]
- \* David 1950 - [609]
- \* David 1951 - [750]
- \* Metcalf and March 1953 - [626]
- \* Pietri-Tonelli and March 1954 - [626]

### Sevin

- \* Eldefrawi 1960 - [740]

### Systox

- 732 Ahmed, M.K., Newsom, L.D., Emerson, R.B., Roussel, J.S. THE EFFECT OF SYSTOX ON SOME COMMON PREDATORS OF THE COTTON APHID. J. econ. Ent. 47, 3 (1954) 445-9.

Aphids which had been rendered moribund were supplied twice a day for a week as food to the predators in petri dishes. The predators tested were the Syrphids, Baccha clavata (F.), Metasyrphus wiedemanni (Johnson) and Allograpta obliqua (Say), the Coccinellids, Scymnus haemorrhous Lec., S. creperus Muls., Hippodamia convergens (Guér.), Ceratomegilla (Coelomegilla) maculata (Deg.) and Cycloneda sanguinea (L.), and the Chrysopids, Chrysopa rufilabris Burm. and C. oculata Say; larvae of all these species and adults of the Coccinellids were used and mortality counts were made daily. The different susceptibilities shown by the results are discussed. In some of the tests, Systox prepared from radioactive sulphur ( $S^{35}$ ) was used, and the predators were dried, ground and assessed for radioactivity. The radioactive material apparently accumulated in the bodies of the larvae, since third- and fifth-instar individuals that survived treatment showed 4.26 and 7.29 cpm/mg, as compared with 22.8 and 15.32 for those that were killed, respectively. Adults of H. convergens showed much less radioactivity than larvae when both fed on radioactive aphids, and adults that developed from such larvae showed less than the prepupae; the cast pupal skin showed much more than either. Larvae of Chrysopa oculata that fed for 8 d showed 1.54 cpm/kg, but survived.

- \* David 1957 - [632]  
 \* Eldefrawi and Gordon 1959 - [633]  
 \* Fukuto et al. 1955 - [635]  
 \* March et al. 1955 - [640]

### Tepp

- 733 Fernando, H.E., Roan, C.C., Kearns, C.W. THE PENETRATION, DISTRIBUTION AND METABOLISM OF ORGANIC PHOSPHATES IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA (LINN.). Ann. ent. Soc. Amer. 44, 4 (1952) 551-65.

In order to study the fate of organic phosphates in Periplaneta americana (L.), radioactive TEPP and Parathion were dissolved in acetone and administered to adults of both sexes by topical application to the cervical membrane or by mouth with a microsyringe. Quantitative data on the concentrations of the compounds in the tissues and blood after various periods were obtained by assay with a counter, and radioautographs were used to study the gross distribution of TEPP after topical application. The method of preparing them, which is suitable for use with compounds soluble in water and in the organic solvents used in the preparation of tissues for microtomy, is described. The distribution and relative concentrations of TEPP, Parathion and Paraaxon in the body of the cockroach are discussed, and also their rate of penetration. The effects of different dosages are described. Blood was found to be the chief medium of transmission of all the compounds in the body.

- \* Roan et al. 1950 - [653]

### Miscellaneous

- 734 Babers, F.H., Roan, C.C. DISTRIBUTION OF RADIOACTIVE PHOSPHORUS IN SUSCEPTIBLE AND RESISTANT HOUSE FLIES. J. econ. Ent. 47, 6 (1954) 973-5.

The strains of houseflies compared were the susceptible S-F, derived from NAIDM 1948 stock, and the resistant R-OB, selected for DDT resistance for 143 generations. Fly eggs were added to what amounted to a solution of about 0.135 mc  $P^{32}$ /ml. The culture was maintained in a room held at 26.2°C and 50.5% relative humidity. The resulting adults were fed, and later extracted by the methods described. It is concluded that housefly larvae are able to utilize inorganic phosphorus to synthesize phosphates of widely differing chemical nature. The radioactive phosphorus decreased rapidly in the adult insects except in the lipid fraction. The biological half life of the radioactive material was 4.7 d for the trichloroacetic acid fraction,

5.3 d for the residue, but more than 11 d for the lipid fraction. This work emphasizes the necessity for supplementing radioisotopic techniques with routine chemical procedures in the study of biological processes.

\* Benjamini et al. 1959 - [656],[657]

\* Bettini et al. 1955 - [499]

\* Bettini and Boccacci 1958 - [500]

\* Casida 1955 - [659]

735 Casida, J.E. TOXICITY OF AROMATIC ACIDS TO THE LARVAE OF THE MOSQUITO Aedes Aegypti L. AND THE COUNTERACTING INFLUENCE OF AMINO ACIDS. Biochem. J. 59, 2 (1955) 216-21.

The toxicity of benzoic acid to these larvae was reduced in the presence of glycine. The efficiency of this counteraction decreased as the larvae matured, and was greatest at pH 7 or below. The quantitative relationship of the decrease in benzoic acid toxicity in the presence of low glycine concentrations suggested an equimolar detoxication reaction. Benzoic acid was 15 times as toxic as hippuric acid to these larvae. Using [ $\alpha$ - $C^{14}$ ] glycine it was shown that mosquito larvae can synthesize hippuric acid and probably excrete the conjugated product. Thirty amino acids and closely related compounds were tested for their efficiency in reducing the toxicity of benzoic acid. Although glycine was the most efficient amino acid, in its absence many others were capable of reducing the toxicity of benzoic acid. The structural specificity for this counteraction is discussed. The toxicity of 50 aromatic or closely related compounds was determined. The relation of structure to the toxicity and mechanism of action of these acids is discussed. An example is presented for a synergistic action through competition for a common detoxication mechanism. (auth. summary)

\* David 1952 - [751]

\* Fredericksen and Lilly 1955 - [357]

\* Kossobutsky 1955 - [664]

736 Mengle, D.C., Casida, J.E. BIOCHEMICAL FACTORS IN THE ACQUIRED RESISTANCE OF HOUSEFLIES TO ORGANOPHOSPHATE INSECTICIDES. J. agric. Food Chem. 8, 6 (1960) 431-7.

The metabolic fate of  $P^{32}$ -labelled Diazinon, Malathion, and methyl Parathion was studied in three housefly strains, two of which were resistant to organophosphates. Rate differences between the strains in cuticle penetration, phosphorothionate oxidation, or phosphate hydrolysis did not appear to explain the resistance. The lesser *in vivo* cholinesterase inhibition in resistant than susceptible flies treated with the same dose of the organophosphate probably results from some other mechanism than detoxification. Flies treated with the organophosphate immediately after decapitation were similar to whole flies in the symptomatology of poisoning and degree of resistance. Evidence is presented for a "factor" in the thorax and/or abdomen which contributes to resistance by reducing the rate of cholinesterase inhibition without destroying active antilesterase organophosphate.

\* Plapp and Casida 1958 - [665]

737 Schmidt, C.H., Weidhaas, D.E. ABSORPTION AND TOXICITY OF THREE RADIOACTIVE INSECTICIDES IN LARVAE OF TWO SPECIES OF MOSQUITOES. J. econ. Ent. 51, 5 (1958) 640-4.

Acetone-water suspensions of solutions of radioactive DDT, Bayer 21/199, and Am. Cyanamid 12880 (O,O-dimethyl S-(N-methyl-carbamoylmethyl)-phosphorodithioate), labelled with  $C^{14}$  and  $P^{32}$  respectively, were tested against 4th-instar Anopheles quadrimaculatus Say and Aedes taeniorhynchus (Wied.) larvae (Culicidae; Diptera). Concentrations required for equivalent 24 h mortality were in the order of DDT < 21/199 < 12880. A. quadrimaculatus were more susceptible to DDT and 12880 but less to 21/199 than taeniorhynchus; however, at the  $LD_{50}$  only small differences (0.0033-0.0142  $\mu$ g/larva) were seen between species and chemicals. Increasing the number of quadrimaculatus larvae per unit volume resulted in lower mortalities with DDT, but no change with 21/199 and 12880. A. quadrimaculatus larvae exposed to 21/199 for 48 h absorbed a maximum amount in the first few hours but the mortality increased with time. When quadrimaculatus larvae were transferred to clean water, 73% of the acquired dosage of 21/199 was excreted in 12 h. Live larvae of both species absorbed more 21/199 than did dead larvae. (from auth.)

- \* Winteringham 1959 - [155]

## II-H-2 MAMMALS

### Surveys

- \* Lüdcke 1954 - [505]  
 \* Winteringham and Barnes 1955 - [433]  
 \* Winteringham 1957 - [724]

### Bayer 22408

- \* Boyd and Arthur 1960 - [726]

### Co-Ral

- \* Kaplanis et al. 1959 - [513]  
 \* Krueger et al. 1959 - [514]  
 \* Lindquist et al. 1958 - [515]  
 \* Radeleff and Claborn 1960 - [516]  
 \* Robbins et al. 1959 - [517], [518]  
 \* Vickery and Arthur 1960 - [519]

### DDT

- 738 Jensen, A.J., Cueto, C., Dale, W.E., Rothe, C.F., Pearce, G.W., Mattson, A.M. DDT METABOLITES IN FECES AND BILE OF RATS. J. agric. Food Chem. 5, 12 (1957) 919-25.

A study of DDT-derived products occurring in rat feces and bile, following the ingestion of DDT, show that the major products are complexed forms of DDA [bis(p-chlorophenyl) acetic acid] in both bile and feces. Uncomplexed DDA is found in the bile, and insignificant amounts of DDE [1,1-dichloro-2,2-bis(p-chlorophenyl)-ethylene] are present in both bile and feces. DDT-C<sup>14</sup> was used to demonstrate that the Schechter-Haller method fails to account, quantitatively, for these metabolites. Biliary excretion is responsible for almost all of the DDT metabolites in feces. Although bile and fecal metabolites have certain similarities, they are not necessarily identical. (from auth.)

- \* Rothe et al. 1957 - [489]

### Delnav

- \* Arthur and Casida 1959 - [520]

- 739 Chamberlain, W.F., Gatterdam, P.E., Hopkins, D.E. METABOLISM OF P<sup>32</sup>-DELNAV IN CATTLE. J. econ. Ent. 53 (1960) 672-5.

P<sup>32</sup>-labelled Delnav® (2,3-p-dioxanedithiol S, S-bis (O,O-diethyl phosphorodithioate)) was applied to steers dermally and orally. Analyses of blood, urine, and feces indicated that the insecticide was rapidly metabolized and excreted. After 7 d both animals showed only trace amounts of radioactivity in the urine and feces, but the elimination of 20.4% of the dermal treatment indicates efficient absorption of the insecticide in comparison with other organophosphorus insecticides. The presence of three major hydrolysis products in the urine of both animals indicates a cleavage of Delnav at the P-S-C as well as the P-S-C bond, with oxidation before or after hydrolysis. (auth.)

- \* Plapp et al. 1960 - [521]



### DFP

- 740 Jandorf, B.J., McNamara, P.D. DISTRIBUTION OF RADIOPHOSPHORUS IN RABBIT TISSUES AFTER INJECTION OF PHOSPHORUS-LABELLED DIISOPROPYL FLUOROPHOSPHATE. J. Pharmacol. 98 (1950) 77-84.

When  $P^{32}$ -labelled diisopropyl fluorophosphate (DFP), a highly toxic phosphoric ester, is injected intravenously in rabbits,  $P^{32}$  is retained in relatively large amounts by kidney, liver, and lung; other organs take up only small amounts. No correlation seems to exist between the cholinesterase activity (I) of rabbit organs and their ability to retain DFP-derived P. No significant retention of  $P^{32}$  in any tissue was found when labelled diisopropyl phosphate was administered. Of the total amount of DFP-derived  $P^{32}$  retained in liver, lung, and kidney, about 100% of it is protein-bound within 4 h after injection. In plasma of rabbits injected with labelled DFP, most of the  $P^{32}$  originally present is eliminated before regeneration of I has started. In the erythrocytes a maximum value of  $P^{32}$  associated with the cells is not attained until about an hour after injection and this level is maintained for at least 9 h. Maximum inhibition of I is maintained for the same length of time, then both the radioactivity and I inhibition decrease at the same rate and return to zero at approximately the same time. This indicates destruction of erythrocytes whose I was destroyed by DFP, and their replacement with new cells containing active cholinesterase. (CA 44: 4578e, 1950)

### Diazinon

- \* Krueger et al. 1960 - [541]

- \* Robbins et al. 1957 - [543]

- 741 Vigne, J.P., Chouteau, J., Tabau, R.L., Rancien, P., Karamanian, A. SUR LE MÉTABOLISME D'UN INSECTICIDE ORGANO-PHOSPHORÉ, LE DIÉTHYLTHIONOPHOSPHATE DE 2 ISOPROPYL 4 MÉTHYL 6 OXY-PYRIMIDINE, CHEZ LA CHÈVRE. Bull. Acad. Vét. 30 (1957) 85-92.

Les auteurs ont préparé un diazinon marqué avec du phosphore radioactif. Après en avoir administré per os 235 mg à une chèvre en fin de lactation, ils ont mesuré la radioactivité des urines, des fèces, du sang et du lait. Cette étude montre une élimination rapide et complète du produit en 3 ou 4 jours. Seule l'élimination radioactive, d'ailleurs extrêmement faible du lait reste linéaire et correspondrait au  $^{32}P$  provenant des réserves osseuses après métabolisme de l'insecticide. Le dosage de l'insecticide lui-même, soit par extraction, soit par la mesure de l'activité anticholinestérasiq ue des excréti ons montre une élimination très minime (2 à 3 mg) de la dose totale en 4 jours, indiquant que la quasi-totalité de l'insecticide est métabolisé et le  $^{32}P$  éliminé sous forme de phosphates organiques ou minéraux autres que l'insecticide. Ce comportement différencie nettement les insecticides organophosphorés des insecticides chlorés.

- 742 Vigne, J.P., Chouteau, J., Tabau, R.L., Rancien, P., Karamanian, A. CONTRIBUTION À L'ÉTUDE DU MÉTABOLISME D'UN INSECTICIDE ORGANO-PHOSPHORÉ, LE DIÉTHYLTHIONOPHOSPHATE DE 2 ISOPROPYL 4 MÉTHYL 6 OXY-PYRIMIDINE. Ann. Epiphyt. 8, 2 (1957) 225-34.

A female goat (36.5 kg) was given a single oral dose of  $P^{32}$ -labelled Diazinon (O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate) towards the end of the lactation period. Excretion of radioactive material in the urine, faeces and milk, measured with a G-M counter was completed within 4 d, and the blood was free within 2 d. Only very small amounts were found in the milk or blood. Only the urine showed any ability to inhibit horse-serum cholinesterase, and this was of a low order and persisted only for 3 d. The trial was repeated with similar results a month later, and it is concluded that Diazinon, unlike the chlorinated-hydrocarbon insecticides, is rapidly metabolized in the animal body. (from RAE-A 47:214, 1959)

### Dimethoate

- \* Chitwell and Beecham 1960 - [763]

- \* Dauterman et al. 1959 - [552]

- \* Dauterman et al. 1960 - [551]

- \* Kaplan et al. 1959 - [553]

### Dipterex

\* Arthur and Casida 1958 - [556]

- 743 Robbins, W. E., Hopkins, T. L., Eddy, G. W. THE METABOLISM OF  $P^{32}$ -LABELED BAYER L13/59 IN A COW. J. econ. Ent. 49, 6 (1956) 801-6.

A study was made of the metabolism and excretion of  $P^{32}$ -labelled Bayer L13/59 (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) by a lactating Hereford cow to which it was administered orally at the rate of 25 mg/kg and of its uptake by larvae of Hypoderma bovis (Deg.) in cysts in the cow's back. Radioactivity appeared to be dissipated more slowly in the exudate in the cysts of H. bovis than in the blood. Only low levels of radioactivity were detected in larvae removed at various times after treatment, and the maximum per unit weight was found in those removed after 6-24 h. The percentage of radioactivity administered appearing up to 144 h after treatment in the milk is discussed. L13/59 was rapidly metabolized by the cow and eliminated in the urine. The rate of elimination is described. Ready absorption of L13/59 by the cow was implied by the small amount of radioactivity in the feces. Less than 3% of the dose was accounted for in all fecal samples collected. (RAE-B 46: 21-22, 1958)

### DNP

\* Sacks and Marott Sinex 1952 - [709]

### Fumigants

- 744 McCollister, D. D., Beamer, W. H., Atchison, G. J., Spencer, H. C. ABSORPTION, DISTRIBUTION, AND ELIMINATION OF RADIOACTIVE CARBON TETRACHLORIDE BY MONKEYS UPON EXPOSURE TO LOW VAPOR CONCENTRATIONS. J. Pharmacol. 102 (1951) 112-4.

The distribution of radioactive material in different tissues was examined, following absorption of  $C^{14}Cl_4$ . In order to study the metabolism of  $CCl_4$ , monkeys were exposed to low vapour concentrations of the radioactive form. Rhesus monkeys inhaled air containing 46 ppm of  $C^{14}$ -labelled  $CCl_4$  for 139-300 minutes. About 30% of the inhaled  $CCl_4$  was absorbed. The highest concentration of deposited radioactive material was in the fat (7.94 times the concentration in the blood).  $C^{14}$  was found in the blood carbonate, exhaled  $CO_2$  and urinary urea and carbonate. Most of the radioactivity in the urine appeared to be present in a non-volatile fraction other than urea, carbonate, or amino acids. This material was retained on anion-exchange resin and was converted to another unidentified substance by acid hydrolysis. The equivalent of at least 51% of the absorbed  $CCl_4$  was eliminated in the expired air within 1800 h. The remainder was excreted to a large extent in the urine and feces. In monkeys receiving skin exposures to radioactive  $CCl_4$  vapour for 4 h negligible amounts of radioactive material were found in the blood and expired air. (cf. CA 45: 81361, 1951)

\* Strittmatter et al. 1950 - [428]

### Malathion

\* Knaak and O'Brien 1960 - [564]

\* March et al. 1956 - [567]

- 745 March, R. B., Metcalf, R. L., Fukuto, T. R., Gunther, F. A. FATE OF  $P^{32}$ -LABELED MALATHION SPRAYED ON JERSEY HEIFER CALVES. J. econ. Ent. 49, 5 (1956) 679-82.

Two Jersey heifer calves were each treated twice at an interval of two weeks with one US pint spray containing 0.5%  $P^{32}$ -labelled Malathion, and the fate of the Malathion and its metabolites was studied after the second application. The Malathion was rapidly absorbed, metabolized and eliminated in the urine; 98-99% of the radioactive material eliminated was in the form of water-soluble metabolites and degradation products, and the amount of activity appearing in the urine was greatest in the first 24 h, after which it gradually decreased. The calves were killed one and two weeks after the second spraying, and residues in ten cuts of the meat and in tongue, brain, spinal cord, thymus, thyroid, pancreas, kidney, liver, heart, rumen, suet, bone, marrow and hide were determined radiometrically. Only water-soluble metabolites and degradation products were present in detectable quantities in the tissues, except in the hide, where some of the labelled compounds recovered after two weeks was in the form of unchanged Malathion and chloroform-soluble metabolites. Total residues in the meat cuts were low (0.05 - 0.15 ppm)

and indicated very uniform distribution throughout the animal. Somewhat higher values (0.15-0.18 ppm) for the tongue were probably attributed to the heifers' habit of licking themselves. Higher residues (0.2-2 ppm) were found in thymus, thyroid, pancreas, liver and bone, and indicated that phosphorus from the degraded compounds was being used in the normal metabolic activities of the animal. The largest amounts (3-18 ppm) were found in the hide. Chemical analysis for Malathion in tissues of foreleg, hind leg and rump of the two heifers showed no detectable Malathion (less than 0.2 ppm). (RAE-B 45: 177, 1957)

\* Seume and O'Brien 1960 - [569]

#### Nicotine

\* Bennett et al. 1954 - [881]

\* Ganz et al. 1951 - [995]

\* Larson and Harlow 1958 - [596]

#### Parathion

\* Ahmed et al. 1958 - [571]

\* Jäger 1953 - [576]

\* Jensen 1952 - [577]

\* Lüdcke 1954 - [584]

#### Phorate

\* Bowman and Casida 1958 - [590], [591]

#### Phosdrin

746 Casida, J.E., Gatterdam, P.E., Knaak, J.B., Lance, R.D., Niedermeier, R.P. BOVINE METABOLISM OF ORGANOPHOSPHATE INSECTICIDES. SUBACUTE FEEDING STUDIES WITH  $O,O$ -DIMETHYL 1-CARBO-METHOXY-1-PROPEN-2-YL PHOSPHATE. J. agric. Food. Chem. 6, 9(1958) 658-62.

Dairy cows that ingested subacute doses of Phosdrin (dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate) daily in capsules for a period of 12 weeks showed marked blood-cholinesterase inhibition, but the insecticide was not detected in their milk or tissues. Tests with radioactive Phosdrin confirmed the lack of significant residues in milk or tissues and showed that the chemical was rapidly detoxified and excreted as dimethyl phosphoric acid. Calves that were fed on milk from the cows also showed reduced blood-cholinesterase activity. The compound was hydrolyzed by cow, calf and human plasma to yield dimethyl phosphoric acid. (from auth. summary)

\* Gatterdam et al. 1957 - [596]

#### Ronnel

\* Louloudes 1958 - [600]

\* Piapp and Casida 1958 - [601]

\* Robbins et al. 1956 - [602]

#### Schradan

\* Arthur and Casida 1958 - [604]

\* Gardiner and Kilby 1950 - [610]

\* Gardiner and Kilby 1952 - [612]

- 747 Hofmann-Credner, D., Siedek, H. DISTRIBUTION AND FATE OF SCHRADAN (BIS-DIMETHYL-AMINO-PHOSPHONOUS ANHYDRIDE) IN MAMMALS, USING A RADIOACTIVE COMPOUND. Arch. int. Pharmacodyn. 89, 1 (1962) 74-81.

The distribution, destruction and excretion of the above named compound (D), an anticholinesterase, was investigated in rats and rabbits. I is less toxic than DFP. High concentrations of unchanged I were found in the liver and skeletal muscles, and in the latter most was found when the animal was convulsed. Little is found in brain in acute or subacute poisoning. Metabolic products were excreted in bile, urine and feces. The intraperitoneal route was the most effective mode of administration. (EM 2: 447, 1963)

- \* Kilby 1953 - [622]

#### Systox

- \* Fukuro et al. 1955 - [635]  
\* March et al. 1955 - [640]  
\* Tietz 1960 - [652]

#### Miscellaneous

- \* Halberstadt 1958 - [502]  
" 1959/1960 - [503]  
\* Plapp and Casida 1958 - [685]

### II-H-3 PLANTS

#### Surveys

- \* Lüdcke 1954 - [505]  
\* Metcalf 1960 - [413]

- 748 Spencer, E. Y. SIGNIFICANCE OF PLANT METABOLITES OF INSECTICIDES. Canad. J. Biochem. Physiol. 37 (1959) 1146-50.

Review article. The metabolites of insecticides produced by plants are known to be mostly derived from the organophosphorus insecticides with the exception of Aldrin which may be oxidized to Dieldrin. The residue of the relatively stable chlorinated hydrocarbons is largely reduced by the microflora in the soil. Activation, degradation, selective toxicity, etc., are discussed with frequent reference to results obtained by means of radiotopes.

#### Amiton

- \* Baldit 1958 - [512]

#### Bayer 22408

- \* Boyd and Arthur 1960 - [726]

#### BHC

- \* Bradbury and Whitaker 1956 - [446]

#### Carbamate

- \* Fang and Theisen 1960 - [705]  
\* Baldwin et al. 1954 - [702]

#### DDT

- \* Lichtenstein and Schulz 1960 - [476]

\* Winteringham 1951 - [761]

### Delnav

749 Casida, J. E., Ahmed, M. K. MECHANISM OF RESIDUE LOSS OF HERCULES AC-528 COMPONENTS ON PLANT FOLIAGE. J. econ. Ent. 52 (1959) 111-5.

The acaricide and insecticide, Hercules AC-528 (Delnav) is a mixture of the cis and trans isomers of 2,3-p-dioxanedithiol S,S-bis(O,O-diethyl phosphorodithioate) along with certain other phosphorodithioates. Loss of the Hercules AC-528 components from plants resulted from volatilization, hydrolysis, and the formation of more polar derivatives and more potent anticholinesterase agents. The cis and trans isomers were similar in persistence so that the isomer ratio did not change during residue loss from that of the insecticide initially applied to the plants. No inter-conversion occurred on plants between the cis and trans isomers and the dioxene derivative, which is an impurity in the technical insecticide. The components of Hercules AC-528 were only slowly hydrolyzed on the plant surface but rapidly when absorbed into the plants. Several of the components were converted to more polar derivatives and more potent anticholinesterase agents when applied to plants. This conversion may be due in part to the formation of phosphorothiolate derivatives. Attempts at chemical oxidation of certain components of Hercules AC-528 to yield the phosphorothiolate derivatives were only partially successful. Several components of technical Hercules AC-528 and certain non-hydrolyzed derivatives formed from the Hercules AC-528 components after application to plants are not determined by the residue analysis procedure of Dunn. The toxicological significance of the organophosphate present in residues of Hercules AC-528 on crops but not determined by the colorimetric method of analysis cannot be fully evaluated with the limited data presented in the paper. Hercules AC-528 was labelled with P<sup>32</sup> by preparation and purification techniques described earlier (Casida and Arthur 1958). (auth.)

### Di-Syston

\* Carter and Gortner 1958 - [558]

\* Metcalf et al. 1959 - [559]

\* Reynolds et al. 1957 - [560]

### Gusathion

\* Tietz et al. 1957 - [562]

\* Tietz et al. 1960 - [561]

### Malathion

\* Tomizawa and Sato 1960 - [570]

### Nicotine

\* Toczko 1960 - [701]

### Parathion

\* Gar and Kiplani 1956 - [574]

\* Kiplani and Gegenava 1955 - [579]

\* Lüdcke 1952 - [583]

\* Lüdcke 1954 - [584]

### Phorate

\* Bowman and Casida 1957 - [589]

\* Bowman and Casida 1958 - [590], [591]

\* Haczky et al. 1959 - [593]

\* Reynolds et al. 1957 - [595]

#### Phosdrin

\* Getzin and Chapman 1959 - [597]

#### Sulphur-35

\* Turrell 1950 - [710]

\* Turrell and Chervenak 1959 - [711]

#### Schradan

\* Arthur and Casida 1958 - [604]

\* Batt et al. 1954 - [605]

\* Bennett and Thomas 1952 - [606]

\* " " " 1953 - [607]

\* " " " 1954 - [608]

\* David 1950 - [609]

750 David, W.A.L. INSECTICIDAL-ACTION STUDIES WITH BISDIMETHYLAMINOPHOSPHONOUS ANHYDRIDE CONTAINING  $^{32}$ -PHOSPHORUS. Ann. appl. Biol. 38, 2 (1951) 508-24.

The radioactive anhydride was absorbed by the roots of broad bean plants placed in culture solutions containing it. The level of radioactivity in the plant increased as the solution was absorbed and was higher in the washed roots than in the rest of the plant. The activity of the remaining culture solutions increased as more was absorbed, showing that the roots selectively reject the radioactive anhydride. The material was absorbed more slowly from soil than from sand. In both cases, the concentration per gram of tissue was highest in the leaves on the middle part of the stem. By introducing the insecticide by the cut tap-root technique, it was shown that 50% of the anhydride is decomposed within the plant in 8 d. The concentration of undecomposed anhydride in the plant necessary to give a complete kill of *Aphis fabae* Scop. was found to be about 50 mg/kg plant tissue. Dead aphids were found to contain about 15-20 mg/kg radioactive material calculated on the assumption that it was undecomposed anhydride. The honeydew of aphids feeding on treated plants was also radioactive. Absorption and translocation of the radioactive material occurred following application to the leaves of broad bean, cabbage, hop, pea and strawberry. In broad bean, radioactive material was detected within the leaf a few hours after it had been applied to the surface. In all plants, there was evidence that radioactive material is translocated to untreated parts. Much more was translocated to leaves younger than to leaves older than those treated. In favourable cases, where a large number of leaves on the plant was treated, where the plant held a large quantity of the anhydride applied, or where a heavy dose was given, either by repeated treatments or by the use of high concentrations, insecticidal quantities of what was presumed to be the anhydride were translocated to untreated young growing parts of the plants. No measurable quantity of radioactive material was transpired by plants taking up the material through the roots.

751 David, W.A.L. INSECTICIDAL-ACTION STUDIES WITH BISDIMETHYLAMINO FLUOROPHOSPHINE OXIDE CONTAINING  $^{32}$ PHOSPHORUS. Ann. appl. Biol. 39, 2 (1952) 203-10.

The absorption of the systemic insecticide bis(dimethylamino) fluorophosphine oxide containing  $P^{32}$  was studied and, where possible, comparisons were made with Schradan (bisdimethylaminophosphonous anhydride). The radio-oxide was absorbed by the roots of broadbean plants from culture solutions. The level of radioactivity in the plant increased as the solution was absorbed and was higher in the roots than in the rest of the plant. The radioactivity of the remaining culture solution decreased as more of it was taken up by the plants, showing that the roots selectively absorb the oxide from solution. In this respect, it differs from Schradan, which is selectively rejected at similar rates of transpiration. At the end of a day with roots in the culture solution, the plants became free from aphids. The radio-oxide was absorbed more rapidly by

plants growing in sand than in soil, and aphids were killed at lower dosages and in shorter periods on the former plants than on the latter. An appreciable part of the oxide absorbed by the roots is given off as vapour by the leaves. This vapour was collected and shown to be radioactive and toxic to Aphis fabae Scop. on the cut tops of broad bean plants. Examples of A. fabae feeding on treated plants were shown to contain radioactive material. The radio-oxide was less soluble in lipoids than Schradan and did not penetrate as readily into leaves of broad beans. Since it is also lost by vaporization from the plants, only small amounts were translocated following leaf applications to broad bean, cabbage and hops.

\* Hartley and Heath 1951 - [616]

\* Heath et al. 1952 - [618]

\* " " 1953 - [617]

\* Heath and Llewellyn 1953 - [619]

\* Heath et al. 1955 - [620]

\* Metcalf and March 1953 - [624]

\* Metcalf et al. 1955 - [625]

\* Stein et al. 1952 - [627]

752 Thomas, W.D.E., Bennett, S.H. THE ABSORPTION, TRANSLOCATION AND BREAKDOWN OF SCHRADAN APPLIED TO LEAVES, USING <sup>32</sup>P-LABELLED MATERIAL. III. TRANSLOCATION AND BREAKDOWN, Ann. appl. Biol. 41, 3 (1954) 501-19.

The translocation of P<sup>32</sup>-labelled Schradan from dipped or sprayed leaves was studied in apples, chrysanthemums, broad and runner beans and Coleus. Light was found to be perhaps the most important single factor in promoting translocation in bean, apple, and chrysanthemum, suggesting that the insecticide moved along with the products of photosynthesis. The direction of translocation from lower or middle leaves was predominantly upward toward new growth although small amounts were found in the lowest leaves of apple and chrysanthemum following application to middle leaves. Upward translocation occurred largely in the phloem in apple stocks. Although limited upward translocation also occurred in the xylem, downward translocation occurred exclusively in the phloem. No major difference has been observed in the ratio translocated/absorbed for Coleus, beans and chrysanthemums but in apples this proportion is greater. The breakdown of Schradan into non-chloroform-extractables varies between plant species and is far greater in beans than in Coleus. In chrysanthemums and apples the breakdown appears similar throughout the plant whilst in beans and, possibly, Coleus the breakdown in the untreated sections is higher. Concentrations necessary for the kill of certain species of aphids are given (80% mortality for Aphis fabae Scop. with 10-15 µg/g of fresh weight of plant tissue, 20-25 µg/g for Macrosiphum (Macrosiphoniella) sabornii Gill. and 20-30 µg/g for Aphis pomi Deg.)

(cf. I. "Experimental techniques" by Batt et al., and  
II. "Evaporation and absorption" by Bennett and Thomas)

\* Wedding and Metcalf 1952 - [629]

#### Systemic

\* Ahmed et al. 1954 - [630]

\* Chatters 1953 - [631]

753 David, W.A.L., Gardiner, B.O.C. THE APHICIDAL ACTION OF SOME SYSTEMIC INSECTICIDES APPLIED TO SEEDS. Ann. appl. Biol. 43, 4 (1955) 594-614.

The authors studied the process of absorption of systemic insecticides by seeds. P<sup>32</sup>-Systox thiol isomer was not selectively absorbed by broad bean seeds from 0.05% solution, but penetrated at an equal rate with the water. Maximum absorption occurred over a 24-h period but was quite variable with individual seeds. In comparing the amount of radioactivity in seed coat and cotyledons, it was found that after 4 h of soaking an

average of ca. 73% of the material was in and on the seed coat, but after 24 h only 35% remained. Removal of the seed coat from seeds treated for 4 h showed that insecticide held in the seed coat at time of planting was subsequently translocated into the growing plant in quantities lethal to *Aphis fabae*. Translocation occurred directly from the material absorbed in the cotyledons which passed to the leaves along with the food reserves. However, some of the toxicant was also found to have diffused out of the treated seed into the soil where it was subsequently absorbed by the roots. It is clear that these two methods of absorption also apply to seed coats where the relative rates of absorption depend upon the lipid and water solubility of the toxicant; the sorptive power of the coating substance, generally charcoal; and the adherence of the coating to the treated seed.

\* David 1957 - [632]

\* Fukuto et al. 1955 - [635]

\* Fukuto et al. 1956 - [636]

754 Fukuto, T. R., Wolf, J. P., III., Metcalf, R. L., March, R. B. IDENTIFICATION OF THE SULPHONE PLANT METABOLITE OF THE THIONO ISOMER OF SYSTOX. J. econ. Ent. 50, 4 (1957) 399-401.

Experiments are described on the metabolism of  $O,O$ -diethyl  $S$ -2-(ethylthio)ethyl phosphorothioate [Demeton-O] in cotton plants. Demeton-O prepared with  $P^{32}$  was applied to the bases of young plants, and leaves were picked after 10 d and treated by methods that are described to recover and isolate the metabolites. One of these was found by examination of its infra-red spectrum to be identical with  $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorothioate (the thionophosphate sulphone), which is therefore shown to be a metabolite of Demeton-O. It is a secondary one, since the first step in the metabolism of Demeton-O in plants has been found to be conversion to the sulphoxide,  $O,O$ -diethyl  $S$ -2-(ethylsulphinyl)ethyl phosphorothioate. (from RAE-A 46; 336, 1958)

\* Hartley 1952 - [638]

\* Metcalf et al. 1954 - [641]

\* Metcalf et al. 1956 - [642]

\* Metcalf et al. 1957 - [644]

755 Metcalf, R. L., Fukuto, T. R., March, R. B. PLANT METABOLISM OF DITHIO-SYSTOX AND THIMET. J. econ. Ent. 50, 6 (1959) 338-46.

When the bases of young cotton and lemon plants were treated with dithio-Systox [ $O,O$ -diethyl  $S$ -2-(ethylthio)ethyl phosphorodithioate] and Thimet [ $O,O$ -diethyl  $S$ -ethylthiomethyl phosphorodithioate] synthesized from  $P^{32}$ , they were absorbed and translocated at about equal rates, but only about 0.5-0.75 times as fast as Demeton-S [ $O,O$ -diethyl  $S$ -2-(ethylthio)ethyl phosphorothioate], which was found to be much more soluble in water. The processes of metabolism for the two compounds were primarily oxidative. After uptake of dithio-Systox by cotton, lemon, bean or lucerne plants, the compound was oxidized very rapidly to produce the sulphoxide, [ $O,O$ -diethyl  $S$ -2-(ethylsulphinyl)ethyl phosphorodithioate], and more slowly to produce the corresponding sulphone, [ $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorodithioate]. The sulphoxide and sulphone, were also oxidized to produce  $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorothioate and  $O,O$ -diethyl  $S$ -2-(ethylsulphonyl)ethyl phosphorothioate, respectively. Thus, at intervals of a few days to a month after application, all 4 oxidation products may be present in plant residues, but no dithio-Systox remains. Thimet behaved in an analogous manner, but showed different rates of metabolism. The sequence of consecutive reactions for dithio-Systox and Thimet in isolated cotton leaves was plotted, and preliminary investigations on their kinetics were made. All the simple oxidative metabolites of dithio-Systox and Thimet were prepared in the pure state, and their properties recorded; the successive steps in oxidation increased the anti-cholinesterase activity of both compounds, as measured against fly-brain cholinesterase, the Thimet series being somewhat the more active of the two. Typical harvest residues of the dithio-Systox metabolites were evaluated in experiments in which the radioactive compound was used as a direct spray on cotton plants 52 d before harvest and as a seed treatment for lucerne. The results indicated that the ultimate toxic residues are present in only fractional parts per million. The application of the knowledge of the metabolism of these compounds in plants to analytical studies by cholinesterase assay is briefly discussed. (from auth. summary)



- \* Mühlmann and Tietz 1956 - [645]
- \* Stein and Smith 1954 - [646], [647]
- \* Thomas and Glynne Jones 1955 - [648]
- \* Thomas et al. 1955 - [649]
- \* Tietz 1954 - [651]

756 Wedding, R. T. PLANT PHYSIOLOGICAL ASPECTS OF THE USE OF SYSTEMIC INSECTICIDES. J. agric. Food Chem. 1, 13 (1953) 832-4.

Partly review. Investigations are reported in which radioactive tracer-labelled Systox ( $S^{35}$ ) and OMPA ( $P^{32}$ ) have been used. When Systox is applied to the stem or leaves of citrus plants it is translocated both up and down in the phloem at first, but gradually diffuses into the xylem. The rate of movement in the phloem was determined to range from 2.5 to 10 cm/h.

#### Miscellaneous

- \* Bowman and Casida 1958 - [658]
- \* Halberstadt 1959/1960 - [503]

757 Voight, G. K. EFFECT OF FUNGICIDES, HERBICIDES, AND INSECTICIDES ON THE ACCUMULATION OF PHOSPHORUS BY PINUS RADIALTA AS DETERMINED BY THE USE OF PHOSPHORUS $^{32}$ . Agron. J. 46 (1954) 511-3.

Results of greenhouse trials indicated that some of the eradicating agents inhibited the absorption of P and arrested the development of seedlings. This was especially true of  $Al_2(SO_4)_3$  and benzene hexachloride. Determinations of O uptake and P content of excised root tips showed that reduction of P accumulation in the tissue was accompanied by a decrease in the rate of O consumption. This response occurred within a relatively short time after the tissues had been exposed to the biocides, and was especially marked in the case of benzene hexachloride. The results point out the importance of obtaining uniform distribution of biocides in the soil as well as using the proper application rate to avoid injury to planting stock. (from CA 49: 5754d, 1955)

## II - I Insecticide Residues in

### II-1-1 MAMMALS

#### Bibliography

- \* McCormick 1958 - [799]

#### Co-Ral

758 Claborn, H. V., Bushland, R. C., Mann, H. D., Ivey, M. C., Radeleff, R. D. MEAT AND MILK RESIDUES FROM LIVESTOCK SPRAYS. J. agric. Food Chem. 8, 6 (1960) 439-42.

Before an insecticide can be recommended for use on livestock, studies must be made to determine whether it will contaminate meat and dairy products. Results of residue studies show that all the chlorinated hydrocarbon insecticides, Co-Ral, and Malathion were excreted in the milk after spray treatments. Studies were also made on DDT, TDE, methoxychlor, Chlordan, gamma Chlordan, Heptachlor, Dieldrin, Lindane, Strobane, Toxaphene, Malathion, and Co-Ral in the fat of beef cattle following spray treatments.  $P^{32}$ -labelled Co-Ral and Delnav were employed.

(A more detailed report was published in Dec. 1960 by Claborn and Radeleff "Pesticide residues in meat and milk" Agr. Res. Serv. US Dept. Agric., ARS-33-83, which also includes results on residues from insecticides on pasture and forage crops)

- \* Kaplans et al. 1959 - [513]

- \* Knueger et al. 1959 - [514]
- \* Radeleff and Claborn 1960 - [518]
- \* Robbins et al. 1959 - [518]

#### Delnav

- \* Plapp et al. 1960 - [521]

#### Diazinon

- \* Robbins et al. 1957 - [543]

#### Dimethoate

- \* Dauterman et al. 1959 - [552]
- \* Kaplanis et al. 1959 - [553]

#### Phosdrin

- \* Casida et al. 1958 - [746]
- \* Gatterdam et al. 1957 - [596]

#### Ronnel

- \* Robbins et al. 1956 - [602]
- \* USDA 1957 - [603]

### II-I-2 PLANTS

#### Surveys

- \* Metcalf et al. 1954 - [507]
- \* Redemann and Meikle 1958 - [781]

759 Zeumer, H. RÜCKSTÄNDE VON PFLANZENSCHUTZ- UND VORRATSSCHUTZMITTELN, VON SONSTIGEN SCHÄDLINGSBEKÄMPFUNGS- UND UNKRAUTBEKÄMPFUNGSMITTELN SOWIE VON MITTELN ZUR BEEINFLUSSUNG DES PFLANZENWACHSTUMS. LITERATUR-ÜBERSICHT. (Residues of materials used for the protection of plants and stored products, of miscellaneous materials used for the control of pests and weeds, and also of substances regulating plant growth. A review of the literature) Mitt. biol. Bundesanst. f. Land- u. Forstwirtschaft, Berlin-Dahlem. pt. 94, 124 p. Berlin 1958. (In German)

This is a bibliography of the literature published principally in 1955-57, arranged in sections concerned mainly with the level of residues on foodstuffs of plant origin, the effects of residues on domestic animals and plants, residues in soils, and methods of residue determination, including bioassay. Includes references relevant to the present bibliography. Alphabetical listing by first author. No index.

#### BHC

- \* Bridges 1958 - [447]

#### DDT

760 Winteringham, F.P.W., Harrison, A., Jones, C.R., McGirr, J.L., Templeton, W.H. THE FATE OF LABELED INSECTICIDE RESIDUES IN FOOD PRODUCTS. I. STUDIES WITH A RADIOACTIVE BROMINE ANALOGUE OF DDT. J. Sci. Food Agric. 1 (1950) 214-9.

A radioactive bromine analogue, 1:1:1-trichloro-2:2-di-(4-bromo\*phenyl)ethane, of the insecticide DDT has been used to indicate the fate of DDT sprayed on to wheat grain which is subsequently milled, baked

conditions, it was shown that the decomposition of methyl bromide in gluten was due almost entirely to methylation with the formation of 50% of N-methyl derivatives, 30% of dimethyl sulphonium derivatives, and of 20% of methoxyl and thiomethoxyl derivatives in about equal proportions. Similar results were obtained when gluten alone was exposed to the labelled fumigant. The production of free methanol in the flour by hydrolysis of the absorbed fumigant was about 10% or less. The rate of spontaneous decomposition of the dimethyl sulphonium compounds formed as a result of fumigation was estimated by using wheat which had been grown on S<sup>35</sup>-labelled sulphate. (auth.)

- 765 Bridges, R. G. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. III. N-METHYLATION AS A RESULT OF FUMIGATING WHEAT WITH METHYL BROMIDE. J. Sci. Food Agric. **6** (1955) 261-8.

The principal reaction between C<sup>14</sup>-labelled methyl bromide and the nitrogen-containing groups of wheat protein has been shown, by combined radioactive tracer-chromatographic techniques, to be with the histidine residue. Three methylated histidines are present in the hydrochloric acid hydrolysate of the protein that has been exposed to methyl bromide, and these have been identified as 1-N-methylhistidine, 3-N-methylhistidine and 1:3-N-dimethylhistidine. The amount of reaction occurring under typical fumigation conditions is so small that the loss of the semi-essential amino acid, histidine, is negligible. (auth.)

- 766 Bridges, R. G. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. V. THE NATURE AND SIGNIFICANCE OF ETHYLENE DIBROMIDE RESIDUES IN FUMIGATED WHEAT. J. Sci. Food Agric. **7**, 5 (1956) 305-13.

Ethylene dibromide labelled with radioactive bromine (Br<sup>82</sup>) was used to study the absorption in wheat during fumigation and on subsequent airing and heating. In spite of the high physical sorption of the fumigant and its slow rate of dispersal by airing, there is little chemical reaction between it and the wheat at room temperature. When fumigated wheat that has been imperfectly aired is heated, part of the ethylene dibromide sorbed on it undergoes decomposition to ethylene glycol and inorganic bromide, the remainder being lost by volatilization; as ethylene glycol is a less toxic material, heating provides a safeguard against possible poisoning due to ethylene-dibromide residues. There is some evidence that the glycol formed reacts with the wheat protein. The hydrogen bromide liberated when the ethylene dibromide is decomposed by heating appears to cause some splitting of the starch-granule sheaths. It is concluded that no significant changes appear likely to take place in the nutritive value of wheat as a result of fumigation.

- 767 Winteringham, F. P. W. THE FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. IV. THE POSSIBLE TOXICOLOGICAL AND NUTRITIONAL SIGNIFICANCE OF FUMIGATING WHEAT WITH METHYL BROMIDE. J. Sci. Food Agric. **6**, 5 (1955) 269-74.

The major products of the chemical reactions between methyl bromide and the constituents of wheat under the conditions of fumigation have been characterized or identified. Their rate of absorption by an adult human consuming fumigated flour products has been estimated. The likely nature of the effective end-products of human digestion has been considered and is believed to be represented by the compounds methanol, methylglucoses, S-methylcysteine, methyl methionine sulphonium salts, and N-methyl derivatives of histidine and lysine. These appear to be compounds which have been fed experimentally to mammals at concentrations very much larger than those likely to obtain in fumigated wheat. In some cases their metabolism *in vivo* has also been studied. On the basis of all the available data an appraisal has been made of the toxicological and nutritional significance of consuming fumigated flour products. There is no evidence that the principal fumigant decomposition products are toxic or that their formation would be associated with any significant reduction in essential food constituents. C<sup>14</sup>-labelled methyl bromide was used (see Winteringham, Harrison, Bridges and Bridges, 1955) (from auth.)

#### Gusathion

- \* Tietz et al. 1957 - [562]  
\* Tietz et al. 1960 - [561]

#### Malathion

- 768 Matsumura, F. MALATHION RESIDUES ON AND IN THE LEAVES OF PHASEOLUS VULGARIS. J. econ. Ent. **53** (1960) 452-4.

By using  $P^{32}$ -labelled Malathion, the speed of migration of Malathion in the tissues of *P. vulgaris* L. was measured. Speed of migration was found to be very low in leaves. Malathion was taken up by the leaf tissues very rapidly, and the rate of entry of Malathion into the tissue was found to satisfy Langmuir's absorption equation. It was found also that the slow dissipation of Malathion residues in the later stage (persistence stage) in this experiment was owing to the lower rate of evaporation effected by absorption of the insecticide by plant tissue. (auth.)

#### Parathion

- \* Gar and Kiplani 1956 - [574]

#### S<sup>35</sup>

- \* Turrell 1950 - [710]
- \* Turrell and Chervenak 1959 - [711]

#### Schradan

- \* Glynne Jones and Thomas 1953 - [613], [614]
- \* Heath et al. 1952 - [618]
- \* " 1953 - [617]
- \* Heath and Llewellyn 1953 - [619]
- \* Heath et al. 1956 - [621]
- \* March et al. 1954 - [623]
- \* Metcalf et al. 1955 - [625]

#### Systox

- \* David and Gardiner 1955 - [753]
- \* Hartley 1952 - [638]
- \* Metcalf et al. 1955 - [643]
- \* Mühlmann and Tietz 1956 - [646]
- \* Stein and Smith 1954 - [646], [647]
- \* Thomas and Glynne Jones 1955 - [648]
- \* Thomas et al. 1955 - [649]
- \* Tietz 1956 - [650]

#### Miscellaneous

- \* Casida et al. 1956 - [660]
- \* Halberstadt 1959/1960 - [503]

#### II-1-3 SOIL

#### DDT

- \* Jackson and Hopkins 1952 - [472]

\* Miles and Pearce 1957 - [481]

Parathion

\* Lichtenstein 1958 - [582]

Phorate

\* Getzin and Chapman 1960 - [592]

### III TECHNIQUES

#### Survey

- 769 Comar, C. L. RADIOISOTOPES IN BIOLOGY AND AGRICULTURE. PRINCIPLES AND PRACTICE. New York, McGraw-Hill Book Company, Inc. 1955, 481p.

Very useful book, with extensive bibliography. The principles of tracer methodology are discussed in detail, including isotope dilution techniques and double labelling. Different chapters deal with basic difficulties; facilities and handling of radioisotopes in animals and plants; general procedures for radioassays; properties and procedures for individual radioisotopes; autoradiography; paper chromatography; and radioactivation analysis. An author and subject index are included.

#### III - A Autoradiography

- 770 Duncombe, W. G. AN AUTORADIOGRAPHIC METHOD FOR DISTINGUISHING SAMPLES LABELLED WITH PHOSPHORUS-32 AND SULPHUR-35. Nature 183 (1959) 319.

The method used by Gillies (1958) for studying insects labelled with both  $P^{32}$  and  $S^{35}$  was modified by using film coated with photographic emulsion on both sides such as in most commercial x-ray films. Kodak "Kodirex" film was used for radiography of chromatograms which enables the two isotopes to be distinguished easily. It might be feasible to distinguish more than 2 isotopes by this method.

- 771 Gillies, M. T. A SIMPLE AUTORADIOGRAPHIC METHOD FOR DISTINGUISHING INSECTS LABELLED WITH  $P^{32}$  AND  $S^{35}$ . Nature 182 (1958) 1683-4.

Specimens labelled with both  $S^{35}$  or  $P^{32}$  could be distinguished by covering them with two pieces of x-ray film, and preparing autoradiographs. The low-energy  $S^{35}$   $\beta$ -particles (0.167 MeV) were found to blacken only one film, while the high-energy  $P^{32}$   $\beta$ -particles (1.71 MeV) penetrated the first film and blackened the second as well.  $S^{35}$ , in addition to  $P^{32}$ , is being used for field studies on Anopheles gambiae. The technique is described.

- 772 Mazia, D., Plaut, W. S., Ellis, G. W. A METHOD FOR THE QUANTITATIVE ASSESSMENT OF AUTORADIOGRAPHS. Exp. Cell Res. 9 (1955) 305-12.

An optical system for scanning autoradiographs is described. It is based essentially on forming a band pattern of the grains in a strip of the autoradiograph by means of a cylindrical lens camera and on the photoelectric recording of the distribution of band intensities along the strip. Examples in which Drosophila salivary gland preparations are used for measurements are given, where the DNA was measured in terms of  $P^{32}$ .

- \* Metcalf 1960 - [413]

- 773 Strlin, J. L. AUTORADIOGRAPHY OF NUCLEOLAR CONTENTS. Exp. Cell Res. 14, 3 (1958) 447-53.

Work on nucleoli of somatic cells, including those of the salivary gland of Drosophila, is described where  $S^{35}$ -labelled methionine was used. This and other results are discussed, emphasis being placed on the relations between DNA, RNA, and associated and non-associated proteins.

- 774 Winteringham, F. P. W., Harrison, A., Hammond, J. H. AUTORADIOGRAPHY OF WATER-SOLUBLE TRACERS IN HISTOLOGICAL SECTIONS. Nature 185, 4187 (1950) 149-50.

One method tried for locating water-soluble  $Br^{82}$  in larvae of Calliphora erythrocephala (alcoholic  $AgNO_3$  was used for dehydration and precipitation of the halide in situ) caused some damage to the tissue and the stripping emulsion applied afterwards. Useful autoradiographs of  $P^{32}$  have been obtained of larvae poisoned by methyl iodide, by a combination of the Altmann-Gersh process and a modified stripping-emulsion technique. The method is described in some detail with some illustrations.

### III - B Dosimetry

- 775 Gaulden, M.E., Sheppard, C.W., Cember, H. TECHNIQUE FOR EXPOSING GRASSHOPPER NEUROBLASTS TO BETA-RAYS. Nature 169 (1952) 228-9.

Mechanical details of an apparatus for exposing grasshopper embryos to radiation from  $P^{32}$ -bakelite plaques are illustrated. An accurate determination is possible of the amount of radiation to which the cells have been exposed. Maximum protection is provided for the operator. (NSA 6: 3887, 1952)

- 776 Hickey, J.D., Cooper, R.D. DOSIMETRY FOR STUDIES ON THE RADIOBIOLOGY OF TRIBOLIUM CASTANEUM USING THE VAN DE GRAAFF ELECTRON ACCELERATOR. J. econ. Ent. 53 (1960) 496-500.

A means is given for calculating the dose of radiation, in rads, absorbed by adult Tribolium castaneum (Hbst.) when irradiated with high-energy electrons from a Van de Graaff accelerator. The expression for dose is based on (1) the power output of the accelerator; (2) the amount of time the target (insect) is in the beam; (3) the fraction of the scanned area occupied by the target; (4) the fraction of the energy of the incident electrons which is lost in the target; and (5) the mass of the target. The expression is developed in detail on the basis of the ideal case, but possible departures from the ideal in practice are discussed. The physical parameters of the insect which pertain to the calculation of dose are reported. (auth.)

- \* King 1952 - [388]

- 777 Kloft, W. DIREKTES UND INDIKTES VERFAHREN ZUR MESSUNG DER BETA-STRAHLENABSORPTION VON KLEINEN GEWEBESCHICHTEN AN INSEKTEN. (Direct and indirect techniques for measuring  $\beta$ -ray absorption) G-I-T Glas+Instrumenten-Technik 3, 3 (1959) 79-110. (In German)

In order to determine directly the absorption coefficients for  $\beta$ -rays of different tissues, the various tissue layers of the  $P^{32}$ -labelled insects are removed. Changes in radiation intensity thus produced are measured. For a known, microscopically determined tissue thickness the true activity (minus the absorbing tissue) may be calculated from the measured impulse rate. In the indirect method, the original impulse rate is re-established by interposing aluminium foils of known surface density, which will give data on the chitinous cuticle. Possible errors and experimental details are discussed, and also other applications of the technique.

### III - C Isotope Dilution

- 778 Craig, J.T., Tyron, P.F., Brown, W.G. DETERMINATION OF THE GAMMA ISOMER CONTENT OF BENZENE HEXACHLORIDE BY CHLORINE-36 ISOTOPE DILUTION METHOD. Analyt. Chem. 25, 11 (1953) 1661-3.

Considerable disagreement among a number of analytical methods for determination of the  $\gamma$ -isomer of benzene hexachloride led to the development of a new isotope dilution method using  $Cl^{36}$ -labelled pure  $\gamma$ -isomer as a tracer. A known quantity of chemically pure radioactive  $\gamma$ -isomer of benzene hexachloride, labelled with  $Cl^{36}$ , is added to a known weight of a technical benzene hexachloride sample of unknown  $\gamma$ -content. A sample of pure  $\gamma$ -isomer is then isolated from the mixture by an extraction procedure. The specific activity of the isolated material is compared to that of the original labelled isomer. The standard deviation of the method is  $\pm 0.2\%$  in  $\gamma$ -isomer content. Four determinations can be made by one analyst in an 8 h day. This analytical procedure can be classified as an absolute method and is being used as a referee for other routine methods for the determination of the  $\gamma$ -isomer. It is being used to analyse benzene hexachloride samples having  $\gamma$ -contents ranging from 1 to 50%. (auth.)

- 779 Craig, J.T. MEASURING THE ACTIVE INGREDIENT IN AN INSECTICIDE. CASE STUDY. Nucleonics 14, 3 (1956) 60-1.

The essentials of the isotope dilution method are outlined.  $Cl^{36}$ -labelled pure  $\gamma$ -isomer was used as tracer, primarily because of the ease of affixing the labelled atoms to the molecule of BHC. Technical details are given. (See also Craig 1960, where methods and results are discussed in some detail)

- 780 Craig, J.T. APPLICATION OF ISOTOPE DILUTION TECHNIQUE TO THE ANALYSIS OF AN INSECTICIDE AND AN ANTIBIOTIC. p. 73-88 in "Radioactivity for Pharmaceutical and Allied Research Laboratories". Edelman, A., ed. New York, Academic Press, 1960.

Labelling of benzene hexachloride by means of the  $\text{Cl}^{36}$ -labelled pure  $\gamma$ -isomer is described, including precautions taken to ensure purity and safety. Some details of assay procedure (see Craig et al., 1953) are given, and the accuracy and uniformity of the results discussed. Tabulated results indicate the precision of the isotope dilution method, also compared with the infra-red method and with paper chromatography. Collaboration studies between different laboratories on the percentages of  $\gamma$ -isomer in various samples of technical grade BHC indicate close agreement as well as fine precision within each lab.

\* Palin 1954 - [454]

781 Redemann, C. T., Melkie, R. W. ISOTOPE DILUTION TECHNIQUES FOR THE DETERMINATION OF PESTICIDE RESIDUES. p. 183-206 in "Advances in Pest Control Research", Vol. 2. Metcalf, R. L., ed. New York, Interscience Publishers, Inc. 1958, 426 p.

A method of residue determination is described which involves dilution of the material initially present in the sample with a precisely known quantity of a particular isotopic form (either stable or radioactive) of the same substance. The various experimental steps and general procedure are discussed. Attention is paid to the dilution of non-radioactive residues with radioactive isotopes, and illustrated with data from work with a herbicide.

### III - D Labelled Pool Technique

\* Winteringham and Hellyer 1954 - [729]

782 Winteringham, F. P. W., Harrison, A. STUDY OF ANTICHLINESTERASE ACTION IN INSECTS BY A LABELLED POOL TECHNIQUE. Nature 178 (1956) 81-3.

For the study of adult houseflies under the influence of an insecticide,  $1 \mu\text{l}$   $\text{H}_2\text{O}$  containing  $18 \gamma$  Na acetate- $2\text{-C}^{14}$ , equivalent to  $2 \mu\text{C}$   $\text{C}^{14}$ , was injected intrathoracically. Immediately afterwards,  $1 \mu\text{l}$   $\text{Me}_2\text{CO}$  (control) or  $1 \mu\text{l}$   $\text{Me}_2\text{CO}$  containing  $10 \gamma$  diisopropyl phosphorofluoridate (I) was applied topically. By paper chromatographic separation (Winteringham et al., CA. 49: 5691b) of extracts of heads and thoraxes, 7 distinct  $\text{C}^{14}$ -labelled fractions were resolved. The mean  $R_f$  values ( $\text{H}_2\text{O}$ -formic acid-acetone) were: (1) 0, (2) 0.25, (3) 0.47, (4) 0.58, (5) 0.66, (6) 0.75, and (7) 0.91. Fractions 3, 5 and 6, representing 75% of the total soluble  $\text{C}^{14}$ , were identified as glutamine, glutamic acid, and proline. Hydrolysis of the insoluble thoracic protein showed that almost all the protein  $\text{C}^{14}$  was present as glutamate and proline only. No detectable fraction of the soluble  $\text{C}^{14}$  behaved as free choline. The proportion of  $\text{C}^{14}$  found in the acetylcholine (II) fraction was independent of the weight of unlabelled II added at any stage of the fractionation, which fact showed that no isotope exchange occurred between carrier and some other labelled metabolite. II was labelled *in vivo* in the acyl moiety only. The glutamine accumulation suggested that I may have rendered necessary an  $\text{NH}_3$  detoxification mechanism. There was a relative rise of II after  $\frac{1}{2}$  h, followed by a fall to normal after 2 and 5 h; this suggests that the cholinesterase inhibition was reversible. (CA 51: 1343c, 1957)

783 Winteringham, F. P. W. LABELLED METABOLIC POOLS FOR STUDYING QUANTITATIVELY THE BIO-CHEMISTRY OF TOXIC ACTION. Intern. J. appl. Radiation and Isotopes 1, (1956) 57-65.

By feeding suitably labelled substrates to insects, well-defined metabolic pools become rapidly labelled which may then be separated and resolved by suitable chromatographic techniques. Multi-dimensional paper chromatography may be used; separated compounds may be scanned on uni-dimensional strips for a quantitative evaluation of the particular labelled compound. The soluble phosphorus pool of adult Musca domestica L. was studied by feeding carrier-free  $\text{P}^{32}\text{O}_4$ . The nature and relative specific activities of the  $\text{P}^{32}$ -labelled intermediates extracted from tissues were determined by co-chromatographic and neutron activation techniques. This technique has also been extended to the use of  $\text{C}^{14}$ -labelled pools.

\* Winteringham 1958 - [418]

\* Winteringham et al. 1958 - [730]

\* Winteringham 1959 - [156]

\* Winteringham et al. 1960 - [495]



### III - E Paper Chromatography

\* Metcalf 1960 - [413]

- 784 Winteringham, F. P. W., Harrison, A., Bridges, R. G. ANALYSIS OF DDT DERIVATIVES BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Nature **166** (1950) 999.

In order to study the metabolism in insects of a radioactive bromine analogue of DDT,  $(\text{BrC}_6\text{H}_4)_2\text{CH.CCl}_3$  (I), a method was developed for the separation and estimation of (I) and the possible metabolites,  $(\text{BrC}_6\text{H}_4)_2\text{CH.CCl}_2$  (II) and  $(\text{BrC}_6\text{H}_4)_2\text{CH.COOH}$  (III) on the micro-mole scale. Mixtures of such compounds labelled with  $\text{Br}^{82}$  were analysed by reversed phase uni-dimensional paper partition chromatography. Details of the resolution obtained and the time factors involved are given. No isotope exchange between compounds was detected when a mixture containing radioactive (I) and inactive (II) and (III) were resolved.

- 785 Winteringham, F. P. W. RADIOCHEMICAL TECHNIQUES IN ANALYSIS. Nature **168** (1951) 153-5.

Summary of a meeting of the Society of Public Analysts and Other Analytical Chemists. For relevant paper presented, see 786 and 787.

- 786 Winteringham, F. P. W., Harrison, A., Bridges, R. G. RADIOACTIVE TRACER-PAPER CHROMATOGRAPHY TECHNIQUES. Analyst **77** (1952) 19-28.

An example of the application of this technique is cited where mixtures of  $\text{DBr}^{82}\text{DT}$  and its metabolites, " $\text{DBr}^{82}\text{DE}$ " and " $\text{DBr}^{82}\text{DA}$ ", were resolved. The uses and potentialities of combined radiochemical and paper chromatography techniques are discussed. The principle of the methods is to associate one or more radioactive isotopes with one or more substances separated on a paper chromatogram. The labelled substances can then be located and estimated by scanning the paper radiometrically. A simple device for doing this automatically, and its use in quantitative work is described. (from auth.)

- 787 Winteringham, F. P. W., Harrison, A., Bridges, R. G. RADIOACTIVE-TRACER TECHNIQUES IN PAPER CHROMATOGRAPHY. Nucleonics **10**, 3 (1952) 52-7.

Their application to paper chromatography may permit the separated components not only to be located and characterized but to be estimated quantitatively. The principle is to associate one or more suitable radio-isotopes with one or more of the components of the mixture, either before or after chromatography. The components separated on the chromatogram are then located and estimated by their associated radioactivity. Three methods of associating the isotope with one or more bands of the resolved components of the chromatogram are described, as follows: labelling of mixture before paper chromatography, treatment of chromatogram with labelled reagent, and neutron activation of the chromatogram. Diagrams are presented of a device which automatically scans the chromatogram. Methods of quantitative interpretation of the results and necessary corrections are discussed. This method has been used to resolve mixtures of  $\text{DBr}^{82}\text{DT}$  and its metabolites, " $\text{DBr}^{82}\text{DE}$ " and " $\text{DBr}^{82}\text{DA}$ ".

\* Winteringham, et al. 1958 - [730]

### III - F Miscellaneous

- 788 Green, B. C., Spinks, J. W. T. AUTOMATIC PLOTTING OF THE POSITION OF A MOVING RADIOACTIVELY TAGGED OBJECT. Canad. J. Res., C- Canad. J. Technol. **33** (1955) 307-16.

An apparatus is described for automatically registering the movement of an object in the three dimensions of space and in time. It has been designed specially in order to register the movements of a Myriapod burrowing into the ground. The fundamental principles in which the apparatus is based are discussed. The description includes a thyrode, a Geiger counter, and a container for 20  $\mu\text{C}$  of  $\text{Co}^{60}$ .

- 789 Green, B. C., Spinks, J. W. T., LAPSE-TIME MOTION PICTURE STUDIES OF SOIL-BURROWING INSECTS. Nature **181** (1958) 434-5.

A machine had been developed for the automatic recording of radioactively tagged insects such as a wire-worm. By means of the tag and the machine the wireworm was effectively provided with a pencil. The movements of the pencil and the machine were photographed, using lapse-time technique. A tagged

wireworm was liberated in a tray of soil placed on the floor. The machine was placed on a table above the tray, and a sheet of glass over the machine. A piece of grease pencil was attached to the machine on the Geiger axis, and held in contact with the under-surface of the glass by a spring. The path taken by the worm was thus traced on the lower side of the glass sheet. A 16 mm cine camera was mounted above the machine for viewing through the glass sheet. The particular wireworm travelled at the rather high speed of 23 in/h.

- 790 Jones, J. C., Perry, A. S. A NIB-POINT MICROLOOP AND ITS CALIBRATION. Mosquito News 19, 1 (1959) 26-7.

A simple modification of a microloop is described which enables a drop of 0.1-0.8  $\mu$ l of insecticide or another substance in a suitable solvent to be placed with precision on a selected area of a small organism (e.g. as required for topical applications to insects). The construction is described, and also methods for calibration. The three methods were (1) spectrophotometric; (2) colorimetric; and (3) radioassay, using 1.0% p, p'-DDT- $C^{14}$  (one loopful applied to a filter paper disc of 2.97  $cm^2$ ), activity being measured in a Q-gas flow counter.

- 791 Oftedal, P. HANDLING RADIOACTIVE FLIES. Drosophila Inform. Serv. 30 (1956) 163-4.

An apparatus made of perspex is described for handling flies (both insertion and removal from a capsule) which eliminates the need for repeated etherizations. It is illustrated by two figures.

- 792 Oftedal, P. MEASURING THE VOLUME OF INJECTION NEEDLES. Drosophila Inform. Serv. 30 (1956) 165.

A simple tracer method is proposed. A very weak solution of a fairly high-energy  $\beta$ -emitter (e.g.,  $P^{32}$ ) is expelled into a drop of water on one of the usual plaquettes used in most scaler assemblies. The solution is then diluted 1:100 or 1:1000, and a known volume, e.g., 5  $\mu$ l of it pipetted onto a similar plaquette. After evaporation to dryness, the plaquettes are placed under the G-M tube for radioassay. A comparison of the 2 activities, corrected for the relevant dilution factor, gives the volume with a high degree of precision. To minimize inaccuracies due to adsorption to the pipette walls, the solution used should contain inactive carrier isotope.

- 793 Smales, A. A., Pate, B. D. DETERMINATION OF SUBMICROGRAM QUANTITIES OF ARSENIC BY RADIO-ACTIVATION. GENERAL METHOD AND APPLICATION TO GERMANIUM OXIDE. Analyt. Chem. 24 (1952) 717-21.

By irradiation with the Harwell pile followed by distillation from HCl and free Cl solution, precipitation by  $(NH_4)_2H_2PO_4$  and counting it was possible to detect 0.001  $\gamma$  of As within 10% of the truth. With Ge present, the counting is done through an absorber or better by scintillation spectrometer to diminish the contribution of the low-energy As activity desired from Ge. (CA 46: 11021h, 1952)

- 794 Jenkins, D. W., Davis, J. M. FIELD ASSESSMENT OF AIRPLANE SPRAYED INSECTICIDES WITH RADIO-ACTIVE GOLD. Proc. Ann. Mtg. Amer. Mosq. Control Ass. 1952.

## IV BIBLIOGRAPHIES AND GENERAL SURVEYS

### IV - A Bibliographies

- 795 Anonymous A CLASSIFIED BIBLIOGRAPHY ON THE APPLICATION OF ISOTOPES IN PURE AND APPLIED RESEARCH - I AGRICULTURE - ENTOMOLOGY 47-49. Intern. J. Appl. Radiation and Isotopes 3 (1958) 46-77.  
This bibliography covers the period 1955-1956, "to be continued in subsequent issues."
- 796 McCormick, J. A., comp. ISOTOPE TECHNIQUES IN BIOLOGICAL SCIENCES. TID-3512, Technical Information Service, AEC. Feb. 1958, 44p.  
Amongst the 807 selected references on techniques for the use of radioactive and stable isotopes in the biological sciences, taken from the 1948-1956 open literature, there are some which are relevant to this bibliography. The percentage is not very high. An author index and an alphabetical listing of literature reference sources is included.
- 797 McCormick, J. A., comp. ISOTOPES IN BIOCHEMISTRY AND BIOSYNTHESIS OF LABELED COMPOUNDS. A selected list of references. TID-3513, Technical Information Service, AEC. March 1958, 89p.  
This bibliography contains 2430 selected references on uses of radioisotopes in biochemistry and biosynthesis of labelled compounds, taken from the 1948-1956 open literature. Some references come within the range of the present bibliography. A list of the journals from which the references were selected and an author index are included.
- 798 McCormick, J. A., comp. ISOTOPES... A BIBLIOGRAPHY OF UNITED STATES RESEARCH AND APPLICATION 1955-1957. TID-3076, Technical Information Service, AEC. May 1958, 267p.  
The contents include sections on A. Diagnostic Medicine B. Therapeutic Medicine C. Clinical Research D. Human Physiology E. General Medical Research F. Immunology G. Metabolite Physiology in Animals H. Non-Metabolite Physiology in Animals I. Injurious Agent Physiology in Animals J. General Animal Physiology K. Animal Husbandry L. Bacteriology M. Fertilizer Uptake by Plants N. Plant Physiology O. Photosynthesis P. Radiation Effects on Living Organisms Q. Biochemistry R. Biosynthesis of Labeled Compounds S. Chemical Synthesis of Labeled Compounds T. General Chemistry U. Reaction Mechanisms and Kinetics V. Radiochemistry W. Radiation Detection X. Radiation Physics Y. Nuclear Properties of Isotopes Z. General Physics AA. General Topics BB. Isotope Techniques CC. Applied Industrial Use DD. Entomology.  
Nearly 6000 references cover work with radioactive and stable isotopes. Reference is only made to material appearing in scientific technical and professional journals during the 3 years ending Dec. 1957 or, more specifically, since publication of Isotopes: An Eight-Year Summary of United States Distribution and Utilization, dated March 1955. An author index and a key to journal abbreviations are included. Sections of interest are underlined.
- 799 McCormick, J. A., comp. RADIOISOTOPES IN ANIMAL PHYSIOLOGY. A selected list of references. TID-3515, Technical Information Service Extension, Oak Ridge, Tenn. Dec. 1958, 118p.  
The 2439 references cited in this bibliography, and obtained from 1948-1957 open literature, include those that have appeared in ISOTOPES: A Three-Year Summary of U.S. Distribution (1949); ISOTOPES: A Five-Year Summary of U.S. Distribution (1951); ISOTOPES: An Eight-Year Summary of U.S. Distribution and Utilization (1955); ISOTOPES: A Bibliography of United States Research and Application 1955-1957 (1958). A list of journals from which these references were selected and an author index are provided.
- 800 McCormick, J. A., comp. RADIOISOTOPES IN AGRICULTURE: ANIMAL HUSBANDRY, BACTERIOLOGY, FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY. A selected list of references. TID-3516, Technical Information Service, AEC. Jan. 1959, 67p.

This bibliography contains 1335 selected references on uses of radioactive and stable isotopes in animal husbandry, bacteriology, fertilizer uptake by plants, plant physiology, photosynthesis, and entomology. These references were selected from scientific journals published during 1948-1957. They include those that have appeared in ISOTOPES: A Three-Year Summary of U.S. Distribution (1948); ISOTOPES: A Five-Year Summary of U.S. Distribution (1951); ISOTOPES: An Eight-Year Summary of U.S. Distribution and Utilization (1955); and ISOTOPES: A Bibliography of United States Research and Application 1955-1957 (1958). A list of the journals from which the references were selected and an author index are included. (auth.)

- 801 McCormick, J. A., comp. RADIOISOTOPES IN AGRICULTURE: FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY, A selected list of references. TID-3516 (Suppl. 1), Technical Information Service, AEC. 1959, 22p.

This bibliography contains 151 selected references on the uses of radioactive and stable isotopes in animal husbandry and in studies of fertilizer uptake by plants, plant physiology, photosynthesis, and entomology. These references were selected from scientific journals published during the period 1957 to 1958. An author index is included. (auth.)

- 802 McCormick, J. A., Voress, H. E., comps. RADIOISOTOPES IN AGRICULTURE: ANIMAL HUSBANDRY, FERTILIZER UPTAKE, PLANT PHYSIOLOGY, PHOTOSYNTHESIS, AND ENTOMOLOGY. TID-3078, Technical Information Service, AEC. Dec. 1960, 39p.

This bibliography supersedes TID-3516, Suppl. 1. The 148 references cited are those which have appeared in scientific journals published during the period 1957-1958. The section on entomology contains only 7 references. An author and a subject index are supplied.

- 803 Smetana, O. BIBLIOGRAFIE ČESKOSLOVENSKÝCH ENTOMOLOGICKÝCH PRACÍ ZA ROK 1952. Bibliography of Czechoslovak entomological literature - 1952) Acta Soc. ent. Bohem. (Čsl.) 51 (1954) 237-53. (In Czech)

(It has not been possible to obtain this publication. It is presumed to contain some references to the use of radioisotopes in the field)

#### IV - B Surveys

- 804 Asperen, K. van DE TOEPASSING VAN RADIOISOTOPEN IN DE INSEKTENFYSIOLOGIE EN HET INSEKTICIDENONDERZOEK (The application of radioisotopes in insect physiology and insecticide research). Landbouwk. Tijdschr., Groningen 70 (extra no.) (1958) 358-69. (In Dutch)

Review article. The section on insecticides lists radioisotope-labelled insecticides reported to date, and studies on their uptake, transport and breakdown in plants, and the various lines of research being followed at present. 50 refs.

- 805 Dahm, P. A. STUDIES OF INSECTS AND INSECTICIDES WITH TRACERS. p.162-99 in "Conference on the Use of Isotopes in Plant and Animal Research, 12-14 Apr. 1952". TID-5098, Kansas State Coll. and Argonne National Lab. and Isotopes Div., AEC. 1953.

A review is presented of the fast-growing literature dealing with studies of insects and insecticides employing tracers. The literature has been divided into five broad categories: tagging insects and related arthropods with radioelements, physiological studies with insects, biological effects of irradiation, studies relating to medical and veterinary entomology, and the preparation and use of labelled insecticides. Summaries of the observations reported in the literature on the use of radioelements to tag insects and related arthropods and the preparation methods and uses of radioisotope-labelled insecticides and related compounds are presented in tabular form. Experimental results are presented dealing with the distribution and metabolism of doubly labelled ( $P^{32}$  and  $S^{35}$ ) Parathion in the goat and the American cockroach. 149 references (auth.)

- 806 Dahm, P. A. USES OF RADIOISOTOPES IN PESTICIDE RESEARCH. p. 81-146 in "Advances in Pest Control Research", Vol. 1, Metcalf, R. L., ed. New York, Interscience Publishers, Inc. 1957.

A very important and comprehensive review of the whole field. The topics covered are: insecticides (DDT and related chemicals, Lindane and BHC, organic phosphorus insecticides, pyrethroids and piperonyl butoxide, nicotine, fumigants, and miscellaneous insecticidal chemicals), fungicides, herbicides and

plant growth regulators, the tagging of insects, mites, and ticks with radioisotopes, epidemiology and public health, and food preservation and pest control through radiation effects. Special techniques and equipment are mentioned only where they have some bearing on the pest control problem. 323 references.

- 807 Fisher, W. RADIOISOTOPE IN PHYTOPATHOLOGIE UND PFLANZENSCHUTZ. (Radioisotopes in phytopathology and plant protection) *NachrBl. dtsh. PflSchDienst, Berl.* 9 (1957) 88-94. (In German)

This review article is divided into two parts. One deals with radiation effects in terms of induced mutations and the sterilization of food, stored products, pharmaceuticals and packaging materials, with some discussion of radiation sources. The second part is concerned with the use of radioisotopes as tracers as applied in studies on pests, plants and plant protection. 64 references.

- 808 Jenkins, D.W., Hassett, C.C. RADIOISOTOPES IN ENTOMOLOGY. *Nucleonics* 8, 3 (1950) 5-14.

Applications of radioisotopes to a variety of entomological problems are reviewed, from 1927 onwards. A type of application is described here which uses isotopes to study phenomena without actually interfering with them. Migration, feeding and breeding habits of many insects have been reported, and studies mentioned on the role of insects in disease transmission, and on predation. Some unpublished work (Hassett & Jenkins) is quoted in which malaria, house, and rockpool mosquitoes, houseflies, fruitflies, and screwworm flies were made radioactive by mixing  $P^{32}$  with the food of the larvae. Cockroaches and flesh flies were injected with  $\gamma$ -emitting  $Zr^{95}$  to study the possibility of locating insects at greater distances than is possible with  $\beta$ -emitting  $P^{32}$ . Cunliffe (unpublished) confirmed a suspected mite parasite of the cockroach by introducing  $P^{32}$  into the roaches.  $P^{32}$ -labelled mosquitoes and fruitflies were shown (H. & J.) to be caught and eaten by praying mantids (laboratory). - Feeding by mosquitoes on plants was confirmed (H. & J.) by  $P^{32}$ -labelling plant juices which were later found to have been absorbed by yellow-fever and house mosquitoes. Some work in physiology is mentioned, including some initial work on labelled inorganic insecticides. Studies on the effects of radiation on growth and reproduction are cited. - 41 references.

PART II

IONIZING RADIATIONS



## I RESEARCH

### I - A Radiosensitivity

#### I-A-1 RADIOSENSITIVITY TO DIFFERENT TYPES OF RADIATION

##### Survey

- 809 Langham, W. H., ed., Bell, P., Godfrey, L., Stearns, H., comps. LITERATURE SEARCH ON THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF IONIZING RADIATIONS. LAMS-2343, Los Alamos Scientific Laboratory, New Mexico, 1960, 251p.

Numerous references are relevant, in part, to the present bibliography. Results of a literature search to aid in establishing appropriate values for relative biological effectiveness (RBE) are presented. RBE may be defined as the ratio of the dose of 200- to 250-kV x-rays required to produce a specific biological effect to the dose of another radiation required to produce the same level of effect. Although some references may have been missed, the compilation is believed to be relatively complete up to mid-year 1959. The references are listed in alphabetical order, according to author. In most cases, the abstracts given are those of the author or the abstracting medium from which the reference was taken. Approximately 500 references are given.

- \* Alexander 1958 - [1165]

- 810 Amy, R. L. (Univ. Virginia, Charlottesville) A COMPARATIVE STUDY OF THE EFFECTS OF BETA RAYS, GAMMA RAYS AND X-RAYS ON DEVELOPMENT IN HABROBRACON (WITH APPENDIX. DESCRIPTIVE STUDIES ON THE EMBRYOGENESIS AND ORGANOGENESIS OF HABROBRACON). Diss. Abstr. 15, 11 (1955) 2347.

An appendix to the dissertation describes typical embryological development.

(For abstract, and publication of the dissertation in part, see Radiation Res. 3, 2 (1955) 166.

- 811 Amy, R. L. A COMPARATIVE STUDY OF THE EFFECTS OF  $\beta$ -RAYS,  $\gamma$ -RAYS AND X-RAYS ON DEVELOPMENT IN HABROBRACON. Radiation Res. 3, 2 (1955) 166-81.

Eggs of Habrobracon juglandis (Ashmead) were subjected, 1-3 h after they were laid, to  $\beta$ -rays ( $P^{32}$ ),  $\gamma$ -rays ( $Co^{60}$ ), or 125-kV potential x-rays under equivalent physical conditions. At each of the 7 dose levels used dosages were adjusted so that the amount of energy dissipated within the eggs was approximately the same for all three types of radiation. X-rays were most effective in reducing the percentage of eggs hatching,  $\beta$ -rays were less effective and  $\gamma$ -rays were least effective in this respect. Histological observations made on embryos exposed at the highest dose level are described. Enlargement of nuclei (up to 3 times the diameter of those found in untreated animals) was a prominent feature of the degenerative changes observed. Although there was indication that cell division continued for a time after exposure, other developmental processes were for the most part completely inhibited. Externally visible structural derangements were seen in damaged eggs but none which were interpreted as being peculiar to any of the types of radiation employed. In general, the time between irradiation and the appearance of visible signs of injury was inversely proportional to the amount of radiation received by the eggs. (auth.)

(An abstract of earlier work appeared in Anat. Rec. 115 (1953) 273)

- \* Baeumer and Müller 1952 - [1169]

- 812 Bateman, A. J. RELATIVE MUTAGENIC EFFICIENCY OF 4 MeV X-RAYS AS ASSESSED BY THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA. p. 144-9 (disc. 149-55) in "Progress in Radio-



biology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd.

There are indications that the Linear Accelerator (4M 4 MeV) is less efficient than the conventional Resomax (300 keV), at least as regards its mutagenic effects on Drosophila.

- 813 Bateman, A. J. THE RELATIVE BIOLOGICAL EFFICIENCY OF 4 MeV AND 300 KV RADIATIONS. V. THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA SPERM. Brit. J. Radiol. 30 (1957) 347-9.

Production of mutations and lethal dominants are always proportional to the dose administered. The relative efficacy is 0.83. (BS 19: 105255, 1958)

- 814 Bertram, C., Höhne, G. ÜBER DIE MUTATIONS-AUSLÖSUNG MIT SCHNELLEN ELEKTRONEN (Induction of mutations by fast electrons). Strahlentherapie 106 (1958) 269-72. (In German)

The authors report about comparative investigations on the induction of mutations in Drosophila by fast electrons of a betatron and by conventional x-rays. The rates of radiation-induced, sex-linked recessive lethal mutations were determined by means of the Muller-5-(Basc) method. Under the described conditions of equivalent doses (4000 and 2000 r resp. rep) 15 MeV electrons and 200 kV x-rays were found to produce the same mutation rates within the range of statistical error. The relative biological effectiveness of the betatron electron is approximately 1. (auth.)

- \* Brandt and Höhne 1952 - [1372]

- 815 Brandt, H. von, Höhne, G. MUTATIONS-AUSLÖSUNG BEI DER TAUFLIEGE DROSOPHILA MELANOGASTER DURCH SCHNELLE ELEKTRONEN EINES 6 MeV-BETATRONS (Production of mutations in Drosophila melanogaster by fast electrons from a 6-MeV betatron). Strahlentherapie 90 (1953) 93-9. (In German)

In studying the mutagenic activity of fast electrons from a 6-MeV betatron it is shown that, as concerns the elicitation of recessive sex-limited lethal factors in D. melanogaster, there does not exist a significant difference between fast electrons and the röntgen radiations conventionally used for therapeutic purposes. For mature male generative cells as well as for immature germ-cells, the relative biologic activity is  $\approx 1$ . If equal doses are applied, then the rate of mutation induced in immature germ-cells lies considerably below that induced in mature male generative cells. (CA 47: 6993b, 1953)

- 816 Brandt, H. von, Höhne, G. ÜBER DIE AUSLÖSUNG AUTOSOMALER CHROMOSOMENMUTATION BEI DROSOPHILA DURCH SCHNELLE ELEKTRONEN UND RÖNTGENSTRAHLEN (On the induction of autosomal chromosome mutation in Drosophila by fast electrons and x-rays). Zool. Anzeiger, Suppl. 17 - Verh. dtsch. zool. Ges. 1952 (1953) 365-9. (In German)

Since the rate of radiation-induced chromosome mutations depends very considerably on the stage of development of the irradiated gamete, translocations were only considered for mature sperm, with copulation limited to one day. Dosages used for both types of radiation (3 MeV electrons and 200 kV x-rays) ranged from 1000 r to 8000 r. The percentages of II/III translocations induced in D. melanogaster were tabulated. The results of the study were discussed. The effectiveness of fast electrons relative to x-rays was found to scarcely deviate from 1.

- 817 Brandt, H. von, Dittrich, W. ENDUZIERTER BRÜCHE DES RING-CHROMOSOMS  $X^{C2}$  VON DROSOPHILA MELANOGASTER NACH BESTRAHLUNG MIT RÖNTGENSTRAHLEN UND SCHNELLEN ELEKTRONEN (Induced breaks of the  $X^{C2}$  ring chromosome of Drosophila melanogaster after irradiation with x-rays and fast electrons). Strahlentherapie 91 (1953) 149-56. (In German, but see ABC-tr-3478, 12p.)

Maies of an  $X^{C2}$  strain of D. melanogaster were irradiated with various doses of fast electrons from a 6-MeV betatron and with x-rays (180 kV). Immediately after irradiation the males were bred with Berlin normal females. The  $F_1$  generation produced by fully-developed spermatozoa exhibited a more or less marked deficit of females, the investigations covering a total of 350 000 flies. The results were compatible with the assumption of a linear increase of the deficit of females with dosage within the dosage range investigated, from 0-6000 r. The x-ray experiments made it at least highly probable that the effect increases with the dose for x-rays, and the same holds true for fast electrons in the more highly scattering electron experiments. No difference in the action of the two types of rays could be found. The ring-X method is not very suitable in the form employed here for a more precise comparison of the biological activity of different types of ionizing rays. (auth.)

\* Dittrich et al. 1950 - [989]

\* Dittrich et al. 1950 - [1182]

- 818 Edington, C. W. THE INDUCTION OF RECESSIVE LETHALS IN DROSOPHILA MELANOGASTER BY RADIATIONS OF DIFFERENT ION DENSITY. Genetics 41, 6 (1956) 814-21.

It has been shown that fast neutrons are 1.62 times more effective than  $\text{Co}^{60}$   $\gamma$ -rays in inducing sex-linked recessive lethals. Since the frequency of recessive lethals induced by x-rays increases with increasing dose more rapidly than one would expect on the basis of linearity, the relative biological effectiveness for x-rays as compared to fast neutrons or gamma rays is dependent upon the dose of x-rays used. It was also shown that the frequencies of recessive lethals induced by x-rays in acrocentric- and a ring-X chromosome were significantly different. The possible reasons for this ring-rod difference and the non-linear dose response for x-ray-induced recessive lethals are discussed. (auth.)

- 819 Edington, C. W., Randolph, M. L. A COMPARISON OF THE RELATIVE EFFECTIVENESS OF RADIATIONS OF DIFFERENT AVERAGE LINEAR ENERGY TRANSFER ON THE INDUCTION OF DOMINANT AND RECESSIVE LETHALS IN DROSOPHILA. Genetics 43 (1958) 715-27.

An investigation was made of the effects of monochromatic 14-MeV fast neutrons and  $\text{Co}^{60}$  gamma rays on the induction of dominant lethals and of 14-MeV neutrons on the production of sex-linked recessive lethals in Drosophila. These results were compared with those of other reports from this laboratory, in which radiations of different average LET were used. It was shown that the RBE of different radiations for the induction of both genetic effects studied is dependent on the LET of the radiation used. 34 references. (auth. summary)

- 820 Evans, T. C., Yu Ying Fu. RELATIVE EFFECTIVENESS OF FAST NEUTRONS AND X-RADIATION ON EMBRYOS OF THE GRASSHOPPER. (abstr.) Radiation Res. 5 (1956) 477.

Eggs of Melanoplus differentialis were irradiated on the 4th day of development ( $25^{\circ}\text{C}$ ). They were examined 3 weeks later, at which time the controls were in the diapause stage. Radiation effect was indicated as either injured or complete destruction of the embryo. X-ray doses were from 100 r to 450 r in increments of 50 r. Two sources of fast neutrons were utilized. The first was the direct beam of the Argonne 60-in cyclotron and was produced by bombarding a beryllium target with deuterons. The second was a field at the rear of the target ( $180^{\circ}$  from first field utilized). The second irradiation field differed from the first in including lower energy neutrons, and the intensity was lower by a factor of 2. Exposures were measured in air with thimble ion chambers. Neutron doses in rep were calculated by a conversion factor based on studies employing different methods of measuring neutron dose. The results of two experiments were consistent in that the  $\text{LD}_{50}$  for the x-radiation was 265 and 257 r; for the higher energy neutron beam 133 and 112 rep; and for the lower energy neutron beam 63 and 49 rep. Based on the 250 kV potential x-radiation as unity, the RBE of the higher energy neutron beam was 2 to 2.3 and that for the lower energy beam was 4.2 to 5.3. So far, the results of another criterion (that of complete destruction) have given similar conclusions in that the relative effectiveness appears of the same order. Attempts to determine whether qualitative as well as quantitative differences exist are now being investigated.

- 821 Frey, E. STRAHLENWIRKUNG EINES 31-MeV BETATRONS AUF EIER VON DROSOPHILA MELANOGASTER (Radiation effect of a 31-MeV betatron on the eggs of Drosophila melanogaster). Oncologia 4, 4 (1952) 191-208. (In German)

Lethal dose curves were established in eggs of various ages and compared with that caused by 180 keV x-radiation. In 3-h eggs 31-MeV radiation was less effective than the x-rays or the fast electrons of 3 MeV. In 4-h eggs the curves of 3-MeV and 31-MeV radiation coincide, both being less effective than x-rays. In 7.5-h eggs 31-MeV radiation is less effective than 3-MeV, both being less effective than x-rays. (BA 26; 26952, 1952)

- 822 Fritz-Niggli, H. ERSTE BIOLOGISCHE VERSUCHE MIT DEM 31-MeV-BETATRON (First biological experiments with a 31-MeV betatron). Arch. Klaus-Stift. VererbForsch. 26 (1951) 454-9. (In German)

Drosophila melanogaster pupae of various ages were subjected to 50- and 180-keV and 31-MeV radiation. Pupae of 5 h, 15 h, 22 h and 40 h were given doses of 12 000 r, 36 000 r and 80 000 r. Relative developmental changes are described briefly.

\* Fritz-Niggli 1952 - [1185]

\* Fritz-Niggli 1955 - [1186]

- 823 Fritz-Niggli, H. DOMINANT LETHAL FACTORS AND EMBRYONIC MORTALITY AFTER IRRADIATION AT 180 kV AND 31 MeV. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/1070. 11 (1956) 179-83.

Non-irradiated females of Drosophila melanogaster mated with irradiated males (3000 r) lay eggs which show different rates of hatchability depending on the time after treatment. The peak of reduced hatchability lies between the 5th and 7th day. This effect must be caused not only by dominant lethal factors but also by a lack of normal active sperms. Histological studies show that spermatocytes and spermatogonia are resistant to irradiation. On the other hand the stage during late spermatogenesis is very sensitive. 31 MeV photons are less effective than 180 kV photons. (auth. summary)

- 824 Fritz-Niggli, H. QUALITATIVE AND QUANTITATIVE DIFFERENCES IN THE INDUCTION OF DOMINANT LETHALS IN DROSOPHILA BY 31 MeV X-RAYS, 30 MeV ELECTRONS, AND 180 kV X-RAYS. Drosophila Inform. Serv. 31 (1957) 171.

The tests described consisted of determining the percentage of unhatched embryos in different periods after irradiation of the male parents. This and data from other tests proved the effectiveness of 30-MeV electrons and 31-MeV x-rays from a betatron in inducing dominant lethals as compared with ordinary x-rays. Four strictly marked stages of spermatogenesis with different reaction patterns were distinguished. A strict dependence of RBE (relative biological effectiveness) on the age of irradiated gametes and also on dosage can be observed.

- 825 Fritz-Niggli, H. DIFFERENT RESPONSES (PRODUCTION OF MUTATIONS) OF DIVERSE STAGES OF SPERMATOGENESIS TO CHANGES IN OXYGEN TENSION, CHEMICAL ENVIRONMENT, AND QUALITY OF RADIATION (10-30 MeV-ELECTRONS, 31 MeV- AND 180 keV-PHOTONS). Radiation Res. 9 (1958) 117.

It is well known that the number of certain mutations depends on the developmental stage of the irradiated germ cells. In the hope of elucidating this differential sensitivity, there were irradiated sperms of Drosophila (in adult males) spermatids (in 48 h pupae and adult males), spermatocytes (in 0-2 h prepupae and adult males), spermatogonia (in 4 h larvae and adult males) in  $N_2$ , air,  $O_2$ ,  $CO_2$ , etc. Experiments were also carried out with radiations of different ionization densities (180 keV- and 31 MeV-photons, 10 and 30 MeV-electrons). The production of visible mutations, recessive and dominant lethal factors, chromosome losses, gynanders, and translocations was tested. We found the most radiosensitive stages (spermatocytes and spermatids) are very sensitive to a reduction of oxygen tension, whereas mature sperms show little response. The pronounced effects of other chemical factors are also discussed. A strict dependence of relative biological effectiveness upon the age of the irradiated gametes and also upon the dosage can be observed. There is no manifest influence of varying radiation qualities upon the relatively radioresistant stage of sperms, whereas in spermatids and specifically spermatocytes, the high-energy radiations are less effective. The following problems are discussed: Whether the differential sensitivity of sperms, spermatids and spermatocytes may be due to different oxygen tensions (depending on the cell function) and whether in different stages there are two types of induction of mutation (by the OH-H radicals and  $H_2O_2$ ).

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont: 10-16 Aug. 1958)

- 826 Fritz-Niggli, H. ABHÄNGIGKEIT DER MUTATIONSENTSTEHUNG VON DER STRAHLENQUALITÄT (30 MeV-ELEKTRONEN, 31 MeV-PHOTONEN UND 180 keV-PHOTONEN) (The dependence of mutation development on the quality of irradiation (30 MeV-electrons, 31 MeV- and 180 keV-photons)). Naturwissenschaften 45 (1958) 117-8. (In German)

Drosophila males were irradiated with 180 keV x-, 31 MeV  $\gamma$ -, x- and 30 MeV  $\beta$ -rays from a betatron. When developing sperm were irradiated quantitative differences could be observed. The lower-energy radiation (180 keV) proved more effective in terms of translocations and chromosome breaks. Such differences were not observed on irradiating mature sperm where one assumes that it is mostly the free radicals which are effective whereas  $H_2O_2$  plays a highly active part in developing sperm. The life time of free radicals and the production of  $H_2O_2$  will depend on linear energy distribution (ionization density) which will differ with the type of radiation employed.

Gaulden, M. E., Loemker, K., Darden, E. B., Jr. FRAGMENTATION OF CHROMOSOMES IN GRASSHOPPER NEUROBLASTS BY BETA RAYS AND X-RAYS (abstr.). AECU-1898, Oak Ridge National Lab., Tenn. 1p.

Dissected 14-d-old embryos of Chortophaga viridifasciata were exposed to 1.7 MeV  $\beta$ -rays from  $P^{32}$  and some to 125 kV potential x-rays, conditions for exposure being identical in both cases. A dose of 64 r of x-rays and 70.4 rep of  $\beta$ -rays was used, the amount of energy dissipated in the tissue being equal for the two types of radiation. The embryos were made into hanging drop preparations following irradiation and placed at 38°C. At intervals of 44, 220, 264 and 352 minutes after irradiation the embryos were fixed and stained. Cells in late anaphase and very early telophase were examined for chromosome fragments and the number of single fragments produced were the same in both x-rayed and  $\beta$ -irradiated cells. The number of  $\beta$ -ray induced double fragments observed in cells fixed 352 minutes after irradiation, however, was greater than the number observed in x-rayed cells, fixed at the same interval. This difference was statistically significant at the 0.02 level. Since the mitotic rate of  $\beta$ -irradiated cells differs from that of x-rayed cells, the difference observed in frequency of double fragments may be due to the fact that cells analysed 352 minutes after irradiation were treated in different stages of mitosis and not due to a difference in effectiveness of the two types of radiation in producing fragments at one stage of mitosis.

(Entire report. Abstract of paper for Atlanta meeting of Association of Southeastern Biologists, April 18-19, 1952)

(An abstract was also published in J. Tenn. Acad. Sci. 27 (1952) 211)

Gaulden, M. E., Nix, M., Darden, E. B., Jr. EFFECTS OF BETA RAYS AND X-RAYS ON MITOTIC RATE OF LIVING GRASSHOPPER NEUROBLASTS (abstr.). AECU-1896, Oak Ridge National Lab., Tenn., 1p.

14-d-old embryos of Chortophaga viridifasciata were removed from eggs and dissected as for hanging preparations. Some were exposed to 1.7-MeV  $\beta$ -rays from  $P^{32}$  and some to 125-kV potential x-rays, conditions for exposure being identical in both cases (Gaulden, Sheppard and Cember, Nature 169 (1952) 228). Two doses of radiation were used, namely, 8 r and 64 r of x-rays and 8.8 rep and 70.4 rep of  $\beta$ -rays; dose rates were adjusted so that the amount of energy dissipated in the tissue at a given dose level would be the same for both types of radiation. The irradiated and control embryos were made into hanging drop preparations following irradiation and the neuroblasts observed with a microscope enclosed in an incubator maintained at 38°C. The number of cells in mid-mitosis (prometaphase, metaphase, and anaphase) was recorded every 22 minutes for 6 h. Twenty-two minutes is the average duration of mid-mitosis and the doses of radiation used do not affect it, consequently, the number of cells going through mitosis in a given period of time can be determined. At both doses x-rays and  $\beta$ -rays affect mitotic activity similarly with respect to the extent to which it is depressed but differently with respect to recovery - a greater number of cells recover after treatment with  $\beta$ -rays than with x-rays. This difference in recovery is statistically significant at the 0.02 level.

(Entire report. Abstract of paper for Atlanta meeting of Association of Southeastern Biologists, April 18-19, 1952)

(An abstract was also published in J. Tenn. Acad. Sci. 27 (1952) 211)

Ginix Melcior, I. R. ESTUDIO COMPARATIVO ENTRE UNA MISMA DOSIS DE RADIACIÓN GAMMA DEL RADIUM Y DE RAYOS X, DESDE EL PUNTO DE VISTA DE SU ACCIÓN BIOLÓGICA (A comparative study of the same dose of gamma-radiation of radium and of x-rays from the point of view of biological action). An. Med. Chirurg., Paris 29, 70 (1951) 318-37.

In tests using Drosophila, 50% of the eggs were killed by 240 r  $\gamma$ -rays or 210 r x-rays. (EM 14, 6: 1238, 1952)

Glemobitsky et al. 1960 - [1993]

Grosch, D. S., Sullivan, R. L., LaChance, L. E. BIOLOGICAL RESPONSE TO MIXED RADIATIONS. Nucleonics 15, 12 (1957) 64, 66.

In reactor and certain accelerator situations radiation is often present as a mixture of radiations. To study the additive effects of such mixtures, a series of experiments was made on the combined sterilizing effects of external x-rays and ingested  $\beta$ -emitters ( $P^{32}$  and  $Sr^{90}$ ) on the ectoparasitic wasp, Habrobracon juglandis. (NSA 12: 2666, 1958)

- 831 Gund, K., Paul, W. EXPERIMENTS WITH A 6-MeV BETATRON. Nucleonics 7, 1 (1950) 36-45.  
The relative biological efficiency of fast electrons is compared to 200 kV x-rays, and data presented for 3-, 4- and 7½-b old Drosophila eggs and chrysalises.
- 832 Heidenthal, G., Clark, L.B., Gowen, J.W. COMPARATIVE EFFECTIVENESS OF X-RAYS OF 124 kV AND 50 MeV ON HABROBRACON EGGS (abstr.). Radiation Res. 1 (1954) 499.  
First meiotic metaphase eggs of Habrobracon were used to test the comparative effectiveness of 124 kV and 50 MeV x-radiations. Dosages ranged from 100 r to 1750 r for low-voltage work and from 100 r to 1500 r for high-voltage studies. Failure of unfertilized eggs to hatch has been attributed to the presence of dominant and, to a lesser extent, of recessive lethals. Dose action curves are approximately exponential. Test for difference between the slopes of the two curves when these were plotted and fitted on a semi-logarithmic scale revealed no statistically significant difference. Variance analysis of data within dose and for each voltage of radiation used showed that the data for each dosage appeared to be conveying the same information from experiment to experiment. Comparisons between data for 124 kV and 50 MeV indicated that for a given dosage radiations of low and high voltage were revealing similar effects. A review of previous work by Whiting, on which the method was based, has led to the conclusion that x-radiation induced chromosome breakage, terminal deletions, and the formation of chromosomal bridges in most of the eggs which died. Thus dominant lethals were mainly responsible for failure of eggs to hatch as larvae. It is concluded that equivalent x-ray dosages from 124-kV and 50-MeV machines appear to be equally effective in inducing lethals in Habrobracon eggs treated in first meiotic metaphase.  
This study was reported in detail in the Amer.J. Roentgenology 74 (1955) 677-85.
- 833 Heidenthal, G., Clark, L.B., Gowen, J.W. COMPARATIVE EFFECTIVENESS OF ROENTGEN RAYS OF 124 kV AND 50 MeV ON HABROBRACON EGGS. Amer.J. Roentgenology 74 (1955) 677-85.  
An abstract of this paper was published in Radiation Res. 1 (1954) 499.
- 834 Höhne, G., Schubert, G. DIE AUSLÖSUNG VON CHROMOSOMENMUTATIONEN BEI DROSOPHILA MELANOGASTER DURCH SCHNELLE ELEKTRONEN UND RÖNTGENSTRAHLEN (Induced chromosome mutations in Drosophila melanogaster by fast electrons and X-radiation). Strahlentherapie 94 (1954) 72-8. (In German).  
D. melanogaster was exposed to a 3-MeV electron beam from a betatron and to 200-kV x-radiation, such as is generally used in therapy, for the purpose of studying the effect of these radiations on chromosome mutations. With respect to the reciprocal translocations between the second and third chromosome that were covered by the analysis of the crossing over, it was found that the increase in the rate of mutation induced by the radiation was a little greater than proportional to the dose. No differences were found between the effects produced by these two radiations of unlike differential ionization. (auth.)  
(Also available in English, cf. AEC-tr-3474, Atomic Energy Commission, Washington, D.C., 11 p.)
- 835 Kayhart, M. (Pennsylvania Univ., Philadelphia) A COMPARATIVE STUDY OF DOSE-ACTION CURVES FOR VISIBLE EYE-COLOR MUTATIONS INDUCED BY X-RAYS, THERMAL NEUTRONS, AND FAST NEUTRONS IN MORMONIELLA VITRIPENNIS. Diss. Abstr. 14, 9 (1954) 1480-1.  
Part of this work was published subsequently in Radiation Res. 4 (1956) 65.
- 836 Kayhart, M. A COMPARATIVE STUDY OF DOSE-ACTION CURVES FOR VISIBLE EYE-COLOUR MUTATIONS INDUCED BY X-RAYS, THERMAL NEUTRONS, AND FAST NEUTRONS IN MORMONIELLA VITRIPENNIS. Radiation Res. 4 (1956) 65-76.  
Virgin female wasps (70449) were treated with a series of doses of x-rays, thermal neutrons, and fast neutrons. They were set unmated, and their haploid sons (354439) were examined for bright eye-colour mutants. Dose-action curves for production of visible eye-colour mutations by each of the three radiations were obtained. The shape of the curves is similar; each shows an initial linear portion and then a rise more rapid than that calculated for proportionality. It is suggested that the mutations occurring at the lower doses, forming the linear part of the curve, are due to single hits, and that the proportion of two-hit mutations (small deletions and inversions) increases rapidly at the higher doses, causing the curve to rise steeply. The neutron data adequately fit this one-hit two-hit hypothesis, but in spite of the general resemblance of the three curves the x-ray data do not. With visible eye-colour mutations in Mormoniella as a criterion, the relative biological efficiency at higher doses is to be expected if many of the visible mutations are due to minute rearrangements and deletions. (auth.)

- 837 Kimball, A. W. SHORTCUT FORMULAS FOR THE EXACT PARTITION OF CHI-SQUARE IN CONTINGENCY TABLES. *Biometrics* 10, 4 (1954) 452-8.

Short-cut formulas are given which permit the exact partition of chi-square from an  $r \times c$  contingency table into  $(r-1) \times (c-1)$  individual degrees of freedom. Each single degree of freedom chi-square is computed from a formula which is a function only of the observed frequencies. A general expression is given which permits the construction of such formulas for contingency tables of any order. The method is applied to some experiments which compare the effects of x- and  $\beta$ -radiation on mitotic rates in grasshopper neuroblasts (*Chortophaga viridifasciata*). (auth.)

- 838 Lamarque, P., Gary-Babo, J. A STUDY OF RECOVERY FOLLOWING EXPOSURE OF PART OR THE WHOLE OF THE BODY TO IONIZING RADIATION. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/372. 11 (1956) 351-61.

Insect eggs were amongst the various types of biological material subjected to various doses of x-radiation, mixed  $\gamma$ - and  $\beta$ -radiation ( $^{137}\text{Cs}$ ) and pure  $\beta$  ( $^{90}\text{Sr}$ ). The insects were *Bombyx mori* and *Bacillus Rossii* (phasmidae). Two sets of experiments were made for testing recovery following (1) total irradiation, and (2) partial irradiation. In each part, recovery was made evident by (a) the study of massive irradiation in a single dose and (b) the study of fractionated irradiation. In addition, the effect of cold on recovery was studied for insect eggs. Results are illustrated by graphs and discussed. Cold did not completely eliminate recovery in this study. The time during which the cold acts appears to have a certain influence, the existence of an optimal duration for the action of the cold being observed, which also corresponds to the optimal interval for recovery.

- \* Lobbbecke and Müller 1959 - [1025]

- \* Lobbbecke and Müller 1960 - [1026]

- \* Medical Research Council 1957 - [1034]

- 839 Mickey, G. H. VISIBLE AND LETHAL MUTATIONS IN *DROSOPHILA*. *Amer. Nat.* 88 (1954) 241-55.

Fast neutrons from the Oak Ridge National Laboratory 86-inch cyclotron and from nuclear test devices (about 1 MeV) are approximately four times as efficient in producing specific loci mutations at the *res* markers in the third chromosome of *Drosophila melanogaster* as are x-rays of 250 kV potential. Dominant visible mutations are produced at a much higher rate per rep of neutrons than per r of x-rays, the RBE of neutrons for all observed variants being from 6 to 37 and for the proved dominant mutations from 3 to 22. The relative biological effectiveness of fast neutrons as compared to x-rays in the production of dominant mutations likewise is quite high. Contrary to reports of previous investigators that fast neutrons are only about two-thirds as effective as x-rays in producing sex-linked recessive lethal mutations, it was found that the neutrons have an RBE of 2. Dominant lethals are produced at a much higher frequency per rep of fast neutrons than per r of x-rays, the RBE at lower doses being about 7 and at higher doses falling off to about 4. It appears, therefore, with all the biological criteria used to measure the genetic damage of radiations in *Drosophila*, that fast neutrons cause a much greater effect than do x-rays. (auth.)

(An abstract of earlier work "Comparison of rates of visible mutations produced by fast neutrons and by X-rays at specific loci in the third chromosome of *Drosophila melanogaster*" by Mickey and A. F. Yanders was published in *Genetics* 38 (1953) 876-7)

- 840 Mickey, G. H., Yanders, A. F. THE PRODUCTION OF DOMINANT MINUTES IN *DROSOPHILA (MELANOASTER)* SPERM IRRADIATED WITH X-RAYS, GAMMA RAYS AND FAST NEUTRONS (abstr.). *Genetics* 39 (1954) 983.

Mature sperm of *D. melanogaster* (Oregon-R) were given doses ranging from 1500 r to 9000 r of either  $\text{Co}^{60}$  gamma rays of 250 kV potential x-rays or from 250 rep to 2000 rep of fast neutrons. Treated males were mated to wild type virgins and transferred to fresh cultures each day through four cultures. The dominant Minutes were detected in the  $F_1$  flies. Rates of Minutes induced by these high energy x-rays did not differ statistically from those induced by gamma rays. The fast neutrons, however, were much more efficient per unit of dose in producing Minutes; their RBE was about 4.5. Measured in terms of Minutes induced, the effects of these agents appear to be directly proportional to dose and also related to specific ionization density of the path.

- 841 Mossige, J. THE RELATIVE BIOLOGICAL EFFICIENCY OF 31 MeV BETATRON X-IRRADIATION AND 175 keV X-RAYS AS MEASURED BY RECESSIVE SEX-LINKED LETHALS IN DROSOPHILA MELANOGASTER, p. 137-43 in "Progress in Radiobiology. Proceedings of the 4th International Conference on Radiobiology, Cambridge 14-17 Aug. 1955". Mitchell, J. S., Holmes, B. E., Smith, C. L., eds. London, Oliver and Boyd. 1956.

The average number of offspring/male/day of irradiation with 2500 r and 500 r of 175 keV x-rays is plotted. Both curves show a typical increase from the 1st to the 2nd day (particularly where newly emerged males are used) associated with a slight decrease in recessive lethals. The curves fall, more sharply with higher doses, to a practically sterile period of varying length, depending on dose. The percentage of sex-linked lethals after irradiation at 31 MeV and 175 keV (1000 r and 2500 r) are given, also the RBE curves. On the whole, the RBE is lowest during the period of highest mutational sensitivity.

- 842 Mossige, J., Oftedal, P. ON THE CONSTANCY OF THE RELATIVE BIOLOGICAL EFFICIENCY OF  $\beta$ -PARTICLES DURING SPERMATOGENESIS IN DROSOPHILA MELANOGASTER, p. 245-52 in "25th Anniversary Publication from the Norwegian Radium Hospital". Oslo, H. Aschehoug and Co. (W. Nygaard), 1958, 323 p.

An apparatus for external irradiation of flies with  $\beta$  particles from a solution containing radioactive isotopes is described, and the biologic dosimetry of the source is reported. The apparatus has been used for obtaining the sex-linked recessive lethal mutation curve after irradiation with  $P^{32}$   $\beta$  particles, using a dose biologically equivalent to 930 r for the induction of dominant lethals in mature sperm. The curve was found similar to the one obtained after 1000 r of x-rays. (auth.)

- 843 Muller, H. J. CHARACTERISTICS OF THE FAR STRONGER BUT "SPOTTIER" MUTAGENICITY OF FAST NEUTRONS AS COMPARED WITH X-RAYS IN DROSOPHILA SPERMATOZOA (abstr.). Genetics 39 (1954) 985.

Experiments of 1953 establish frequency of translocations connecting second and third chromosomes at approx.  $68 \times 10^{-6}$  per rep, practically independently of dose, for neutrons from either the Oak Ridge cyclotron or pile, applied to mature spermatozoa in young males. This effectiveness is 2.4 times that of 4000 r x-rays, varying with x-ray (dose) $^{-1/2}$ . - NXE (neutron:x-ray effectiveness) in inducing male exceptions, lacking either paternal sex-chromosomes or its marked portion, was 3-5. However, subtraction of partial losses, estimated by tests, indicated that NXE for complete losses, presumably representing isochromatid bridges derived from individual breaks, was about 7. Causes of lower NXE for eucentric rearrangements than for individual breaks are listed. - NXE for producing separately registered sex-linked recessive lethals was 2.4. However, for all visible changes of expression of specific loci, NXE was about 4, as it was for proved "point-mutations" of these loci (this holds also for female germ cells). This difference from lethals is caused by multiple neighbouring effects with neutrons, which hide some third of point-mutational lethals, yet cause neutron-induced rearrangements to affect more loci (hence to give more "visibles") than x-ray-induced rearrangements. (from abstr.)

\* Naville 1955 - [1045]

\* Paul and Schubert 1950 - [1051]

\* Regehr et al. 1950 - [1056]

- 844 Rudnicki, T. DETERMINATION OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF  $P^{32}$  BETA RADIATION, p. 754-6 in "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotwórczych W Biologii, Medycynie, i Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa", Warsaw, Bur. of the At. Energy Ministry. 1959. (In Polish)

The comparison of the biological effectiveness of  $P^{32}$   $\beta$  radiation and 70-keV  $\gamma$  radiation was made for three biological specimens; the specimens were fruit fly eggs, pea sprouts, and the tops of the sprouts of V. faba. A large number of batches of fruit fly eggs, specially prepared and incubated, were irradiated with 70-keV x-rays and  $P^{32}$  betas. One set of batches was irradiated after 1 h of incubation and another set after 3 h. The number of irradiated eggs hatched after 48 h was in each case compared with an unirradiated control batch. A plot of fatality vs. dose was thus obtained for each case. The 1-h incubated eggs were much less resistant to radiation than the 3-h eggs. A value of 1.0 for the RBE of  $P^{32}$  betas was obtained with the former and 0.85 with the latter by comparing the  $\beta$ - and x-ray doses required to produce a 50% fatality.

The statistical uncertainty of these two determinations did not clearly establish that the RBE for  $P^{32}$  betas was different from 1.0. It did, however, in measurements of rate of growth of the sprout specimens. The doses required to reduce the rate of growth by 50% yielded a value of RBE of 0.6 for both pea sprouts and the tops of the sprouts of V. faba. It is concluded that the value of RBE depends on experimental conditions as well as on the biological specimen, that extreme care must be taken in any attempts to carry over results with biological specimens to the realm of human pathology, and that concrete experimental conditions must be chosen and clearly stated in determining the RBE in biological radiation-damage studies as well as in medicinal methods. (NSA 15: 13204, 1961)

- 845 Russell, W. L., Kelly, E. M. RADIATION DOSE RATE AND MUTATION FREQUENCY. Science 128 (1958) 1546-50.

New data have clearly confirmed the earlier finding that specific locus mutation rates obtained with chronic  $\gamma$ -irradiation of spermatogonia are lower than those obtained with acute x-rays. Since this result is in contrast to classical findings for Drosophila spermatozoa, and apparently contradicts one of the basic tenets of radiation genetics, it was important to determine the factors responsible for it. Experiments undertaken for this purpose reveal the following: the lower mutation frequency is due mainly to difference in dose rate of radiation, rather than quality; a dose-rate effect is not obtained in experiments with mouse spermatozoa, confirming classical findings for spermatozoa, and indicating that the explanation for intensity dependence in spermatogonia resides in some characteristic of gametogenic stage; and a dose-rate effect is found not only in spermatogonia but also in oocytes, where cell selection is improbable, indicating that the radiation intensity effect is on the mutation process itself. A threshold response for all mutations in spermatogonia and oocytes is not a necessary consequence of the findings. Plausible hypotheses consistent with the present results can lead to other predictions. From a practical point of view, the results indicate that the genetic hazards, at least under some radiation conditions, may not be as great as those estimated from the mutation rates obtained with acute irradiation. However, it should not be forgotten that even the lower mutation rates obtained with the present intensity levels are still appreciable. (auth.)

- 846 Schmid, W. VERGLEICH DER GENETISCHEN WIRKSAMKEIT DER 31-MeV-BETATRONSTRAHLUNG MIT 180 keV-RÖNTGENSTRAHLUNG DURCH ERZEUGUNG VON SICHTBAREN REZESSIVEN MUTATIONEN UND BEI DROSOPHILA MELANOGASTER (Comparison of the genetic effectiveness of radiation from a 31 MeV betatron and 180 keV x-rays in terms of the production of visible recessive mutations and gynandry in Drosophila melanogaster). Oncologia 11 (1958) 218-43. (In German)

In order to compare the biological efficiency of the 2 sources, some normal Drosophila males from a wild inbred strain were subjected to 2000 r of  $\beta$ -radiation (31 MeV) and others to an equal dose from a conventional x-ray source (180 keV). Similar experimental conditions were ensured. After mating with females homozygous for 5 factors, the descendants were examined for radio-induced visible, recessive mutations. Values for mutation rates and the number of XO-males and gynanders were found to be of the same order. There appeared to be no essential quantitative difference in the genetic effects of the two qualities of radiations used.

- 847 Shenfield, A. J. DIE ERZEUGUNG VON REZESSIVEN GESCHLECHTSGEBUNDENEN LETALFAKTOREN BEI DROSOPHILA MELANOGASTER DURCH SCHNELLE 30-MeV ELEKTRONEN UND DURCH 180-keV RÖNTGEN-STRAHLEN (The response of sex-bound lethal factor in Drosophila melanogaster to irradiation by 30-MeV electrons and 180 keV x-rays). Oncologia 10 (1957) 281-94. (In German)

The relative effects of 180 keV conventional rays and of fast 30 MeV electrons, both at 3000 r, were investigated on immature male germ cells of Drosophila melanogaster which were irradiated 5-11 d before fertilization. The Muller-5 method was employed, and the lethal and sublethal factors resulting in the  $F_2$  generation were counted. Using fast electrons, 6.07% lethal factors were obtained, compared to 5.18% with conventional rays, i. e., the mutagenic effect of fast electrons was 1.17 times stronger. This difference, however, could not be verified statistically. The number of sublethal factors produced was too minute for quantitative evaluation. It may be presumed from the experiments that fast 30 MeV electrons possibly have a stronger mutagenic action than 180 keV roentgen rays. (auth.)

(For translation see AEC-tr-3443, tr. for Los Alamos Scientific Lab. 1959)

- \* Stone et al. 1954 - [1068]

- \* Sullivan and Grosch 1958 - [1295]



- 848 Tahmisiian, T. N., Vogel, H. H., Jr. RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS, GAMMA-RAYS, X-RAYS ON GRASSHOPPER NYMPH OVARIOLES (MELANOPLUS DIFFERENTIALIS). Proc. Soc. exp. Biol., N. Y., 84 (1953) 538-43.
- Fifth or sixth instar grasshopper nymphs were used. In order to destroy every egg in each grasshopper ovariole, with the exception of the most advanced, it was necessary to irradiate the total body with 350 r (200 kV) x-rays, 420 r Co<sup>60</sup> gamma rays, or 22.5 rep of fast neutrons. Thus, the relative biological effectiveness of Co<sup>60</sup> gamma rays: 200 kV x-rays: fast neutrons, for this specific effect, is 1.0:1.2:19. This is correlated with relative specific ionization and linear energy transfer. It is suggested that damage to the grasshopper ovariole could be used as a biological dosimeter for fast neutron doses in the range 10-15 rep. The high anabolic rate in the formation of the grasshopper egg within the ovariole may well be a major cause for its sensitivity to ionizing radiation.
- 849 Vogel, H. H., Jr., Clark, J. W., Jordan, D. L. RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST NEUTRONS AND Co-60 GAMMA RAYS. Radiation Res. 1 (1954) 233.
- During the past several months, the Neutron Radiobiology group at Argonne National Laboratory has had the opportunity to test various organisms in a gamma/neutron chamber. Comparisons of the relative biological effectiveness of the two radiations have been made for a variety of biological materials, including the incidence of chromosomal aberrations in Drosophila melanogaster and the destruction of egg nuclei of grasshopper (Melanoplus differentialis) nymphs.
- (See also M-5225, Argonne National Lab., Dec. 1953, 7 p.)
- 850 Witte, E. EXPERIMENTELLE UNTERSUCHUNGEN ÜBER DEN BIOLOGISCHEN EFFEKT INTERMITTIERENDER RÖNTGENBESTRAHLUNG (Ultra-fractionated x-ray treatment. I. Experimental study of the biological effect of an intermittent irradiation). Strahlentherapie 82 (1950) 209-22. (In German)
- Experiments on the biological action of intermittent (so-called "ultra-fractionated") roentgen irradiation showed that the effects become noticeable only when the elementary periods of irradiation and intermission are very small. The effect, which is a weakening of the x-ray action as compared with that of a continuous treatment, can exceed 50%. As a working hypothesis, it can be surmised that the effect of a quantum hit within the limits of an elementary target in a living cell lasts for a certain time interval; if another hit reaches the same target before the expiration of that interval, the effect is increased; this is the case of a continuous irradiation. Experiments with 12-h-old Drosophila pupae showed that the width of elementary targets is at least 0.1 mm (10 to 100 cells), and that the hit effect lasts for about 1/350 s. (auth.)
- 851 Zirkle, R. E. RADIOBIOLOGICAL ADDITIVITY OF VARIOUS IONIZING RADIATIONS. Amer. J. Roentgenology 63, 2 (1950) 170-5.
- A discussion is presented on the problem of additivity of various types of ionizing radiations. A summary is included which outlines the degree of additivity found in various experiments by the author and others through combinations of  $\alpha$ -,  $\beta$ -,  $\gamma$ -, fast-neutron and x-rays on the mouse, bean roots, Drosophila eggs, Drosophila pupae and the human skin. It is concluded from the analysis of these studies that incomplete additivity of two types of radiation indicates some difference in the mechanism of action of the radiations. Complete additivity indicates that the mechanisms of action of the radiations are identical in their most essential feature, the promotion of the same determinative events (one of a succession of unknown relevant events leading to the production of the known biological effects), but are not necessarily alike otherwise. It is concluded that it is probably wise to assume that additivity of fast-neutrons and  $\gamma$ -rays is the complete type. (NSA 4: 2142, 1950)
- 852 Zirkle, R. E., Parrish, M. E. COMPARATIVE LETHAL ACTION OF X-RAYS AND CYCLOTRON NEUTRONS ON DROSOPHILA EGGS. CH-3904. Univ. Chicago Metallurgical Laboratory, Dec. 1950, 6 p.
- The x-rays were generated at 200 kV and 5 mA and were filtered by 0.5 mm of Cu and 1 mm of Al. The target-to-object distance was adjusted to give a dose rate of about 10 r/min. The fast neutrons were generated by 8 MeV deuterons impinging on a beryllium probe in the University of Chicago cyclotron. The eggs were exposed in a leadwalled chamber which was so constructed that radiation directly from the probe was filtered through 4 inches of lead, while scattered radiation from other directions was filtered through at least 2 inches. Various lots of eggs were given graded doses of x-rays, of fast neutrons, and of mixed neutrons and  $\gamma$ -radiation. The LD<sub>50</sub> of x-rays is 170 r, that of fast neutrons is 31 n, and that of the mixed

cyclotron emission is 43 Victoreen scale units. Accordingly the x/n dosage ratio is 170/31 or 5.5, whereas the apparent x/n ratio, from data obtained when  $\gamma$ -rays were present, is 170/43 or 4.0. (NSA 5: 911, 1951)

# I-A-2 RADIOSENSITIVITY OF ONE OR MORE STAGES OF DEVELOPMENT

- 853 Abeleva, Z.A., Potekhina, N.A. РАДИОЧУВСТВИТЕЛЬНОСТЬ РАЗНЫХ СТАДИЙ СПЕРМАТОГЕНЕЗА У DROSOPHILA MELANOGASTER. АН СССР, Москва, 1960, 8 стр.  
Приводятся данные по частоте возникновения доминантных леталей у Drosophila melanogaster при оуточном облучении спермий и сперматид рентгеновскими лучами. Использовались однократная доза в 2400 р и фракционированное облучение, даваемое трехкратно по 800 р через полуторачасовой интервал, а также однократные облучения 400 р и 1200 р и 3 фракционированных облучения дозами в 400 р через такие же промежутки времени. Дается оценка радиочувствительности разных стадий сперматогенеза.  
Abeleva, E. A., Potekhina, N. A. RADIOCHUVSTVITEL'NOST RAZNYKH STADIJ SPERMATOGENEZA U DROSOPHILA MELANOGASTER (The radiosensitivity of different stages of spermatogenesis in Drosophila melanogaster). А/АС. 82/Г/Л. 409, Akademiya Nauk SSSR, 1960, 8 p.  
The development of dominant lethals in irradiated 24-h-old Drosophila melanogaster sperm and spermatids was investigated. Single exposure to 2400 r, 3 exposures to 800 r at 1.5-h-intervals, single exposure to 400 and to 1200 r, and 3 exposures to 400 r at 3-h-intervals were used. Radiosensitivity at various stages of spermatogenesis was evaluated. (NSA 15: 15395, 1961)
- 854 Alexander, M. L. RADIOSENSITIVITY AT SPECIFIC AUTOSOMAL LOCI IN MATURE SPERM AND SPERMATOGONIAL CELLS OF DROSOPHILA MELANOGASTER. Genetics 45 (1960) 1019-22.  
The mutation rate, when calculated with point mutations, was higher in mature sperm than the rate for spermatogonia with 900 r of x-radiation. The higher rate in sperm shows a difference in the mutational sensitivity of the two types of cells. Selection of chromosome breakage types from spermatogonia cannot account for the difference. The spermatogonial mutants show the same proportion of viable and lethal mutations as obtained with mature sperm with 900 r. The absence of chromosome aberrations remained characteristic of spermatogonial mutants. (auth.)
- \* Alexander and Stone 1955 - [1156]
- 855 Brockway, A. P. THE EFFECTS OF X-RADIATION ON LARVAL AND PUPAL STAGES OF THE YELLOW MEALWORM, TENEbrio MOLITOR LINN. Biol. Bull. 109 (1955) 355. (Paper read by title only)  
In preliminary experiments, dosages of 4600 to 46 000 r were used on larvae of T. molitor Linn. Since the precise age of the larvae was unknown, specimens were divided into two weight groups. There was no observable difference in effects between doses ranging from 2750 to 4600 r when given to pupae within 8 h after formation. The time required for pupation was increased. Irradiation thus tends to inhibit the pupation of larvae and also prevents the formation of normal adults. In determining LD<sub>50</sub> values, it appears that the lighter larvae are more radiosensitive than the heavier and presumably older larvae. Details are given.
- 856 Brockway, A. P. THE EFFECT OF X-IRRADIATION ON THE PUPAE OF THE YELLOW MEALWORM, TENEbrio MOLITOR LINN. (abstr.) Biol. Bull. 111 (1956) 297-8. (Paper read by title at Marine Biological Laboratory)  
A genetically mixed culture of larvae was used. All pupae used as controls or given 500 r and 1000 r hatched normally. After 2000 r, only 33% did so. From 2500 r to 20 000 r all hatched abnormally. The region between 1000 r and 2500 r appeared to be quite critical. Some effect was also observed on the length of the pupal stage. Pupation of controls was 8.15 d; 500 r increased it to 9.0 d, 4000 r to 10.0 d,

5000 to 20,000 r to 11 d. At 2500 r the emerging adult was unable to shed the pupal cuticle. The tanning process of the new cuticle was incomplete in all adults irradiated with 3000 r at the pupal stage. Blistering was also observed.

- 857 Chandley, A. C., Bateman, A. J. MUTAGENIC SENSITIVITY OF SPERM, SPERMATIDS, SPERM-ATOCYTES AND SPERMATOGONIA IN DROSOPHILA MELANOGASTER. Heredity 15 (1960) 363-75.

F<sub>1</sub> males irradiated with 1000 r x-rays were mated with different classes of females 2, 5, 8 and 11 d after treatment. The incidence of dominant lethals, hyperploidies and translocations (structural changes) and recessive autosomal and sex-linked lethals (gene changes) were recorded for each day (tables and graphs). Estimates of induced crossing-over in the b pr vg region, made in daily samples from the 2nd to the 13th day, were used to identify specific stages of germ cell development. In addition, the excess of animals showing a single recessive marker over those showing two markers was used to estimate the proportion of "mutations" or small deletions. The pattern of sensitivity was similar for recessive autosomal and sex-linked lethals and translocations, showing a rise from the 2nd day (sperm) to the 5th (spermatids) followed by a fall on the 8th (spermatocytes or later spermatogonia?). Deleted X's showed a unique sensitivity pattern with a peak on the 8th day. This was attributed to the high sensitivity of spermatocytes to intra-changes and in particular to deletions. (auth. summary)

- 858 Clark, A. M. RESEARCH PERTAINING TO X-RADIATION DAMAGE IN THE PARASITIC WASP, HABROBRACON. FINAL REPORT FOR THE PERIOD JULY 1, 1950 TO AUGUST 31, 1953. AECU-2764, Delaware. Univ., Newark. 1953, 29 p.

Results are reported in an investigation of the relationship between chromosome number and radiosensitivity in the parasitic wasp, Habrobracon. In this species haploid males and diploid females occur normally. Data on the differential radiosensitivity of the cleavage stage of the embryo, larval stage, and pupal stage indicate that the differential radiosensitivity between haploids and diploids is dependent upon the stage of development at which the organisms were irradiated and cannot be correlated with gene number. No direct correlation was found between the radiosensitivity pattern and oxygen consumption, phosphatase activity, nucleic acid changes, and catalase activity. (NSA 8: 973, 1954)

- 859 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY IN HABROBRACON. (abstr.) Radiation Res. 1 (1954) 491.

Haploids and diploids of the parasitic wasp, Habrobracon, were x-irradiated at different stages during their development. Their radiosensitivity was measured by counts of adults that emerged from cocoons. The data show that the differential radiosensitivity between haploids and diploids does not remain constant throughout the life cycle but varies with the stage of development. During the cleavage stages of the embryo, haploids are more radio-resistant than diploids. At later embryonic stages, haploids and diploids are equal in radiosensitivity. In the larval stages the differential radiosensitivity varies with age; among young larvae, diploids are only slightly more resistant than haploids, whereas among older larvae, diploids are markedly more resistant than comparable haploids. This increase in differential radiosensitivity becomes greater during the prepupal and pupal stages. It is concluded, therefore, that there exists no simple correlation between genome number and radiosensitivity throughout the life cycle of Habrobracon.

- 860 Clark, A. M. SENSITIVE PERIODS AND APPARENT FRACTIONATION EFFECTS IN IRRADIATED DROSOPHILA. Amer. Nat. 89 (1955) 179-81.

Five successive matings, 72 h apart, of newly emerged Canton S males treated with 4 doses of 700 r delivered at 24 h intervals were compared to a group receiving 2800 r at 72 h of age. No significant over-all differences were seen; the distribution of lethals and translocation was altered, however, so that the peak seen at the 2nd and 3rd brood was not marked in the fractionated group. Both translocations and lethals were significantly lower in the 4th and 5th broods of the fractionated series.

- 861 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY IN HABROBRACON. Amer. Nat. 91 (1957) 111-9.

Haploids and diploids of the parasitic wasp Habrobracon were x-irradiated during known stages of embryonic and post-embryonic development, and compared with regard to their sensitivity to damage by x-rays. The ability to continue development and to emerge from cocoons as adults was used as the criterion of injury. The ratio of haploid to diploid radiosensitivity is different for different stages of development. During cleavage stages of embryonic development haploids and diploids are equal in sensitivity; during the post-

embryonic stages diploids are more resistant than haploids. The bearing of these data on determining the site of injury from radiation is discussed. (auth.)

862 Clark, A. M. THE RELATION OF GENOME NUMBER TO RADIOSENSITIVITY. TID-6051, Delaware. Univ., Newark. 7 June 1960.

Progress is reported in studies on the effects of oxygen on insects, a comparison of radiation damage and oxygen poisoning, and the effects of x-radiation on the life span in haploids and diploids of Habrobracon. (NSA 14: 15528, 1960)

863 Clark, A. M., Kelly, E. M. DIFFERENTIAL RADIOSENSITIVITY OF HAPLOID AND DIPLOID PREPUPAE AND PUPAE OF HABROBRACON. Cancer Res. 10 (1950) 848-52.

Habrobracon prepupae and pupae were exposed to x-radiation, and the lethal effects of the radiation were studied. Eclosion ratios show that x-rays have a greater lethal effect upon haploid males than upon diploid females. Diploid males and diploid females are equally susceptible to the lethal effects of x-radiation. Prepupae are more sensitive than pupae. No significant difference in eclosion ratios was obtained for adults given the same total dose but at different intensities. The response, therefore, seems to be independent of intensity. Comparison of adults developing from irradiated prepupae and pupae shows that a greater number of haploid males show structural malformations than diploids irrespective of sex and that the haploids show these malformations to a greater degree. Comparison of individuals unable to emerge from cocoons shows that the diploids are in general more advanced in their development than are the haploids. The data show that diploids are more resistant than haploids to the lethal action of x-rays, suggesting that the number of chromosome sets is a factor in determining the radiosensitivity of cells. (auth.)

864 Clark, A. M., Mitchell, C.J. RADIOSENSITIVITY OF HAPLOID AND DIPLOID HABROBRACON DURING PUPAL DEVELOPMENT. J. exp. Zool. 117 (1951) 489-98.

The study was aimed at establishing whether there exists a constant difference in resistance during different stages of pupal development. Diploids were found to be more radioresistant than haploids during all stages of pupal development. During the earlier pupal stages, diploids are about three times as resistant as comparable haploids while during the later pupal stages the differential radiosensitivity is not as great. Resistance increases with age. For haploid pupae, the increase in resistance is exponential for the period from 5 to 8 d. The increase in resistance for 5-7 d diploid pupae is identical with the haploids; the older diploid pupae (7-8 d) do not, however, increase as rapidly in resistance. The deleterious action of radiation on somatic tissues is interpreted to be due primarily to injury to the genetic mechanism. (auth.)

(A report, AECU-1444, Technical Information Service, AEC. 15 p., was published, also an abstract in Genetics 36 (1951) 547)

865 Clark, A. M., Mitchell, C.J. EFFECTS OF X-RAYS UPON HAPLOID AND DIPLOID EMBRYOS OF HABROBRACON. Biol. Bull. 103, 2 (1952) 170-7.

Haploid and diploid embryos of Habrobracon were x-rayed at known stages of development in order to determine to what extent radiosensitivity can be correlated with genome number. When embryos are x-rayed during cleavage, haploids are more resistant than diploids; when embryos are x-rayed immediately after cleavage has been completed, haploids and diploids are equally radiosensitive. Embryos x-rayed during cleavage or early blastema are deleteriously affected during the egg stage or not at all. Older embryos when x-rayed may hatch, but show post-embryonic injury. Embryos that are x-rayed during cleavage and fail to hatch are arrested before blastulation. The nuclei are arrested at interphase and become enlarged up to four times the diameter of untreated nuclei. Since the differential radiosensitivity between haploids and diploids depends upon the stage of development at which they are irradiated, it is difficult to pose a single hypothesis that will account for these facts. (auth.)

866 Colombo, G. DIFFERENT SENSITIVITIES OF X-RADIATION WITH RESPECT TO THE STAGE OF DEVELOPMENT OF THE EMBRYOS OF LOCUSTA MIGRATORIA MIGRATORIOIDES (R. AND F.) R. C. Accad. Lincei Sed. solen. 26 (1959) 583-91. (In Italian)

The variation in the radiation sensitivity of Locusta embryos was studied with various x-radiation exposures at embryonic ages from 1 to 6 d. The ED<sub>50</sub> was determined as a measurement of the sensitivity. These values are tabulated, and show that the resistance to irradiation increases rapidly with the age, varying

from an ED<sub>50</sub> of 136 r on the 1st day to 6900 r on the 6th day. The high resistance of insects to radiation was shown to develop during the embryonic stage after organogenesis. (NSA 14: 3415, 1960)

- 867 Erdman, H. E. DIVERGENCE BETWEEN LETHAL DOSES AND STERILIZING DOSES OF X-RAYS WITH PROGRESSIVE DEVELOPMENT IN HABROBRACON FEMALES. Nature 186 (1960) 254-5.

Data are presented on Habrobracon juglandis (Ashmead), and a figure is given which shows the pattern of radiation-induced effects for most of the life-cycle, to demonstrate the divergence between sterilizing and lethal doses. (Doses of up to 15 000 r at 600 r/min were given, the age in hours ranging from 0 to 180.) The weakest link in an insect life-cycle was determined and related to the quantitative differences between the sterility and lethality doses when virgin females were irradiated at various developmental stages. The curve for increased radiosensitivity does not progress smoothly. Biological considerations are offered in explanation.

- 868 Erdman, H. E. ADULT LONGEVITY AS A SENSITIVE CRITERION OF RADIATION-INDUCED DAMAGE WHEN 24-HOUR HABROBRACON EMBRYOS ARE X-RAYED. J. econ. Ent. 53 (1960) 971-2.

Evidence is presented to show that adult longevity of Habrobracon juglandis (Ashmead) is a sensitive criterion of radiation damage compared with other parameters when the wasps are x-rayed as 24-h-old embryos. The performance of adult females thus x-rayed as 24-h-old embryos is tabulated in terms of adult females eclosed, and egg hatchability and longevity. On the basis of longevity, the wasps were damaged by a 900 r exposure, with a striking effect at a 1500 r-dose.

- \* Fritz-Niggli 1952 - [1305]

- 869 Fritz-Niggli, H. MÖGLICHE URSACHEN DER VERSCHIEDENEN STRAHLENEMPFINDLICHKEIT DES ERBMATERIALS IN KEIMZELLEN UNTERSCHIEDLICHEN ALTERS (Possible causes of the differences in radiosensitivity of genetic material observed in germ cells of different ages). Naturwissenschaften 45 (1958) 557-64. (In German)

Much of the experimental data is derived from Drosophila melanogaster. Radiation-induced mutation rates depend on the age of the germ cells, and they may be raised or lowered by a variety of factors which are discussed. It may be supposed that the differences in sensitivity may, at least in part, be due to changes in intracellular oxygen content.

- \* Gray 1956 - [1311]

- \* Heidenthal 1953 - [999]

- 870 Luce, W. M., Quastler, H., Chase, H. B. REDUCTION IN FACET NUMBER IN BAR-EYED DROSOPHILA BY X-RAYS. Genetics 36 (1951) 488-99.

The paper deals with a quantitative well-controlled response to x-rays: reduction of eye facet number in Bar-eyed flies. Larvae of Bar-eyed Drosophila, kept at a temperature of 28°C, which were irradiated with x-rays of dosages varying from 115 to 1840 r, developed into adult flies whose compound eyes had a smaller number of facets than untreated controls. With a dosage of 920 r the effect of the x-rays was largely confined to a radiosensitive period extending from about 55 to 70 h of egg-larval life, with a maximum reduction occurring between 57 and 67 h. The radiosensitive period closely corresponds to similar sensitive periods for other environmental agents affecting facet number in Bar-eyed Drosophila. The reduction in facet number following application of x-rays during the sensitive stage was nearly proportional to the dosage applied. In males the reduction in facets per unit dose was always greater than in females. The biological effect of the x-rays and the nature of the mode of action of the Bar mutants are discussed.

- \* Lünig 1954 - [1400]

- \* Lünig 1958 - [1288]

- \* Lünig and Jonsson 1956 - [1210]

- \* Lünig and Jonsson 1957 - [1031]

- 871 Nakanishi, Y. H. PHASE CINEMATOGRAPHY STUDIES ON THE EFFECTS OF RADIATION AND CHEMICALS ON THE CELL AND THE CHROMOSOMES. III. IMMEDIATE EFFECTS OF BETA-IRRADIATION, FROM A STRONTIUM-90 SOURCE AT SOME DIFFERENT STAGES, ON MEIOSIS OF GRASSHOPPER (PODISMA SAPPORENSE) SPERMATOCYTES. Hokkaido Univ. Facul. Sci. J. Ser. VI. Zool. 14, 2 (1959) 157-65.
- 872 Nishiwaki, Y., Tamagusuku, S., Shinozaki, K., Murata, S. ON THE LETHAL EFFECT OF X-RAY ON THE EGGS AND SPERM OF MOSQUITOES. Nippon Acta Radiol. 13, 2 (1953) 94-8.
- The lethal effects of x-rays on sperm and unfertilized eggs of mosquitoes, Aedes togoi and Culex pipiens pallens, were studied. The x-ray dose was 100-1000 r and the dose rate was 93-115 r/min at 60 kV potential. LD<sub>50</sub> in fertilized eggs was 500 r in Aedes togoi and 150 r in Culex pipiens pallens. A marked discontinuous change in radioresistance was observed in fertilized eggs between 2-3 h after oviposition which seems to indicate that cleavage accompanying mitosis or nuclear division might be occurring at that age. The hatching rate of unfertilized eggs and sperm showed no marked decrease with doses less than 500 r. Sperm seemed to be more sensitive to irradiation in vivo than unfertilized eggs. (BA 28; 2896, 1954)
- 873 Olenov, Yu. M., Galkovskaya, K. F., Pushnitsyna, A. D. MATERIALS FOR DESCRIBING THE EFFECT OF IONIZING RADIATION ON INDIVIDUAL DEVELOPMENT. Tsitologiya 1 (1959) 293-305. (In Russian, translation into English issued June 1960: JPRS-3398, p. 60-77)
- Roentgen exposure of larvae and pupae of Drosophila melanogaster causes the destruction of part of the cells of the imaginal disks, the rudiments of definite organs of the insect. X-ray mutations are the result of the incomplete repair of this injury. Their frequency depends upon the time of repair. The data obtained permit one to give a new interpretation of the concept of the sensitive period in ontogenesis. The stage for which the repair process caused by the inflicted injury coincides with sensitive period for a given indication, for a given external influence. The destruction of part of the undifferentiated cells and the deviations caused by it in the further course of ontogenesis are obviously a general characterization of the effect of ionizing radiation on the developing organism. One should have this picture in mind when working out a theory of the biological action of ionizing radiation. (auth.)
- \* Oster 1959 - [1047]
- 874 Potts, W. H. SOME EFFECTS OF GAMMA RAYS ON TSETSE PUPAE (GLOSSINA MORSITANS WESTW.) (abstr.) Proc. R. ent. Soc. Lond. - Ser. C (L. Mtg.) 22, 4 (1957/58) 2.
- 875 Ray, D. T. X-RAY SENSITIVITY OF MEIOTIC STAGES OF MORMONIELLA EGGS. Genetics 42 (1957) 391.
- Female wasps were treated with x-rays of different doses (1000 r - 1500 r - 2000 r - 2500 r - 3000 r), and set with host pupae of the fly Sarcophaga bullata. They were transferred to new host pupae at frequent intervals. Eggs laid at successive times after treatment were treated at different meiotic (and even pre-meiotic) stages. Eggs laid within 6 h after x-raying had been rayed during the first meiotic metaphase. Since the females were unmated they produced all haploid males parthenogenetically. Offspring per females as compared to controls furnished a rough estimate of the presence of lethals. Results seem to indicate that while the fecundity of treated females decreased with the increase of x-ray treatment, as expected, there was a drastic reduction in the number of offspring secured from eggs laid during the first 6 h after treatments above 1500 r. Reduction in the number of offspring as treatment increased from eggs laid in successive hours was not nearly as drastic. This indicates a higher sensitivity of the first meiotic metaphase to high doses of radiation with sensitivity decreasing in the earlier meiotic and pre-meiotic stages. A more accurate estimate is being made by egg counting. This was made possible by investigations during the summer of 1955, demonstrating rearing offspring from counted eggs (damp chamber technique) hitherto not possible.
- (Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, Aug. 26 to 28, 1957)
- 876 Ray, D. T. SENSITIVITY OF DIFFERENT STAGES OF THE EGGS OF MORMONIELLA TO X-RAYS. (abstr.) p. 230 In "Proceedings of the 10th International Congress of Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958).
- Female Mormoniella wasps were irradiated with varied dosages (500 r - 1000 r - 1500 r - 2000 r - 2500 r).

They were placed with host pupae of the fly Sarcophaga bullata and transferred to new host pupae at frequent intervals. Eggs (laid at successive times after irradiation) had been irradiated at different meiotic stages. Eggs laid within 6 h after irradiation have been x-rayed during the first meiotic metaphase. Egg counts were made using the damp chamber technique. Because of the parasitic nature of Mormonella an accurate count of eggs can only be made by removing them from their host. The counted eggs must be placed in another host for further development. The new host pupae were first stung by sterile female wasps. A small aperture was made in the stung pupae and the eggs inserted within. The pupae were then placed in open mouth vials and suspended by metal racks over a saturated solution of NaCl in large covered jars, to ensure the correct humidity and discourage mold. The eggs were observed for hatching and development without being disturbed. Results indicate that while the number of eggs hatching decreased as expected with increase in x-ray treatment, the number of offspring from eggs laid during the first 6 h decreased drastically. Only 8% of these eggs from females given 1000 r developed as against 20% of eggs laid after 24 h. No eggs developed from wasps given dosages above 1500 r in this group. Reduction in the number of offspring from eggs laid in successive hours was not nearly as drastic. This seems to indicate a higher sensitivity of the first meiotic metaphase to irradiation, with the sensitivity decreasing in the earlier meiotic and premeiotic stages.

- 877 Sävhen, R. RELATION BETWEEN X-RAY SENSITIVITY AND CELL STAGES IN MALES OF DROSOPHILA MELANOGASTER. Nature 188, 4748 (1960) 429-30.

An attempt is made to find the time of appearance of sperm irradiated in meiosis by a direct method, and at the same time to correlate it with the sensitivity pattern. It could be shown that the treated meiotic cells become available for insemination during the 7th day after irradiation and onwards. The peak of sensitivity would appear to correspond to cells treated during metaphase I or before anaphase I is completed.

- 878 Sérenó, C. EVIDENCE OF RADIOSENSITIVE STAGES DURING THE EMBRYONIC DEVELOPMENT OF GRYLLUS BIMACULATUS. C. R. Acad. Sci., Paris 251 (1960) 2430-2.

The radiosensitivity of the cricket embryo at various stages of development was studied. Embryos were exposed at ages 2, 24, 48 and 72 h and 4, 5, 6, 7, 8 and 9 d to 250 and 350 r. The variations in the percentage of hatching and the variation in the length of embryogenesis were used as the criteria to evaluate the radiation effects. The two radiation doses had essentially the same effect. The results showed that the radioresistant stages are characterized by zero (2 h) or slow (48 h) mitotic activity. In the radiosensitive stages corresponding to periods of intense mitotic activity, the radiation doses used appeared to either completely stop the embryonic development or to have no effect at all. (NSA 15: 8540, 1961)

- 879 Тульцева, Н.М., Астауров, Б.Л. ПОВЫШЕННАЯ УСТОЙЧИВОСТЬ ПОЛИПЛОИДОВ ШЕЛКОВИЧНОГО ЧЕРВЯ (BOMBYX MORI, L.) К ЛУЧЕВЫМ ПОВРЕЖДЕНИЯМ, В СВЯЗИ С ОБЩЕЙ ТЕОРИЕЙ БИОЛОГИЧЕСКОГО ДЕЙСТВИЯ ИОНИЗИРУЮЩИХ РАДИАЦИЙ. Биофизика 3, 2 (1958) 197-205.

Использован Bombyx mori, L.

Tultseva, N. M., Astaurov, B. L. INCREASED RADIO-RESISTANCE OF BOMBYX MORI L. POLYPOIDS AND THE GENERAL THEORY OF THE BIOLOGICAL ACTION OF IONIZING RADIATIONS. Biophysics (USSR) (English Translation) 3 (1958) 183-9.

The radio-resistance of silkworm embryos in the stages from diapause to middle spring development increases with the degree of polyploidy, other things being equal. There is a marked rise in resistance between diploid and triploid, and a lesser one between triploid and tetraploid. The data support the ideas as to the essence of the biological effects of ionizing radiations. They show that the main causes of such effects as radiation damage to embryos of multicellular organisms are genotype changes in the cell nucleus. (auth.)

- 880 Ulrich, H. RÖNTGENTEILBESTRAHLUNG VON DROSOPHILA EIERN (Partial x-irradiation of Drosophila eggs). Naturwissenschaften 38, 5 (1951) 121. (In German)

Drosophila eggs 1 h after being laid were irradiated with 200 r of x-rays. By using a screen with a splitlike window it was possible to investigate the influence of irradiation on 5 successive zones each 0.1 mm wide. A maximal sensitivity, expressed in percentages of non-hatchability, could be established for the second region of the anterior part of the egg. (EM 14, 7: 32, 1953)

- 881 Ulrich, H. ERGEBNISSE EINER PARTIELLEN RÖNTGENBESTRAHLUNG VON DROSOPHILA EIERN (Results of partial irradiation of Drosophila eggs). Biol. Zbl. 70 (1951) 274-85.
- On exposing different portions of 1 - 2 h-old Drosophila eggs to an x-ray dose of 200 r, the percentage of dead eggs demonstrate a non-uniform radiosensitivity. Maximum sensitivity occurs in the anterior second fifth portion of the egg, effectively at the cleavage centre, beyond which the sensitivity decreases. A similar but somewhat shifted curve for the distribution of radiosensitivity is obtained for the posterior portion of the egg, with a maximum in the third or middle fifth of the egg.
- 882 Ulrich, H. SINGLE EVENT IN KILLING OF DROSOPHILA EGGS BY X-RAYS? Drosophila Inform. Serv. 27 (1953) 117-8.
- 883 Ulrich, H. DIE BEDEUTUNG VON KERN UND PLASMA BEI DER ABTÖTUNG DES DROSOPHILA-EIES DURCH RÖNTGENSTRAHLEN (The significance of nucleus and cytoplasm in the killing by x-rays of the Drosophila egg). Naturwissenschaften 42 (1955) 468. (In German)
- Dose-effect curves obtained from 10-20 minute-old Drosophila eggs prior to cleavage can be used for a quantitative investigation into the significance of nucleus and cytoplasm in the process of killing the egg by irradiation. Irradiation was applied either to the anterior or the posterior half of the egg. Anterior and total irradiation showed that damage to the nucleus caused death, whereas posterior irradiation indicated that cytoplasmic damage can also be responsible for death. The possible mechanism of killing is discussed.
- 884 Ulrich, H. EIN VERGLEICH DER RÖNTGENSTRAHLENWIRKUNG AUF KERN UND PLASMA DES DROSOPHILA-EIES (A comparison of the effects of x-rays on the nucleus and cytoplasm of Drosophila eggs). Biol. Zbl. 74, 9/10 (1955) 498-515. (In German)
- 10-20 min-old eggs from mated wild-type females were irradiated in late telophase of the second maturation division, during first and second cleavage. The nucleus of the unfertilized egg lies in the anterior half. The radiation effects, both qualitatively and quantitatively, were found to be quite different for separate irradiation of the anterior and posterior halves. Results for anterior irradiation correspond quantitatively with lethality records for whole-egg irradiation. The sensitivity ratio of nucleus to cytoplasm certainly exceeds 182:1 (in terms of equivalent lethality at the 50% lethality dose).
- (A note also appeared in Drosophila Inform. Serv. 29: (1955) 170-1, under "Comparative studies on the lethal action of x-rays on nucleus and cytoplasm of Drosophila eggs before cleavage")
- 885 Ulrich, H. DIE STRAHLENEMPFINDLICHKEIT VON ZELLKERN UND PLASMA UND DIE INDIREKTE MUTAGENE WIRKUNG DER STRAHLEN (Sensitivity of the nucleus and cytoplasm to irradiation, and the indirect mutagenic effects of radiation). Zool. Anz. Suppl. 20 - Verh. dtsch. zool. Ges. 1956 (1957) 150-82.
- 10-20 min-old Drosophila eggs were used to further study the differences in radiosensitivity and dose-dependence of the nucleus and plasma, and to investigate radiation death. Death from irradiation of the nucleus appears to result from a dominant lethal mutation. Such irradiation leads to an early death of the individual still during early embryonic development whereas irradiation of the plasma leads mostly to death of the larvae, i.e. later death. Physiological damage (segmentation disturbances) frequently occur in surviving flies. When death resulted from damage to the plasma (irradiation of posterior half), recessive lethal mutations were also found in the screened-off nucleus. Further work is required to determine whether this indirect effect on the nucleus is due to scattered radiation or chemical action resulting from irradiation.
- 886 Van den Bruel, W.E., Bollaeers, D. RESISTANCE DES DIVERS STADES DE DÉVELOPPEMENT DE SITOPHILUS GRANARIUS L. ET S. ORYZAE L. AUX IRRADIATIONS PAR LES RAYON GAMMA ( $Co^{60}$ ) Bull. Inst. agron. Gembloux hors sér. 2 (1960) 883-905.
- A dose of 20 000 rad did not destroy all pupae and adults in wheat grain. A dose of 1000 rad applied within 2 d of deposition prevented almost all the eggs of S. oryzae from giving rise to adults but reduced the number of adults that developed from those of S. granarius and their larval progeny by 40 and 27% respectively. Irradiation of the 1st and 2nd instar larvae of both species at 1000 rad had little effect on the number and fertility of the adults, but at 2500 rad a sterilizing effect on the adults was noticed, especially when applied to 2nd and 3rd instars of S. granarius and 3rd instar pupae and adults and to a lesser extent 2nd instar S. oryzae. No adults were produced by eggs and 1st instars of this species following irradiation at 2500 rad.



In both species 5000 rad prevented the development of adults when applied to the 3rd instar or to younger stages and greatly reduced the numbers that developed when applied to later stages; virtually all the adults produced were sterile.

- 887 Wharton, D. R. A., Wharton, M. L. THE EFFECT OF RADIATION ON THE LONGEVITY OF THE COCK-ROACH, PERIPLANETA AMERICANA, AS AFFECTED BY DOSE, AGE, SEX AND FOOD INTAKE. Radiation Res. 11, 4 (1959) 600-15.

A 2-MeV Van de Graaff electron accelerator was used for irradiation. The technique for irradiating individual cockroaches under controlled conditions is described. The exposure dose was 10 000 rads. The sensitivity of the adult cockroach, Periplaneta americana, to radiation increases with age, as measured by the change in ratio between the  $T_{50}$ 's (time in days when 50% mortality occurs) of irradiated and unirradiated insects of different ages. Irradiated females survive longer than males. Survival is affected by the state of nutrition. Death due primarily to irradiation with 10 000 rads has been demonstrated to occur independently of starvation effects. Post- as well as preirradiation starvation reduced resistance to radiation injury. Free-feeding after irradiation increases the longevity of the male but does not affect the survival of the female. Irradiated and starved insects of both sexes die sooner than starved controls. They lose a smaller fraction of their weight than the controls but at a greater rate. The effect of a divided dose at any given time is less than that of the single total dose. The results are discussed with special reference to the nutritional state of the insects and to the change of radiosensitivity with age.

### I-A-3 RADIOSENSITIVITY OF DIFFERENT SPECIES OR STRAINS

- \* Baker et al. 1953 - [1239]
- \* Baker et al. 1954 - [1241]
- \* Baker et al. 1953 - [1240]
- \* Baker and Edington 1952 - [1360]
- \* Borstel and Pardue 1956 - [979]
- \* Borstel and Pardue 1957 - [980]
- \* Borstel and Rekemeyer 1959 - [982]

- 888 Cole, M. M., LaBrecque, G. C., Burden, G. S. EFFECTS OF GAMMA RADIATION ON SOME INSECTS AFFECTING MAN. J. econ. Ent. 52, 3 (1959) 448-50.

The  $LD_{50}$  of gamma radiation from  $Co^{60}$  against the body louse (Pediculus humanus humanus L.), house-fly (Musca domestica L.), American cockroach (Periplaneta americana L.), German cockroach (Blattella germanica L.), firebrat (Thermobia domestica (Pack.)), bed bug (Cimex lectularius L.), and Pharaoh ant (Monomorium pharaonis L.) ranged from 130 r for half-day old fly eggs to 190 000 r for body louse nymphs and Pharaoh ant queens. Doses required to cause 100% mortality ranged from 600 r to 250 000 r. Among the species tested, the  $LD_{50}$  varied inversely with the size of the insect. Reproduction in body lice was inhibited at dosages of 75 000 r or higher. DDT-resistant body lice were as susceptible to gamma rays as non-DDT-resistant lice. (auth.)

- \* Cornwell and Burson 1958 - [1304]

- 889 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF THE GRAIN AND RICE WEEVILS CALANDRA GRANARIA L. AND C. ORYZAE L. TO GAMMA RADIATION. AERE R. 3065, Atomic Energy Research Establishment, Harwell, Berks, England. Sep. 1959, 32 p.

For abstract only, see 891.

(This paper was presented at the "Conference on the Application of Large Radiation Sources in Industry, Warsaw 8-12 Sep. 1959", Conf. Proc., Vol. 2. Vienna, International Atomic Energy Agency, 1960)

- 890 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF LABORATORY AND WILD STRAINS OF CALANDRA GRANARIA L. TO GAMMA RADIATION. AERE R.3163, Atomic Energy Research Establishment, Harwell, Berks, England. Dec. 1959. 36 p.

A comparison was made of the susceptibility to  $\gamma$ -radiation of adults of 5 laboratory strains and 30 wild strains of Calandra granaria L. with that of the Pest Infestation Lab., used as a standard. It was concluded that the dose level of 16 500 rep evaluated for the sterilization of large populations of the standard strain of C. granaria might safely be recommended for the commercial disinfection of naturally occurring populations.

- 891 Cornwell, P. B., Morris, J. A. SUSCEPTIBILITY OF THE GRAIN AND RICE WEEVILS CALANDRA GRANARIA L. AND C. ORYZAE L. TO GAMMA RADIATION. p. 291 in "Large Radiation Sources in Industry. Conference Proceedings, Warsaw 8-12 Sep. 1959", Vol. 2, Vienna, International Atomic Energy Agency, 1960.

The paper forms a contribution to present knowledge of the entomology of radiation treatment of grain. An examination is made of the effects of  $\gamma$ -radiation on the two principal grain pests, when these are reared and retained under near optimum conditions for the species. The effects of radiation on the complete life-history of a laboratory strain (ex Pest Infestation Laboratory, D. S. I. R.) of the grain weevil, C. granaria, were examined at 24-hourly intervals during the life-history. Each stage of development was subjected to 17 doses ranging from 250 - 20 000 rep. Three criteria were used to determine radiation susceptibility: (1) emergence of immature stages as adults from grain, (2) survival after emergence and (3) the production of adult progeny. Similar observations on all stages of the rice weevil, C. oryzae, allow a comparison of susceptibility in the two species. Additional studies with C. granaria include: (1) radiation susceptibility of the sexes and (2) periodicity in fertility at sub-sterilizing doses. Doses evaluated for commercial disinfection are tested against massive populations and under a limited range of commercial storage conditions. The relative merits of fumigation treatment and radiation disinfection are compared.

(This paper was published in full as AERE R. 3065, Atomic Energy Research Establishment, Harwell, Berks, England, 1959, 32 p.)

- \* Fluke 1957 - [1184]
- \* Gray 1956 - [1311]
- \* Hassett 1957 - [1253]

- 892 Ives, P. T., Conklin, P. M., Burwell, L. R. RADIATION EFFECTS ON DIFFERENT STRAINS OF DROSOPHILA MELANOGASTER (abstr.) Genetics 44 (1959) 517.

Tests were carried out on male mutational, and male and female longevity responses to  $\gamma$ -radiation using various strains of D. melanogaster. Both mutational and longevity responses to radiation appear to be subject to genetic modification in phenotypically normal Drosophila.

- \* Kaufmann et al. 1955 - [916]
- \* Kihara 1953 - [934]
- \* Lee 1956 - [1019]
- \* Lee 1958 - [1020]
- \* Nishiwaki et al. 1953 - [872]

- 893 Передельский, А.А. ДЕЙСТВИЕ ИОНИЗИРУЮЩИХ ИЗЛУЧЕНИЙ НА НАСЕКОМЫХ. В кн. "Итоги науки. Биологические науки", I. Радиобиология. Биологическое действие ионизирующих излучений. Под общ. ред. А.М. Кузина. М., Акад.наук СССР, стр.313-28 (1957).

Раздел I. Радиорезистентность насекомых. а) Изменение дозы летального действия ионизи-

звующих излучений в связи с возрастом. б)Зависимость радиорезистентности от рода и характера облучения. г)Механизм радиорезистентности. Влияние обмена веществ и защитных веществ. д)Сравнительная радиорезистентность в состояниях анаболизма, катаболизма, деления клеток и во время процесса дифференцировки.

Раздел II. Вопросы борьбы с вредными насекомыми с помощью ионизирующих излучений.

а)Ионизирующие излучения в борьбе с вредителями продовольственных товаров. б)Ионизирующие излучения в борьбе с мухой Callitroga.

Исследовано отношение к ионизирующим излучениям ряда вредных насекомых: Calandra (Sitophilus) granaria, C. oryzae, Tribolium confusum, Tenebrio molitor, Oryzaephilus surinamensis, Rhizopertha dominica, Lasioderma sericorne, Acanthoscelides obtectus и др. Во всех исследованиях показаны сходство действия различных родов облучения и нецелесообразность применения высоких доз порядка 100 000 р и более, так как даже при 200 000 р 100% насекомых вымирает лишь к 7-му дню после облучения. Подобные дозы неэкономичны и приводят к нежелательным изменениям зерна. Поэтому была предложена половая стерилизация, т.е. применение доз, вызывающих прекращение размножения вредителя и некоторых ускорение вымирания облученных особей.

Peredelsky, A. A. THE EFFECT OF IONIZING RADIATION ON INSECTS. p. 313-28 in "Itogi Nauki. Biol. Nauki", Vol. 1. Radiobiology. Biological effects of ionizing radiations. Kuzin, A. M., ed. Moscow, Izdatel. Akad. Nauk SSSR, 1987.

Part I. Radioresistivity of insects.

- Variation of lethal dose from ionizing radiations with age.
- Dependence of radioresistivity on the type and quality of the radiation.
- The mechanism of radioresistivity. Influence of metabolism and protective substances.
- Comparative radioresistivity during anabolism, catabolism, division of cells and during differentiation.

Part II. Problems in the control of insect pests by ionizing.

- Ionizing radiation for controlling insects infesting food stuffs.
- Ionizing radiations for controlling Callitroga.

The action of ionizing radiation has been studied on a number of insect pests: Calandra (Sitophilus) granaria, C. oryzae, Tribolium confusum, Tenebrio molitor, Oryzaephilus surinamensis, Rhizopertha dominica, Lasioderma sericorne, Acanthoscelides obtectus and others. All experiments show the similarity in the effect of different kinds of radiation and the inexpediency of using high doses (~ 10 000 r or even higher), as with 200 000 r 100% of insects are only killed 7 d after irradiation. Such doses are uneconomical and result in undesirable changes in the crops. Instead, doses are proposed for causing sterilization and stopping reproduction or resulting in a certain accelerated mortality in irradiated individuals.

\* Ray and Whiting 1954 - [1056]

- 894 Rohde, C. J. STUDIES ON THE BIOLOGY OF THE MITE CALOGLYPHUS MYCOPHAGUS MEGN., 1874 (ACARINA: ACARIDAE) INCLUDING THE EFFECTS OF GAMMA RADIATION UPON CERTAIN DEVELOPMENTAL STAGES. Bull. ent. Soc. Amer. 3, 3 (1957) 30-1, abstr. 14.

(See later article in Ecology 40 (1959) 572-9 for fuller account)

- 895 Rohde, C. J. STUDIES ON THE BIOLOGIES OF TWO MITE SPECIES, PREDATOR AND PREY, INCLUDING SOME EFFECTS OF GAMMA RADIATION ON SELECTED DEVELOPMENTAL STAGES, Ecology 40 (1959) 572-9.

A preliminary study. The life history of Caloglyphus mycophagus (prey) is presented in detail (life-cycle 4-9 d). Fuscuropoda marginata (predator) has a life-cycle of 30-40 d. A  $Co^{60}$ -radiation chamber was used, the doses delivered ranging from 250 to 3750 r at 19 r/s. The predator male is rendered permanently sterile by doses that produce temporary sterility in the prey male. Data on the effects of irradiation on egg hatchability and on the viability of eggs from irradiated virgin adults are presented. F. marginata eggs are insensitive to doses producing 50% mortality in C. mycophagus eggs of comparable age (LD<sub>50</sub> for Caloglyphus eggs = 2930 ± 75 r).

\* Russell 1956 - [1063]

- 896 Schinz, H. R., Fritz-Niggli, H. DIE STRAHLENEMPFINDLICHKEIT FRÜHER EMBRYONALSTADIEN VON DROSOPHILA HYDEI STURTEVANT IM VERGLEICH ZU DROSOPHILA MELANOGASTER MEIGEN (A comparison of the radiosensitivity of early embryonic stages of Drosophila hydei Sturtevant and Drosophila melanogaster Meigen). Strahlentherapie 104 (1957) 328-37. (In German)
- Experiments were carried out to test whether number of chromosomes affected radiosensitivity. No increase in resistance was found with higher chromosome number. It is assumed that lethal effects are due more to biochemical changes than to chromosome damage.
- 897 Шалиро, Н.И., Страшневков, С.И., Плотникова, Е.Д., Сусликов, В.И. СРАВНИТЕЛЬНАЯ ОЦЕНКА ПОВРЕЖДАЮЩЕГО ДЕЙСТВИЯ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА НАСЛЕДСТВЕННОСТЬ МЫШИ И ДРОЗОФИЛЫ. Журнал общей Биологии 21, 2 (1960) 104-12.
1. Генетическая радиочувствительность мыши, определяемая по частоте возникновения доминантных леталей, выше, чем дрозофилы, в среднем в пять - десять раз.  
2. Частота возникновения доминантных леталей у мыши и дрозофилы пропорциональна общему размеру хромосом сравниваемых видов.
- Shapiro, N. I., Strashnekov, S. I., Plotnikova, E. D., Suslikov, V. I. A COMPARATIVE EVALUATION OF THE GENETIC DAMAGE FROM IONIZING RADIATION TO MOUSE AND DROSOPHILA MELANOGASTER. J. gen. Biol., Moscow 21, 2 (1960) 104-12.
- The genetic radiosensitivity of mouse, determined from the rate of formation of dominant lethals is, on an average, 5-10 times higher than for D. melanogaster. The dominant-lethal mutation rates in mouse and Drosophila are directly proportional to the overall chromosome size of the species.
- (See also report received from Moscow, USSR, by the UN Scientific Committee on the Effects of Atomic Radiation, A/AC.82/G/L.415, 1960, 31p.)
- 898 Strømnaes, Ø. X-RAY INDUCED LETHAL MUTATIONS IN SEVERAL STRAINS OF DROSOPHILA MELANOGASTER. Hereditas 37 (1951) 532-59.
- Males from 31 strains of D. melanogaster were tested in regard to their sensitivity to the induction of dominant lethal mutations by 2300 r x-rays. Genetic differences in the sensitivity to induction of dominant lethal mutations by x-rays were found to exist between unrelated strains. (NSA 6: 770, 1952)
- 899 Strømnaes, Ø. STOCK DIFFERENCES IN X-RAY MUTATIONAL SENSITIVITY PATTERN OF DROSOPHILA MELANOGASTER. Hereditas 45, 2-3 (1959) 221-9.
- These may be ascribed to differences in metabolic and maturation rates in the two stocks tested (Iso-Amherst and Oslo).
- 900 Струнников, В.А. ОТНОСИТЕЛЬНЫЙ ЭФФЕКТ ПЕРИЧНЫХ РАДИАЦИОННЫХ ПОВРЕЖДЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ ПОЛОВЫХ КЛЕТОК ТУТОВОГО ШЕЛКОПРЯДА (ВОМБУХ МОРИ). Цитология (СССР) 2 (1960) 573-80.
- В 4 опыта с помощью метода экспериментального андрогенеза изучался относительный эффект перичных радиационных повреждений ядра и цитоплазмы половых клеток тутового шелкопряда. С этой целью неосеменяемые бабочки-самки облучались рентгеновскими и гамма-лучами в дозах от 20 до 1100 кр, после чего спаривались с необлученными самцами. Одна часть отложенной гребни каждого варианта не подвергалась (контроль), а вторая подвергалась термическому воздействию с целью индукции андрогенеза. Не прогретая, зиготически развивавшаяся гребня контрольных серий погибала после всех доз облучения, включая и наименьшую (20 кр), вследствие участия в развитии облученного женского ядра. Прогреванием гребни из оплодотворения устранялось облученное женское ядро, и развитие яйца перекладывалось на андрогенетический путь с участием диплоидного ядра дробления, образованного слиянием двух необлученных мужских ядер. Резкое снижение выхода андрогенетических гусениц при облучении дозами выше 60-90 кр и гибель яиц при самых больших дозах являются показателями наличия перичных радиационных повреждений цитоплазмы. Облучение

цитоплазм 20-54 кр не приводит к стерильности и понижению жизнеспособности андрогенетических особей.

Strunnikov, V. A. OTNOSITEL'NYI EFFEKT Pervichnykh radiatsionnykh povrezhdenii yadra i tsitoplazmy polovykh kletok tutovogo shelkopryada (The relative effect of primary radiation damage to the nucleus and cytoplasm of the germ cells of *Bombyx*). *Tsitologiya* 2, 5 (1960) 573-80.

By means of experimental androgenesis the relative effect of primary radiation damage to nuclei and cytoplasm of the germ cells of *Bombyx* was studied. Unfertilized female moths were x-irradiated with doses of 20-1100 kiloröntgens, and then mated with nonirradiated males. The unheated zygotically developing worm eggs of the control series died after all doses of irradiation. Heating the eggs after fertilization eliminated the irradiated female nucleus; the development of the eggs switched over to the androgenetic path with the division of the diploid nucleus formed by the merging of 2 unirradiated male nuclei. The appearance of single androgenetic caterpillars from eggs, the cytoplasm of which had been irradiated with 500 kiloröntgens, was noted in 2 experiments. Irradiation of cytoplasm with doses of 20-54 kiloröntgens did not result in sterility or decrease in vitality of androgenetic individuals. (BA 37: 4851, 1962)

(The article may also be found in *Referat. Zhur., Biol.*, No. 13 A 107 (1961))

- 901 Tazima, Y. DIFFERENCES IN SENSITIVITY OF GERM-CELLS AND CHROMOSOMES TO RADIATION AMONG SOME MUTANT STRAINS OF THE SILKWORM. p. 280-6 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956". Suppl. to *Cytologia* 1957. Tokyo, Science Council of Japan. 1957, 702 p.

The results indicate that the sensitivity to x-rays of the same locus is clearly different according to the mutant strain, even in the same developmental stage of the same sex. Marked differences were observed, especially in the male germ-cells. The *rh* strain of silkworm contains a large quantity of reducing substances in its body fluid; contrary to expectations, its sensitivity was considerably higher than that of other strains. The role of reducing substances in determining the effects of irradiation is not clear.

\* Bruel and Bollaerts 1960 - [886]

#### I-A-4 RADIOSENSITIVITY AT THE CELLULAR LEVEL

##### Survey

- 902 Carlson, J. G. IMMEDIATE EFFECTS ON DIVISION, MORPHOLOGY AND VIABILITY OF THE CELL. p. 763-824 in "Radiation Biology", Vol. 1, Hollaender, A., ed. New York, McGraw-Hill 1954.

Comprehensive review of the action of high-energy as compared with ultraviolet radiations, in terms of mitotic, morphological and cell viability effects, and their possible interpretation. Amongst the examples cited is work on grasshopper (*Chortophaga*) and *Drosophila*. The extensive literature (p. 817-24) goes back to the beginning of the century.

- 903 Астауров, Б. Л. ДИФФЕРЕНЦИАЛЬНЫЙ ЭФФЕКТ РАДИАЦИОННЫХ ПОВРЕЖДЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ КАК СЛЕДСТВИЯ ИХ ФУНКЦИОНАЛЬНОЙ СПЕЦИФИЧНОСТИ. Выводы Моск. Общества Имплателей Природы, Отдел биологии. 63, 1 (1958) 35-48.

Использовался *Bombyx mori*, L.

Astaurov, B. L. DIFFERENTIAL EFFECT OF RADIATION DAMAGE TO NUCLEUS AND CYTOPLASM, RESULTING FROM THEIR SPECIFIC FUNCTIONS. Byulleten Mosk. Obshchestva Ispytatelei Prirody, Otдел biologich. 63, 1 (1958) 35-48.

A study on *Bombyx mori*.

- 904 Астауров, Б. Л. ФУНКЦИОНАЛЬНЫЙ ПРИНЦИП В ОЦЕНКЕ ОТНОСИТЕЛЬНОЙ ЗНАЧИМОСТИ РАДИАЦИОННЫХ ПОРАЖЕНИЙ ЯДРА И ЦИТОПЛАЗМЫ И ГЕНЕТИЧЕСКАЯ ТЕОРИЯ ЛУЧЕВОЙ БОЛЕЗНИ. Тезисы докладов и выступлений на симпозиуме "Первичные механизмы биологич. действия иониз. излучений", изд. МОИП, Москва 30/V-1/VI(1960)37-9.

Использовался Bombyx mori, L.

Astaurov, B. L. INTERPRETING THE DIFFERENCES IN RADIATION DAMAGE TO THE NUCLEUS AND CYTOPLASM, IN CONNECTION WITH THEIR RESPECTIVE FUNCTIONS AND THE GENETIC THEORY OF RADIATION SICKNESS. Tezisy dokladov i vystupleniy na Simpoziume "Pervichnye mekhanizmy biologich. deystviya ioniz. izlucheniya", 30 May - 1 June 1960, 37-9. Izd. MOIP, Moskva (1960). (In Russian)

Work on Bombyx mori is described.

- 905 Bonnier, G., Ulning, K. G., Arnberg, B. ON A POSSIBLE MUTAGENIC EFFECT OF X-RAYED EGG CYTOPLASM. (abstr.) Hereditas 38, 1 (1952) 109-12.

Experiments were made on the mutagenic effect on paternal chromosomes of x-raying egg cytoplasm in Drosophila melanogaster. The results indicate that if fertilization takes place shortly after irradiation such an effect may be produced. Further experiments are, however, desirable. (auth. summary)

- 906 Borstel, R. C. von, Rogers, R. W. ALPHA-PARTICLE BOMBARDMENT OF THE HABROBRACON EGG II. RESPONSE OF THE CYTOPLASM. Radiation Res. 8 (1958) 248-53.

Alpha-radiation was used to kill newly laid Habrobracon eggs by inactivation of the cytoplasm. Cytoplasmic inactivation is kinetically and morphologically distinct from nuclear inactivation. The egg nucleus is inactivated by one  $\alpha$ -particle; the 50% lethal dose is approximately  $16 \times 10^8$   $\alpha$ -particles per egg when the cytoplasm is irradiated. Death occurs late in development when the cytoplasm is  $\alpha$ -irradiated, and in most respects the morphology of the dead embryos resembles that from ultraviolet irradiation of the cytoplasm. (auth. summary)

- 907 Carlson, J. G. EFFECTS OF RADIATION ON MITOSIS. J. cell. comp. Physiol. 35, Suppl. 1 (1950) 89-101. (This work was published in a 22 p-report ORNL-570, Oak Ridge National Lab., Tenn., in 1950)

Neuroblasts of grasshopper (Chortophaga viridifasciata DeGeer) embryos were used, growing in hanging-drop culture preparations. Instead of reverting to an earlier stage, cells which had passed the "critical" period completed mitosis regardless of the dose given (which ranged from 4 r to 8000 r of x-rays). Subsequent mitoses are discussed. The effects of ultraviolet radiation are described. Dosage rate effects were also tested for  $\gamma$ -rays (from activated tantalum), and the relation of mitotic rate to time after irradiation shown graphically for 3 different doses given at 0.25 r/min. This rate appears to be so low that the recovery processes in the cells are able to keep pace with the radiation effects, at least between 2½ and 8½ h after treatment has begun. Observed changes in cell morphology are described.

- 908 Carlson, J. G., Harrington, N. G., Gaulden, M. E. MITOTIC EFFECTS OF PROLONGED IRRADIATION WITH LOW-INTENSITY  $\gamma$ -RAYS ON THE CHORTOPHAGA NEUROBLAST. Biol. Bull. 104, 3 (1953) 313-22.

Prolonged treatment of neuroblasts of Chortophaga viridifasciata (DeGeer) with low intensity  $\gamma$ -rays reduced mitotic activity much less than a comparable dose at high intensity. Details of the source, calibration, treatment, and a summary of data and biometrical analysis for dose rates of 3.4 and 0.80 r/h are given. The results demonstrate that radiation can retard but not stimulate the mitotic progress of cells. It appears that any increase in the number of cells in a given stage of mitosis soon after treatment can be interpreted to result from either retardation of mitotic progress within that stage resulting in an accumulation of cells or in entry into that stage, in a brief period of time, of an abnormally large number of cells that accumulate in a preceding stage as a result of mitotic retardation.

\* Gaulden and Nix 1950 - [1385]

\* Gaulden et al. 1953 - [1386]

- 909 Gaulden, M. E., Kokomoor, K. L. INFLUENCE OF YOLK ON MITOTIC RATE IN UNTREATED AND X-RAYED GRASSHOPPER NEUROBLASTS IN VITRO. Proc. Soc. exp. Biol. Med., N.Y. 90 (1955) 309-14.

Neuroblasts of the Chortophaga viridifasciata embryo were studied in hanging-drop cultures. Frequency of mid-mitotic neuroblasts was found to increase as the quantity of yolk in the culture was increased up to a quantity equivalent to 1/4 that in an egg. The influence of yolk on mitosis in the untreated neuroblast is

interpreted as indicating that, in this cell at least, the first half of prophase does not operate solely on energy stored within the cell but is dependent on an outside source of energy for continuance of mitosis. In x-rayed embryos it was found that the duration of the radiation-induced mitotic inhibition is shorter and the beginning and completion of recovery is faster in the neuroblasts of embryos cultured in yolk than in those of embryos cultured without yolk. The pronounced positive effect of yolk on recovery of neuroblasts from radiation damage demonstrates that, in this cell, some extracellular substance or substances can greatly enhance repair of mitotic damage. (BA 30: 13945, 1956)

\* Gaulden 1956 - [217]

- 910 Gaulden, M.E. EFFECTS OF LOW-LEVEL RADIATION (1 to 3 r) ON MITOTIC RATE OF GRASSHOPPER NEUROBLASTS. ORNL-2267, Oak Ridge National Lab., Tenn. (Part of Semiannual Progress Report for period ending 15 Feb. 1957 of the Biology Division).

It would appear that low doses of radiation affect mitotic rate in the grasshopper (Chortophaga viridifasciata) neuroblasts not by inhibiting DNA synthesis but by altering in some unknown way the physical structure of the chromosome. No influence of oxygen on mitotic effects of low doses of x-rays has yet been demonstrated. It should be noted that although the neuroblasts are extremely sensitive to the effects of radiation in producing temporary mitotic inhibition, they are fairly "resistant" to its effects in producing permanent inhibition.

- 911 Geyer-Duszynska, L. X-RAY INDUCED FRAGMENTATION OF SALIVARY GLAND CHROMOSOMES IN DROSOPHILA MELANOGASTER. Zool. Polon. 6 (1953-5) 250-82.

- 912 Harrington, N.J., Koza, R.W. EFFECT OF X-RADIATION ON THE DESOXYRIBONUCLEIC ACID AND ON THE SIZE OF GRASSHOPPER EMBRYONIC NUCLEI. Biol. Bull. 101 (1951) 138-50.

Cytological and cytochemical studies were made on embryonic nuclei of the grasshopper, Chortophaga viridifasciata, after x-ray doses of 4000, 10 000 and 12 500 r. The changes were measured photometrically by using (1) the Feulgen reaction to determine relative changes in the desoxyribonucleic acid (D) desoxypentose, and (2) the methyl green stain to indicate the degree of polymerization of the nucleic acid. X-radiation caused swelling of the nuclei. When correction was made for this, the Feulgen-stained nuclei showed no significant loss of D after irradiation, but the nuclei stained with methyl green disclosed loss of stainability. This indicates that x-rays do not destroy D but rather induce depolymerization of the nucleic acid; hence, estimates of D in tissues stained with Feulgen or methyl green are not reliable. (CA 46: 9634c, 1952)

- 913 Horikawa, M., Sugahara, T. STUDIES ON THE EFFECTS OF RADIATION ON LIVING CELLS IN TISSUE CULTURE. I. RADIOSENSITIVITY OF VARIOUS IMAGINAL DISCS AND ORGANS IN LARVAE OF DROSOPHILA MELANOGASTER. Radiation Res. 12 (1960) 266-75.

In order to study the effect of radiation on larvae of D. melanogaster, various imaginal discs and organs of 3rd instar larvae were cultured in a synthetic medium together with cephalic complexes as a source of the metamorphic hormone. Irradiated discs or organs were used for culture in one series, and irradiated cephalic complexes were used in the other. From the difference in results obtained in the two series, it was concluded that the decrease in % ecdysis was caused by a functional disturbance of the cephalic complex induced by radiation. It was shown that the brain, the wing disc, and the testis were more radiosensitive than the eye disc, the leg disc, the salivary gland, and the fat body. (auth.)

- 914 Horikawa, M., Sugahara, T. STUDIES ON THE EFFECTS OF RADIATION ON LIVING CELLS IN TISSUE CULTURE. II. RADIOSENSITIVITY OF CELLS ISOLATED FROM VARIOUS IMAGINAL DISCS AND ORGANS OF LARVAE OF DROSOPHILA MELANOGASTER. Radiation Res. 13 (1960) 825-31.

In the present experiment, from the degree of incorporation of radioactive thymine-C<sup>14</sup> into single cells isolated from irradiated larvae, differences in radiosensitivity of their constituent cells were found corresponding to the previous results. The ratio of P<sup>32</sup> incorporation into the whole tissue compared to DNA was highest in the cephalic complex, which may indicate an increased metabolic activity of the cytoplasm. The primary sites of the radiation attack were the large and the small cells of the ring gland, which is a part of the cephalic complex. Those are assumed to be the most active cells for the secretion of the metamorphic hormone in Drosophila larvae. (auth.)

- 915 Howard, A. INFLUENCE OF RADIATION ON DNA METABOLISM. p. 196-206 (disc. p. 206-11) in CIBA Foundation Symposium on "Ionizing Radiations and Cell Metabolism". Wolstenholme, G. E. W., O'Connor, C. M., eds. London, J. & A. Churchill Ltd. 1956.

Interference with DNA synthesis is known to be one of the most general and important biological effects of radiation. The effect of irradiation on DNA metabolism in some mammalian tissues is discussed, and also the radiosensitivity of DNA metabolism. Radiation-induced changes in cell populations, and the results of changes in cell populations are described. Mention is made of mitotic delay in grasshopper neuroblast caused by radiation. The significance of the findings is considered. In the discussion, Hollaender cited work by Gaulden on the grasshopper neuroblast, where radiation effects were counteracted by placing the neuroblast in a hypertonic solution immediately after irradiation. Experimental details were described. Reference was further made to work by Harrington and Koza who had found swelling of the cell immediately after a certain minimum dose, suggesting a radiation-induced change in osmotic-pressure relationships in the cells.

- 916 Kaufmann, B. P., McDonald, M. R., Bernstein, M. H. CYTOCHEMICAL STUDIES OF CHANGES INDUCED IN CELLULAR MATERIALS BY IONIZING RADIATIONS. Ann. N. Y. Acad. Sci. 59, 4 (1955) 553-66.

Cytochemical methods were used to study the alterations effected by ionizing radiations in nucleoproteins of dividing cells. In the studies on grasshopper embryos (Melanoplus femur-rubrum, Trimerotropis maritima, and Chortophaga viridifasciata), comparisons were made between irradiated and nonirradiated (shielded) halves of the embryos, as well as between individuals removed from the same egg pod. The capacity of salivary-gland cells of larvae of Drosophila melanogaster to swell when treated with an aqueous solution of trypsin, with water, with a solution of electrolytes, and finally with water was reduced when the larvae had been exposed to ionizing radiation, demonstrating that structural nucleoproteins were partially degraded by the x-rays.

- 917 King, R. C. THE CYTOLOGY OF THE IRRADIATED OVARY OF DROSOPHILA MELANOGASTER. Exp. Cell Res. 13 (1957) 545-52.

A cytological study was made of ovaries from 12-d-old flies, irradiated with 4000 r (about 100 r/s) of  $\gamma$ -rays from a  $\text{Co}^{60}$ -source shortly after emergence. Irradiated and control ovaries amounted to about 500. Many severely damaged oocytes underwent pycnotic degeneration. The number of developing eggs was reduced to 80% of the control value. Treated ovaries showed abnormalities which are ascribed to radiation-induced disturbances of cell growth, division, migration and differentiation. The abnormalities are described.

(An abstract was published in Anat. Rec. 128: (1957) 576, abstr. 14)

- \* Limbaugh and Gaulden 1957 - [1259]

- 918 Mounter, L. A. STUDIES OF THE EFFECTS OF RADIATION ON ENZYMES. I. INACTIVATION OF CHYMOTRYPSIN AND CHYMOTRYPSINOGEN BY X-RAYS. Radiation Res. 12 (1960) 487-94.

The effect of x-irradiation on the esterase and protease activities of chymotrypsin and chymotrypsinogen has been studied. The degree of inactivation has been compared to results obtained in a study of the ability of the irradiated samples to react with a specific inhibitor (DFP<sup>32</sup>). The data suggest that radiation damage to enzyme molecules may result in impairment of catalytic efficiency without complete destruction of biological activity. These results are discussed. (auth. summary)

- 919 Oster, I. L. SUGGESTED MECHANISM UNDERLYING THE DIFFERENTIAL RADIOSENSITIVITY OF CELLS HAVING CONDENSED CHROMOSOMES. Genetics 42 (1957) 387.

Both spermatids and spermatozoa have condensed chromosomes, found to be the most radiosensitive state in many organisms. The differential radiosensitivity found in Drosophila melanogaster spermatids and spermatozoa was investigated by x-irradiation in nitrogen, air and oxygen of spermatids, and of mature spermatozoa in 3-4 d-old males and in 2 d-old females with 1200 r and 2800 r (both single and fractionated dose). In spermatids,  $\text{O}_2$  produced no appreciable effect over air but  $\text{N}_2$  lowered radiation effects (autosomal translocations) considerably. In spermatozoa, in the male or in the female,  $\text{N}_2$  and  $\text{O}_2$  modified the dose response below and above the air response about equally. The high sensitivity of the spermatids may be due to more intra- and/or intercellular  $\text{O}_2$  being normally present (or available) in these cells. (from abstr.)



- 920 Rogers, R. W. A MODIFIED PHOTOMULTIPLIER SCINTILLATION DETECTOR FOR ALPHA-PARTICLE DOSIMETRY IN SINGLE CELL BIOLOGICAL IRRADIATION. (abstr.) J. Tenn. Acad. Sci. **28** (1953) 187.  
Includes tests with preparations of grasshopper embryos. (See application of technique in study on  $\alpha$ -particle dosimetry and the inhibition of mitosis in the grasshopper neuroblast by low dosage  $\alpha$ -irradiation, Radiation Res. **3**: 18-37, 1955)
- 921 Rogers, R. W.  $\alpha$ -PARTICLE DOSIMETRY AND THE INHIBITION OF MITOSIS IN THE GRASSHOPPER NEUROBLAST BY LOW DOSAGE  $\alpha$ -IRRADIATION. Radiation Res. **3** (1955) 18-37.  
Polonium  $\alpha$ -particle sources and a microscope-adapted source holder were utilized for irradiating special mica hanging-drop, living culture preparations of grasshopper embryos. The technique is described in some detail. The effects of 56 rad of  $\alpha$ -radiation on the mitotic rate of grasshopper neuroblast cells were determined. Comparison with similar studies of  $\beta$ - and x-ray inhibition indicated that  $\alpha$ -particles were most and  $\beta$ -particles least effective in inhibiting mitosis. A comparison of inhibition of the midprophase and late prophase stages by x-rays and  $\alpha$ -particles (56 rad) showed greater radiosensitivity in early mid-prophase, the effectiveness of both radiations becoming inappreciable by prometaphase. At this dose level,  $\alpha$ - and x-radiation effects on early and late midprophase are indistinguishable in terms of mitotic inhibition or failure to inhibit division.
- 922 Rogers, R. W., Borstel, R. C. von. ALPHA-PARTICLE BOMBARDMENT OF THE HABROBRACON EGG. I. SENSITIVITY OF THE NUCLEUS. Radiation Res. **7**, 5 (1957) 484-90.  
Dose-hatchability experiments were conducted on newly laid eggs of Habrobraccon irradiated by a polonium-210  $\alpha$ -particle source. Lethality is induced by the passage of one  $\alpha$ -particle through the nucleus. From target considerations, it is concluded that an  $\alpha$ -particle must pass through the nucleus to induce lethality. It is unnecessary to assume that lethality is caused by diffusion of "mutagenic substance" from the irradiated cytoplasm to the nucleus. Dose-action analysis of the different species of morphological appearance of dead embryos suggests that different modes of death from nuclear irradiation are independent in origin. (auth. summary)
- 923 St. Amand, W. DIFFERENTIAL FREQUENCY OF ACENTRIC FRAGMENTS INDUCED IN GRASSHOPPER NEUROBLASTS BY X-IRRADIATION AT KNOWN MITOTIC STAGES. Genetics **38** (1953) 688-9.  
The x-ray sensitivities of the stages of mitosis were determined in hanging-drop preparations of neuroblasts of the grasshopper, Chortophaga viridifasciata (DeGeer), at  $38 \pm 0.5^\circ\text{C}$ . Cells were mapped and identified as to stage of mitosis just before treatment with 32 r of x-rays. The mapped cells were examined immediately after treatment and then re-examined at short time intervals for as long as 8 h to detect acentric fragments as the cells passed through subsequent anaphases. All determinations were made in living, unstained cells at the first anaphase following treatment. The highest frequencies of fragments are found in cells irradiated in middle and late anaphase and telophase. The sensitivity of cells in interphase at the time of treatment is slightly lower than that of cells irradiated in early prophase. The numbers of fragments induced decreases from early to late prophase and reaches a minimum in cells irradiated in prometaphase. During metaphase and early anaphase sensitivity increases to reach the anaphase-telophase peak.  
(Abstract of paper presented at the 1953 Meetings of the Genetics Society of America, Boston, Mass., 28-30 Dec. 1953)
- \* St. Amand 1953 - [1229]
- 924 St. Amand, W. THE RELATIVE RADIOSENSITIVITY OF GRASSHOPPER NEUROBLAST CHROMOSOMES X-IRRADIATED AT KNOWN MITOTIC STAGES. (abstr.) J. Tenn. Acad. Sci. **29** (1954) 186.  
The breakage frequency of neuroblast chromosomes in each of the stages of mitosis was determined in hanging-drop preparations of grasshopper embryos (Chortophaga viridifasciata), at  $38 \pm 0.5^\circ\text{C}$ . Cells were mapped and identified as to stage of mitosis before treatment with 32 r of x-rays. The mapped cells were examined immediately after treatment and re-examined at short intervals for 8 h or longer. Breakage frequencies have been determined from acentric fragments detected as cells progressed through anaphase. The sensitivities reported here are based on the combined breakage frequencies found at the first and second anaphases following treatment. The curve of chromosome breakage frequency shows two maxima and two minima. The maximum frequency is found in cells irradiated in middle telophase; a smaller peak occurs in middle prophase. Cells in interphase and in very late prophase at the time of treatment show minimum

sensitivities. Middle telophase (most sensitive) is about twice as sensitive as very late prophase (least sensitive).

- 925 St. Amand, W. X-RAY-INDUCED MITOTIC AND CHROMOSOMAL EFFECTS IN THE GRASSHOPPER NEUROBLAST AND IN THE EHRLICH ASCITES CARCINOMA. Radiation Res. 3, 3 (1955) 344.

The response of the ascites tumor cell to x-rays is identical to that of the grasshopper neuroblast. In both forms there is an initial decrease followed by a compensatory rise in mitotic activity. Maxima of chromosomal effects correspond to maxima of mitotic inhibition. The neuroblast study, in which cells in known stages of mitosis were irradiated, shows that the temporal correspondence of mitotic inhibition and chromosome breakage is not a causal relation. The relative sensitivities of mitotic stages in populations of dividing cells cannot be determined by the use of devices such as "time after irradiation" or "hours before metaphase" because of the mixture in terms of stage treated represented by cells in meta- or anaphase at any given time after treatment. The admixture of cells is a function of (1) different degrees of inhibition exhibited by cells irradiated in any given stage, (2) stage differences in inhibition sensitivity, (3) reversion of cells irradiated in some prophase stages, and (4) differences in inhibition in cells which show chromosomal damage as compared with those which have suffered no apparent chromosomal damage. (Almost entire abstract)

- 926 St. Amand, W. MITOTIC INHIBITION AND CHROMOSOME BREAKAGE INDUCED IN GRASSHOPPER NEUROBLASTS BY X-IRRADIATION AT KNOWN MITOTIC STAGES. Radiation Res. 5 (1956) 65-78.

Using living, unstained cells, the relative sensitivity of each stage of mitosis in the neuroblasts of the grasshopper Chorophaga viridifasciata (DeGeer) was determined with respect to mitotic inhibition and chromosome breakage induced by 32 r of x-radiation. The stage of mitosis at the time of irradiation is known for all cells from direct observation. The sensitivity curve of chromosome breakage shows 2 maxima (middle prophase and middle telophase) and 2 minima (interphase and very late prophase). The sensitivity curve relating mitotic stage to chromosome breakage obtained is strikingly similar to that relating mitotic stage to viability obtained for other kinds of cells. The sensitivity curves for viability and chromosome breakage differ in mitosis and meiosis.

- 927 Stone, W.S., Haas, F.L., Alexander, M.L., Clayton, F.E. STUDIES IN THE GENETICS OF DROSOPHILA. VIII. COMMENTS ON THE MECHANISM OF ACTION OF RADIATIONS ON LIVING SYSTEMS. Univ. Tex. Publ. No. 5422 (1954) 244-71.

D. virilis males, 15 to 30 h after eclosion, were irradiated with 2000 r in 1 minute at 0-5°C in different gas environments. The number of dominant lethals and translocations induced in cells which were in the different stages of spermatogenesis were scored using sequential multiple matings over a three-week test period. The stages from meiosis through spermiogenesis were much more susceptible to x-rays than spermatogonia or mature sperm. The cycle of damage for dominant lethals is similar to that for translocations but does not coincide with it completely. Pupae were irradiated in air 1-3 d after pupation, the period during which larval structures including protein systems are being broken down. The rate of chromosomal abnormality produced is very high for the cells past spermatogonia. Complex translocations which involve 3 or more chromosomes occur much more frequently than in tests of mature sperm and re-joining of broken ends is not at random. Several enzyme systems are involved in a reduction of radiation damage or in the attachment of broken chromosomes. (BA 30: 15812, 1958)

- 928 Tahmisian, T.N., Adamson, D.M. A PHASE CONTRAST MICROSCOPY STUDY OF X-RAY-INDUCED PYKNOSIS IN THE LIVING CELL. Soc. Exp. Biol. & Med. Proc. 78 (1951) 597-602.

Melanoplus differentialis embryos were used. The effect of 25000 r of x-rays can be kept latent for 6 months by maintaining the eggs at sub-metabolic temperatures. When the eggs are irradiated and immediately placed at 0°C, and are thus maintained for 6 months no immediate morphological or physiological changes are observed upon returning them to 25°C. However, pyknosis occurs by 8 d at 25°C, depending on the irradiation and on the metabolic activity of the cell. Various changes in the cell are discussed.

(This work was also published on p. 54 in ANL-4488, Argonne National Lab., 1950, 149 p, and as abstr. 134 in Anat. Record 108: 72-3, 1950)

- 929 Tahmisiian, T. N., Adamson, D. M., Passonneau, J. V. THE RESPONSE OF MELANOPLUS DIFFERENTIALIS CELLS TO X-IRRADIATION BEFORE AND AFTER INDUCTION. Anat. Record 111 (1951) 574, abstr. 274.

Prior to induction, cells in the grasshopper embryo are very susceptible to x-irradiation. A cell that has responded to the evocator, although it is undifferentiated morphologically but differentiated physiologically, is not easily affected by x-irradiation. Before induction, the ability of cells to differentiate into tissue can be inhibited with 2500 r. After induction, a dose of 25 000 r will not inhibit tissue differentiation. The cell will differentiate and the embryo will hatch. The time of x-irradiation, in relation to physiological processes is, therefore, of great importance.

- 930 Whiting, A. R. ABSENCE OF MUTAGENIC ACTION OF X-RAYED CYTOPLASM IN HABROBRACON. Proc. nat. Acad. Sci., Washington 36, 7 (1950) 368-72.

Results on the response of Habrobracon eggs to x-rays are consistent in indicating two kinds of changes in the cell: (1) chromosome alterations connected with the production of dominant and recessive lethal and visible mutations, and (2) a lethal cytoplasmic effect. In the Habrobracon egg this cytoplasmic injury is constant with respect to doses for incidence and complete lethal action, regardless of the stage of the chromosome at time of treatment. It is concluded from the experimental data that x-rays can induce permanent changes in the egg cytoplasm, which may have a lethal effect on the egg without, however, inducing visible mutations in untreated chromosomes.

(Earlier work was reported as abstract in Genetics 35 (1950) 139-40, under the title "The non-induction of mutations by x-rayed cytoplasm")

- 931 Whiting, A. R. ANDROGENESIS AS EVIDENCE FOR THE NATURE OF X-RAY-INDUCED INJURY. Radiation Res. 2 (1955) 71-8.

Irradiated cytoplasm of Habrobracon eggs was found to function normally after exposure to doses of x-rays many times greater than that lethal to the nucleus. High doses of irradiation prevented normal function, even in combination with an uninjured nucleus. The phenomenon of androgenesis was used as a source of evidence. (NSA 3: 2573, 1955)

## I - B Genetic Effects

### I - B - 1 GENERAL

#### Surveys

- 932 Ehrenberg, L. RADIOBIOLOGICAL MECHANISMS OF GENETIC EFFECTS. A REVIEW OF SOME CURRENT LINES OF RESEARCH. Radiation Res., Suppl. 1 (1959) 102-23.

Contents include a discussion of the limitations of the field (genetic changes investigated; mutagenic agents; chemical nature of the genetic material; influence of variables); radiation-induced mutations—dependence on dose; questions related to target and gene size; influence of ion density; substructure of the gene; specificity of mutagenic agents; back mutations; sensitive stage for the induction of mutation; modifying factors; and radiomimetic effects of oxygen. Citations of work include data on Drosophila and Mormoniella.

- 933 Kaufmann, B. P. CHROMOSOME ABERRATIONS INDUCED IN ANIMAL CELLS BY IONIZING RADIATIONS. p. 627-711 in "Radiation Biology", Vol. 1, Part 2, Hollaender, A., ed. New York, McGraw-Hill, 1954.

A very comprehensive review article, dealing with the nature of the induced arrangements (methods of diagnosis, types of induced chromosomal aberrations), the process of structural rearrangement (the breakage process), differences in sensitivity to ionizing radiations (relative sensitivity of different organisms, effect of ploidy, relative sensitivity of chromosomes in different types of cells of the same species, changes in sensitivity of chromosomes in cells of the same type), and chemical and cytochemical studies. Many references to work on insects are included. Extensive bibliography, going back far beyond 1950.

- 934 Kihara, H. GENETICS OF BOMBYX AND DROSOPHILA: A COMPARISON OF MATERIALS, METHODS AND RESULTS. Seiken Zihq 6 (1953) 15-29.
- Bombyx is one of the best materials for genetic research. Many findings of sex-determination, crossing-over, linkage analysis and artificial mutation correspond in general to those in Drosophila. A comparison of the two insects is therefore of interest. Based on a bibliographical survey, Tanaka's book "Genetics of Bombyx" (1952) mentions 1241 titles of papers which deal with Bombyx genetics, about 90% of which are Japanese. The genetics of Bombyx and of Drosophila were compared with respect to chromosomes, sex-determination, linkage groups, crossing-over, physiological genetics, and practical applications. In physiological genetics, the excellent contribution of Kikkawa's biochemical studies and Morohoshi's developmental genetics were introduced. In practical applications, heterosis and induced mutations were discussed. Tazima's discovery that the sexes in larval and egg stages may be distinguished with the help of induced mutations is of great importance for commercial purposes. (from BA 30: 205, 1956)
- 935 Muller, H.J. SOME PRESENT PROBLEMS IN THE GENETIC EFFECTS OF RADIATION. J. cell. comp. Physiol. 35 (Suppl. 1) (1950) 9-70.
- A review paper of wide scope. Experimental data largely based on work with Drosophila. Discussion: p. 62-70.
- 936 Muller, H.J. THE NATURE OF THE GENETIC EFFECTS PRODUCED BY RADIATION. p. 351-473 in "Radiation Biology", Vol. 1. Hollaender, A., ed. New York, McGraw-Hill, 1954.
- Comprehensive review and assessment of present day data, with extensive bibliography. Results obtained with Drosophila are cited throughout. The most recent work quoted dates from 1952; most references cover publications between 1935 and 1945.
- 937 Peredelsky, A. A. THE EFFECT OF IONIZING RADIATION ON INSECTS. Izvestiya Akad. Nauk SSSR Radiobiol. (Moscow: Izdatel. Akad. Nauk. SSSR) (1957) 313-27. (In Russian)
- 938 Stone, W. S. INDIRECT EFFECTS OF RADIATION ON GENETIC MATERIAL. p. 171-90 in "Brookhaven Symposia in Biology. 15-17 June 1955", Vol. 8. BNL-350 (C-22), Brookhaven National Lab., Upton, N. Y. 1957.
- The author presents a review of work done on Drosophila, and the different implications of the results obtained. Different types of radiation are known to produce measurably different effects on the genetic system. Spontaneous and induced mutagens are also discussed. Chemical effects are a further complication. Radiation damage in relation to cell cycle and susceptibility (as in spermatogenesis) represent complex problems of interpretation. Mention is made of numerous publications in which the general view of the action of radiation chemical mutagens as well as their synergistic effect with the direct action of radiation is discussed.
- 939 Tanaka, Y., ed. GENETICS OF THE SILKWORM. Tokyo, Shokabô (1952). (In Japanese)
- Very comprehensive work, particularly on Japanese research. More than 100 references, including much work on radiation-induced mutations.
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- 940 Baker, W. K. CONSEQUENCES OF RADIATION-INDUCED CHROMOSOME BREAKAGE IN DROSOPHILA SPERM. p. 235-8 in "Proceedings of the International Genetics Symposia, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957.
- Experiments are described which were designed to measure three criteria of radioinduced chromosome breakage. These criteria were measured on three types of Drosophila sex chromosomes. Correct interpretation of experiments using ring chromosomes are discussed. (NSA 12: 15263, 1958)
- \* Bonnier et al. 1952 - [905]

- 941 Burdick, A. B., Mukai, T. EXPERIMENTAL CONSIDERATION OF THE GENETIC EFFECT OF LOW DOSES OF IRRADIATION ON VIABILITY IN DROSOPHILA MELANOGASTER. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 15/P/895. 22 (1958) 325-9.
- The observed mutations are dominant in the sense that they produce a phenotypic effect in heterozygous condition. Their effect in homozygous condition is not predictable from results which could be gene changes that only give a detectable effect in heterozygous condition. The variance increases are more prominent than the mean increases, indicating that both viability-increasing and viability-decreasing mutations have been observed and that a substantial number of each has been produced. A mutation rate of at least  $1 \times 10^{-8}/r$  or  $1 \times 10^{-6}/r$  is required to obtain a sufficient number of mutations to explain the variance increases.
- (A paper of the same title has also appeared on p. 38 in "Proceedings of the 10th International Congress on Genetics, Montreal, 1958", Vol. 2. Toronto, University of Toronto Press. 1958)
- 942 Carlson, J. G., Harrington, N. G. X-RAY-INDUCED "STICKINESS" OF THE CHROMOSOMES OF THE CHORTOPHAGA NEUROBLAST IN RELATION TO DOSE AND MITOTIC STAGE AT TREATMENT. Radiation Res. 2(1955) 84-90.
- Observations of x-rayed hanging-drop preparation of grasshopper neuroblasts in artificial medium at short time intervals immediately after treatment demonstrate that of the mitotic stages examined, namely, very late prophase, prometaphase, metaphase and anaphase, the earlier the stage, the greater the effect for a given dose. This may indicate either that a positive correlation exists between the degree of "stickiness" produced and the time interval available for it to develop between treatment and detection or that the susceptibility of the chromosomes to this effect diminishes as cells progress through the mitotic stages studied. (auth.)
- (An abstract was published earlier in Radiation Res. 1 (1954) 491)
- 943 Clark, A. M. GENETIC EFFECTS OF X-RAYS IN RELATION TO DOSE-RATE IN DROSOPHILA. Nature 177 (1956) 787.
- Using dose rates of 1000 r/min and 2000 r/min, it has been confirmed that, for a given dose, a greater amount of genetic damage is produced if the radiation is delivered at high intensity. With a total dose of 2000 r, the high dose rate gives an increase of up to 25% in the yield of recessive sex-linked lethals and of translocations. The intensity effect is enhanced if the flies are injected with 0.005 M sodium azide in saline just prior to irradiation.
- 944 Downes, J. A. THE GYPSY MOTH AND SOME POSSIBILITIES OF THE CONTROL OF INSECTS BY GENETIC MEANS. Canad. Ent. 91, 10 (1959) 661-4.
- Available basic information on mating habits, etc. is reviewed. A preliminary assessment is made of the conditions under which induced mutations might be used to control the gypsy moth, Porthetria dispar (L.).
- \* Glass and Plaine 1950 - [1307]
- 945 Gowen, J. W., Umaerus, M. BIOLOGICAL RECOVERY FROM RADIATION EFFECTS AS RELATED TO GENETICS. p. 101 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.
- Cells of the Drosophila germ tracts were exposed to multiples of 2000 r given on 0 d after emergence and at 14, 28 and 42 d thereafter. Eight days immediately following the first irradiation the percentage of sex-linked lethal mutations were: no radiation, 0.0; 2000 r, 3.6; 4000 r, 10.3; 6000 r, 13.5; and 8000 r, 18.3. A 14-d interval between irradiation of the germ cell sample had reduced the initial percentages to one-fifth, a 28-d interval to one-seventh, a 42-d interval to one-eleventh. The potential germ cell population has undergone biological improvement. To allow time for repair irradiations were spaced: 2000 r at 0 d; 2000 r at 14; 2000 r at 28; and 2000 r at 42 d, giving an accumulated series of 2000, 4000, 6000 and 8000 r to each male. Sperm from these periods showed mutation rates of 4.9, 5.2, 5.9 and 10.7% as contrasted with 3.6, 10.3, 13.5 and 18.3% where the corresponding irradiation dosages were received in single periods. The populations of repeatedly irradiated sperm recovered most of their normal characteristics before the following irradiation again raised the mutation percentages. Mutations in early germ cell lines appear to increase somewhat the observed lethals in the

progenies of the 42-day males receiving high irradiation dosages. Biological recovery has significance in clearing radiation damage from both the soma and populations of germ cells.

Haas et al. 1952 - [1388]

- 946 Haas, F. L., Dudgeon, E., Clayton, F. E., Stone, W. S. MEASUREMENT AND CONTROL OF SOME DIRECT AND INDIRECT EFFECTS OF X-RADIATION. Genetics 39, 4 (1954) 453-71.

The translocation rate in Drosophila virilis was used to measure the biological effect of x-radiation. Variables tested included the dosage rate, the temperature, and the gaseous environment ( $O_2$ , mixtures of  $O_2 + N_2$ ,  $O_2 + CO_2$ ,  $O_2 + CO$ ,  $O_2 + CO + CO_2$ ) of the organisms during irradiation. It was found that x-radiation damage was greater at  $3 \pm 2^\circ C$ , and with a fast dose rate (about 1900 r/min) than a slow (100 r/min). More damage was induced in  $O_2$ ,  $CO + O_2$ , and  $CO_2 + O_2$  than in air or 96%  $N_2 + 4\% O_2$ . The amount of  $O_2$  and other factors which influence the oxidative metabolism of the cell modify the radiation damage. (BA 23; 18296, 1955)

- 947 Herskowitz, I. H. THE RELATION BETWEEN X-RAY DOSAGE AND THE FREQUENCY OF SIMULATED HEALING OF CHROMOSOME BREAKAGES IN DROSOPHILA MELANOGASTER FEMALES. Proc. nat. Acad. Sci., Washington 40 (1954) 576-586.

Female Drosophila were treated with two different dosages of x-radiation, and the number of exceptional  $F_1$  individuals of appropriate types were determined. Analysis of the data indicates that all the exceptional flies may be considered to carry gross chromosomal rearrangements, and that gross rearrangements occur more frequently after x-irradiation of oöcytes than after x-irradiation of oögonia. (NSA 8: 5474, 1954)

\* Herskowitz 1954 - [1192]

\* Herskowitz 1957 - [1195], [1196]

\* Herskowitz and Abrahamson 1957 - [1199]

\* Herskowitz 1958 - [1200]

\* Hollaender et al. 1952 - [1390]

\* Kaufmann and Wasserman 1957 - [1121]

- 948 Keyl, H.-G. UNTERSUCHUNGEN AM KARYOTYPUS VON CHIRONOMUS (i. e. TENDIPES) THUMMI. II. STRUKTURVERÄNDERUNGEN AN DEN SPEICHELDRÜSEN-CHROMOSOMEN NACH RÖNTGENBESTRAHLUNG VON EMBRYONEN UND LARVEN (Studies on the karyotype of Chironomus (i. e. Tendipes) thummi. II. Structural modifications of the salivary gland chromosomes after x-irradiation of embryos and larvae). Chromosoma 9, 5 (1958) 441-83. (In German)

Embryos of Chironomus thummi thummi at 4 different stages and larvae up to 150 h-old were irradiated with x-rays, and the resultant modifications are described. The most frequent types of 2-break-recombination (deletion with open fragment, and open inversions) show different distributions of inter-break-spacing. Some deductions on the possible structure of the embryonic salivary gland chromosomes may be made, based on the experimental data collected.

\* Koiwai 1957 - [1204]

- 949 Laven, H. GENETICS OF CULEX PIPIENS (DIPTERA: CULICIDAE). p. 875-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956". Vol. 2. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

Fundamental genetic research in Culicidae is desirable for several reasons, e. g. for the study of crossing relations in the Culex pipiens complex, for the problems of susceptibility to infection, resistance to insecticides and others. Several mutations have been produced in Culex pipiens by means of x-rays. These and some spontaneous ones are enumerated. The phenomena associated with reproductive incompatibility in the Culex pipiens complex are briefly reviewed. By means of marker genes it could be demonstrated that

the crossing type is determined by extra-chromosomal cytoplasmic factors. This intrinsic incompatibility mechanism seems to be a specific mechanism of evolution in Culicidae. (auth.)

- 950 Lewis, E. B. THEORY AND APPLICATION OF A NEW METHOD OF DETECTING CHROMOSOMAL REARRANGEMENTS IN DROSOPHILA MELANOGASTER. Amer. Nat. 88 (1954) 225-39.

A new type of position effect called the "trans-vection effect" permits rapid and highly efficient detection of chromosomal rearrangements in the first generation following an induction treatment. By the use of this new method fast (pile) neutrons have been found to be more effective than x-rays or  $\gamma$ -rays in producing rearrangements in Drosophila, and estimates of the dose of fast neutrons at different stations during a nuclear detonation have been derived. (from auth. summary)

- 951 Lindsley, D. L., Edington, C. W., Halle, E. S. von. THE RELATION OF THE GENETIC CONSTITUTION OF DROSOPHILA SPERMATIZOEA TO THEIR X-RADIATION. Radiation Res. 9 (1958) 145.

The relation between sex ratio and dose was used to investigate the effect of sex chromosome constitution on sperm sensitivity. As has been repeatedly demonstrated, irradiation of a normal male has little or no effect on the sex ratio of its progeny, suggesting nearly equal sensitivity of X-bearing and Y-bearing sperm. Irradiation of XY/Y males produces a slight shift in  $\sigma/\sigma'$  from 0.890 with no irradiation to 0.806 with 4000 r, whereas irradiation of XY/O males produces a spectacular shift in ratio from 0.743 with no irradiation to 0.435 after 4000 r. These observations have been interpreted to indicate that (a) XY-bearing sperm are much more sensitive than nullo-X, nullo-Y sperm, and slightly more sensitive than Y-bearing sperm; consequently (b) Y-bearing sperm are considerably more sensitive than nullo-X, nullo-Y sperm, and this difference may be directly attributable to the presence of the Y in the former; (c) since X- and Y-bearing sperm exhibit similar sensitivity, X-bearing sperm are also considerably more sensitive than nullo-X, nullo-Y sperm. (from auth.)

- 952 Luce, W. M. REDUCTION IN FACET NUMBER IN FULL-EYED (REVERTED BAR) DROSOPHILA BY X-RAYS. (abstr.) Genetics 36 (1951) 563.

Larvae of an inbred full-eyed (reverted to full from Bar) strain of Drosophila melanogaster, kept at 28°C, were treated with x-ray dosages ranging from 1000 to 3000 r applied at the rate of 500 r per min. The corneas of the eyes of the imagoes which developed from the treated larvae were dissected off, mounted on slides, projected, and the facets counted. The x-rays produced a reduction in facet number. The rate of reduction was approximately 0.075 facets per r. The x-rays when applied before the larvae were 54 h old (reckoned from the time when the larvae were laid as eggs) had no effect. Larvae treated at any time when they were from 59 to 80 h of age responded with essentially similar rates of reduction in facet number per r applied, with some evidence that the rate was less for the lowest dosage used (1000 r). The x-rays prolonged larval development. The rate of prolongation, approximately 0.011 h per r, appeared nearly constant for all x-ray applications within the age limits (38-80 h) used in this experiment with the qualification that the 3000 r treatments had a slightly diminished effect on the rate of prolongation.

\* Luce et al. 1951 - [870]

\* Luning 1952 - [1206]

- 953 Luning, K. G., Jonsson, S. DOES THERE EXIST MUTATIONAL ADAPTATION TO CHRONIC IRRADIATION? Radiation Res. 8 (1958) 181-6.

This study concerns the possible mutational adaptation due to incorporation in the population of mutational isalleles with lower mutability than the alleles originally present. A comparison was made between the rates of recessive lethals and y, w and sn mutations induced by x-rays in males from Drosophila melanogaster stocks kept at normal background radiation versus those under constant  $\gamma$ -irradiation (5 r/h). No difference in mutability was found between these two stocks, and hence there are no indications of mutational adaptation due to mutational isalleles. These negative results do not exclude a possible mutational adaptation, or recovery phenomenon, which is discussed. (auth.)

(A report of the same title has also been published in A/AC. 82/G/R. 69, Stockholm, Univ., Inst. Genetics. 1957, 7p)

- 954 Oster, L. L. THE CONSEQUENCES OF X-IRRADIATING MORPHOLOGICALLY DISSIMILAR CHROMOSOMES  
Radiation Res. 9 (1958) 163-4.

On the expectation that the morphology of the chromosomes may affect their radiosensitivity several investigators have irradiated ring-shaped chromosomes and ordinary rod-shaped ones in spermatozoa of Drosophila melanogaster. In general, they found that although rings are lost more often than rods, both chromosome types yield similar lethal mutation frequencies. To investigate further this problem special stocks were constructed which permitted the simultaneous detection of lethal mutations, genetically demonstrable chromosome deficiencies, and nonlethal visible mutations. Homogeneous samples of spermatozoa containing either ring- or rod-shaped sex chromosomes were treated in inseminated females. X-raying rods yielded 46/1366 (i.e. lethals among tested chromosomes) for 1000 r, 65/1208 for 2000 r, 436/3693 for 4000 r, while the controls gave 41/10 288; X-raying rings yielded 44/1063 for 1000 r, 31/501 for 2000 r, 187/2201 for 4000 r, while the controls gave 14/4967. With high doses significantly more lethals were recovered from rods than from rings. Significantly more chromosome deficiencies were induced in the rod-X (16/17 436) than in the ring-X (4/12 300) by 4000 r, the control count for deficiencies being 1/41 524 for rods and 0/23 504 for rings. Nonlethal visible mutations were rare and induced in similar frequency in both stocks; there being none among controls. Thus treatment with high doses of x-rays results in a greater loss of those mutations associated with structural changes in the case of ring-shaped than of rod-shaped chromosomes. These findings supply additional evidence against the view that point mutations originate via the restitution of chromosome breaks.

(Abstract of paper presented at the Intern. Congr. of Radiation Res., Burlington, Vermont, 10-16 Aug. 1958)

- 955 Parker, D. R., McCrone, J. A GENETIC ANALYSIS OF SOME REARRANGEMENTS INDUCED IN  
OOCYTES OF DROSOPHILA. Genetics 43 (1958) 172-86.

The technique of detachment of attached-X chromosomes has supplied a means of studying translocation processes in Drosophila females. The analysis was based on data obtained from x-irradiation.

- 956 Ray-Chaudhuri, S. P., Pyne, C. K. THE FREQUENCY OF INDUCED DICENTRIC BRIDGES IN MEIOSIS IN  
THE GRASSHOPPER, GESONIA PUNCTIFRONS, IN RELATION TO THE INTENSITY OF RADIATION. (abstr.)  
Indian Sci. Cong. Ass. Proc. 41 (Section VII. Zoology and Entomology) (1954) 167.

Gesonia punctifrons males were subjected to  $\gamma$ -rays from Ra. The frequency of bridges were shown to be independent of the intensity of radiation within the limits of the experiment (80 r given in  $\frac{1}{2}$  h or in 23 h), counts on cells in anaphase I being made on material fixed 30 h after irradiation. The significance of these data with respect to the hypothesis put forward by Ray-Chaudhuri and Sarkar (1952) is discussed. (from abstr.)

- \* Ray-Chaudhuri et al. 1957 - [1227]

- 957 Schmid, W. SIND DIE SICHTBAREN MUTATIONEN BEI DROSOPHILA MELANOGASTER FÜR QUANTITA-  
TIVE STRAHLENGENETISCHE UNTERSUCHUNGEN GEEIGNET? (Are the visible mutations in Drosophila  
melanogaster significant for quantitative radiogenetic investigations?) Strahlentherapie 109 (1959) 79-96.  
(In German)

Applications of data on dominant and recessive viable mutations and gynandromorphs in Drosophila melano-  
gaster in quantitative radiation genetic experiments are discussed. Data are reviewed from a number of  
genetic studies on Drosophila. Somatic mutations and modifications, as well as induced somatic cross-overs,  
are discussed. (NSA 13; 16727, 1959)

- 958 Strangio, V. A. A STUDY OF THE PERIOD OF ACTION IN A SERIES OF SEX-LINKED RECESSIVE LETHALS  
IN DROSOPHILA. Austr. J. exp. Biol. med. Sci. 36, 5 (1958) 425-32.

Sixty-eight sex-linked, recessive lethals were recovered following the irradiation of Drosophila males with  
2150 r, 31 at the dose-rate of 2000 r/min and 37 at 100 r/min. Except for the rare extended phase lethal,  
the lethals were individually stage specific and also tended to group about sensitive stages in the develop-  
mental cycle. The relative frequencies of these lethal clusters tally with previous published estimates. A  
cytogenetic approach was used to interpret one such exceptional lethal. Some evidence already exists for  
a relationship between the time of onset of genetically-induced developmental abnormality and the magni-  
tude of the chromosomal aberration involved. Intensity differences are responsible for a differential yield



of gross rearrangements. An attempt to demonstrate a more obvious embryonic trend in the sensitivity pattern of the high dose-rate lethals mirroring this intensity effect was unsuccessful. Visible abnormalities associated with the lethals were tabulated. (auth.)

- 959 Strunnikov, V. A. OBTAINING BIPATERNAL ANDROGENETIC HYBRIDS IN THE MULBERRY SILKWORM. Dokl. Akad. Nauk SSSR (Biol. Sci. Sect. Trans.) 122, 1/6 (1958) 768-71. tr. from: Dokl. Akad. Nauk SSSR 122, 3 (1958) 516. (In Russian)
- 960 Strunnikov, V. A. OBTENTION D'UNE DESCENDANCE NON HYBRIDE ISSUE DE DEUX MÂLES ET PROVENANT D'UNE MÊME FEMELLE DE VER À SOIE. Vest. Selskokhoz. Nauk SSSR 5 (1960) 126-8. (In Russian)
- 961 Tazima, Y. ALTERATION OF FOOD SELECTING CHARACTER BY ARTIFICIAL MUTATION IN THE SILKWORM. Intern. Silk Ass. B, 20 (1954) 27-9.
- \* Wallace 1956 - [1459]

- 962 Whiting, A. R. ABSENCE OF MUTAGENIC EFFECT OF HEAVILY IRRADIATED HOST ON THE PARASITIC WASP HABROBRACON. Anat. Record 111 (1951) 585, abstr. 256.

Eighty-seven freshly emerged females were mated and kept without food until only oögonia and very young oöcytes remained in their ovaries. They then fed and oviposited on host Ephesia caterpillars immediately after these had been x-rayed with doses ranging from 40 000 r to 160 000 r. They were transferred every third day to freshly irradiated caterpillars. No evidence of a lethal effect of irradiated food was observed. Females appeared reluctant to sting and feed on most heavily irradiated hosts although they did so. It is evident that heavily irradiated host caterpillars exerted no mutagenic effect on the parasite. (from auth.)

## I-B-2 INDUCED MUTATIONS

### Surveys

- 963 Blair, H. A., ed. BIOLOGICAL EFFECTS OF EXTERNAL RADIATIONS. New York, McGraw-Hill Book Company, Inc. 1954, 522p.

Results are reported from a series of studies on the biological effects of x-radiation and the chronic effects of neutron irradiation. Amongst many others, experiments on the relation of mutation frequency to x-ray dose in Drosophila are reported; the influence of chronic irradiation with  $\gamma$ -rays at low dosages on the mutation rate in Drosophila is considered. A list of references is included with each chapter, and a complete subject index is provided.

- 964 Glass, B. INDUCTION OF MUTATIONS WITH RADIATION. p. 569-75 (disc. p. 575-6) in TID-7554, John Hopkins Univ., Baltimore, "Proceedings of the Inter-American Symposium on the Peaceful Application of Nuclear Energy, 13-17 May 1957". Brookhaven National Lab., Upton, N. Y.

Review article, freely illustrated with data from Drosophila.

- 965 Muller, H. J. GENERAL SURVEY OF MUTATIONAL EFFECTS OF RADIATION. p. 145-77 in "Radiation Biology and Medicine". Claus, W. D., ed., Reading, Mass., Addison-Wesley Publishing Co. 1958, 944p.

Review article. The nature and incidence of induced gene mutations are discussed, and the estimation of genetic damage. Work is cited on Drosophila, also on grasshopper. General bibliography: 121 refs.

- \* Abeleva and Potekhina 1960 - [853]
- \* Abrahamson and Telfer 1956 - [1157]
- \* Abrahamson and Herskowitz 1957 - [1158]

- 966 Alexander, M. L. X-RAY INDUCED MUTATION RATES AT SPECIFIC LOCI ON THE THIRD CHROMOSOME OF DROSOPHILA MELANOGASTER. (abstr.) Genetics 37 (1952) 563.
- The mutation rates were obtained both for irradiated spermatogonia and mature sperm. Special techniques were employed (1) to limit the sperm sample from treated adult males, (2) to detect "spontaneous cluster" mutations, (3) to assure samples from treated spermatogonia by use of early larval stages. An average rate of  $5.72 \times 10^{-8}$  mutations per r per locus is reported in some 50 000 flies in testing the effects of 3000 r of x-rays on the 8 loci of the *res* group of mutations. The rates per locus varied from 1.35 to  $8.75 \times 10^{-8}$  per r. The induced mutations from treated sperm were lethal, semilethal, viable, or phenotypically normal when tested in the homozygous condition. No mutations were observed in the unirradiated sperm. (from abstr.)
- (For critical discussion, cf. Ives 1954 - [1002])
- \* Alexander 1954 - [1159]
- \* Alexander 1956 - [1181]
- \* Alexander 1957 - [1162]
- \* Alexander 1958 - [1163], [1166]
- \* Alexander 1959 - [1134]
- \* Annan 1954 - [1134]
- \* Armason et al. 1951 - [377]
- 967 Atwood, K. C., Borstel, R. C. von, Whiting, A. R. AN INFLUENCE OF PLOIDY ON THE TIME OF EXPRESSION OF DOMINANT LETHAL MUTATIONS IN HABROBRACON. Genetics 41 (1956) 804-13.
- The frequencies of x-ray-induced dominant and recessive lethal mutations in Habrobracon oöcytes are unchanged by subsequent fertilization with unirradiated sperm. A significant proportion of the dominant lethal effect induced at metaphase I is expressed at a later stage in diploids than in haploids. When dominant lethals are induced at prophase I, the proportion expressed after hatching is the same in diploids as in haploids. The dependence of delayed expression on the stage irradiated is consistent with the assumption that lethality caused by observable chromosome breakage can be delayed, whereas that due to other causes cannot. Chromosome breakage is apparently a more frequent cause of lethality after irradiation of oöcytes in metaphase than in prophase. (auth. summary)
- \* Baker and Sgourakis 1950 - [1359]
- \* Baker and Edington 1952 - [1360]
- \* Baker and Halle 1953 - [1362]
- 968 Baker, W. K., Halle, E. S. von. THE PRODUCTION OF DOMINANT LETHALS IN DROSOPHILA BY FAST NEUTRONS FROM CYCLOTRON IRRADIATION AND NUCLEAR DETONATIONS. Science 119 (1954) 46-9.
- Data are presented on the relative biological effectiveness of fast neutrons from cyclotron irradiation and from nuclear detonations as determined by means of induction of dominant lethals in Drosophila. It is concluded that the frequency of dominant lethals may be useful as a rather rapid, but crude, biological measurement of fast neutron dosage at high levels. Findings are compared with similar data on Tradescantia. (NSA 8: 3652, 1954)
- \* Bateman and Sinclair 1950 - [379]
- \* Bateman 1955 - [812], [378]
- \* Bateman 1956 - [1172]

- \* Bateman 1957 - [1173], [813]
- \* Bateman 1958 - [1174]
- 969 Becker, H. ÜBER RÖNTGENMOZAIKFLECKEN UND DEFEKTMUTATIONEN AM AUGE VON DROSOPHILA UND DIE ENTWICKLUNGSPHYSIOLOGIE DES AUGES (Study on x-ray induced mosaic spots and deletion mutations and on the developmental physiology of the Drosophila eye). Z. indukt. Abstamm.-VererbLehre 88, 3 (1957) 333-78. (In German)
- Drosophila eggs and larvae at different stages were subjected to x-rays which caused changes that ultimately led to spots in the adult eye. An interpretation of the complex process involved is attempted. It appears that the definite delimitation of the eye occurs certainly not earlier than at the end of the 2nd larval stage.
- \* Belgovsky 1958 - [1175]
- \* Belgovsky et al. 1959 - [1176]
- 970 Benz, G. DER FAKTOR LETAL-BLUTER (lb) BEI DROSOPHILA MELANOGASTER (The lethal-bleeding factor (lb) in D. melanogaster). Arch. Klaus-Stift. VererbForsch. 29, 3/4 (1954) 346-52. (In German)
- A recessive x-ray mutation is described. Its gene lies in the left arm of the second chromosome. The pupal development is normal, but the pupal covering is twice the normal thickness, the protein and not the chitin sheath being thickened. As a result, in escaping from its covering the hemolymph is lost, apparently through an opening in the anterior wall of the thorax, and the animal dies. If carefully removed by hand, the apparently normal fly survives and is fertile, but its offspring are 84% lethal, the remainder escaping normally. The thickened puparium is thus the only apparent abnormality.
- \* Bertram and Höhne 1958 - [814]
- \* Bertram et al. 1960 - [1371]
- 971 Bonnier, G. INDIRECT EFFECTS OF X-RAYS ON CHROMOSOMES. Brit. J. Radiol. 25 (1952) 180-2.
- Work is reviewed which has been completed to date on the induction of mutations in Drosophila by indirect x-irradiation.
- 972 Bonnier, G. SECONDARY INFLUENCES FROM X-RAY IRRADIATION ON MUTATIONAL PROCESSES IN DROSOPHILA MELANOGASTER. Heredity 8, 3 (1954) 199-210.
- It is shown that certain aberrations occurring in irradiated paternal X-chromosomes are produced at a higher rate when the chromosomes are irradiated in impregnated females than when they are irradiated in males. It is furthermore shown that the rates are dependent on the strain from which the females, which harbour the sperm, are taken. In one instance it was also found that the rate of fractionals due to breaks in the paternal chromosomes produced by irradiation of males was enhanced if the females were irradiated, prior to mating. (auth.)
- 973 Bonnier, G. SECONDARY CAUSES OF VARIATION IN THE RATES OF X-RAY INDUCED MUTATIONAL PROCESSES IN DROSOPHILA MELANOGASTER. (abstr.) p. 892-3 In "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6(II). Montalenti, G., Chiarugi, A., eds. Florence, 1956.
- Spermatozoa in D. melanogaster may be irradiated in males or impregnated females. In studies which were begun some years ago it was found that sex-linked lethals were produced in male gametes at a slightly higher rate when the treatment was given to impregnated females, confirmed in experiments on a larger scale. The differences in the rates, though still small, were clearly significant. It was further found that other mutational processes also obey the same rule. Dr. Lüning has investigated the nature of those processes which show the mentioned differences in rates. When irradiating male spermatozoa containing the "Muller-5" X-chromosome, breaks in this chromosome produce, after mating the males to yellow females, fractional yellow females at a low rate. This rate was slightly, but significantly, increased if the females as well were irradiated — even if before mating. This effect was, however, influenced by the

genotype of the females, also found true with regard to the differences mentioned earlier. Possible explanations are discussed. (from abstr.)

- 974 Bonnier, G. RATE OF DEVELOPMENT OF X-RAY-INDUCED DETRIMENTALS AND THE INFLUENCE OF SELECTION PRESSURE. p.433-6 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology, Stockholm 15-19 Aug. 1956". de Hevesy, G. C., Forsberg, A. G., Abbatt, J. D., eds. London, Oliver and Boyd. 1957.
- Some preliminary experiments on Drosophila and their results are reported. A growth rate index is used. Several detrimental, though perhaps not all, could have been picked out by their average rates of development alone.
- 975 Bonnier, G., Jonsson, U.-B. STUDIES ON X-RAY INDUCED DETRIMENTALS IN THE SECOND CHROMOSOME OF DROSOPHILA MELANOGASTER. Hereditas 43, 2 (1957) 441-61.
- A study is reported on problems concerning x-ray induced subvitals in the second chromosome of D. melanogaster. The frequency of such viability mutations are considered, and the comparisons made are in some cases also combined with the effects of different degrees of environmental stresses. The study is divided into a discussion of the material used, estimates of the frequency of subvitals, partitioning of the variance into its components, discussion on survival rates, larval competition tests, and considerations concerning the study and the structure of irradiated populations.
- 976 Bonnier, G., Luning, K. G. X-RAY INDUCED DOMINANT LETHALS IN DROSOPHILA MELANOGASTER. Hereditas 36, 4 (1950) 445-56.
- Wild-type males of D. melanogaster were irradiated with about 2900 r and mated to y w sn females of a maximum age of 3 d. Corresponding controls (without irradiation) were available. The hatchability of the eggs was studied after varying the age of the males at fertilization and after varying the length of time between irradiation and fertilization. It was found that both these factors were active in decreasing the hatching rate. The decline ranged from about 50% to about 30% or still lower. In the controls a normal hatching rate of between 80 and 90% was found without any effect from aging the males. Unmated or mated state of the males prior to the present mating had no effect on the hatchability. (from auth.)
- 977 Bonnier, G., Luning, K. G. SEX LINKED LETHALS IN DROSOPHILA MELANOGASTER FROM DIFFERENT MODES OF X-RAY IRRADIATION. Hereditas 39, 1-2 (1953) 193-200.
- It is shown that x-ray irradiation of male X-chromosomes of D. melanogaster produces a higher rate of recessive lethals if the irradiation is given to spermatozoa which are stored in impregnated females than if the irradiation is given to males. This effect is probably not caused by the irradiation per se of the females, but may perhaps be due to a difference in the state of the spermatozoa when being within the seminal receptacles of the females as compared with their state within the males. (auth. summary)
- 978 Borstel, R. C. von, Atwood, K. C., Whiting, A. R. DELAYED EXPRESSION OF INDUCED DOMINANT LETHALS IN DIPLOID HABROBRACON. Genetics 40 (1955) 564.
- In Habrobracon unfertilized eggs develop normally to become haploid males; fertilized eggs become diploid females. Females which had stored eggs in the first meiotic metaphase were x-irradiated and one half of them subsequently mated. The fertilized eggs had a much higher hatchability frequency than the unfertilized eggs; however, adult survival did not differ markedly in the two groups. The higher frequency of death during the larval stage in the diploid embryos accounts for the difference. Those mutations which cause death of diploid embryos at a later stage of development than haploid embryos are referred to as conditionally delayed dominant lethal mutations; up to 25% or more of dominant lethals can be of this class in eggs irradiated in metaphase I. Examination of unfixed dead embryos also shows that fertilized eggs die at later stages than do unfertilized ones when the eggs are irradiated in either the first meiotic metaphase or prophase, but a higher proportion of eggs, fertilized and unfertilized, die early in the latter case. Conditionally delayed dominant lethals by criterion of hatchability do not occur to any appreciable extent when eggs are irradiated in the first meiotic prophase.

(Abstract of paper presented at the 1955 meetings of the Genetics Society of America, East Lansing, Michigan, 6-8 Sep., 1955)

- 979 Borstel, R. C. von, Pardue, M. L. ON THE NATURE OF RADIATION-INDUCED DOMINANT LETHAL MUTATIONS IN HABROBRACON AND DROSOPHILA. Genetics 41 (1956) 665.

In Habrobracon and Drosophila, induction of the breakage-fusion-bridge cycle with consequent gene imbalance has been considered as the primary source of dominant lethality. Habrobracon eggs irradiated in the first meiotic metaphase show terminal deletions that result in bridges in the second meiotic anaphase and bridge-breakage during cleavage. Since the breakage-fusion-bridge cycle does not appear to become established in eggs irradiated in the first meiotic prophase, the question arises as to the cause of dominant lethality in these eggs. Examination of dead Habrobracon embryos from irradiated eggs (unfertilized, or fertilized subsequent to x-irradiation) at about the 50% lethal dose (15 000 r) shows that approximately 80% have been blocked in development at the sixth or seventh cleavage and the nuclei are Feulgen negative. Thus it appears that dominant lethality in these eggs is associated with interruption of deoxyribonucleic acid synthesis. Approximately 90% of dead Drosophila embryos from irradiated sperm (ca 50% lethality; 2000 r) die under similar circumstances. These resemble the specific lethality in Habrobracon in that death occurs during the early cleavage stages. In order to test whether this action is caused by induced chromosomal deletions, the dead embryos from unirradiated triploids were examined. The chromosome complements of such embryos comprise a variety of aneuploid types. Since all eggs from Habrobracon triploids and most eggs from Drosophila triploids died during later development, it appears likely that radiation-induced dominant lethal mutations are not necessarily brought about by induction of chromosomal deficiencies. In particular, those dominant lethals associated with the radiation effect on deoxyribonucleic acid synthesis in Habrobracon are clearly not the result of chromosomal deficiencies.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

- 980 Borstel, R. C. von, Pardue, M. L. COMPARISON OF RADIATION-INDUCED AND GENETICALLY CONTRIVED DOMINANT LETHALITY IN HABROBRACON AND DROSOPHILA. Genetics 42 (1957) 401.

In Habrobracon and Drosophila most of the deaths from irradiation of eggs and sperm occur early in embryonic development before the blastoderm is formed. The problem exists as to whether this early type of radiation-induced lethality can be attributed to gene imbalance. A solution to this problem may be reached by determining the time of death of inviable progeny of triploids or translocation heterozygotes. It has been found that aneuploid embryos from Habrobracon and Drosophila females die after blastoderm formation unlike the majority of radiation-induced dominant lethals. Corroborative evidence was obtained from examination of dead embryos from heterozygotes of two different Drosophila translocations and four different newly induced Habrobracon translocations; it was found in each instance that death is expressed after blastoderm formation. Since aneuploidy in neither Drosophila nor Habrobracon brings about death during early development that is most characteristic of radiation-induced lethality, it appears that radiation induces in large measure a type of dominant lethality that is not attributable to the loss of chromosomes or chromosome parts resulting from chromosome breakage.

(Abstract of paper presented at the 1957 meetings of the Genetics Society of America, Stanford, California, 26-28 Aug. 1957)

- 981 Borstel, R. C. von. DOMINANT LETHAL MUTATIONS IN HABROBRACON AND DROSOPHILA. (abstr.) p. 303 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.

In the parasitic wasp Habrobracon, unfertilized eggs become normal haploid males; fertilized eggs, diploid females. Three types of dominant lethal mutations have been identified in Habrobracon. Type I dominant lethality kills the embryo during the first few cleavages and is believed to represent a defect in deoxyribonucleic acid synthesis. These account for 60-80% of the deaths when eggs or sperm are irradiated and Type I lethality is unaffected in expression by fertilization. Type II kills the embryo after blastula formation and before the embryo hatches if the embryo is haploid, after hatching if the embryo is diploid. These are called conditionally delayed dominant lethal mutations and are characteristic, with Type I, of Habrobracon eggs irradiated in the first meiotic metaphase. They are believed to be manifestations of chromosome imbalance. Type III kills the embryo after blastula formation and before hatching whether the embryo is haploid or diploid. Death may occur later in embryogeny in the diploids than in the haploids, but always before hatching. Type III, with Type I, is characteristic of Habrobracon eggs irradiated in the first meiotic prophase. In Habrobracon, five translocations, when heterozygous, produced aneuploid embryos that all died under the same circumstances that characterize Type II dominant lethality. Type III dominant lethals

are exactly mimicked by aneuploid embryos from triploid Habrobracon females, indicating that Type III radiation-induced dominant lethality may be caused by chromosome loss. Type I dominant lethality remains specifically inducible only with mutagenic agents. In Drosophila, dominant lethal analogues of Type I and Type III have been observed following x-irradiation. Type III is mimicked in Drosophila by aneuploids from triploid females or translocation heterozygotes; Type I is specifically induced by radiation. Even Drosophila zygotes deprived by genetic means of the X and Y chromosomes and lacking the associated nucleoli develop further than Type I dominant lethal embryos.

- 982 Borstel, R.C. von, Rekemeyer, M.L. RADIATION-INDUCED AND GENETICALLY CONTRIVED DOMINANT LETHALITY IN HABROBRACON AND DROSOPHILA. Genetics 44 (1959) 1053-74.

Three kinds of dominant embryo lethals, distinguished phenotypically, are induced by radiation in Habrobracon; a similar situation exists in Drosophila but only two kinds are distinguished by the criteria specified in the paper. Although chromosome imbalance phenomena can mimic some of the dominant lethality induced by radiation, the majority of radiation-induced dominant lethals in Habrobracon and Drosophila are not mimicked by genetically contrived loss of chromosomes or loss of chromosome parts.

- \* Borstel 1960 - [1436]

- 983 Borstel, R.C. von. NATURE OF THE DOMINANT LETHALITY INDUCED BY RADIATION. Arti Ass. genet. ital. 5 (1960) 35-50. (In Italian)

In the wasp Habrobracon it was found that radiation-induced dominant lethality is a complex consisting of at least three types distinguished phenotypically and genotypically. In Drosophila, two types are phenotypically distinguishable. By comparing radiation-induced with genetically contrived dominant lethality, it is possible to show that one of the three types of dominant lethality can be attributed to chromosome imbalance and that another type is possibly caused by chromosome loss or severe chromosome imbalance. The most common type of dominant lethality appears to be caused by excessive depression of the mitotic rate. The slowing of the rate of mitosis does not appear to be caused by inactivation of the nucleolus or nucleolus organizer but can be brought on by induction of the breakage-fusion-bridge cycle. It is possible that any other action of radiation that depresses the mitotic rate also will induce this type of dominant lethality. (auth.)

- \* Brandt and Höhne 1952 - [1372]

- \* Brandt and Höhne 1953 - [815], [816]

- 984 Buzzati-Traverso, A. A. ON THE ROLE OF MUTATION RATE IN EVOLUTION. p. 450-62 in "Proceedings of the 9th International Congress on Genetics, Bellagio, Italy 1953", Suppl. to Caryologia 6. Montalenti, G., Chiarugi, A., eds. Florence. 1954.

It was shown that, under the experimental conditions described, an artificially (x-ray induced) raised mutation rate proved an advantage to the Drosophila population and raised its productivity. The evolutionary implications of these observations are discussed.

- \* Buzzati-Traverso and Scossiroli 1958 - [1437]

- 985 Caspari, S. B. AN X-RAY SPERM-DOSE-ACTION CURVE FOR MUTATIONS AT A SINGLE LOCUS IN MORMONIELLA. Radiation Res. 8, 3 (1958) 273-83.

A study of mutants and mutation rates for a single locus, R, in Mormoniella was made by x-raying (at doses of 1000 to 5000 r) wild-type males, mating them to females of a double recessive peach stock, and counting and analysing the mutants appearing among the F<sub>2</sub> daughters. Analyses were made for four kinds of mutations: S, O, recessive lethals and recessive sterile. (from auth. summary)

- 986 Clark, A. M., Rubin, M. A., Fluke, D. ALPHA-PARTICLE-INDUCED DOMINANT LETHAL IN THE MATURE SPERM OF HABROBRACON. (abstr.) Radiation Res. 7 (1957) 461.

Males from stock No. 1 were irradiated with 40 MeV  $\alpha$ -particles from a cyclotron at doses ranging from 1150 to 58500 rep. At a dose of 6700 rep, 98% of the sperm carried at least one dominant lethal. X-irradiation of males with 7000 r showed that 98% of the sperm carried at least one dominant lethal. These

x-ray data are comparable to those reported by Heidenthal (1945). Thus, for equal expenditures of energy, the same number of dominant lethals are obtained for  $\alpha$ -particles and for x-rays.

- 987 Clayton, G., Robertson, A. MUTATION AND QUANTITATIVE VARIATION. Amer. Nat. 89 (1955) 151-8.

Selection for abdominal chaetae has been carried out in an inbred line of D. melanogaster, both with and without irradiation by 1800 r x-rays of each generation. The response in the control stocks in 17 generations was not significant. The irradiated lines responded to selection but slowly compared with wild populations. This is discussed in relation to the results of other workers. Two papers by Mather and co-workers are found to give consistent estimates of the rate of spontaneous production of new variance in abdominal chaetae of the order of 0.01 units each generation, which is not inconsistent with our results. The variance found in several wild populations is about 5 units. The evolutionary aspect of these results is discussed. (auth. summary)

- 988 Colombo, G. PRIME RICERCHE SUI LETALI DOMINANTI INDOTTI DAI RAGGI X SU MASCHI DI LOCUSTA MIGRATORIA MIGRATORIOIDES R. AND F. (ORTHOPTERA) (Initial research on the dominant lethals induced with x-rays on the males of Locusta migratoria migratorioides R. and F. (Orthoptera)). Ric. Sci. 28, 10 (1959) 2133-41. (In Italian)

Males of L. m. migratorioides at 4th instar, just after the last moult and a month after the last moult were irradiated with x-rays from 50 to 1600 r. The irradiated males were mated to non-irradiated virgin females and the offspring scored for embryo mortality. Dominant lethals induced in spermatogonia, spermatocytes and sperm were studied. The relation of dosage to effect, for dominant lethals induced on sperm, follows a one-event curve; but it is possible that doses high enough to produce multi-event effects were not used. The sex ratio was observed to be altered in favour of males. The frequencies of dominant lethals increase when more mature germ cells are irradiated. This result is explained as cell selection against germ cells irradiated in premeiotic and meiotic stages. This view is supported by several experiments on chromosome and cell damage by x-rays on Orthoptera. The percentages of embryo death at different stages of development were determined. When sperm were irradiated there was a higher mortality during segmentation, whereas when spermatogonia were irradiated mortality was higher in later stages of the embryonic development. This result is considered to be further evidence of cell selection against germ cells irradiated during premeiotic stages. (auth. summary)

- \* Cunha et al. 1958 - [1439, 1440]

- \* Cunha et al. 1959 - [1441]

- 989 Dittrich, W., Höhne, G., Paul, W., Schubert, G. ÜBER DIE AUSLÖSUNG REZESSIV-GESCHLECHTS-GEBUNDENER LETALFAKTOREN BEI DROSOPHILA DURCH SCHNELLE ELEKTRONEN EINES 6 MeV-BETATRONS (Production of recessive sex-linked lethals in Drosophila by fast electrons of a 6 MeV betatron). Naturwissenschaften 37, 23 (1950) 545-6. (In German)

Fast electrons (>3 MeV) were found more effective in inducing recessive sex-linked lethal mutations in D. melanogaster than equal x-ray doses in experiments of Timofeff-Ressovsky (1944) and others. This difference, however, is not statistically significant. Spontaneous mutations of this kind did not occur. (BA 26: 17130, 1952)

- 990 Edington, C. W. A NONLINEAR FREQUENCY-DOSE RELATION FOR RECESSIVE LETHALS INDUCED BY X-RAYS IN DROSOPHILA. Genetics 41 (1956) 640.

It has been found that the frequency of recessive lethals induced by x-rays in Drosophila melanogaster increases more rapidly with increasing dose than is expected on the basis of linearity. This nonlinear increase may be due to the increasing frequency at higher doses of one, two, or all of the following two-hit genetic effects: (1) two independent semilethals, which together act as a recessive lethal, (2) gross deficiencies, and (3) "position-effect" lethals, which are dependent on gross chromosome aberrations for their expression. (from abstr.)

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut, 27-29 Aug. 1956)

- \* Edington 1956 - [818]

\* Edington 1958 - [1377]

\* Erdman 1960 - [867]

- 991 Falk, R. STUDIES ON X-RAY-INDUCED VIABILITY MUTATIONS IN THE THIRD CHROMOSOME OF *DROSOPHILA MELANGASTER*. *Hereditas* 41, 1/2 (1955) 259-78.

An isogenic *Drosophila* stock was irradiated with an x-ray dose of 2000 r. Forty-seven experimental stocks were isolated in such a way that in each only the third irradiated chromosome was left for the study of viability mutations. Hatchability was used as a measure of viability, and thus it was possible to study the effect of the mutations in the homozygous as well as the heterozygous flies. The lethal and part of the subvital mutations only were left for the viability test. Of the tested experimental stocks, 73% were affected in their viability. Among these the subvitals occurred about 3.5 times more frequently than the lethals. Among the subvital mutations, those less affected occurred more frequently. In about 1/3 of the mutations the effect was partially or completely dominant. (auth.)

- 992 Falk, R. STUDIES ON X-RAY INDUCED VIABILITY MUTATIONS. *Bull. Res. Council, Israel, Sec. B*, 5 (1958) 314.

Subvital mutations were induced in an isogenic stock of *Drosophila* by 2000 r of x-rays. Third chromosome mutations only were studied. Among the stocks tested the subvitals were about 3.5 times more abundant than the lethals. 73% of the tested chromosomes carried lethal or subvital mutations. The mutations with the lesser detrimental effect were the more frequent ones. In at least 1/3 of the mutations the effect was partially or completely dominant. The theoretical expectation that the more detrimental mutations are the less dominant ones could only be confirmed in part.

\* Fritz-Niggli 1956 - [823]

- 993 Глемобитский, Я.Л., Абелева, Э.А., Лапкин Ю.А. ВЛИЯНИЕ МАЛЫХ ДОЗ ИОНИЗИРУЮЩЕЙ РАДИАЦИИ НА ЧАСТОТУ ВОЗНИКНОВЕНИЯ ССЫЛЕННЫХ С ПОЛОМ РЕЦЕССИВНЫХ ЛЕТАЛЬНЫХ МУТАЦИЙ У ДРОЗОФИЛ. *Журнал общей Биологии* 21 (1960).

1. Облучение  $\gamma$ -лучами в дозе 5 р спермиев и сперматид у дрозофилы индуцирует появление рецессивных летальных мутаций. Фракционированное облучение дозой в 20 р и по 5 р за сеанс с полуторачасовыми промежутками между сеансами облучения сопровождается кумулятивностью мутагенного эффекта. Относительная частота (на 1р) рецессивных леталей, индуцированных в спермиях при фракционированном облучении дозами по 5 р, соответствует данным, полученным другими исследователями при одновременном облучении более высокими дозами. 2. Одинаковые малые дозы быстрых нейтронов давали в  $1\frac{1}{2}$  - 2 раза больший мутагенный эффект, чем  $\gamma$ -лучи. 3. Сперматиды, по сравнению со спермием, при использовании малых доз радиации были примерно в два раза мутабилинее при облучениях как  $\gamma$ -лучами, так и быстрыми нейтронами. 4. Данные опыта при использовании малых доз вплоть до 5 р указывают на отсутствие порога для мутагенного эффекта ионизирующей радиации. В основном следует считать с отсутствием пороговых доз. Если пороговые дозы и будут обнаружены, то они будут характерны лишь для данного вида радиации, для определенных типов мутаций и при воздействии на определенную стадию гаметогенеза конкретного вида организмов.

Glemobitsky, Ya. L., Abeleva, E. A., Lapkin, Yu. A. EFFECT OF SMALL DOSES OF IONIZING RADIATIONS UPON THE RATE OF FORMATION OF SEX-LINKED RECESSIVE LETHALS. *J. gen. Biol.*, Moscow 21 (1960) p. p. (Preprint); see A/AC. 82/G/L/408.

Irradiation of *Drosophila* sperm and spermatids by a 5 r-dose of  $\gamma$ -rays gives rise to the formation of recessive lethals. Fractional irradiation with a dose of 20 r, given 5 r at a time at  $1\frac{1}{2}$  h-intervals, increases the mutagenic effect. The relative rate of recessive lethals per r induced in sperm by fractional doses of 5 r corresponds to the results obtained by other workers with higher single doses. Equal small doses of fast neutrons have a mutagenic effect 1.5 - 2 times higher than that of  $\gamma$ -rays. At small doses of either  $\gamma$ -rays or fast neutrons spermatids prove twice as mutable as sperm. Results from small doses up to 5 r point to the absence of a threshold. The absence of threshold values must be borne in mind. If threshold doses should



eventually be found they will be characteristic only for the particular radiation, the particular mutations and the particular stage in gametogenesis of that one species.

- 994 Green, M. M. RADIATION INDUCED REVERSE MUTATIONS IN DROSOPHILA MELANOGASTER. Proc. nat. Acad. Sci., Washington **45** (1959) 16-23.

Evidence is presented that x-rays and  $\gamma$ -rays can induce back mutations which, according to current criteria, do not differ from spontaneous mutations. D. melanogaster females homozygous for one or the other forked pseudoalleles,  $f^{1n}$  and  $f^1$ , both known to back-mutate spontaneously, were irradiated. A comparison of the induced and spontaneous rates of reversals shows that 4000 r x-rays increased  $f^{1n}$  reversals 7 fold, whereas equivalent  $\gamma$ -irradiation somewhat more than tripled the reversal frequency. Back mutations of  $f^{1n}$  were significantly increased; those of  $f^1$  apparently not. The back mutations are not associated with detectable chromosome alterations.

- 995 Guyénot, E., Thélin, L., Kiortsis, V. ACTION MUTAGÈNE DE PETITES DOSES DE RAYONS X. (abstr.) 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/237. **22** (1958) 292.  
(For details see ref. 996)

- 996 Guyénot, E., Thélin, L., Kiortsis, V. ACTION MUTAGÈNE DE FAIBLES DOSES D'IRRADIATION CHEZ DROSOPHILA MELANOGASTER. Arch. Klaus-Stift. VererbForsch. **24**, 1/4 (1959) 256-64.

L'étude des mutations létales récessives, liées au sexe chez D. melanogaster montre que le pourcentage des mutations spontanées apparaissant dans la souche utilisée s'élève à 0.0881%; des doses de rayons X aussi faibles que 40 r ou 20 r peuvent augmenter de façon appréciable le taux de mutabilité (respectivement à 0.3078% et 0.1918%); les mêmes quantités totales de rayonnement, fractionnées en doses partielles de 1 r sont encore efficaces; le fractionnement de la dose a pour conséquence la diminution relative du pourcentage des mutations induites par l'irradiation (0.1944% au lieu de 0.3078%). Il semble que le raccourcissement des intervalles entre les expositions partielles conduit à une augmentation progressive du taux des mutations, qui tend vers celui obtenu après irradiation continue. (auth.)

- 997 Hasimoto, H. TRANSLOCATION OF A PIECE OF AN AUTOSOME TO THE W CHROMOSOME, AND INDUCTION OF A DOMINANT LETHAL FACTOR IN THE SILKWORM BY X-RAYS. p.248-51 in "Proceedings of the International Genetics Symposia, 1956, Tokyo & Kyoto, Sep. 1956". Suppl. to Cytologia 1957. Tokyo, Science Council of Japan. 1957, 702p.

The translocation induced by chromosome irradiation is probably a reciprocal interchange involving the W chromosome and a Zebra-lemon autosome, where a W chromosome segment bearing the female-determining factor is combined with a segment bearing the Zebra gene, while the rest of the W chromosome is united with the part of the autosome bearing the lemon locus. The lemon locus-bearing segment apparently carries the lethal factor in question. In ordinary circumstances the W chromosome is transmitted in the female line, but when the segment enters a male as in the present case, it produces a lethal effect. Therefore, it may be concluded that the W chromosome has a regional differentiation, and the female-determining factor occupies a certain restricted region of the chromosome, while the other region has a lethal effect for the male which carries it. (auth.)

- 998 Heidenthal, G. X-RAY INDUCED RECESSIVE LETHALS IN HABROBRACON. Genetics **37** (1952) 590.

A method for detecting x-ray induced recessive lethals has been developed as follows: Virgin females which have been forced to store 1st meiotic metaphase eggs were irradiated and then outcrossed to haploid males.  $F_1$  virgins which developed only from eggs x-rayed in 1st metaphase were then tested by allowing each to lay eggs. These were counted and later examined for hatchability. Control hatchability for comparable  $F_1$ s was well above 90%; for no female was it as low as 50%. In the experimental series, any  $F_1$  which laid eggs 50% or fewer of which hatched, was tallied as bearing one or more recessive lethals. The eggs counted were haploid; therefore, a recessive lethal on any chromosome, which would act prior to hatching of larva, would give approximately a 1:1 ratio of dead eggs to live larvae; those bearing two independently assorting lethals a ratio of 3 dead eggs to 1 live larvae etc. The data thus far indicate a ratio for one or more lethals of approximately 5.1% for 500 r and 14.2% for 1000 r. Comparable data for recessive

lethals induced in sperm give 5.0% and 10.7% for the same dosages respectively. The above method has also been shown to be applicable to the much more resistant prophase stage.

(Abstract of paper presented at the 1952 meetings of the Genetics Soc. of America)

- 999 Heidenthal, G. A COMPARISON OF X-RAY INDUCED DOMINANT AND RECESSIVE LETHALS IN FIRST MEIOTIC METAPHASE EGGS AND IN SPERM OF HABROBRACON. (abstr.) Genetics 38, 7 (1953) 668.  
Methods have been developed for estimating x-ray induced dominant and recessive lethals. Natural parthenogenesis has permitted study of rates for the entire chromosomal complement. For the metaphase eggs the dominant lethal curve is a simple exponential function with the 50% lethal point at about 375 r and the 90% at about 1600 r. The dominant lethal curve for the sperm is markedly different. The metaphase eggs were found to be more radiosensitive than the sperm. The effect of dose rate on induction of dominant and recessive lethal factors is discussed. (from abstr.)
- 1000 Henke, K., Pohley, H.-J. DIFFERENTIELLE ZELLTEILUNGEN UND POLYPOIDIE BEI DER SCHUPPEN-BILDUNG DER MEHLMOTTE EPHESTIA KÜHNIELLA Z. (Differential cell divisions and polyploidy in the scale formation of the flour moth Ephestia kühniella Z.). Z. Naturf. 7, 2 (1952) 65-79. (In German)  
The cells of the rudimentary hind wings of Ephestia pass through 5 - not 4, as previously supposed - differential steps of cell division in the course of the mitoses of the prepupal and pupal period. A somatic mutation in the form of dark scales is often observed as the result of irradiation. The frequency of appearance of such mutant aggregates and their dependence on the moment of irradiation which is fixed somewhere between the last larval moult and before the onset of the prepupal mitotic period is discussed.
- \* Herskowitz and Abrahamson 1955 - [1193]
- \* Herskowitz 1956 - [1192]
- \* Herskowitz and Schalet 1957 - [1198]
- 1001 Herskowitz, L.H., Baumiller, R.C. PHENOTYPIC EFFECTS OF HETEROZYGOUS, X-RAY-INDUCED MUTATIONS IN DROSOPHILA. Science 130, 3368 (1959) 182-3.  
Heterozygous mutations produced by 8000 r delay pupation in about 9% of larvae of D. melanogaster under nutritional stress and kill approximately 8%. The effects are less, though appreciable, when there is excess nutrient; no effects are detectable after oögonia are irradiated. Irradiated sperm and oöcytes cause detriment, partly via different types of mutations, in approximately equal amounts. (auth.)
- \* Herskowitz et al. 1959 - [1202]
- \* Höhne and Schubert 1954 - [834]
- \* Höhne et al. 1955 - [1389]
- 1002 Ives, P.T. RADIATION INDUCED MUTATION RATES IN DROSOPHILA AND MICE. Amer. Nat. 88 (1954) 361-4.  
A comparison is made of radiation-induced mutation rates in Drosophila melanogaster and mice by considering principally the data of Russell (Symp. Quant. Biol. 16(1951) 327-36), Alexander (Rec. Gen. Soc. America 21(1952) 7) and the author. It is argued that the comparison should be made on the basis of F<sub>2</sub> results using only autosomal loci. Considering also the extreme non-randomness of the mutation rates of the few autosomal loci so far studied it is concluded that for the present the radiation-induced mutation rate per r per locus appears to be similar in flies and mice.
- 1003 Ives, P.T., Levine, R.P., Yost, H.T. THE PRODUCTION OF MUTATIONS IN DROSOPHILA MELANO-GASTER BY THE FAST NEUTRON RADIATION OF AN ATOMIC EXPLOSION. Proc. nat. Acad. Sci., Washington 40 (1954) 165-71.  
The fast neutrons of an atomic explosion were three to four times as effective as x-rays in producing sex-linked lethal and autosomal visible mutations in the mature sperm of D. melanogaster. About 42% of the sex-linked lethal chromosomes gave evidence of containing gross chromosomal aberrations, eight times as

many as appeared in a group of mutator-caused lethals. The increase in mutation rate with increasing dosage of fast neutrons appeared to be linear for sex-linked lethals, both with and without gross chromosomal aberrations; but the rate may not have been linear in the case of the autosomal visibles. (auth. summary)

- 1004 Ives, P. T. THE MUTATION RATE IN DROSOPHILA SPERM AFTER COBALT-60  $\gamma$ -RADIATION. p. 132 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol. 2. Toronto, University of Toronto Press. 1958.  
Spermatozoa from 2d-old inbred Oregon-R males were tested by Basc after exposure to Co<sup>60</sup>  $\gamma$  in doses ranging from 300 r to 12500 r in intervals of 700 r to 2500 r. For each of 7 doses a minimum of 1202 X-chromosomes was tested and a minimum of 112 lethal chromosomes was observed. Plotted directly the data fit a straight line with a slope of 1.85% lethal chromosomes per 1000 r. Individual mutational events probably occurred at a greater than linear rate of increase with increase in dose. Tests with 438 lethal chromosomes from 300 r showed only 2 instances of separable lethal genes and 23 cases with reduced crossing-over of which 9 were translocations and 14 inversions. These results are comparable to those in a previously published study of lethals produced by a genetic mutator except that in that study all of the 13 analysed cases of reduced crossing-over were inversions. (from abstr.)
- 1006 Ives, P. T. THE RELATIONSHIP BETWEEN RADIATION DOSE AND DOMINANT VISIBLE MUTATION RATE IN DROSOPHILA MELANOGASTER. Genetics 44 (1959) 967-78.  
Mature sperm of Drosophila melanogaster were subjected to  $\gamma$ -radiation from a Co<sup>60</sup>-source. Tests were made of the frequency of easily seen visible mutations, chiefly autosomal dominants, induced at ten radiation dosage levels in the 0.5 to 10 kr range. Results are related to findings in sex-linked lethal tests.
- 1008 Ives, P. T. CHROMOSOMAL DISTRIBUTION OF MUTATOR- AND RADIATION-INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. Evolution 13 (1959) 526-31.  
Three series of X-chromosome lethal mutations, from the mutator hi, from 300 r and from 12.5 kr of cobalt-60  $\gamma$ -radiation were analysed for distribution of lethal loci, chiefly with respect to the four regions set off by the marker genes. The distributions are compared to each other and to proportions of available genetic material in each region. The difference between mutator and radiation lethal loci distribution is consistent with the hypothesis that mutator genes are genetically more specific, ionizing radiations more general, in their mutagenic effects. It is suggested that series of spontaneous lethals from strains of D. melanogaster derived recently from different geographic areas may be expected sometimes to show different chromosomal distributions but that series of lethals induced in such strains by a given radiation treatment should be generally alike. (from auth.)
- 1007 Ives, P. T. THE MUTATION RATE IN DROSOPHILA AFTER HIGH DOSES OF GAMMA RADIATION. Proc. nat. Acad. Sci., Washington 45 (1959) 188-92.  
Data are presented from a study of the sex-linked mutation rate in mature sperm of Drosophila melanogaster at seven dosage levels of Co<sup>60</sup>  $\gamma$ -radiation in the 300 r to 12.5 kr range. Lethal chromosomes from the lowest and highest doses were analysed genetically, and the results are compatible with the interpretation that a Poisson-like accumulation of lethal mutations occurred throughout this dosage range, with an average increase of 2% lethal mutations per kr. (auth.)
- 1008 Käfer, E. VITALITÄTSMUTATIONEN, AUSGELÖST DURCH RÖNTGENSTRAHLEN BEI DROSOPHILA MELANOGASTER. (Study on mutations affecting vitality, induced by x-rays in Drosophila melanogaster). Z. indukt. Abstamm.-Vererb.lehre 84 (1953) 508-35. (In German)  
A comparison of x-ray-induced mutations in the x- and in the second-chromosome in sperm was made. It was found that in both types of chromosomes slightly higher rates of recessive lethals were induced than of strong detrimental.
- \* Kaplan and Lyon 1953 - [1391]
- \* Kayhart 1954 - [835]
- \* Kayhart 1956 - [836]