did not influence subsequent mating competitiveness. In population dynamics and sterile-male-release* experiments, the peak number of 1st generation weevils were observed during the 5th week. Emergence of the 1st generation weevils was also indicated by the sharp weekly increase in the average rate of oviposition-punctured squares. The 2nd generation began during week seven and peaked during week eight. The rate of increase between generations was dependent upon the population density of the original population. Thus, the rate of increase from the overwintered to the F_1 generation was greater than that from the F_1 to the F_2 generation. The rate of increase per generation was only slightly inhibited by releases of sterile males. Shedding of squares following egg deposition was found to be due largely to the hatching of the egg and not just to the damage incurred in the act of oviposition. Terminal data indicated that the weekly releases of sterile males failed to achieve control. Failure of the tests was most likely due to the low ratio of sterile to normal males present. However, some inhibition of population buildup was observed, indicating possible future successes with this method of control. (From DA)

* apholate used here.

1580 Horber, E. MAIKÄFER GEGEN MAIKÄFER! EIN VERSUCH ZUR TILGUNG EINES ENGERLING-HERDES DES FELDMAIKÄFERS (Melolontha vulgaris Fabr.) MIT RÖNTGENBESTRAHLTEN MÄNNCHEN. (Cockchafer against cockchafer! An attempt to eradicate a larval population of M. melolontha (L.) (vulgaris F.) by the release of x-irradiated males.) Waldhygiene 6, 6 (1967) 161-170. (In German, with English summary)

A field trial is described to eradicate white grubs by means of irradiated males. During two flight periods, in 1959 and 1962, respectively, irradiated males were released over a 30-ha area A. Gradation in that area as well as in three control areas, C, continued to be checked since 1953. In 1959, for the 1st treatment, 6 ℓ of sterilised males were released over A, representing ~50% of the male population. White grub infestation sampled in grassland subsequently dropped to ~ 1/5 of that in the other areas. Reproduction rate remained < 1 in A only. Further reduction of the population in A to 1/10 of that in C was observed when the number of surviving cockchafers was estimated in spring 1962. The greatest mortality between 1959 and 1962 occurred in A. - In 1962, for the 2nd treatment, a total of 17 ℓ was released over A, representing 76-100% of the male population of A. Subsequent sampling showed complete eradication in A. Some reduction was also observed in B and C, resulting from drought in the whole region. - For the last flight period in 1965 no treatment was necessary since only a few cockchafers occurred in A, whereas their number had increased in C 1-3. Subsequent sampling of the white grub population confirmed complete eradication in A, and increases in C 1-3. The results are a demonstration that the sterile-male technique may be successfully applied to insects in an area which is not strictly isolated geographically, where the females of the pest mate several times, the artificial breeding in large quantities is not feasible because of a long developmental cycle, and the most voracious and destructive stages of the insect live hidden in the soil.

1581 Horber, E. USE OF ALTERNATIVE BIOLOGICAL CONTROL SCHEMES. p. 167-183 of "Proceedings of the FAO Symposium on Integrated Pest Control, Pt. 2. Rome, Italy. 11-15 Oct. 1965". Rome, Food and Agriculture Organization of the United Nations. 1966. 183 p.

Among the topics discussed in this review are biogenetic control measures such as the use of ionizing radiation. (His own work on Melolontha vulgaris is quoted by the author, where small-scale field experiments with irradiated white grubs on grassland resulted in eradication.) The use of chemosterilants, antimetabolites, and alkylating agents is discussed. The use of selective agents is described; they are divided into attractants (sex attractants, attractants and arrestants associated with host plants), repellents, antifeeding compounds, and hormones (ecdysone, juvenile hormone, and competition and coordination between hormone activities).

1582 Jermy, T., Nagy, B. LABORATORY EXPERIMENTS TO CONTROL THE COCKCHAFER (Melolontha melolontha L.) BY THE STERILE MALE TECHNIQUE. Acta phytopath. hung. 2, 3 (1967) 211-217. (In English)

Cockchafer adults dug out from the soil just before emergence were irradiated with x- and γ-rays, respectively. The sterilising dose was found to be > 1.5 kR, 3 kR giving 98-100% sterility. x-rays and γ-rays showed the same sterilising effect at the dose rates used in the experiments (8.58 kR/min

for x-rays, 3 kR/h and 2.82 kR/h at 38 and 100 cm, respectively, for γ-rays). Feeding before irradiation seems not to affect sterilisation. Irradiated (3 kR) males were fully competitive with normal males in cage experiments. High locomotor activity of males was observed during irradiation even at 12°C. (Codling moth pupae showed the same reaction.) Longevity of cockchafer males was not shortened by irradiation. (From auth.)

See also:

1124 Sterilization of the male alfalfa weevil (Hypera postica: Curculionidae) by x-radiation. (Burgess, E.E. et al., 1966)

1320 Reproductive potential of the sweetpotato weevil after exposure to ionizing radiations. (Walker, J.R., 1966)

1340 Study on the sterilization and radiosensitivity of Chrysomela decemlineata Say by means of radioisotopes. (Cavalloro, R. et al., 1966/1967)

1569 Radiation-induced sterilization. (LaChance, L.E. et al., 1967)

2.4.2.1.2. Diptera

1583 Abdel-Malek, A.A., Tantawy, A.O., Wakid, A.M. STUDIES ON THE ERADICATION OF Anopheles pharoensis Theobald BY THE STERILE-MALE TECHNIQUE USING COBALT-60. I. BIOLOGICAL EFFECTS OF GAMMA RADIATION ON THE DIFFERENT DEVELOPMENTAL STAGES. J. econ. Ent. 59 (1966) 672-678.

Pupae of A. pharoensis Theobald were subjected to ^{60}Co γ-radiation from 500 R to 7000 R with 500 R increments, to study the biological effects of γ-rays on fitness components. The results indicate clearly that lifetime egg production increased significantly at lower doses (1000 R) with no significant effects at doses between 1500 and 2000 R, after which a highly significant decline was observed. Percentage of hatchability was greatly affected at all doses, falling below 1% at 5000 R, above which it remained constant. Percentages of pupation and emergence, sex ratio, and longevity of adults were not affected by irradiation; irradiated adults live longer than controls, though not significantly so. (Auth.)

1584 Abdel-Malek, A.A., Tantawy, A.O., Wakid, A.M. STUDIES ON THE ERADICATION OF Anopheles pharoensis BY THE STERILE-MALE TECHNIQUE USING COBALT-60. III. DETERMINATION OF THE STERILE DOSE AND ITS BIOLOGICAL EFFECTS ON DIFFERENT CHARACTERS RELATED TO "FITNESS" COMPONENTS. J. econ. Ent. 60, 1 (1967) 20-23.

Pupae of A. pharoensis Theobald were subjected to various doses of γ-rays from ^{60}Co, i.e. 10 000-13 000 R with 1000 R increments to study their effects on lifetime egg production, egg hatchability, and longevity of adult mosquitoes and to find the exact dose of γ-rays which may cause complete male sterility. The sterilizing dose (12 000 R) was used to investigate its adverse effects on pupae of different ages and the dose fractionation on the emerged adults. The results indicate clearly the adverse effects of high doses of γ-radiation on all characters studied except longevity of adult mosquitoes. A dose of 12 000 R caused complete sterility in both sexes. The results suggest that it was better to give the whole amount of the sterilization dosage at once rather than in fraction when pupae aged 15-20 h were used. (Auth.)

1585 Abdel-Malek, A.A., Tantawy, A.O., Wakid, A.M. STUDIES ON THE ERADICATION OF Anopheles pharoensis Theobald BY THE STERILE-MALE TECHNIQUE USING COBALT-60. VI. SPERM ACTIVITY IN MALES IRRADIATED WITH THE STERILIZING DOSE. J. econ. Ent. 60, 5 (1967) 1300-1302.

Matings between unirradiated female A. pharoensis Theobald and either normal or irradiated males (12 000 R) were carried out in breeding cages to investigate the sperm activity in γ-irradiated males. Normal or irradiated males, after complete matings with females, were replaced by irradiated or normal males and egg production and hatchability were recorded daily for the first 10 d. Replacing normal males by irradiated males caused a decrease in egg hatchability compared with the controls, but insemination by normal males did not nullify insemination by irradiated males. Sterilisation of males with 12 000 R γ-rays did not damage the sperm, as the sperm of irradiated males competed successfully with that from normal males, whether it was present in the spermatheca before or after

copulation with normal males. Delaying the mating of males for 5 d after irradiation did not restore viability of the sperm. (Auth.)

1586 Alley, D.A., Hightower, B.G. MATING BEHAVIOR OF THE SCREW-WORM FLY AS AFFECTED BY DIFFERENCES IN STRAIN AND SIZE. J. econ. Ent. 59, 6 (1966) 1499-1502.

The anticipated length of sterile-male release programmes such as those in progress in the southwestern United States and northern Mexico require constant evaluation of the effects of prolonged colonization and changes in rearing, irradiation, and release techniques on the mating behaviour of released male flies. Tests were conducted to evaluate some of the changes in mating behaviour that occur among colonized flies as laboratory adaptation increases with time in culture. The effects of differences in strains and size on the mating frequency of male screw-worm flies, Cochliomyia hominivorax (Coquerel), were studied in observed mating tests with a recently colonized (Mexican) and a laboratory-adapted (Florida) strain of flies. Large or small males of the Florida strain were obtained by rearing the flies on 2 different artificial media. Flies comparable in size to wild flies were reared in artificial wounds on sheep. Ancillary studies required sterilisation of the males by exposure to γ-irradiation. Differences in mating frequency among male flies that were attributable to strain disappeared after the Mexican flies had been colonized for 15 generations. However, differences in mating frequency between large and small Florida males persisted, regardless of the strain of the female flies, when the females were as large as flies in natural populations.

1587 Andrewartha, H.G., Monro, J., Richardson, N. FIELD EXPERIMENTS FOR CONTROL OR ELIMINATION OF LOCAL POPULATIONS OF THE QUEENSLAND FRUITFLY, Dacus tryoni; PART OF A CO-ORDINATED PROGRAMME OF INSECT CONTROL BY RADIATION. IAEA-R-234-F, International Atomic Energy Agency, Vienna (Austria). Apr. 1965. 3p.

During the spring of 1964 and the summer of 1964/65 twenty and one half million sterile pupae of the Queensland fruit fly, D. tryoni were distributed through two towns in western New South Wales. It was estimated that adults emerged from 63.8% of the pupae. About half of the adults would have been males. The results were measured by collecting, at fortnightly intervals, samples of fruit from all the trees bearing fruit ripe enough to be infested with maggots of the fruit fly. In one of the treated towns, where the overwintering population had already been reduced to an unusually low level by pre-treatment with insecticide during the previous summer, the wild population was exterminated soon after the experiment began and no sign of a fertile fruit fly was found in this area for the remainder of the experiment. In the other town where the initial wild population was greater and where the risk of re-infestation from neighbouring farms was also greater, the wild population was reduced almost to the point of extinction by late January and kept low for the duration of the experiment except for several minor re-infestations on the periphery of the treated area. In two comparable towns that were left untreated as controls the routine samples of ripe fruit contained the usual high proportion of fruits infested with maggots of D. tryoni throughout the summer. The pupae were reared at the University of Sydney, Department of Zoology, and sterilised at Lucas Heights. The mean weekly production of sterile pupae during eight months was 623 000, varying between 242 000 and 1 700 000.

1588 Baumhover, A.H. ERADICATION OF THE SCREWWORM FLY: AN AGENT OF MYIASIS. J. Am. med. Ass. 196 (1966) 240-248.

Development of the radiosterilised male technique for elimination of the screw-worm fly and other parasitic insects is reviewed. Eradication of the screw-worm from Curaçao by this method is considered from the point of view of mass production, sterilisation, release, and field evaluation of the project. For irradiation, a 480 Ci ^{60}Co unit was used for a 2000 square mile test with an initial dose rate varying from 788 to 910 R/min. To completely sterilise the screw-worms, 8000 R was delivered to pupae at 5.2-5.7 d of age. During a two-year campaign in Florida, 3.7 billion screw-worm pupae were produced. Twenty light aircraft were used to release flies over a max. area of 85 000 mi^2, and peak employment totalled 500. Irradiation studies showed that a sterilising dose of radiation could be administered to screw-worms without seriously affecting longevity or male competitiveness. Economic aspects of the programme are discussed. (NSA 21: 1967, 6746)

1589 Cohen, I., Nadel, D., Peleg, B.A., Kahan, R.S., Eisenberg, E. CONTROL OF THE MEDITERRANEAN FRUIT FLY (C. capitata Wied.) BY MASS IRRADIATION STERILISATION OF LABORATORY-BRED FLIES. p. 281 of "Research Laboratories Annual Report. For the Period January-December 1965", IA-1082, Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center, 363p.

Tests are being carried out under field conditions in three selected areas in order to evaluate the efficacy of fly control by the release of large numbers of flies bred at the Biological Control Institute, Rehovoth, and irradiated at the pupal stage, on the last day before emergence. The dose of 5-8 krad is used. Currently about 7 million pupae are irradiated and released per week. A total of 80 million pupae have been treated since the project was begun in April, 1965.

1590 Dale, P.S. PROSPECTS FOR CONTROL OF CODLING MOTH BY THE STERILE MALE TECHNIQUE. Orchard. N. Z. 38 (1965) 157.

In fruit-growing areas in New Zealand the codling moth population has been estimated at ~ 4 moths/tree/season, a number unlikely to be reduced further by the use of conventional insecticides. Three of the main apple-growing areas (Hawke's Bay, Nelson, and Central Otago) are naturally isolated from neighbouring areas by geographical barriers. Better rearing methods and detailed ecological studies are needed, but it would seem that the method has definite possibilities for New Zealand.

1591 Hoffman, R.A., Schmidt, C.D., Matter, J.J. LABORATORY AND FIELD STUDIES WITH ^{60}Co STERILIZED HORN FLIES. Bull. ent. Soc. Am. 12 (1966) 285. Abstr. 261, Presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov.- 1 Dec. 1966".

^{60}Co irradiation of horn fly pupae resulted in high mortalities at sterilisation levels but newly emerged adults were sterilised by and survived 2000-5000 rad. Sterilised adults were released onto an isolated beef herd alone and in integrated insecticide—sterile-fly studies. The integrated tests provided the more promising horn fly control. (Abstr.)

1592 Huque, H., Ahmed, H. CONTROL OF FRUIT FLIES BY GAMMA RAYS. Fd Irrad. 6, 3 (1966) A28-A32.

The results of a preliminary study on Dacus cucurbitae in the Karachi area are reported. A standardized rearing technique has been developed and a laboratory culture maintained. Pupae were irradiated with γ-rays just prior to emergence. A dose of 7000-9000 R from a 1800-Ci ^{60}Co-source ensured sterilisation. The role of anoxia in the irradiation chamber is discussed.

1593 Huque, H., Malik, Q.R. CONTROL OF FRUIT FLIES Dacus zonatus Saunders BY GAMMA-RAYS. Int. J. appl. Radiat. Isotop. 18, 9 (1967) 658-661.

The min. dose for sterilising males of D. zonatus irradiated at the late pupal stage was found to be 7-9 kR, without involving any adverse effects on pupal survival, adult emergence, longevity or sexual aggressiveness. There was no decrease in oviposition when irradiated males were crossed with virgin females but the eggs did not hatch. - Females which emerged from treated pupae showed noticeably delayed oviposition period, and in some cases eggs failed to be produced. Adult longevity appeared to be normal. The sterile-male technique appears to hold great promise for Dacus zonatus.

1594 International Atomic Energy Agency, Vienna (Austria). INSECT ERADICATION AND PEST CONTROL GROUP. p. 64-66 of "IAEA Laboratory Activities. Third Report". Technical Report Series No. 55. 1966, 157 p. STI/DOC/10/55.

Ceratitis capitata was labelled by adding $MnCl_2$ to the larval food in concentrations of 10^{-4} to 10^{-3} g/g. Resulting 2-weeks-old adults were subjected to a flux density of 1.5×10^{-13} n cm^{-2} sec^{-1} in the Seibersdorf reactor for 20 min at 2.5 MW. Improvements in rearing methods (automatic egg collection, cages, larval media) were developed, also a special device for dispersing adults from aeroplanes. – Some trial releases of the Medfly were made in three areas of Vienna in the (unfortunately unfavourable) summer of 1965, a low dose (5 krad) being given to 8-d-old pupae. No eggs were laid in probed apricots, and no larvae were detected in any of the summer fruit in places where standing populations persisted for up to three months. - Attempts are reported to set up self-sustaining colonies of tsetse flies. - A nearly satisfactory laboratory larval medium has been developed for the olive fly, and interest now focuses on devising an economic larval food.

1595 International Atomic Energy Agency, Vienna (Austria). THE MIDDLE EASTERN REGIONAL RADIO-ISOTOPE CENTRE FOR THE ARAB COUNTRIES, CAIRO. p. 135-151 of "IAEA Laboratory Activities. Third Report". Technical Reports Series No.55. Vienna, International Atomic Energy Agency. 1966, 157p. STI/DOC/10/55.

The scientific programme is outlined. Among the projects already under study and given first priority is the eradication of Anopheles pharaoensis Theo. by the sterile-male technique using γ-irradiation from a ^{60}Co-source (p. 146-147). Field studies are under way. Similar studies on the eradication of Ceratitis capitata Wied. in the Arab region are part of a new project (p. 147-148).

1596 International Atomic Energy Agency, Vienna (Austria). INVESTIGATION OF CONTROL OF THE MEDITERRANEAN FRUIT FLY BY LIBERATION OF ADULT MALES IRRADIATED WITH GAMMA RAYS: PART OF A CO-ORDINATED PROGRAMME OF INSECT CONTROL BY USING RADIATION. Research Contract 193. p. 93-94 of "IAEA Research Contracts. Sixth Annual Report". Technical Reports Series No.53. Vienna, International Atomic Energy Agency. 1966, 131p. STI/DOC/10/53.

Research Institution: Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA), San Salvador, El Salvador.
Principal scientific investigator: E. Morales.
Period of contract: 1 Mar. 1963 - 28 Feb. 1965.

Methods of mass rearing, γ-sterilisation, and field assessment of sterile fly release were basically similar to those used in other laboratories. To avoid damage of wings during the overcrowded field releases, the pupae were mixed with tropical almond leaves. The curled leaves keep the pupae from packing and provide extra perching sites where newly emerged adults can stay until their wings are inflated and hardened.

1597 International Atomic Energy Agency, Vienna (Austria). FIELD EXPERIMENTS FOR CONTROL OR ELIMINATION OF LOCAL POPULATIONS OF THE QUEENSLAND FRUIT-FLY, Dacus tryoni (Frogg): PART OF A CO-ORDINATED PROGRAMME OF INSECT CONTROL USING RADIATION. Research Contract 234. p. 99-100 of "IAEA Research Contracts. Sixth Annual Report". Technical Reports Series No.53. Vienna, International Atomic Energy Agency. 1966, 131p. STI/DOC/10/53.

Research Institution: University of Adelaide, Department of Zoology, South Australia.
Principal scientific investigator: H. G. Andrewartha.
Period of contract: 1 Oct. 1963 - 30 Sep. 1965.

During the spring of 1964 and the summer of 1964/65, 20 million pupae were sterilised by γ-irradiation and distributed through two towns in western New South Wales. It was estimated that adults emerged from 64% of pupae; about half the adults were males. Two comparable towns were left untreated as controls. Results were measured by collecting, at fortnightly intervals, samples of fruit from all trees bearing fruit ripe enough to be infested with fly maggots. The primary objective of the project was achieved since it could be shown that the sterile-male technique could be used to control or perhaps to eliminate local populations of the Queensland fruit fly.

1598 Katiyar, K.P. DETERMINATION OF THE STERILIZATION DOSE OF THE MEDFLY WITH THE OIRSA Co-60 IRRADIATOR. p. 108-109 of "The Application of Nuclear Energy to Agriculture. Annual Report". Moh, C.C., Ed. NYO-2043-52, Inter-American Inst. of Agricultural Sciences, Turrialba (Costa Rica). 1 Jul. 1967. 165p.

10 kR was found to reduce male fertility to 0.04%.

1599 Katiyar, K.P. p.110-111 of "The Application of Nuclear Energy to Agriculture. Annual Report". Moh, C.C., Ed. NYO-2043-52, Inter-American Inst. of Agricultural Sciences, Turrialba (Costa Rica). 1 Jul. 1967, 165p.

A progress report on the cooperative project with OIRSA on Medfly control in Central America by sterile male releases.

1600 Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo (Egypt). ANNUAL REPORT, JANUARY 1, 1965 - DECEMBER 31, 1965. NP-16547. Jan. 1966, 38p.

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

1601 Nadel, D.J., Peleg, B.A. THE ATTRACTION OF FED AND STARVED MALES AND FEMALES OF THE MEDITERRANEAN FRUITFLY, Ceratitis capitata Wied., TO "TRIMEDLURE". Israel J. agric. Res. (Ktavim) 15, 2 (1965) 83-86.

Investigations in Israel on the influence of feeding on the attraction of C. capitata to trimedlure showed that starved females are attracted preferentially to yeast hydrolysate, whereas starved males are attracted to trimedlure. When no food was supplied, both newly emerged and sexually mature females were found to be attracted to trimedlure. The rate of attraction of females to this male lure increased in proportion to the extent of their starvation. Feeding on a mixture of yeast hydrolysate and sucrose (1:2) or sucrose alone abolished the attractiveness of trimedlure to females. This phenomenon may be useful in monitoring irradiated-fly releases. (From auth. summary)

1602 Organismo Internacional Regional de Sanidad Agropecuaria, San Salvador (El Salvador). SUMMARY OF THE MEDFLY INVESTIGATION SECTION'S ACTIVITIES DURING THE PERIOD JANUARY-MARCH 1965. IAEA-R-193-F, International Atomic Energy Agency, Vienna (Austria). 1965, 13p.

Sterile fly releases continued in the pilot test area of Puntarenas. During this quarter small sterile releases were initiated in Jinotega and Corinto, Republic of Nicaragua, and in Boquete, Republic of Panama. Studies involving the establishment of parasites continued in central Costa Rica. Several experiments involving improvements in mass rearing techniques and sterile fly releases were conducted. Severe fungus infestation of the larval media was successfully controlled by certain treatments using tegocept and sodium benzoate.

1603 Parker, J.S. MEXICAN FRUIT FLY STERILE RELEASE PROGRAM. Bull. ent. Soc. Am. 13, 3 (1967) 203. Abstr. 349. Presented at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Sterilised Mexican fruit flies have been used in place of insecticides along the California-Arizona-Mexico border for the 4th year to prevent infestations from becoming established in the United States. More than 20 million flies are reared and sterilised at Monterrey, Mexico, and flown to the target area for release each year. (Abstr.)

1604 Price, M.A., Newton, W.H. THE SCREWWORM AND ITS CONTROL. SWest. Vet. 16, 1 (1962) 43-49.

Screw-worm control by the use of the sterile-male technique is discussed in detail. Chemical control is recommended with Co-Ral as a 5% dust, 0.25-0.5% spray, or 0.25% dip, ronnel as a 0.5% spray, 5% smear, or 2.5% aerosol spray, lindane as a 3% smear, or diphenylamine as a 35% smear. (CA 64: 1966, 18342d)

1605 Proverbs, M.D., Newton, J.R., Logan, D.M. ORCHARD ASSESSMENT OF THE STERILE MALE TECHNIQUE FOR CONTROL OF THE CODLING MOTH, Carpocapsa pomonella (L.) (LEPIDOPTERA: OLETHREUTIDAE). Can. Ent. 98, 1 (1966) 90-95.

Sterile male codling moths, exposed as pupae to 40 krad of γ-radiation and released in an abandoned 20-tree apple orchard for 3 yr, reduced the percentage of fruits injured by mature or almost mature 2nd-brood larvae from 4.94 to 0.05. Numbers of sterile males released, ratios of sterile to fertile males during peak emergence of 1st-brood moths, and numbers of overwintering larvae were: 1961 (3 DDT sprays applied) - 0, 0:1, 400; 1962 - 21300, 8:1, 957; 1963 - 67500, 21:1, 43; 1964 - 89200, 715:1, 6. (Auth.)

1606 Proverbs, M.D., Newton, J.R., Logan, D.M. AUTOCIDAL CONTROL OF THE CODLING MOTH BY RELEASE OF MALES AND FEMALES STERILIZED AS ADULTS BY GAMMA RADIATION. J. econ. Ent. 60, 5 (1967) 1302-1306.

Larval progeny of Carpocapsa pomonella (L.), was reduced 80% when adult moths, exposed to 48 krad in CO_2, were caged in the laboratory with untreated moths at a ratio of 15 irradiated males and 15 irradiated females to one untreated male and one untreated female. In an abandoned 2-ha apple orchard, release of 271 000 irradiated (50 krad) male and female moths in 1964, and 478 000 in 1965, reduced the numbers of appled injured by codling moth at harvest from approx. 60% in 1963 to 1.6% in 1964 and to 0.3% in 1965. (Auth.)

1607 Rai, K.S. FEASIBILITY OF THE STERILE-MALE TECHNIQUE FOR Culex fatigans CONTROL IN CEYLON. Bull. ent. Soc. Am. 12 (1966) 257. Abstr. 227, at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

Culex fatigans is the only known vector of Bancroftia filariasis in Ceylon. At the request of the International Atomic Energy Agency and the Government of Ceylon, the feasibility of controlling this species using the sterile-male technique was evaluated. Data on various aspects of the study were presented. (From abstr.)

1608 Riedel, M. ZUR BIOLOGIE, ZUCHT UND STERILISATION DER KOHLFLIEGE Phorbia brassicae Bouché, UNTER BESONDERER BERÜCKSICHTIGUNG IHRES VORKOMMENS IM RETTICHANBAU. (Study of the biology, breeding and sterilisation of the cabbage fly, Phorbia brassicae Bouché, with special reference to its occurrence in radish cultures.) Bayer. landw. Jb. 44, 4 (1967) 387-429. (In German)

Ph. brassicae proved highly sensitive to radiation. Doses of > 2 kR caused complete sterility in both sexes. The optimum pupal stage for irradiation proved to be during the last 4 d before adult emergence. Prior irradiation causes visible somatic injury (reduced longevity, inability to fly, rise in pupal mortality). Sexual competitiveness is only adequate if the dose is < 3 kR. At 2-2.5 kR full competitiveness of the sterilised males is ensured. Experiments in the field have shown the need for similar size of the irradiated males if they are to be equally competitive.

1609 Scherney, F., Haisch, A. ÜBER MASSENZUCHT UND STERILISATION DER MITTELMEERFRUCHT-FLIEGE Ceratitis capitata Wied. (EIN BEITRAG ZUR AUTOZITMETHODE). [Study on mass breeding and sterilisation of the Mediterranean fruit fly Ceratitis capitata Wied. (A contribution to the autocidal technique.)] Bayer. landw. Jb. 44, 6 (1967) 748-756. (In German)

Sterilisation by ionizing radiation was preferred to chemosterilisation. A ^{137}Cs-source of 1100 Ci was available, giving relatively soft γ-radiation. A dose rate of 75 R/min was given. Doses of from 4000-15 000 R were tested, in steps of 1 000 R. The aim must be to find an optimal dose which will produce max. sterility and min. somatic injury. A dose of 15 000 R was used in field releases. Flight range determinations were carried out by means of releasing sterilised ^{32}P-labelled pupae which had been labelled as larvae. 8 000 pupae were labelled. The average range was 15 m, the max. 345 m within 10 d. - The application of the method to local control or eradication of the Medfly under prevailing conditions is considered feasible.

1610 Tantawy, A.O., Abdel-Malek, A.A., Wakid, A.M. STUDIES ON ERADICATION OF Anopheles pharoensis BY THE STERILE-MALE TECHNIQUE USING COBALT-60. II. INDUCED DOMINANT LETHALS IN THE IMMATURE STAGES. J. econ. Ent. 59, 6 (1966) 1392-1394.

An experiment was designed to study the percentage of induced dominant lethals in the immature stages of the F_1 generation of A. pharoensis Theobald, following irradiation of parental eggs or pupae. Doses from 500 R to 5000 R of γ-radiation with 500 R increments were used. The results indicate clearly that the percentage of induced dominant lethals in eggs of A. pharoensis irradiated by γ-rays increased linearly with increasing dose; 100% lethality in the F_1 generation appeared at 2000 R γ-rays. On the other hand, the results secured from parental pupae irradiated with γ-rays demonstrate that dominant lethals in the egg, larval, and pupal stages of F_1 offspring resulting from irradiated pupae are most effective during the egg stage followed by the larval stage; complete lethality was achieved at 4500 R and 5000 R, respectively. γ-rays showed no significant effects on the F_1 pupal stage, i.e. adults would emerge from most of the pupae in spite of high doses of γ-irradiation. (Auth.)

1611 Tantawy, A.O., Abdel-Malek, A.A., Wakid, A.M. STUDIES ON THE ERADICATION OF Anopheles pharoensis BY THE STERILE-MALE TECHNIQUE USING COBALT-60. IV. MATING BEHAVIOR AND ITS FREQUENCY IN THE STERILIZED MOSQUITOES. J. econ. Ent. 60, 1 (1967) 23-26.

Late 3rd-instar larvae from the laboratory colony were reared in Nile water containing 0.01, 0.05, 0.10, and 0.20μCi ^{32}P/ml. Insects to be autoradiographed were subsequently placed on x-ray dental films for 7 d. Mating frequency was tested on 200 labelled larvae. Half of the resulting labelled pupae were irradiated with a 12 000 R dose of γ-rays (the sterilising dose). The adult males were then allowed to mate with non-radioactive normal females. It was possible to detect the radioactive semen of males reared in media containing 0.20 μCi/ml ^{32}P in the spermathecae of their mates. By this technique it was feasible to determine whether females could mate more than once. By examining the mating behaviour and mating frequency in males, it was found that irradiated males were as effective as normal males in inseminating normal virgin females. Laboratory males could inseminate either wild females or laboratory females as efficiently as wild males, if each was confined to the same number of females.

1612 Tantawy, A.O., Abdel-Malek, A.A., Wakid, A.M. STUDIES ON THE ERADICATION OF Anopheles pharoensis BY THE STERILE-MALE TECHNIQUE USING COBALT-60. V. MATING COMPETITIVENESS IN RADIOSTERILIZED MALES. J. econ. Ent. 60, 3 (1967) 696-699.

A study of mating competitiveness between sterilised males and normal males of A. pharoensis Theobald showed that males treated with 12 000 R (the sterilising dosage of γ-rays) were slightly less competitive than normal males when present in the population cages in ratios of 1:1:1 and 5:1:1 (irradiated males + normal males + normal females). But at ratios of 10:1:1 and 15:1:1, the competitiveness of the irradiated sterile males was increased. Normal males captured from nature as larvae and bred in the laboratory showed almost the same mating competitiveness as males from the laboratory colony. By replacing normal males with irradiated males in the normal population, egg hatchability showed a decrease as compared with their controls. Replacing irradiated males with normal males did not produce a decrease in egg hatchability. (Auth.)

1613 Wave, H.E., Henneberry, T.J. STERILE-MALE RELEASES CONTROL POPULATIONS OF Drosophila melanogaster * IN CAGE TESTS. J. econ. Ent. 60, 6 (1967) 1758-1759.

Laboratory tests were made at Beltsville with sterile males of Drosophila to determine the effectiveness of the sterile-male technique. In suppressing caged populations, γ-irradiation or feeding with apholate was used. Irradiated flies were exposed about 24 h before release to 16 kR of γ-radiation from a ^{60}Co source delivering about 320 R/min. All flies, irradiated or apholate-fed, were 4-5 d old when they were released. The two methods of sterilisation, at the indicated dosages, have been shown to produce no viable eggs when the treated males, at 1, 5, or 10 d of age, were mated to untreated females. 24 h after treatment, male flies exposed to 16 kR are as reproductively competitive as untreated males. In the first experiment, newly emerged, untreated virgin flies were sexed and 50 pairs placed in each cage. One cage received irradiated, another apholate-treated males. The initial releases of sterile males, made immediately after the untreated flies were introduced, were made at a ratio of 20 sterile to one untreated ♂(1000/cage). The test lasted 57 d (about 4 generations). Temperatures during the test ranged from 17-30°C, with an overall average of 24°C. Additional releases of 3200 and 3000 apholate-treated ♂ each were made 10 and 28 d, respectively, after the start of the experiment. A final release of 1500 irradiated ♂ was made the 34th day. The fly population in the check cage increased noticeably during the first 17 d. Increases in the cages containing irradiated and apholate-sterilised males were not apparent until after 27 d. Then the number of larvae and pupae in the medium in the two cages of treated flies was markedly less than that in the check cages. After 57 d the fly population in the cage containing irradiated males was 93% less, and that in the cage containing the apholate-treated males 87% less than the population in the check cage. However, some flies in the two cages containing treated males produced viable eggs because of the long interval between releases, which permitted a small percentage of the newly emerged females to mate with fertile males. The 2nd experiment consisted of three cages, one receiving weekly releases of apholate-treated males; one receiving weekly releases of γ-irradiated males; and one a check, receiving no releases. All initial releases were based on a ratio of 20 sterile to 1 untreated ♂. The cages were initially infested with 20 untreated pairs, and the 1st releases of sterile males were made at the time of initial infestation with the untreated flies. Eight releases were made during the 56 d. Average daily temperatures ranged from 16-40°C, with an overall average of 25°C. In experiment 2 no reproduction occurred when apholate-treated males or irradiated males were released weekly in the cages.

* Diptera: Drosophilidae.

1614 Whitney, D. STERILE FLIES USED. ENEMY OF OLIVES SUBJECTED. Nat. Hist., N.Y. 75, 3 (1966) 30-35.

Popular illustrated article describing present efforts in Greece to apply the sterile release method to the olive fly, Dacus oleae.

1615 Anonymous. SCREWWORMS ERADICATED FROM U.S. Agric. Res., Wash. 15, 1 (1966) 7.

1616 Anonymous. ATOMIC WAR ON INSECTS INTENSIFIED. Int. atom. Energy Ag. Bull. 9, 3 (1967) 8-13.

The release of sterilised Ceratitis capitata on Capri is the 1st full-scale trial in Europe of the sterile-male technique. Improved rearing techniques allow the production of Medfly at a food and labour cost of ~ $7-10/million flies. A fly cannon was developed through which paper bags containing the flies and wood wool are dropped, ripped open, and released below the slip stream of the aircraft, enabling the flies better to survive the fall and to disperse quickly. Pioneering work was done by the Biological Control Institute of the Citrus Marketing Board of Israel and the Agency's Entomology Laboratory in Seibersdorf, Austria. - A mainland campaign against the Medfly is being carried out in Central America by the IAEA/FAO Joint Division of Atomic Energy in Agriculture, to demonstrate over an area of 60 000 acres the feasibility of eradicating the pest with the help of radiation. Other types of pests (livestock) studied for possible control by the sterile-male technique are indicated.

1617 Anonymous. ATOMIC ENERGY IN LATIN AMERICA. Int. atom. Energy Ag. Bull. 9, 3 (1967) 15-19.

In entomology, the research has consisted chiefly of developing and promoting the application of the sterile-male technique in insect control. The work is being put to good use in the United Nations Development Programme Special Fund project for the eradication of Ceratitis capitata in Central America, where Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama are working together under the technical guidance of the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture.

See also:

14 Insect control. I. Tagging the fruit fly Ceratitis capitata Wied. with radioactive phosphorus for the sterile male technique. (Raimundo, A.C. et al., 1965)
1119 Application of radioactive isotopes to the investigation of methods for the biological control of pests. III. The obtaining of sterile males of C. capitata by irradiation of the pupae with γ-rays. (Arroyo, M. et al., 1965)
1120 Application of radioactive isotopes to the investigation of methods for the biological control of pests. IV. The effects of γ-radiation on C. capitata when the dose of irradiation is fractionated. (Arroyo, M. et al., 1965)
1146 On the radioactive isotope utilization for forest protection. (Popa, A. et al., 1965)
1354 Stérilisation de la mouche méditerranéenne des fruits, Ceratitis capitata Wied., par irradiation des pupes aux rayons gamma. (Féron, M., 1966)
1366 Sterilization of onion maggots by irradiation with cesium-137. (McClanahan, R.J. et al., 1966)
1431 Radiation sterilization of the black blow fly. (Bushland, R.C., 1966)
1504 Effect of selection on whaxy: an autosomal dominant mutation in the screw-worm fly with recessive lethal effects. (LaChance, L.E. et al., 1965)
1568 Sterile technique - principles involved, current application, limitations, and future application. (Knipling, E.F., 1967)
1569 Radiation-induced sterilization. (LaChance, L.E. et al., 1967)
1571 Integrating control of pest populations in large areas. (Lawson, F.R., 1966)
1679 Control of Queensland fruit fly. (O'Loughlin, G.T., 1964)
1702 Economic aspects of the food irradiation programme in Israel. (Lapidot, M. et al., 1966)

1618 Azaryan, G.K., Babayan, V.V., Vasilyan, V.V., Mkrtumyan, K.L. PROSPECTIVE USE OF RADIATION TO CONTROL THE HOLLYHOCK SEED MOTH*(LEPIDOPTERA, GELECHIIDAE). Ent. Rev. 44, 4 (1965) 449-453. Ént. Obozr. 44 (1965) 762-769. (In Russian)

The biological effect of x-irradiation of the hollyhock seed moth is dependent on the age of the irradiated pupae for the dosages employed. Pupae 1-2 d old are the most sensitive to radiation. Moths obtained from these pupae lay single eggs or are sterile. The greatest biological effect is obtained by irradiating 1-2 d old pupae with a radiation dose of 5 000 R: the sterility of the moths reaches 100% in the combination of irradiated male plus non-irradiated female. The radiosensitivity of the pupae is approximately the same for the summer and wintering generations. The biological effect is higher for a single radiation dose. Radiation of this type yields the largest number of externally normal moths and the least number of fertile moths. The egg laying period is far shorter for moths obtained from irradiated pupae than for those from nonirradiated pupae. Life span is approximately the same for moths from irradiated and nonirradiated pupae and is not affected either by radiation dose or by the age of the pupae at the time of irradiation. (tr-Auth.)

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* Pectinophora malvella Hb.

1619 Madsen, H.F. STERILE MOTHS IN CANADA - BEWILDERED, BUT EFFECTIVE. West. Fruit Grow. 19, 5 (1965) 15-16.

1620 Madsen, H.F., Downing, R.S. CODLING MOTH CONTROL. Pesticide Prog. 5, 3 (1967) 61-62. Also presented at "41st Annual Meeting of the Western Cooperative Spray Project, Portland, Oreg., USA, 11-13 Jan. 1967".

Results of release of sterile moths in a commercial orchard were reported successful from both Summerland, B.C., and Yakima, Washington. Both laboratories have found that it is not necessary to separate the sexes, and that release of sterilised mixed sexes gives results equal to release of sterile males alone. The main difference in techniques between the two Stations is that the moths are sterilised by γ-radiation at Summerland and by chemosterilants at Yakima. There is some evidence that moths rendered sterile by chemosterilants are not as long-lived as those sterilised by γ-radiation. An additional complication with chemosterilants is the variability of supplies which requires constant bioassay.

1621 Walker, D.W. ANNUAL REPORT 1965. Sugarcane borer control project. p. 157-159 of "Annual Report, 1965". PRNC-82, Puerto Rico Nuclear Center, Mayaguez. 225p.

Work on the suitability of Diatraea saccharalis (Fab.) for sterilisation by γ-radiation was started in 1963. The sterilising dose for adults of both sexes is 30 krad. Egg hatchability only, not egg number, is affected even at 60 krad. Behavioural changes in males irradiated with 100 krad did not prevent mating. Males irradiated at 2-4 krad mated sooner than non-irradiated males. Optimum ratios and rearing methods are also being studied. The borer usually mates more than once.

See also:

1127 Radiation sterilization studies on the tobacco budworm, Heliothis virescens Fab. (Flint, H.M., 1966)
1145 Sexual sterilization in the fight against codling moth in apple. (Petrushova, N.I., 1967)
1148 Exploratory studies on frequency of copulation in Prodenia litura F. (Lepidoptera: Noctuidae). (Shazli, A., 1963)
1156 Radiation-induced sterility for population control of the sugarcane borer (Diatraea saccharalis) in Puerto Rico. (Walker, D.W., 1966)
1307 Laboratory and field cage studies of the effects of gamma radiation on codling moths. (Hathaway, D.O., 1966)
1355 Gamma irradiation of pupae of the tobacco budworm. (Flint, H.M. et al., 1967)
1569 Radiation-induced sterilization. (LaChance, L.E. et al., 1967)
1577 Radiosterilization in the fight against insect pests. (Andreev, S.V. et al., 1967)
1688 Puerto Rico Nuclear Center. Its principal irradiation facilities and scientific program. (Rushford, F.E., 1967)

2.4.2.1.4. Hemiptera

See:

1144 Biology and radiation sterilization of sugar cane leafhopper. (Osborn, A.W. et al., 1966)
1149 Radiation sterilization of sugar-cane leafhoppers of the family Delphacidae. (Shipp, E. et al., 1966)

2.4.2.1.5. Acarina

1622 Galun, R., Warburg, M., Avivi, A. STUDIES ON THE APPLICATION OF THE STERILITY METHOD IN THE TICK Ornithodoros tholozani. Entomologia exp. appl. 10, 2 (1967) 143-152.

The tick is an important vector of human relapsing fever in Israel, and is also found in Jordan, Iran, Iraq, Syria, Cyprus, Turkey, and the Caucasus. In the Middle East the tick occurs as isolated populations in caves (from several hundred to many thousands) and old ruins. A method for the application of the sterile-male technique in O. tholozani is described, and its practicality discussed. The project is considered to be economical in spite of the long period involved before complete eradication could be achieved. Releases would be required every six months. Techniques for rearing large numbers (10 000-15 000 annually) on rats, and feeding through artificial membranes are given. A ^{60}Co-source emitting 7700 R/min was used. Nymphs are prevented from moulting at $\geq$ 2000 R if exposed before feeding. Both sexes emerging from nymphs irradiated by > 2000 R, two weeks after feeding, are sterile. These males are not competitive due to lack of sperm. Females become sterile after irradiation by > 2000 R, whereas males require 16 000 R in order to induce 99% dominant lethality. They are effective in competing with normal males.

See also:

1267 Effects of gamma radiation and chemosterilants on the cattle tick, Boophilus microplus. (Kitaoka, S. et al., 1967)

2.4.2.2. Overloading Resources

1623 Monro, J. POPULATION FLUSHING WITH SEXUALLY STERILE INSECTS. Science, N.Y. 151, 3717 (1966) 1536-1538.

In theory, populations of animals can be displaced by overloading a resource with introduced sterile animals. The theory was tested on natural populations of the Queensland fruit fly Dacus tryoni Frogg. The sterile flies were reared at 25°C and 8-d-old pupae sterilised with 6000 rad of γ-rays (^{60}Co). After emergence they were held for 4 d, fed for 2 d on sucrose containing ^{32}P ($NaH_2P^*O_4$) at a concentration of 100 μCi/g sugar, and then released into the treated populations. Three of four treated populations declined sharply within 2 d after sterile flies had been introduced. This procedure may be useful both as a tool in experimental ecology and as a means of controlling pests.

See also:

1558 Genetic weapons. Population replacement, induced sterility, or the introduction of deleterious genes - are all promising biological methods of fighting disease-carrying insects. (Collins, P., 1964)

2.4.3. Infestation and Countermeasures

2.4.3.1. Stored Products

1624 Akamine, E.K., Wong, T.F. EXTENDING THE SHELF LIFE OF PAPAYAS WITH GAMMA IRRADIATION. Hawaii Fm. Sci. 15, 1 (1966) 4-6.

Most of the papayas shipped out of Hawaii are hot-water treated to control decay and then fumigated to meet official disinfestation requirements (fruit fly control). The merit of the irradiation treatment in terms of shelf-life extension was judged objectively against that of fumigation treatment. The results of a representative experiment are shown in a table, in terms of storage decay, overall firmness and delay in senescence. In general, the salable life of the irradiated fruits was ≠ 3 days greater than that of the fumigated fruit. The irradiation dose was 75 krad. Irradiation as a quarantine measure has not yet been approved.

1625 Anonymous. THE DEFENSE DEPARTMENT IS ON ITS THIRD TEST PROCUREMENT OF IRRADIATED FOOD. Nucleonics Week 8, 24, June 15 (1967) 7.

"Requests for proposals went out last Friday for 131 500 lb of canned wheat flour, treated with a disinfestation γ-dose of 30-50 000 rad. Although some 60 irradiation companies and millers were solicited directly, other companies may propose, by June 19, to the Subsistence Regional Headquarters, Chicago, of the Defense Personnel Support Center. A spokesman for the Center said it hopes to award two parallel contracts, possibly to two teams of irradiation firms and millers. The military previously made production-test procurements of radiation-sterilized canned bacon and fresh potatoes treated with a low γ-dose to inhibit sprouting. . . The irradiated wheat contracts, which should be awarded by July 1, call for deliveries of varying amounts by late August, to Ft. Leonard Wood, Mo.; Camp Lejeune, N.C.; the Naval Supply Center, Norfolk, Va.; and the Defense Depot, Mechanicsburg, Pa. The military's food-irradiation program advanced on another front last week, with Food & Drug Administration approval of the Army's two-year-old petition for use of 4 flexible packaging materials with Co and Cs irradiation. . ."

1626 Brownell, L., Horne, T. IRRADIATION SHIP WOULD ELIMINATE GRAIN LOSS TO INSECTS IN TROPICS. Nucleonics 19, 6 (1961) 88-89.

A specially constructed grain irradiator ship is envisaged, with a 100 000 Ci ^{60}Co-source. Touring the world, it would call at ports where there was the greatest need, in order to irradiate grain supplies so as to rid them of both insects and insect eggs before they are put into storage.

1627 Daget, J. INSECT INFECTION OF AFRICAN DRIED OR SMOKED FISH AND THE POSSIBILITY OF ITS CONTROL BY IRRADIATION. p. 73-83 of "Application of Food Irradiation in Developing Countries". Technical Reports Series No. 54. Vienna, International Atomic Energy Agency. 1966, 183p. STI/DOC/10/54.

Most fishing interests in the interior of Africa find it impossible to arrange the transport of fresh fish from the fishing grounds to the centres of consumption and storage. Moreover, resort to deep-freezing or simple refrigeration is impossible or too expensive. It is therefore necessary to dry or smoke, on the spot, all fish which is not immediately consumed by the local population. Drying and smoking offer many advantages in the developing countries, including low preparation costs, high nutritional value for low weight, and preservation and transport facilities. However, the dried or smoked fish is attacked by insects of the genera Dermestes and Necrobia and the damage is all the more serious since the fish is stored in large quantities. Chemical methods of disinsectization involve serious disadvantages. An attractive solution appears to be irradiation, which leads to the death or sterilization of the insects and which can be employed when the fish is already packed in hermetically sealed containers. (Auth.)

1628 Dobrovsky, T.M. ADVANCES IN STORAGE TECHNOLOGY WITH SPECIAL REFERENCE TO THE TROPICS. p. 63-68 of "Congress on the Protection of Tropical Crops. Proceedings. Marseille, France, 23-27 Mar. 1965". Marseille, Chambre Comm. Ind. 1965, 998p.

Review of the extent of damage caused by insects to stored food products and their control (by chemicals, natural enemies, and exposure to low temperatures or radiation) and discussion of storage techniques.

1629 Dockal, J., Kolin, J., Blazek, J. CONTROL AND STERILIZATION OF PESTS OF GRAIN STORAGES BY GAMMA RAYS. Ochr. Rost. No.3 (1965) 15-20. (In Czech)

1630 Goldblith, S.A. POSSIBLE APPLICATIONS TO FOOD OF IONIZING AND NONIONIZING RADIATIONS. J. Am. diet. Ass. 51 (1967) 233-237.

Development of processes utilising ionizing and microwave irradiation for food preservation is reviewed. In programmes investigating the use of ionizing radiation, the foods of greatest interest are: fish; shellfish; vegetables and fruits; poultry and eggs; and grains and potatoes. Studies with these foods are described. Relatively low doses (30 000 rad) are effective in destroying the insects that are important economic pests in grain.

1631 Goosens, H.J. LATEST APPROACHES TO FLOUR MILL PEST CONTROL. Fd Engng 36 (1964) 102-103.

Recent approval has been given to "gamma radiating" wheat and flour for insect control. "Gammas" from sources with max. energy not exceeding 2.2 MeV provide a safe-use absorbed dose of 20 000 - 50 000 rad. This insect control technique is effective, and millers don't oppose the issuance of these regulations. However, they have seriously studied this technique and feel, at this time, that there is insufficient data to guarantee γ-radiation not having an adverse effect on the baking quality of the treated flour or wheat. (Battelle Geneva Card-File)

1632 Hossain, M.M., De, H.N., Choudhury, S.U., Nabi, N. PAEC-CSIR JOINT PROJECT ON RICE IRRADIATION: TASTE PANEL REPORT ON ORGANOLEPTIC TESTS. AECD-RB-1, Atomic Energy Centre, Dacca, (Pakistan). Radiobiology Div. May 1966, 8p.

Exposure of stored rice to a dose of 16 000 R of ^{60}Co γ-radiation was found to kill insect pests and their eggs. Results are reported from a taste-panel evaluation of the flavour, texture, taste, and colour of cooked irradiated and control rice. It was concluded that radiation treatment causes no undesirable changes in the organoleptic properties of rice. (NSA 21: 1967, 20453)

1633 Pesson, P. CAN NUCLEAR ENERGY BE USED FOR THE PROTECTION OF CEREAL STORES AGAINST INSECTS? Inf. Doc. Agric. No.2 (1965) 1-12. (In French)

Efforts to destroy the cattle fly in Florida using radiation sources are reviewed. The conditions under which sterilisation of the male can be applicable to insect pests in cereal stores are defined. Hazards from the use of radiation are summarized. (NSA 21: 1967, 9042)

1634 Quartermaster Research and Engineering Center, Natick, Mass. PRESERVATION OF FOOD BY LOW-DOSE IONIZING ENERGY. AD-260894. Jan. 1961, 171p.

A review is presented of the current status of investigations on the radiation processing of foods. The fact that radiation processing of cereal grains, cereal products, and military ration components destroys adult insects, larvae, and eggs of insect pests that infest these foods is mentioned. No radioactivity has been induced in food products by high radiation doses. Extensive studies have shown that radiation processing has no effect on the wholesomeness of foods. The economic feasibility and potentialities of the radiation processing of foods are discussed.

1635 Steiner, L.F. GAMMA IRRADIATION FOR DISINFESTATION OF EXPORT FRUITS AND VEGETABLES. Hawaii Fm Sci. 15, 1 (1966) 11-12.

γ-irradiation at dosages of not less than 21 krad can be used in lieu of ethylene dibromide and methyl bromide fumigation, or vapour heat treatment to destroy the ability of dangerous pests in Hawaii fruits and vegetables to reproduce, and thus permit immediate export of the commodity. Adoption of the method must await final approval by the US Food and Drug Administration and of mainland quarantine officials, both State and Federal. - The mango weevil lives from young larva to adult within the seeds. Irradiated mangoes could carry live adults to the mainland. If a min. dose of ~25 krad is required most of the adults in the treated fruit will weaken and die without escaping from the seed. Any that survive would be sterile. - Some earlier pioneering work, and existing facilities and possibilities are reviewed briefly.

See also:

1436 Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation. (Farkas, J., 1965)
1640 Grain irradiation plant. (Anonymous, 1967)
1641 Lockhead-Georgia and the Hawaii development irradiator are winners. (Anonymous, 1967)
1645 The world's first large-scale continuous grain irradiation plant, Iskenderun, Turkey. (Anonymous, 1967)
1651 Design of the world's first industrial-scale grain-irradiation facility. (Carden, J.E., 1967)
1664 Radiation preservation of several fresh fruits and vegetables. (Hayakawa, A. et al., 1964)
1668 Food irradiation research and pilot facilities in operation or planned in India. (Kumta, U.S. et al., 1966)
1670 Control of the Queensland fruit fly by gamma irradiation. (MacFarlane, J.J., 1966)
1671 Potential role of radiation in alleviating some world food problems. (MacQueen, K.F., 1967)
1672 Conceptual designs for Hawaiian irradiator and quarantine demonstration irradiators. (Manowitz, B. et al., 1963)
1676 Recent advances in food irradiation research in Japan. (Matsuyama, A., 1966)
1678 Applications of intense radiation sources to biosynthetic food and medicaments. Part III. (Mouton, R., 1964)
1682 Hawaii development irradiator - a new tool in tropical fruit processing. (Otagaki, K.K., 1967)
1683 Irradiation of grain and potatoes. (Powers, J.J., 1967)
1684 L'effort belge en matière d'irradiation des aliments. (Proost, M., 1965)
1686 Gamma irradiation of grain and other reserves for sterilizing and exterminating pests. (Rukavishnikov, B.I., 1964)
1689 Gamma-ray attenuation coefficients of grains and forages. (Ruwe, D.M. et al., 1966)
1690 Food irradiation in Australia. (Scott, W.J., 1962)
1691 Prospects and needs for radiation disinfestation of packed fruits and vegetables. (Talhouk, A.S., 1966)
1693 x-Ray irradiation effects on storehouse destructive insects. (Török, G. et al., 1959)
1694 ibid.
1699 Effects of gamma irradiation on the longevity and fertility of five species of stored-product insects. (Watters, F.L., 1966)
1701 Economics of grain irradiation. (Baines, B.D. et al., 1966)
1702 Economic aspects of the food irradiation programme in Israel. (Lapidot, M. et al., 1966)
1751 Rice weevil biology as affected by grain storage conditions. (Russel, M.P., 1966)

2.4.3.2. Disinfestation Measures (Sources, Conveyor Systems, Etc.)

1636 Akamine, E.K., Buddenhagen, I., Brewbaker, J.L., Hilker, D. DOSIMETRY, TOLERANCE, AND SHELF LIFE EXTENSION RELATED TO DISINFESTATION OF FRUITS AND VEGETABLES BY GAMMA IRRADIATION. June 1, 1965 - May 31, 1966. UH-235P5-2, Hawaii Univ., Honolulu, Coll. of Tropical Agriculture. Sep. 1966, 106p.

Food irradiation studies using the Hawaii Research Irradiator are reported. Three commodities have been studied in great detail: the papaya, mango, and pineapple. Evidence obtained for each fruit attests to the biological feasibility of γ-irradiation for insect disinfestation. Associated studies suggest possible applications of γ-irradiation in commodity treatments of ginger, sweet potatoes, and even of Hawaiian fishcake, while its successful application for disinfestation of tangerines and avocadoes appears unlikely. Dosimetry studies were extended to include dose-response patterns when the central chamber was filled with water or papaya juice. (NSA 21: 1967, 4892)

1637 Andreev, S.V., Martens, B.K. CALCULATION OF DOSE DISTRIBUTION IN A GRAIN GAMMA IRRADIATOR AND DETERMINATION OF ITS BASIC PARAMETERS FOR THE "DISINSECTION" FLOW-LINE METHOD. Radiobiologiya 5, 4 (1965) 605-611. (In Russian)

Use of the flowline method for disinfestation ensures greater economy and permits the employment of radiation sources of lower activity than would otherwise be necessary. Formulae including tabulated coefficients are derived for a grain irradiator of such a type.

1638 Anonymous. PROGRESS OF FOOD IRRADIATION WORK AND PROGRAMMES IN O.E.C.D. MEMBER COUNTRIES. Fd Irrad. 5, 4 (1965) A2-A18.

The status of research and developmental studies on food irradiation in 1965 is summarized for Austria, Belgium, Canada, Denmark, France, German Federal Republic, Italy, The Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Research programmes include studies on toxicity and nutritional value of irradiated foods. Developmental studies include various means of quality improvement, methods of extending storage life, and public acceptance or irradiated foods. Foods cleared by the U.S. Food and Drug Administration include wheat and wheat products, bacon, white potatoes, and packaging materials. Foods under intensive investigation include chicken, pork, luncheon meats, pre-cooked meat dishes, fish and other marine foods, onions, carrots, tomatoes, dehydrated vegetables, apples, strawberries, sweet cherries, raspberries, peaches, grapes, bananas, and tropical fruits such as papayas and mangoes. Related studies include studies on the radiosensitivity of certain bacteria involved in food poisoning, such as Clostridium botulinum and salmonellae, and the control of insect pests that infest foods by irradiation. (NSA 20: 1966, 708)

1639 Anonymous. TWO COBALT IRRADIATORS FOR A FOOD-TREATMENT LAB AT INDIA'S TROMBAY ATOMIC ENERGY ESTABLISHMENT.... Nucleonics Week 7, 22 (1966) 7.

"...will be supplied by Canada under the Colombo Commonwealth aid plan. They include a 100 000-Ci package irradiator, capable of treating about 100 lb/h at 0.5 Mrad, and a portable 27 800-Ci device that can handle 500 lb of grain/h at 15 krad. The irradiators are valued at $290 000 and will be delivered by Atomic Energy of Canada Ltd.'s Commercial Products Div."

1640 Anonymous. GRAIN IRRADIATION PLANT. Engineering, Lond. 223 (1967) 97-98.

The first full-scale application of radiation from a ^{60}Co source for insect disinfestation of grain has been installed in Turkey. Specifications of this irradiation plant that is designed to treat wheat, barley, rye, and maize at rates up to 50 t/h, with a dose sufficient to sterilize the insects in the grain are outlined. With the initial loading of 163 000 Ci of ^{60}Co the plant can continuously treat grain at a rate of 30 t/h. The grain irradiation facilities and the process used are described. Safety features and economic aspects of grain irradiation are also discussed. (NSA 21: 1967, 16552)

1641 Anonymous. LOCKHEED-GEORGIA AND THE HAWAII DEVELOPMENT IRRADIATOR ARE WINNERS Nucleonics Week 8, 27, July 6 (1967) 5.

on the irradiation side in the Defense Dept.'s test procurement of 131 500 lb of γ-ray disinfested wheat flour.* Prime contracts went to Helix Milling Co., Portland, Oreg., bidding with Lockhead, and Hawaiian Flour Mills of Honolulu, whose subcontractor will be the AEC-State of Hawaii experimental irradiator. The $500 000 facility coincidentally was dedicated just last Monday, but has been operational for some weeks. The flour contract is its first non-AEC commitment. Seven milling companies bid on the DOD procurement contract. Deliveries of the canned flour will begin next month to four Defense installations. (Cited verbatim)

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* See 1639.

1642 Anonymous. A 150 000 CURIE CESIUM IRRADIATOR WILL BEGIN TOURING THE COUNTRY.... Nucleonics Week 7, 20 (1966) 7.

... late this year under the auspices of the AEC Div. of Isotopes Development. By far the largest ^{137}Cs unit available in the U.S., it is intended primarily for use by food packers and processors to acquaint them with the potential of γ-radiation preservation techniques. The 18 ton irradiator is being designed for AEC by Vitro Engineering Co. Bids for fabrication will be sought by DID next month. Use of the irradiator and the services of an AEC-trained operator will be offered free of charge to qualified organizations whose demonstration proposals will be formally solicited later this year. DID will engage an outside firm to handle the demonstration tour. Bids for this service will be sought by New York Operations. DID has only recently stepped up food-treatment research with

^{137}Cs, to supplement its extensive work with ^{60}Co. Brookhaven National Lab is now doing comparability tests between ^{137}Cs and ^{60}Co in preparation for the mobile irradiator (NU Wk, 23 Dec '65, 4). The cesium unit will have two 14 × 18 × 7-in. irradiation cans. At dosages of 200 rad, it can process about 100 lb/h at a product density of 0.3 and 250 lb/h with a density of 1.0. - Meanwhile, AEC'S Mobile Gamma Irradiator (NU Wk, 13 May '65, 7; 5 May '66, 7) arrived this week at the Davis campus of the Univ. of California. The university will operate the experimental fruit-irradiator under contract to AEC. (Cited verbatim)

1643 Anonymous. 100 000 CURIES OF COBALT FOR THE LARGE GRAIN IRRADIATOR IN TURKEY.... Nucleonics Week 7, 51 (1966) 9-10.

... are on their way from Harwell, England. The prototype plant, designed to hold 170 000 Ci and to process 50 t/h of maize, barley or rye, is located in Iskenderun. The $1.89 million project received $720 000 from the U.N. Special Fund (now known as the Development Program) and its construction was administered by the International Atomic Energy Agency. Nuclear Chemical Plant Ltd. of Britain won the contract to design and build the plant over stiff international competition (NU Wk, 10 Feb. '66, 7). The disinfestation plant is owned by the Turkish firm of Toprak Mahsulleri Ofisio, but its non-U.N. financing came from the Turkish government. (Cited verbatim)

1644 Anonymous. LOW DOSE ELECTRON BEAM RADIATION FOR TREATMENT OF FOOD FOR INSECT CONTROL IN WHEAT AND WHEAT FLOUR. NOTICE OF PROPOSED RULE MAKING. Fedl Reg. 31, 39 (1966) 3196.

1645 Anonymous. THE WORLD'S FIRST LARGE-SCALE CONTINUOUS GRAIN IRRADIATION PLANT, ISKENDERUN, TURKEY. Atom 124 (1967) 27-30.

A ^{60}Co source is used. Designed to treat 30 t wheat/h, with an absorbed radiation dose of 16 000 rad, its max. handling capcity is 50 t of wheat/h, and barley, rye and maize can also be treated. The plant could accommodate 360 000 Ci instead of the present 200 000 Ci of ^{60}Co. The irradiation facility comprises a concrete tower, with the irradiation plant at a low level, and two 125-t feed hoppers at high level, with a covered way connecting the existing silo installation. The feed hoppers are supplied by a system of chutes, sieves and conveyors from the existing plant, and appropriate conveying equipment returns the irradiated grain to the silo installation. Details of the source, cooling, safety aspects, and processing costs are given. Minimum costs for a Co-plant are 0.12 $/t and for a 3 MeV Dynamition installation 0.06 $/t. These costs correspond to throughputs of 150 and 400 t/h, respectively, for 6000 h of plant operation per year at these throughputs. Grain flow is controlled by annular flow channels and the rotating flow regulator. A variable speed drive mechanism is used. The building design is discussed.

1646 Anonymous. NEW GRAIN IRRADIATOR. Agric. Res., Wash. 15, 12 (1967) 11.

1647 Balock, J.W., Burditt, A.K., Jr., Seo, S.T., Akamine, E.K. GAMMA RADIATION AS A QUARANTINE TREATMENT FOR HAWAIIAN FRUIT FLIES. J. econ. Ent. 59, 1 (1966) 202-204.

γ-rays from a ^{60}Co source were applied to egg and larval infestations of the oriental fruit fly, Dacus dorsalis Hendel; melon fly, D. cucurbitae Coquillet; and Mediterranean fruit fly, Ceratitis capitata (Wiedemann), in various fruits and vegetables to investigate such radiation as a quarantine treatment for fresh commodities. A dosage of 10 kR generally prevented immature stages of fruit flies from developing to adults. Dosages over 100 kR failed to prevent pupation. Mortalities were converted to probits, and LD 99.9 and LD 99.9968 determined for the oriental fruit fly and the melon fly. Solo papayas, tomatoes, cucumbers, bananas, litchis, and ripe mangoes tolerated dosages between 25 kR and 100 kR without losing commercial acceptability. Most varieties of avocados and mature-green Haden mangoes were injured by 25 kR. (Auth.)

1648 Bibergal', A.V., Primak-Mirolyubov, V.N. SELECTION OF A RADIATION SOURCE FOR IRRADIATING BULK MATERIALS. Atomn. Energ. 22, 1 (1967) 55-58. (In Russian)-In English translation, p. 64-68.

The effectiveness of irradiation of grains and potatoes to kill insect pests and to prevent germination has been well established. Forced flow is preferable to gravity flow since it minimizes losses due to abnormal irradiation on starting and stopping the plant, and also ensures the greatest constancy and

uniformity of motion within the irradiator. Geometrical considerations play an important role in ensuring a constant absorbed dose throughout the bulk of the material. The cylindrical configuration was more closely examined, determining the efficiency of the system on the basis of the total activity of the central source and the distance of the moving material. Since the relative efficiency of a cylindrical irradiator is relatively low (5-9%), an additional linear source along the axis of the cylindrical irradiator is convenient. The calculations indicated that about 30% of the radiation energy may be absorbed usefully. Only qualitative conclusions could be drawn because "dead angles", reaching areas free from material to be irradiated, were not taken into account. (NSA 21: 1967, 16075)

1649 Boisot, M.H., Gauzit, M. DISINSECTIZATION OF AFRICAN DRIED AND SMOKED FISH BY MEANS OF IRRADIATION. p. 85-94 of "Application of Food Irradiation in Developing Countries. Report of a Panel, Vienna, Austria. 3-6 Aug. 1964". Technical Reports Series No.54. Vienna, International Atomic Energy Agency. 1966, 183p. STI/DOC/10/54.

Fresh water fish are one of the major sources of protein in Africa. More than 100 000 tons of commercial fish are removed from the Niger basin annually and 150 000 tons from the Chad basin. The fish are dried or smoked and shipped throughout Africa. More than 30 wt % of the fish are destroyed by insect infestation (mostly Dermestes and Necrobia) and none of the conventional methods of combating these insects has produced practical results. Results are reported from France on the control of insect infestations in dried or smoked fish by exposure to γ-radiation. Data are included from entomological studies on Dermestes and Necrobia, and on radiation doses necessary to kill these insects during various developmental stages in dried or smoked fish. The exact dose necessary for sterilization has not yet been determined but is estimated as between 15 000 and 40 000 rad. No organoleptic changes were observed at 500 000 rad. The effects of doses of 20 000 to 500 000 rad γ-radiation on the taste of dried and smoked fish of several varieties when exposed in polyethylene bags or removed from them were also studied; the effects of 15 000 to 30 000 rad γ-radiation on the nutritional value of fish; and a study of packaging materials for fish to prevent reinfestation after radiation processing. Studies were also made on the economic feasibility of radiation processing of fish caught in African waters.

1650 Brewbaker, J.L. DOSIMETRY, TOLERANCE, AND SHELF LIFE EXTENSION RELATED TO DISINFESTATION OF FRUITS AND VEGETABLES BY γ-IRRADIATION. p. 58-60 of "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., USA. 3-4 Oct. 1966". CONF-661017, Division of Isotopes Development (AEC), Washington, D.C. 1966, 216p.

Disinfestation and shelf-life extension studies have also included the lychee, ginger, avocado, tangerine, lime, pepper, eggplant, poi, and Japanese fishcake. Insect disinfestation by γ-irradiation appears promising for papaya and mango. Preliminary experiments on possible economic applications in Hawaii are also encouraging for pepper and eggplant. Subtropical fruit flies and the mango seed weevil are the major targets of the University of Hawaii disinfestation programme. A suitable disinfestation (lethal) dose of 33 krad was established for the Oriental fruit fly and melon fly (Dacus dorsalis and D. cucurbitae) although considerably lower doses sterilize these flies. Mango weevils are sterilized by treatments of < 30 krad, and a petition has been made for clearance at that dose.

1651 Carden, J.E. DESIGN OF THE WORLD'S FIRST INDUSTRIAL-SCALE GRAIN-IRRADIATION FACILITY. Isotopes Radiat. Technol. 4 (1967) 396-398.

The design of the world's first industrial-scale (50 t/h) grain irradiator, completed Feb. 1, 1967, is described. (Auth.)

1652 Clor, M.A. COBALT-60 FOR TURKEY FOR A CONTINUOUS GRAIN IRRADIATIVE PLANT. Sci. Cult. 33, 4 (1967) 189.

1653 Cornwell, P.B., Ed. "The Entomology of Radiation Disinfestation of Grain". Oxford, Pergamon Press. 1966, 236p.

See III/1010. (For individual papers see also III/641, 651, 811, 869, 870, 899, and 1001.)

1654 Cornwell, P.B. CONTROL OF INSECTS IN STORED GRAIN BY IRRADIATION. p. 250-255 of "1st International Food Industries Congress and Exhibition. Proceedings. 8-12 Jun. 1964".

A review of the present state of knowledge and the steps being taken to encourage the application of ionizing radiations for disinfestation of grain is given. The grain is treated in motion, passing through a shield housing the source or machine that delivers the required dose of radiation. Consideration of the physical properties of γ- and electron radiations suggest that grain should be treated during gravity fall. The dose level for grain disinfestation (16 000 rad) does not adversely affect the milling, baking or organoleptic properties of wheat, nor does several times this dose. There is no loss in nutritional adequacy and there is no induced toxicity. The minimum annual throughput of grain which can be treated economically by irradiation is about 200 000 t. The operating costs are competitive with those for conventional measures of insect control. The reliability of ^{60}Co plant and electron machines under conditions of commercial grain handling would require pilot operation for evaluation. (NSA 21: 1967, 24703)

1655 Cornwell, P.B. CONTROL OF INSECTS IN STORED FOOD BY IRRADIATION. Fd Mf. 39, 6 (1964) 36.

Radiation disinfestation by subjecting food to radiation from radioisotopes or from an electron machine are discussed. It is shown that with the grain falling through a system or vertical annuli, 70% of the emissions from ^{60}Co can be utilised. Such irradiation is not harmful to the consumer, and clearance has been given in the USA for the use of radiation energies $\not> 2.2$ MeV. Advantages of sterilisation by irradiation over fumigation by ordinary methods including immediate reproductive sterilisation, and the delayed death of irradiated insects affords partial protection against reinfestation. Both methods can give 100% control when properly carried out, while irradiation does not affect the milling, baking or organoleptic properties of the wheat. Operating costs of control by irradiation are competitive with conventional methods of insect control.

1656 Cornwell, P.B. IRRADIATION AS A QUARANTINE CONTROL MEASURE. p. 381-393 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

The author considers some suggested irradiation applications using ^{60}Co plant at export/import centres and interstate collecting centres. Irradiation of passenger baggage at airports was planned for pilot evaluation in 1967. The treatment of fruit and vegetables commercially exported from Hawaii is discussed with reference to fruit flies (Dacus cucurbitae, D. dorsalis, and Ceratitis capitata); also, the movement of fruit between states in Australia (C. capitata and D. tryoni). The treatment of timber imports into Australia (wood wasps, Sirex spp. and European house borer, Hyloptrupes bajulus) is discussed for logs, prepared timber, and packing cases. Stored foodstuffs are threatened by the Khapra beetle (Trogoderma granarium), so that irradiation, particularly for shipments, has great possibilities. Examples of possible quarantine operations of eradication, or containment, by sterile-male releases are discussed.

1657 Cornwell, P.B. STATUS OF IRRADIATION CONTROL OF INSECTS IN GRAIN. p.455-471 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

Research into the uses of ionizing radiations for the control of insects infesting stored foodstuffs has demonstrated the technical feasibility of irradiation for the treatment of grain. Studies in radiation entomology have established the susceptibility of the principal grain storage insects and the extent to which environmental factors may modify the efficacy of treatment. Investigations into chemical and physical properties of irradiated grain have shown no adverse effects on organoleptic and manufacturing properties at the dose level required for disinfestation. Work on the wholesomeness of irradiated grain has shown no loss in nutritional adequacy, with the result that clearance has been given in the United States for the human consumption of irradiated wheat and wheat products. Engineering considerations suggest that irradiation is an economic competitor to chemical methods for the treatment of grain at large exporting or collecting centres. With bulk storage and automated conveying systems now established as the most expedient method of handling grain between producers and consumers, it can be wisely predicted that implementation of radiation disinfestation into the

grain-handling industry will follow in the foreseeable future. Information on infestation problems and the grain-handling industries of various countries is used to illustrate the likely future potential of irradiation for the treatment of grain on an international scale. (Auth.)

1658 Dietz, G.R., Lafferty, R.H., Jr. I - USAEC FOOD IRRADIATOR PROGRAM. Fd Irrad. 6, 4 (1966) A35-A49.

The irradiation facilities that are being built in the USAEC food irradiation programme are described. These irradiators, which have capacities ranging from that needed for university research to that required for semicommercial operations, use ^{60}Co or ^{137}Cs as a source of radiation. Essential characteristics such as source strength, production capacity, radiation dose range, and cost are given for the research irradiators, Marine Products Development Irradiator, Grain Products Irradiator, Mobile Gamma Irradiator, Onboard Ship Irradiator, the Hawaii Development Irradiator, and the Portable Irradiator. (Auth.)

1659 Dietz, G.R. STATUS OF AEC IRRADIATOR PROGRAM. p. 85-86 of "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., 3-4 Oct. 1966". CONF-661017, Division of Isotopes Development (AEC), Washington, D.C. 1966, 216p.

Among the irradiators mentioned is the Mobile Gamma Irradiator (MGI), at present located at the Davis Campus of the University of California.

1660 Fazio, C. IONIZING RADIATIONS FOR THE DISINFESTATION OF STORED PRODUCTS. Agricoltore Ital. 12, 4 (1966) 3-6. (In Italian)

1661 Garber, H.J. HAWAII DEVELOPMENT IRRADIATOR (HDI). p. 89-92 of "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., USA, 3-4 Oct. 1966". CONF-661017, Division of Isotopes Development (AEC), Washington, D.C. 1966, 216p.

Details of siting, design, and irradiation capability, housing, and loading are given. The total cost of the irradiation system less source material (^{60}Co) is ~$400 000. Specialized equipment such as source elevator and product conveyor was scheduled for completion by early Feb. 1967.

1662 Golumbic, C., Davis, D.F. RADIATION DISINFESTATION OF GRAIN AND SEEDS. p. 473-488 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

Current interest in radiation treatment of grain and seeds mainly revolves about its efficacy for control of insect infestation in these products. The recent literature on this subject is reviewed and gaps still existing in fundamental and practical knowledge of radiation disinfestation are pointed out. Research programmes in the United States Department of Agriculture that are under way, or planned for the immediate future, are discussed in detail. Current studies are being directed toward establishing min. effective doses for sexual sterilisation and mortality, influence of environmental factors on dose requirements, and potential for the development of biological resistance. In May 1966 the scope of the work expanded as a new grain products irradiator became operative and applied studies were initiated. An integral part of this research is a study of the effect of irradiation on the quality of food and feed grains and on cereal products, at the doses for both insect control and fungal disinfection. This paper examines critically the results of research in this area and estimates future research needs. (Auth.)

1663 Grimblat, G.Y. L'IRRADIATION DES GRAINES EST-ELLE EFFICACE? Kukuruza, SSSR No.11 (1965) 35-36; Is. Ray. Agr. 4, 3 (1966) 3261.

1664 Hayakawa, A., Umeda, K., Shiroishi, M. RADIATION PRESERVATION OF SEVERAL FRESH FRUITS AND VEGETABLES. Shokuryo Kenkyusho Kenkyu Hokoku No.18 (1964) 200-203. (In Japanese)

The use of γ-radiation for increasing the stability of fresh fruits (oranges, persimmons) was studies with a 400-Ci ^{60}Co source. The storage life of these fruits was prolonged when polyethylene bags were used before irradiation. With dosages of 1.28×10^4 to 6.4×10^5 rep, the storage life of

matsutake was increased for at least 7 d. With dosages from $(1.3-6.4) \times 10^4$ rep chestnuts showed no decrease in organoleptic acceptability, and the possibility of controlling insects in chestnuts by radiation was indicated.

1665 Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center. APPLICATIONS. p. 255-288 of "Research Laboratories Annual Report, January-December 1965". IA-1082. Jun. 1966, 374p.

The use of radioisotopes and Soreq's large ^{60}Co radiation source for application in both industry and agriculture is reviewed. Authorization for using radiation for insect eradication in wheat has been requested.

1666 Kahan, R.S., Eisenberg, E., Lapidot, M. THE ISRAEL FOOD IRRADIATION PROGRAMME AND PROGRESS DURING 1964-1966. p. 743-754 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

The Israel programme on the irradiation of agriculture produce is being co-ordinated by a committee set up by the Israel National Scientific Research Council, consisting of representatives of the Israel Atomic Energy Commission (AEC), The Ministry of Agriculture, and the various growers and marketing associations. The programme is 3-fold: to obtain Government approval of crops already licensed elsewhere (potatoes, onions), to work on local problems (apricots, pears) and on items of export importance (citrus, bananas, avocados). - A 30 000 Ci source was installed in a versatile irradiator of novel design. Objects ranging from a few grams to 50 kg are treated with 20 to 5×10^6 rad doses at dose rates of 1.5-800 krad/h. For citrus, the effects of growing conditions, maturity, irradiation conditions and storage temperature were investigated. 7×10^6 Medflies (Ceratitis capitata) were released per week in a test programme. The lethal doses for immature stages of the fly were determined. A dose of 5.5 krad proved sufficient to prevent emergence of viable adults from any of the stages in laboratory-bred strock and will probably constitute a sufficient dose for quarantine purposes.

1667 Kansu, I.A. AMBAR ZARARLILARI ILE SAVASTA RADYASYONDAN YARARLANMA VE TURKIYEDE YAPILACAK UYGULAMA. (Grain irradiation and the pilot plant to be built in Turkey.) Ankara Üniv. Zir. Fak. Yill. 17 (1967) 172-186. (In Turkish, with English summary)

In 1962, the International Atomic Energy Agency looked into the possibility of setting up a pilot plant. Surveys were undertaken in Pakistan, Turkey and Argentina, and India and Australia were also considered. Turkey appeared to be most suitable for the project, the precise location to be at Iskenderun grain terminal. A ^{60}Co-source giving ~150 000 Ci was planned, the irradiator to be installed as an independent unit, with a handling capacity of 30 t/h, delivering 16 000 rad to the grain (bulk). The dose, too low to kill in a very short time will, however, protect grain against reinfestation by bulk sterilization of the insects. This will be the first commercial project, and will allow a detailed study of the applicability of the method to large-scale operation. Financial support of the project is provided by the UN and the Turkish government. The FAO/IAEA Division of Atomic Energy in Agriculture is responsible for the technical aspects of the operation.

1668 Kumta, U.S., Sreenivasan, A. FOOD IRRADIATION RESEARCH AND PILOT FACILITIES IN OPERATION OR PLANNED IN INDIA. p. 785-803 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

Irradiation facilities, present and planned, are described. The Food Irradiation and Processing Laboratory is to house a ^{60}Co package irradiator (100 000 Ci), a ^{60}Co portable grain irradiator (28 000 Ci) and other facilities for food processing, analytical and research laboratories. The package irradiator is designed for a throughput of 100 lb/h at 0.5 Mrad, and the portable irradiator could handle 500 lb/h of grain at 15 krad. Insect sterilisation and pest control aspects have received considerable attention at the Biology Division of the Trombay Establishment. Since a whole spectrum of insect pests causes damage to stored grains, detailed investigations have been carried out on the effects of γ-radiation on developmental stages (eggs, larvae, and pupae), with special reference to

viability, larval mortality, pupation rate and adult emergence. Considerable differences in the sterilisation dose were noted among the females (6000 rad) and males (16 000 rad) of the Khapra beetle (Trogoderma granarium), a pest on wheat grain. The effective lethal dose for rice weevils of all age groups was found to be 5000 rad. The flour beetle (Tribolium castaneum), the fig moth (Ephestia cautella), and the lesser grain borer (Rhyzopertha dominica) appeared to be relatively resistant, the sterilising dose being near to 10 000 rad. γ-Radiation has advantages over chemical fumigation in being able to sterilise eggs as well as adult insects and in not leaving any toxic residues.

1669 Lurye, L.S., Srapenyants, R.A. USE OF POWERFUL IONIZING RADIATION APPARATUS IN AGRICULTURE. "Vsesoyuznyi Institut Nauchno-Issledovatel'skoi informatsii po sel'skomu khozyaistvu. Moscow, USSR. 1967".

1670 MacFarlane, J.J. CONTROL OF THE QUEENSLAND FRUIT FLY BY GAMMA IRRADIATION. J. econ. Ent. 59, 4 (1966) 884-889.

The lethal effect of γ-radiation on the developmental stages of the Queensland fruit fly, Strumeta tryoni (Froggatt), was investigated. A dose of 80 krad or more was required to kill within 1 d all eggs and larvae treated, but a dose of 5 krad prevented the emergence of adults under normal growing conditions at 25°C. Fractionation of the total radiation dose, or treatment of the larvae at lower temperature, or in a sealed container, was less effective. The radiation resistance of pupae for the first 5 d after pupation was similar to that of mature larvae, LD 50 being near 1.5 krad. Resistance increased rapidly as the pupae aged. The LD 50 exceeded 50 krad for pupae 10 d old. For quarantine purposes a dosage near 5 krad is suggested for the treatment of fruit infested with the Queensland fruit fly. (Auth.)

1671 MacQueen, K.F. POTENTIAL ROLE OF RADIATION IN ALLEVIATING SOME WORLD FOOD PROBLEMS. AECL-2873, Atomic Energy of Canada, Ltd., Ottawa (Ontario). Commercial Products Div. Apr. 1967, 64p. and "International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada".

Applications of radiation processing discussed include the control of insect infestation of foods.

1672 Manowitz, B., Kuhl, O.A., Oltmann, A. CONCEPTUAL DESIGNS FOR HAWAIIAN IRRADIATOR AND QUARANTINE DEMONSTRATION IRRADIATORS. BNL-11512, Brookhaven National Lab., Upton, N.Y. 15 Dec. 1963, 51p.

The proposed Hawaiian Irradiator, and two pool-type and one dry unit quarantine demonstration irradiator are described. The Hawaiian Research Irradiator for irradiating fruits and vegetables would contain two 23½ in. high by 27½ in. long source plaques each containing 15 000 Ci of ^{60}Co. Auxiliary equipment would consist of a refrigeration unit and a packaged water treatment system. One of the pool-type irradiators has a ^{60}Co plaque positioned vertically in a rectangular well inset into the bottom plate of a cylindrical tank. The cylindrical portion of the tank is 12½ ft deep filled with water. The unit is underground and is designed for two-pass operation. The source is made up of 75 individual, double-encapsulated Brookhaven ^{60}Co strips. Two ^{60}Co source loadings are considered, one of 85 000 Ci and one of 425 000 Ci. The 2nd pool irradiator uses an inclined tunnel rather than a vertical elevator, lead shielding is provided on the underside of the pool, multiple passes are employed to take advantage of "shine through", and "spent" source material is used with regular source material. Mechanical handling of food packages in the dry unit are the same as those used in the pool-type irradiator. The dry unit is also located underground. A shipping cask provides shielding above the source. The irradiator uses 50 Brookhaven source strips. (NSA 21: 1967, 34404)

1673 Manowitz, B. STATUS OF GAMMA IRRADIATOR DESIGN. BNL-10257, Brookhaven National Lab., Upton, N.Y. Apr. 1966, 39p.

The status of γ-irradiator design for the destruction of bacteria and insects and for the initiation of chemical reactions is reported. (NSA 20: 1966, 35606)

1674 Marais, P.G., Potgieter, L., Hawkins, C.S., Hanekom, J. ^{60}Co IRRADIATION UNIT FOR AGRICULTURAL RESEARCH. S. Afr. J. agric. Sci. 7 (1964) 837-862.

A ^{60}Co irradiation unit is described and illustrated in detail that was designed for the irradiation of a wide range of materials. The ^{60}Co source consists of two 2 × 17 mm discs with a total activity of 488 Ci. The manipulation of the source is entirely mechanical and is controlled from the outside. A labyrinth-type construction attenuates the dose near the chamber. Various sample holders were constructed for the irradiation of fruit, vegetables, soil, microorganisms, plant materials and insects. With the source raised above floor level, dose-rate measurements were carried out in vertical directions at different distances from the source. An important feature of the source arrangement is that samples can be placed close to the source by means of a turntable, so that irradiation of small samples at a dose rate of 500 000 rad/h is possible. (NSA 20: 1966, 697)

1675 Mariani, A. TECHNIQUES OF THE FUTURE FOR THE PRESERVATION OF FOOD PRODUCTS IN DEPOSITS. Atti Corso Qualificazione Tec. Ent. Merceologica, 1963 (1964) 85-93. (In Italian)

Radiopreservation of food is reviewed with emphasis on required doses, units of measurement, radiation intensity, and the interaction of radiation with matter. Direct and indirect effects of radiation on biological and chemical systems are discussed. Radiosensitivity of the various stages in the life cycle of common pests are reviewed. Grain product irradiation is considered economically with particular reference to the situation in Italy. (NSA 20: 1966, 25453)

1676 Matsuyama, A. RECENT ADVANCES IN FOOD IRRADIATION RESEARCH IN JAPAN. p. 767-784 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-19 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

Practical studies on food irradiation fall into three categories, depending on their purpose: (1) radiation preservation, (2) the elimination of harmful biological and biochemical factors in foods, from the point of view of public health, and (3) the utilization of the chemical effects of radiation. At present, there are about 30 kCi-scale sources of radioisotopes, and almost the same number of electron generators, including some pilot-scale irradiation facilities, such as a 240 000-Ci ^{60}Co-source in Japan. A realistic dose for grain disinfestation in Japan would be in the range of 10-50 krad, judging by results obtained to date, although definite conclusions as to the appropriate disinfestation dose must await further investigations as part of the new national programme. Irradiation of the soybean and azuki bean have also been studied, to control insect and microbial spoilage; somewhat higher doses, 0.1 Mrad for soybean and 0.1-1 Mrad for the azuki bean, have been recommended.

1677 Mayer, E.L., Tilton, W., Laudani, H. p. 69-70 of "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., 3-4 Oct. 1966". CONF-661017, Division of Isotopes Development (AEC), Washington, D.C. 1966, 216p.

A mobile unit (Atomic Energy of Canada Ltd.) was used for determining effects of γ-irradiation on six beetles, two moths, and the grain mite.* Resistance of beetles and moths to radiation increased with advance in life stages. With the mite, however, the most resistant stages were the adult, egg, and hypopus, with the larva showing least resistance. - The bulk-grain and packaged-commodity irradiator in Savannah awaits calibration and subsequent operation (at the time of writing). Radiation exposure to 20-25 krad upset the development of grain-infesting species. Chemical bioassay analyses of grain treated at 25 and 100 krad indicate no noticeable degradation of malathion residue during a storage period of six months. - A research programme is outlined.

* No details given.

1678 Mouton, R. APPLICATIONS OF INTENSE RADIATION SOURCES TO BIOSYNTHETIC FOOD AND MEDICAMENTS. PART III. Inds atom. 8, 11 (1964) 78-85. (In French)

The use of intense radiation sources for the radiation processing of foods, pharmaceuticals, and medical supplies is discussed. Examples cited include the preparation of antihelminthic and bacterial vaccines, the radiosterilization of thermolabile pharmaceuticals, the treatment of grain for the destruction of insect pests, and the radiation processing of potatoes and onions to increase the storage life. The economic potentialities of radiation processing and the possibility of combining radiation with other chemical and physical treatments are discussed. (NSA 19: 1965, 13829)

1679 O'Loughlin, G.T. CONTROL OF QUEENSLAND FRUIT FLY. J. Agric. Vict. Dep. Agric. 62, 9 (1964) 391-401.

The discovery of the Queensland fruit fly in Victoria in 1946 and its spread during the century from Queensland through New South Wales is traced. It is now established in Eastern Victoria. The life history of the fly is described. The occurrence of geographic races has been demonstrated by studying the survival of flies at cool temperatures. Various control measures are considered. An investigation of the possible application of sterile male releases is being carried out by the C.S.I.R.O. but is likely to prove difficult as flies can survive for several months and are known to mate more than once. It is also expected that costs would prohibit the use of the method on a large scale. Mention is made of the potential use of γ-irradiation for infested fruit.

1680 Okanoue, S., Fukutani, M., Sugihara, M., Hashida, I. STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENT COMPONENTS BY GAMMA-RAY IRRADIATION. IV. EFFECTS ON THE RED BEAN. Radio-Isotopes, Tokyo 14 (1965) 93-95. (In Japanese)

Studies were made on the prevention of mould growth and vermin damage on red beans by γ-irradiation. The optimum dose was determined. Red beans were irradiated by ^{60}Co γ-rays at a dose of from 0.05×10^4 to 100.0×10^4 R in about $^1/_7$ mm thick polyethylene film bags. Atmosphere was air or nitrogen. After irradiation, samples were stored at room temperature for 30 months. Outward appearances, tastes, and contents of fats were estimated. Immediately after irradiation, outward appearances remained unchanged. Irradiation at a dose of 1.0×10^4 R could not keep red beans from getting mouldy, but irradiation at 10.0×10^4 to 100.0×10^4 R was effective in suppressing the mould growth. A higher dose was even more effective. The boiled states and the tastes of the samples were equally good as compared to the control in every case. The contents and the characteristic properties of the fats were almost unchanged by γ-irradiation. Vermin were not found during storage. Therefore it was desirable to irradiate red beans that contained fats in small quantities and carbohydrates in large quantities at a dose of 10×10^4 to 100×10^4 R in air. Good results were not obtained by irradiation of the red beans in N atmosphere as in the case of soybeans. (NSA 19: 1965, 24893)

1681 Okanoue, S., Fukutani, M., Sugihara, M., Hashida, I. STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENT COMPONENTS BY GAMMA-RAY IRRADIATION. V. EFFECTS ON THE RICE. Radio-Isotopes, Tokyo 14 (1965) 97-102. (In Japanese)

The prevention of mould growth and vermin damage on rice by γ-irradiation was studied. Rice was irradiated by ^{60}Co γ-rays at a dose of 0.5×10^4 to 400.0×10^4 R in about $^1/_7$ mm thick polyethylene film bags in an atmosphere of air or N. After irradiation, samples were stored at room temperature for 18 months. Outward appearances, tastes, and changes in nutrient components were estimated. Relations between irradiation doses and these factors were investigated and the optimum dose was determined. Irradiation at a dose of more than 40.0×10^4 R caused the colouration of yellowish brown and its density increased with irradiation dose. Vermin did not grow when irradiated at a dose of more than 4.0×10^4 R. Irradiation at 40.0×10^4 R could keep the rice from getting mouldy and prevent the vermin damage. In N atmosphere results were better in some degree. When irradiated at less than 4.0×10^4 R, taste of the boiled rice was good, but over 40.0×10^4 R, the boiled rice was not fit for eating and after six months' storage this difference became quite remarkable. Effects of irradiation on the contents of water and fats were not recognized. Acid value was most changeable by irradiation and more increased in the polished rice than in the unpolished one. The specific gravity, refractive index, saponification value, and I-number were almost unchanged until six months later, but after 18 months' storage, the acid value increased and both the refractive index and the I-number decreased with the irradiation dose. These changes were also more remarkable in the polished rice than in the unpolished one. It was concluded that for the preservation of rice, it is preferable to irradiate at a dose of 10.0×10^4 R on unhulled rice and polish it before cooking. (NSA 19: 1965, 24894)

1682 Otagaki, K.K. HAWAII DEVELOPMENT IRRADIATOR - A NEW TOOL IN TROPICAL FRUIT PROCESSING. Paper presented at the "8th Japan Conference on Radioisotopes, Tokyo, Japan, Nov. 13-16, 1967". AED-Conf. 1967, 381-011.

The prospects for commercial utilization of irradiation to achieve shelf-life extension and effective disinfestation of tropical fruits are very encouraging. Doses of > 21 krad prevent the development

of adult fruit flies in infested fruits and retard ripening and senescence, thus improving shelf-life of papayas, mangoes, and other tropical fruits. Mango seed weevils, not affected by the commercial level of fumigation for papayas, are controlled by > 25 krad. A ^{60}Co-source of 220 000 Ci is available, with a throughput of 4000 lb of packaged papayas/h; it is, however, designed for a 500 000 Ci capacity with a max. throughput of 12 000 lb/h. The system can treat semi-commercial quantities at doses from 15 to > 500 krad, doses suitable for pasteurization or disinfestation. Details of the installation, economics, and projects are given.

1683 Powers, J.J. IRRADIATION OF GRAIN AND POTATOES. p. 39-48 of "Conference on Radiation Preservation of Food. Oak Ridge, Tenn. 2-3 Feb. 1967". CONF-670202, Southern Interstate Nuclear Board, Atlanta, Ga. Jun. 1967, 100p.

Some mention is made of work in process on disinfestation of grain, both in terms of irradiation of bulk grain and of packaged grain products.

1684 Proost, M. L'EFFORT BELGE EN MATIERE D'IRRADIATION DES ALIMENTS. Mede. LandbHoogesch. OpzoeklStns Gent 30, 2 (1965) 667-672.

Les diverses applications ont été classées en trois catégories selon les doses appliquées pour obtenir l'effet désiré: (1) traitements à faibles doses (50 000 rads ou moins); (2) traitements à doses moyennes (50 000 rads à 1 Mrad); (3) traitements à hautes doses (2 à 5 Mrads). Parmi les traitements à faibles doses figure la stérilisation des insectes infestant les produits alimentaires. Une dose de 5 à 10 000 rads est suffisante pour désinfester les denrées alimentaires entreposées. Dans ce cadre, la Station d'Entomologie de l'Etat à Gembloux a effectué une série d'expériences sur des calandres. La résistance de divers stages de développement de Sitophilus granarius L. et S. oryzae L. aux irradiations a été vérifiée. En collaboration avec le C.E.N., une étude sur la radiorésistance des Acanthoscelides obtectus, un coléoptère infestant les haricots blancs, est en cours. Des expériences analogues sont effectuées au "Leerstoel voor Dierkunde, Rijkslandbouwhogeschool à Gand sur la teigne de la farine, Ephestia kuehniella Z.

1685 Reiback, E., Morton, M.R. BULK-GRAIN-IRRADIATOR DESIGN. Trans Am. nucl. Soc. 8 (1965) 323-324.

A prototype irradiator designed by Vitro Engineering Co. to handle 5000 lb/h of grain at 25 000 rad is under construction at the USDA Experiment Station, Savannah, Ga. The grain flows in a square bin, through a source array consisting of doubly encapsulated strips of ^{60}Co, arranged in parallel rows in a horizontal plane. The grain is kept a min. distance from any ^{60}Co-source by an aluminium sheath around each source. The basic advantage achieved by this configuration is that the product approaches the source very closely. The product surrounds the source except at its perimeter, extending to 3 ft in depth above and below the source plane. Thus the loss of unabsorbed photons is minimized. These factors contribute to the unusually high efficiency for this irradiator, which is expected to exceed 50%. The nuclear analysis of the product dosimetry was made using a modified version of an IBM-7094 programme called Fudge-3A. Flow tests were made using transparent-sided bins to determine the flow profile of a variety of grains past the grid of source rods. Appropriate bin bottoms and vibration modes were developed to achieve a uniform product flow. The prototype irradiator has an additional package capability. - A schematic illustration of the design is given.

1686 Rukavishnikov, B.I. GAMMA IRRADIATION OF GRAIN AND OTHER RESERVES FOR STERILIZING AND EXTERMINATING PESTS. Sel'.-khoz. Rubezhom Rastenievodstvo 2 (1964) 58-63. (In Russian)

The author lists lethal and sterilising doses of γ-rays for various insects and mites which damage grain, fruit, furniture, etc. Resistance to lethal and sterilising actions of γ-rays increases, depending upon the extent to which insects have developed from egg to imago and, within one stage of development, with an increase in age. Instead of receiving a single dose, grain was irradiated with divided doses of γ-rays (one or more exposures to sublethal or sterilising doses which, taken together, equalled or slightly exceeded the lethal or sterilising dose for a single exposure) which made it possible to reduce the cost of treatment by a considerable reduction in the output of the source of radiation and had the advantage that insects were sterilised but not killed. With divided doses of irradiation germ-cells were irreversibly damaged, but damaged tissues in the body were able to regenerate in the interval between exposures. The author describes laboratory and industrial (portable and

stationary) equipment used for γ-irradiation. He compares the effectiveness of γ-irradiation and fumigation for grain and other agricultural products. (BA)

1687 Rukavnishnikov, B.I. GAMMA IRRADIATION OF GRAIN AND OTHER RESERVES FOR STERILIZING AND EXTERMINATING PESTS (REVIEW). Translation Referat. Zh., Biol. (1964) 58-63. 22E194. (See 1686)

With fractionated doses, germ cells were damaged irreversibly but body tissues were able to regenerate; insects were sterilised but not killed.

1688 Rushford, F.E. PUERTO RICO NUCLEAR CENTER. ITS PRINCIPAL IRRADIATION FACILITIES AND SCIENTIFIC PROGRAM. Isotopes Radiat. Technol. 4, 3 (1967) 251-255.

The chief irradiation facility at the PRNC is an AMF pool-type research reactor; a 10 000 Ci ^{137}Cs source is also available. Apart from food irradiation programmes, the possible applicability of the sterile male technique, using γ-irradiation, to the sugarcane borer, Diatraea saccharalis (Fab.) is under investigation. Various other programmes are discussed.

1689 Ruwe, D.M., Murphy, G., Bockhop, C.W. GAMMA-RAY ATTENUATION COEFFICIENTS OF GRAINS AND FORAGES. Am. Soc. agric. Eng. Trans. 9, 3 (1966) 312-313.

Some γ-ray irradiation facilities have been built and others are planned for the eradication of insects from grain as it is transported to and from storage. The in-storage irradiation of grain for mould and insect control has not been utilised, largely because of the lack of knowledge regarding the interaction of γ-rays with grain. Linear and mass attenuation coefficients can, however, be measured accurately and the measured values are in good agreement with theory. The density of the material and the number of electrons per atomic mass unit (0.536) are the important parameters in determining the attenuation coefficients. The kind of grain or forage and the moisture contents of these materials have negligible effects on the attenuation coefficients.

1690 Scott, W.J. FOOD IRRADIATION IN AUSTRALIA. Fd Irrad. 2, 4 (1962) A4-A5.

All food irradiation research in Australia is carried out at the A.A.E.C. Research Establishment at Lucas Heights. Radiation sources are an underwater ^{60}Co irradiator which soon will have a strength of 10 000 Ci, a fuel element of 100 Mrad/cc/d, and a small Van de Graaff accelerator. At Dandenong near Melbourne, a very large ^{60}Co source (500 000 Ci), operated commercially for disinfecting animal hair, will also be available for food irradiation. Presently, food preservation is investigated at a low dosage of 10^4 rad at which level no organoleptic changes are detectable. Interest is concentrated on the preservation of fruits which are often infested with the Queensland fruit fly Strumeta tryoni. Dosages of 10 000 rad, which are necessary to kill the insect, have not produced noticeable organoleptic changes in citrus fruits. Dosages of 5000 rad control the sprouting of potatoes under Australian conditions for 6 months. However, the introduction of the commercial irradiation of food must await acceptance by the Public Health Authority which carries out experiments with irradiated foods on animals. (Auth.)

1691 Talhouk, A.S. PROSPECTS AND NEEDS FOR RADIATION DISINFESTATION OF PACKED FRUITS AND VEGETABLES. p. 105-113 of "Applicaton of Food Irradiation in Developing Countries". Technical Reports Series No.54. Vienna, International Atomic Energy Agency. 1966, 183p. STI/DOC/10/54.

In countries with adequate precipitation or irrigation water and high average yearly temperatures the growth of particular crops is favoured. The suitable climatic conditions, however, favour the multiplication of many pests in the stores. The problem of pests of packed fruits and vegetables, although cosmopolitan, presents a particular concern to the developing countries. The pests that are likely to be affected by irradiation and are less susceptible to the conventional methods of control are discussed, and recommendations made. Some specific instances are given where radiation disinfestation would be very useful. Amongst the serious pests of packed fruits and nuts are the dried fruit moths, Ephestia cautella, E. elutella and the polyphagous Pyralis farinalis and Plodia interpunctella. Owing to the lack of forced diapause during their life cycle, these pests reproduce uninterruptedly in the warehouses and ship hulls, and often render the expensive goods utterly unsalable by the time the cargo reaches the retailer, or even the wholesaler. The

commodities often contain Tribolium confusum, T. castaneum as well as a number of Cucujid beetles of cosmopolitan distribution. These beetles, as well as the Calandra granaria and oryzae, spend their entire life in or on the commodities, which fact makes irradiation more advantageous than the conventional methods of treatment. Other serious pests are Ceratitis capitata, the red spider, Metatetranychus ulmi and Tetranychus urticae, and the potato tuber moth Phthorimea operculella.

1692 Tape, N.W., Ferguson, W.E. QUALITY EVALUATION OF IRRADIATED PAKISTANI RICE. Fd. Irrad. 7, 1/2 (1966) A22-A25.

Data are given on the effects of γ-radiation on control of insects on rice. The rice was packaged in 4-lb lots in polyethylene bags. Several 4-lb samples were irradiated by the Atomic Energy of Canada Ltd. in a Gammacell 220 (^{60}Co γ-radiation at a rate of approx. 1.3 million rad). Samples were exposed to 15 000 rad, 30 000, and 60 000 rad. This range was selected because of the approved dose range for wheat in the United States and the results of Watters. The latter found that no progeny of six common grain infesting insects were obtained from adults irradiated in wheat at 12 500 rad or higher. Sensory and objective tests were conducted in the Food Research Institute to determine if differences in quality existed between the control and irradiated rice. Vitamin assays were made in the Food and Drug Directorate (Department of National Health and Welfare). The irradiation of rice to control insect infestation does not have any effect on rice quality. The flavour, texture, and colour of rice was not affected by 30 000 rad. Some indication of a harmful effect on flavour was observed in rice irradiated with 60 000 rad. However, this dose level is more than that required for insect control. The niacin and thiamine content was not changed by irradiation. (Auth.)

1693 Török, G., Farkas, J., Vas, K. RÖNTGENSUGÁRZÁS HATÁSA RAKTÁRI RAVARKÁRTEVŐKRE. (x-Ray irradiation effects on storehouse destructive insects.) Konzerv-Hus Hűtőipari Kut. Intézet. Közl., Budapest 1 (1959) 23-30. (In Hungarian, with English summary)

The radiation tolerance of the salami pest, Enicmus minutus L., and of some flour pests was studied. Irradiation was carried out with apparatus of a 46.7 krad/h capacity, using dose levels of 3, 6, 12.5, 25, 50, 100, and 200 krad/h, at 200 kV. Even with the highest dose there was no immediate destruction of insects. The effect of radiation manifested itself in a gradual lowering of the average life span. Percentage mortality greatly depends on the period of observation. By means of probit analysis it was possible to determine the doses required to give 50% mortality on the 6th, 12th, and 15th day after irradiation. The doses required to accelerate mortality do not go up proportionately: to achieve 50% mortality in 6 instead of 12 days, the original dose needs to be increased 8 to 10-fold. With E. minutus, radiation tolerance varies with age: young adults are much less resistant than older ones. Radiation sensitivity was greater than in the flour pests tested. Metamorphosis in larvae was stopped by 50-h irradiation. Mortality graphs were similar to those obtained for adults.

1694 Deleted.

1695 Török, S., Farkas, J. RESULTS, DEVELOPMENT AND PROSPECTS OF RESEARCH MADE IN THE APPLICATION POSSIBILITIES OF IRRADIATION IN FOOD-INDUSTRIES. Orsz. Müszaki Fejl. Biz. Budapest 1962.

1696 Upadhya, M.D., Brewbaker, J.L. IRRADIATION OF MANGOES FOR CONTROL OF THE MANGO SEED WEEVIL (Sternochetus mangiferae). Hawaii Fm Sci. 15, 1 (1966) 6-7.

S. mangiferae (Fabricius) is restricted to the hard-shelled seed so that standard fumigation methods are almost wholly ineffective against it. Irradiation of infested fruit in the Hawaii Research Irradiator led to no survival in adults after 120 krad and three weeks of storage, while 60 krad sufficed for complete lethality after five weeks of storage. Most "live" weevils remaining after 30 krad or more succumb sooner or later to their irradiation injuries. Adults are most resistant to irradiation. Preliminary data indicate that sterilization occurs after > 10 krad. Further experiments showed that mango varieties like Haden and Pirie tolerate doses that successfully control the weevil, without altering their appearance or flavour. Shelf-life extension of fruits was an unexpected bonus of radiation treatment in the disinfestation range.

1697 Upadhya, M.D., Brewbaker, J.L. EFFECTS OF GAMMA IRRADIATION ON THE PINEAPPLE. Hawaii Fm Sci. 15, 1 (1966) 8-9.

Fruit flies attack all fresh pineapples but the larvae are generally restricted to the shell and often fail to pupate. Preliminary studies indicate that disinfestation in the dose range of 30-50 krad also brings about a significant extension of shelf life without producing undesirable changes in fruit appearance or quality. (The crowns of irradiated fruits could not be used to establish growing plants since irradiation above 15 krad inhibits rooting.)

1698 Val Cob, M. del., Ortin Sune, N. FOOD PRESERVATION BY IRRADIATION. I. EVOLUTION AND PRESENT STATUS IN THE WORLD. AEC-TR-6690, Junta de Energia Nuclear, Madrid (Spain). 1965, 61p. Translation of Report: JEN-156-S1/1-15.

Review article, with a relatively brief section on de-insectation of cereals and stored products.

1699 Watters, F.L. EFFECTS OF GAMMA IRRADIATION ON THE LONGEVITY AND FERTILITY OF FIVE SPECIES OF STORED-PRODUCT INSECTS. Bull. ent. Soc. Am. 12 (1966) 265. Abstr. 338. Presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

A mobile ^{60}Co-source was used to irradiate insects in wheat at dosages of 6250 - 150 000 rad. Results are presented on: (1) initial and delayed mortalities; (2) fertility of survivors; (3) germination, and milling and baking tests of wheats irradiated at 13 and 16% moisture content. (Abstr.)

1700 Wootten, C.B. OPERATION OF THE PORTABLE CESIUM IRRADIATOR. p. 96 of "6th Annual AEC Food Irradiation Contractors Meeting, Washington, D.C., USA. 3-4 Oct. 1966". CONF-661017, Division of Isotopes Development (AEC), Washington, D.C. 1966, 216p.

(First operation of the unit for demonstration purposes was scheduled for March 1967.)

See also:

1342 Gross effects of gamma radiation on the Indian-meal moth and the Angoumois grain moth. (Cogburn, R.R. et al., 1966)

1344 Belgium contributions to the data on irradiation of substances. (DeProost, M., 1965)

1359 Radiation susceptibility of various developmental stages of the Mediterranean fruit fly (Ceratitis capitata Wied.). (Kahan, R.S. et al., 1965)

1436 Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation. (Farkas, J., 1965)

1625 The defense department is on its third test procurements of irradiated food... (Anonymous, 1967)

1627 Insect infection of African dried or smoked fish and the possibility of its control by irradiation. (Daget, J., 1966)

1628 Advances in storage technology with special reference to the tropics. (Dobrovsky, T.M., 1965)

1630 Possible applications to food of ionizing and nonionizing radiations. (Goldblith, S.A., 1967)

1631 Latest approaches to flour mill pest control. (Goosens, H.J., 1964)

1701 Economics of grain irradiation. (Baines, B.D. et al., 1966)

1702 Economic aspects of the food irradiation programme in Israel. (Lapidot, M. et al., 1966)

1760 Information circular on Radiation Techniques and their Application to Insect Pests. No.7. (International Atomic Energy Agency, Vienna (Austria). 1966)

2.4.3.3. Economics

1701 Baines, B.D., Mosely, J. ECONOMICS OF GRAIN IRRADIATION. p. 813-831 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

After three years in which preliminary designs were prepared, a grain irradiation plant has been designed and is being built into an existing silo installation. From this experience actual costs of plant construction are available for a plant using ^{60}Co, and this experience is incorporated in estimates for machine installations for high grain throughput. Costs are compared for plants of compa-

rable complexity, and they indicate those areas in which each type of plant is pre-eminently suitable and those areas where either type may be best, dependent upon local site conditions, the standard of local technology and methods of operation. The two plants compared are described in sufficient detail to enable the precise extent of the equipment supply covered by the costs to be appreciated. The accounting methods employed have been discussed with industrial accountants to ensure that they are acceptable to the potential users. The methods employed are explained so that they can be applied to problems of a similar nature. (Auth.)

1702 Lapidot, M., Foa, E., Sivan, Y., Kahan, R.S. ECONOMIC ASPECTS OF THE FOOD IRRADIATION PROGRAMME IN ISRAEL. p. 851-864 of "Food Irradiation. Proceedings of the International Symposium on Food Irradiation Jointly Organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Karlsruhe, Federal Republic of Germany, 6-10 Jun. 1966". Vienna, International Atomic Energy Agency. 1966, 956p.

The economics of food irradiation must be surveyed on a national scale at the outset of any ambitious technological feasibility study programme. This must be followed by detailed economic studies as the programme progresses. Such a technological-economic survey of radiation-preserved agricultural produce was made in Israel in July 1965. All items which, potentially, could benefit from irradiation (fruits and vegetables, fodder, cereals and cereal products, fish, meat, poultry and poultry produce) were examined. Irradiation costs were estimated on the basis of available and extrapolated data for small irradiators in the growth areas and for large irradiators in ports or along main highways. Surface treatment by electron accelerators and bulk treatment by ^{60}Co, ^{137}Cs or x-ray sources were considered. The survey was useful in formulating the programme for detailed technological applications for the period up to 1971. - Disinfestation problems could easily be solved by incorporating irradiation sources in the flow patterns of the fodder through the silo. This would be at a minimum cost because of the simple design of the irradiation facility and the very efficient radiation absorption. Preliminary packing and service irradiation in central facilities would allow disinfestation of cereal products at an irradiation cost of $< 1\%$ of their value. Irradiation at low doses would provide satisfactory quarantine measures for citrus fruit, and would also allow bulk sale in large shipping containers, or pre-packaging in small perforated plastic bags. - The sterile male technique used on <u>Ceratitis capitata</u> shows great promise here.

See also:

1436 Study of the irradiation tolerance of some destructive storehouse insects and technical and economic aspects of insect destruction by irradiation. (Farkas, J., 1965)
1547 Towards better insect control. (Nelson, S.O., 1965)
1634 Preservation of food by low-dose ionizing energy. (Quartermaster Research and Engineering Center, Natick, Mass., 1961)
1639 Two cobalt irradiators for a food-treatment lab at India's Trombay atomic energy establishment.... (Anonymous, 1966)
1640 Grain irradiation plant. (Anonymous, 1967)
1642 A 150,000 curie cesium irradiator will begin touring the country.... (Anonymous, 1966)
1643 100,000 curies of cobalt for the large grain irradiator in Turkey.... (Anonymous, 1966)
1645 The world's first large-scale continuous grain irradiation plant, Iskenderun, Turkey. (Anonymous, 1967)
1654 Control of insects in stored grain by irradiation. (Cornwell, P.B., 1964)
1658 I - USAEC food irradiator program. (Dietz, G.R. et al., 1966)
1661 Hawaii development irradiator (HDI). (Garber, H.J., 1966)
1668 Food irradiation research and pilot facilities in operation or planned in India. (Kumta, U.S. et al., 1966)
1675 Techniques of the future for the preservation of food products in deposits. (Mariani, A., 1964)
1682 Hawaii development irradiator - a new tool in tropical fruit processing. (Otagaki, K.K., 1967)
1685 Bulk-grain-irradiator design. (Reiback, E. et al., 1965)

2.4.3.4. Detection and Damage Assessment

1703 Calderon, M., Binyamini, N. DAMAGE TO BISCUITS CAUSED BY Lasioderma serricorne (F.) (AND DATA ON ITS BIOLOGY AS SHOWN BY RADIOGRAPHS). Teva Vearetz 2, 6 (1960) 1-6. (In Hebrew, with English summary)

A heavy infestation of stored biscuits by L. serricorne is recorded and the type of damage described. The detection of hidden infestation by means of radiographs is illustrated. Preliminary work on the biology of the insect in biscuits is described, aimed at demonstrating the use of x-rays in the study of the life cycle of insects, in particular borers in stored products. As a result, the following data were obtained, at 30 °C and R.H. 83%: (1) the size of larvae ranged from 0.82 mm-2.8 mm (full size). Pupae are 2.4 ± 0.34 (standard deviation) mm long; (2) one generation (from adult to adult) takes 38.9 ± 1.00 (SD) d, the pupal stage lasting for 6.8 ± 1.22 (SD) d. - Further work is being carried out to obtain additional data. (Based on auth.)

1704 Freeman, C.C. CRITERIA FOR RADIOGRAPHIC EXAMINATION OF INTERNAL INSECT INFESTATION. J. Ass. off. agric. Chem. 48, 6 (1965) 1183-1185.

The insect tunnel is considered the common denominator for radiographic examination of internal insect infestation. General characteristics of insect tunneling are described to distinguish between natural appearance and infestation. Certain criteria have proved applicable to insect tunneling in green coffee beans and other products: rounded terminal ends, parallel walls (primarily true for tunneling in coffee beans), the presence of insect excreta (small patches of granular material visible through a magnifier) and insects (often only visible as ghostly shadows due to lack of moisture), uniform size, definite margins (even when contrast is poor), and tunnels devoid of plant tissue. Coffee beans have certain characteristics which cause confusion to the analyst, such as infoldings and convolutions and, in particular, the germ, especially in old coffee beans that have lost moisture during storage. However, with practice a rapid radiographic analysis is feasible.

1705 Mills, R.B. LABORATORY STUDIES OF THE BIOLOGY AND BEHAVIOR OF THE ANGOUMOIS GRAIN MOTH, Sitotroga cerealella (Oliv.) Diss. Abstr. 25 (1965) 1424-1425.

In part of the study radiography was used. Daily x-ray radiographs were made of the larval-pupal development of 73 insects in wheat kernels, 44 in corn, and 66 in sorghum, using a G. E. Grain Inspection x-Ray Unit. Study of the series of enlarged photographic prints made from these radiographs revealed shorter larval-pupal periods if larvae fed on germ soon after entering the kernels. Penultimate and last larval instars, prepupae, and pupae could be distinguished in radiographs. Insects with longer larval-pupal periods spent more of this additional time in the earlier stadia than in the penultimate and last larval stadia, and pupal period. These later stages were remarkably uniform in comparison to the earlier ones. The late-developers were in the endosperm without access to germ during the early stadia.

1706 Mills, R.B., Wilbur, D.A. RADIOGRAPHIC STUDIES OF ANGOUMOIS GRAIN MOTH DEVELOPMENT IN WHEAT, CORN, AND SORGHUM KERNELS. J. econ. Ent. 60, 3 (1967) 671-677.

Daily x-ray radiographs were made of 73 wheat, 44 corn, and 66 sorghum kernels to study (with little or no disturbance to the insects) development and behaviour of larvae and pupae of Angoumois grain moth, Sitotroga cerealella (Olivier), inside the kernels. Lengths of later stadia were generally ascertained, because time of moulting to the penultimate and last instars usually could be determined. The ranges and means of the periods from hatching to penultimate instar were 8-33 d and 14.9 d in wheat, 9-28 and 13.9 d in corn, and 7-31 and 12.9 d in sorghum; the penultimate larval period was 4-10 and 5.3 d in wheat, 3-7 and 4.7 in corn, and 3-7 and 4.5 in sorghum; ultimate larval period (including prepupa) 6-12 and 8.3 d in wheat, 6-10 and 7.9 in corn, and 5-8 and 6.4 in sorghum; pupal period 8-11 and 9.6 d in wheat, 7-10 and 8.9 in corn, and 7-10 and 9.3 in sorghum. Ranges and means of the total larval-pupal periods were 29-63 and 37.9 d in wheat, 28-52 and 35.3 in corn, and 25-54 and 33.0 in sorghum. Insects with longer developmental periods spent disproportionately more time as earlier instars than the insects with shorter developmental periods. (Auth.)

1707 Perutik, R. AN X-RAY DEVICE FOR THE DEFECTOSCOPY OF SEEDS. TO DETERMINE HEALTHY, INFESTED AND BARREN SEEDS OF OATS AND WINTER BARLEY. Ochr. Rost. Min. Zem. Les. Hosp., UVTI, Sb. 39, 1 (1966) 37-42. (In Czech)

2.4.4. Sericulture

1708 Beard, R.L., Saovanee Chakpitak. KILLING SILKWORM PUPAE BY IRRADIATION. p. 12-13 of "Insect Eradication by Irradiation, Bangkok, Thailand. 28-29 Jun. 1966". THAI.AEC-8, Office of Atomic Energy for Peace, Bangkok (Thailand).

Reports from the USSR suggested that γ-irradiation of cocoons might be superior to heat treatment. The advantages claimed included improved reeling and dynamometric properties, increased yield, less alteration in sericin characteristics, and improved preservation of cocoons for storage. Improved knitting properties because of increased lyophilic and adhesive properties were also observed. - Two lots of 50 fresh silkworm cocoons were each given a dose of 100 000 rad or heat treatment of 52-54°C for 3 h, respectively. The irradiated pupae continued to show some activity for 8-10 d, were of a lighter colour, and had retained their original shape and consistency; their weight was 5.4 g as compared to 2.8 g for heat-treated cocoons. These preliminary tests suggest that the principal difference between the two methods lies in the weight retention and better reeling properties of the irradiated cocoons.

1709 Hossain, M.M., Mallik, M.U., Mollah, S.A. SERICULTURE IN EAST PAKISTAN AND ROLE OF ATOMIC ENERGY FOR ITS IMPROVEMENTS. AECD-RB-3, Atomic Energy Centre, Dacca (Pakistan). Jul. 1966, 17p.

The use of atomic energy to improve sericulture in East Pakistan is discussed. Irradiation of silkworms can stimulate growth, as has been shown by low dose (100-400 R) irradiation of 5th-instar larvae, when more silk was produced. Hot air treatment for killing pupae inside the cocoon injures the silk, and it is envisaged to replace it by γ-irradiation which also preserves cocoons for a much longer period; this also allows the ends of the fibre to be located more easily. Mutations induced by ionizing radiations can be developed to improve commercial varieties of silk. Radiation treatment by its effects on the colloidal properties of sericin can lead to better commercial grading. The production of eggs which permit sex differentiation by colour in new mutant strains as reported elsewhere more than 15 years ago, and the subsequent rearing of males only involves important economies.

2.4.5. Biological Control

1710 Cantwell, G.E., Franklin, B.A. INACTIVATION BY IRRADIATION OF SPORES OF Bacillus thuringiensis VAR. thuringiensis. J. invertebrate Path. 8, 2 (1966) 256-258.

Spores of B. thuringiensis var. thuringiensis on filters or glass slides were exposed to u.v. light, γ-radiation or sunlight. All treatments had deleterious effects. Nearly 50% of the spores were inactivated by exposure for 30 min to sunlight at temperatures of 70-92°F. Irradiation effects might explain some of the discrepancies between laboratory and field tests of biological control of pests with B. thuringiensis. (RAE-A 55: 1967, 71)

1711 Smirnoff, W.A., Cantin, M. EFFECT OF GAMMA IRRADIATION ON THE GROWTH RATE OF SPECIES OF Bacillus cereus GROUP. J. invertebrate Path. 9, 3 (1967) 357-363.

Results are presented of experiments on the influence of γ-irradiation on the growth, in vitro, of six entomopathogenic varieties of the Bacillus cereus Group. Growth of all six varieties was inhibited in the range, 228 280 to 456 560 rad and suppressed at 500 000 rad and over. Bacillus thuringiensis var. entomocidus was the most sensitive. Up to 500 000 rad, no modification in sporulation and crystal formation appeared; the only observable change was the time required for lysis, which increased as the dose increased. (Auth.)

See also:

1298 X-ray response of an endoparasitic wasp. (Ducoff, H.S., 1966)
1581 Use of alternative biological control schemes. (Horber, E., 1966)
1768 Cockroach control, past present future. (Burden, G.S., 1967)

2.4.6. Disease Control

1712 Dame, D.A. et al. CENTRAL AFRICA. I. THE USDA RESEARCH TEAM FOR THE CHEMO-STERILIZATION OF TSETSE FLIES. II. THE RADIO-STERILIZATION OF TSETSE. (2 PAPERS). Annual Report of the Agricultural Research Council of Central Africa. 1965. n.p.

The effects of tepa, metepa and γ-radiation on longevity, viability and reproductive potential are compared.

1713 McDuffie, W.C., Weidhaas, D.E. CURRENT RESEARCH BY THE USDA OF POTENTIAL SIGNIFICANCE TO WORLD-WIDE MOSQUITO CONTROL. Mosquito News 27, 4 (1967) 447-453.

Review of the possible used of insecticides, biocontrol, repellents, attractants, and sterilization in mosquito control.

1714 Weinbren, M.P. ANNUAL REPORT 1965. TERRESTRIAL ECOLOGY PROGRAM II: RADIATION-INDUCED VARIABILITY IN INDIGENOUS ARTHROPOD-BORNE ANIMAL VIRUSES OF PUERTO RICO. p. 147-148 of "Annual Report, 1965". PRNC-82, Puerto Rico Nuclear Center, Mayaguez. 225p.

The programme is designed specifically to study the effects on natural virus cycles (arthropod-borne viruses, especially Arbovirus) in γ-irradiated portions of the tropical rain forest.

See also:

1588 Eradication of the screw worm fly: an agent of myiasis. (Baumhover, A.H., 1966)

2.4.7. Miscellaneous
(Radiation and Pest Resistance. Radiation Effects on Pesticides. Radiation Protection. Etc.)

1715 Affeltranger, C.E., Neel, W.W. EVALUATION OF RADIATION-PROCESSED WOOD-PLASTIC COMBINATIONS AGAINST SUB-TERRANEAN TERMITE ATTACKS. p. 57-61 of "Proceedings of the 2nd Workshop on Termite Research, Biloxi, Miss., USA, 8-10 Nov. 1965". Washington D.C., National Research Council. 1966, 109p.

Results of laboratory and field studies are reported. They indicate that radiation-processed wood-plastic combinations (produced by applying γ-radiation from a ^{60}Co-source to wood previously impregnated with a liquid monomer, the result being to initiate polymerization and to produce a plastic-reinforced wood that is stronger and harder than natural wood) possess considerable resistance to attack by Reticulitermes flavipes. This is true of impregnation with methyl methacrylate or Taylor's solution (30% methacrylic acid and 70% methylacrylate), whereas impregnation with polyvinyl acetate confers considerably less resistance. (Based on RAE-A 55: 1967, ref. 796.)

1716 Boldyrev, M.I. Thomasiniana ribis Mar. AND ITS ERADICATION. Izv. timiryazev. sel'.-khoz. Akad. No.4 (1966) 151-165. (In Russian)

On p.163, it is pointed out that the application of γ-rays from a ^{60}Co-source appears promising for the protection of cuttings. At the doses used (300-1000 R) the cuttings were not injured. Disinfestation by irradiation was directed against Thomasiniana ribis Mar.

1717 Dzhagatspanyan, R.V., Drobiz, A.M. UTILIZATION OF VARIOUS RADIOISOTOPIC DEVICES AND METHODS IN THE OIL AND CHEMICAL INDUSTRIES. CONF-641024-12. "Symposium on Use of Radioisotopes". Warsaw, Poland, n.d., 23p.

Radioisotopes are used in measurement and control equipment, as tracers, and for inducing chemical reactions. They have also been used to evaluate the amount of the γ-isomer in hexachlorocyclohexane, which determines its insecticidal properties, and to monitor the production of Metafos.

1718 Dzhagatspanyan, R.V., Zetkin, V.I. EINIGE REAKTIONEN DER ORGANISCHEN CHEMIE UNTER DEM EINFLUSS VON KERNSTRAHLUNG. (Some reactions in organic chemistry under the influence of nuclear radiation.) Chem. Wiss. Ind. 4 (1959) 761-769. (In Russian)

Industrial applications of nuclear radiation in connection with some chemical processes are outlined. The production of gammexane ($C_6H_6Cl_6$) by radiation-induced chlorination and sulphoxidation of hexanes by means of γ-radiation from a ^{60}Co-source are among them.

1719 Gavrila, V., Jurubescu, V., Alexe, G., Holerca, J. BIOSTIMULATIVE EFFECT OF IRRADIATED CHRYSALIS MEAL ON PIGLET DEVELOPMENT. Lucr. stiint., CVII (1964) 451-454. (In Rumanian)

Feed supplemented with an irradiated industrial meal including silkworm pupae administered to piglets in progressive doses (starting with 0.50 cg/kg bodyweight) stimulated their growth and development rate. The supplement administered to a 1st lot resulted in a 6 kg gain, on the average, while the average daily gain in the 2nd lot was of 60-70 g, as against the controls. The treatment was more efficient during winter than in summer. The ten months observation period showed that the gilts of the 1st lot had 9 to 14-strong litters (as compared with the 6 to 9-strong litters of the controls) and that newly born piglets registered higher birth weights. (Auth.)

1720 Lippold, P.C., Bourke, J.B., Massey, L.M. FURTHER STUDIES ON EFFECTS OF COBALT-60 RADIATION ON PESTICIDES. Bull. ent. Soc. Am. 13, 3 (1967) 192. Abstr. 110. Presented at "New York Meeting of the Entomological Society of America. New York, N.Y., USA. 27-30 Nov. 1967".

Degradation of a number of pesticides were obtained at doses of 0.1-5.0 Mrad. Changes were evident with pesticide solvent standards as well as extracts of treated crops. Chromatographic and biological analyses were employed to analyse solutions. Decreases in concentration followed a 1st-order reaction. (Abstr.)

1721 Neel, W.W., Affeltranger, C.E., Beal, R.H. RADIATION-PROCESSED WOOD-PLASTIC COMBINATIONS CURB SUBTERRANEAN TERMITE ATTACKS. Pest. Contr. 34, 7 (1966) 39-40.

Treated and untreated blocks of maple, birch, and white pine measured 1 in. × 1 in. × 3 in. Radiation from a ^{60}Co-source replaces the activating agent (chemical catalyst) ordinarily used to bond the plastic molecules. Radiation activates the monomers (plastics) themselves, so they join together or polymerize. The treatments consisted of: (1) irradiated blocks impregnated with (a) vinyl acetate, (b) methyl methacrylate, and (c) 30% methacrylic acid and 70% methyl methacrylate of different castes; (2) irradiated control blocks; and (3) untreated control blocks. — 8 to 10 replicates of each treatment were used. Each block, in a sterile jar with its sand contents, was exposed to approximately 500 worker termites, Reticulitermes flavipes. The jars were kept in an incubator at a constant temperature of 77°F and 90% relative humidity. The laboratory results (Table 1) reveal that termite attack, reflected by weight loss, is less for wood treated with the mixture of methacrylic acid and methyl methacrylate. Second most effective is methyl methacrylate, and the least effective is vinyl acetate. The average weight loss of the maple blocks impregnated with vinyl acetate was almost as much as the weight lost in the irradiated and the untreated control blocks. Results of the field tests showed that methyl methacrylate stakes had fewer termite attacks than the vinyl acetate stakes. There was a direct correlation between termite attack and wood decay in each series treated. Some resistance to termite attack may be deduced from the monomer treatment. The length of this resistance over extended period of time is being investigated.

1722 Reistrup, J.V. BEES MAY HELP TO BLUNT STING FROM RADIATION. Washington Post Dec.16 (1966) n.p.

Newspaper article. Protection results from venom-induced stress or free radical scavenging.

1723 Shipman, W.H., Cole, L.J. INCREASED RADIATION RESISTANCE OF MICE INJECTED WITH BEE VENOM ONE DAY PRIOR TO EXPOSURE. USNRDL-TR-67-4, Naval Radiological Defense Lab., San Francisco, Calif. 20 Dec. 1966, 19p.

Mice were injected with bee venom dissolved in a 0.90% NaCl solution. This injection was given either intraperitoneally or subcutaneously 24 h before the mice were irradiated with x-rays. It was found that, after exposure to a lethal dose of radiation (800-850 R) the venom-injected mice had a consistently higher number of survivals than the controls, and that the subcutaneously-injected mice had a higher number of survivals than the intraperitoneally-injected mice. The question as to whether this radioprotective effect of bee venom is due to its general stress-like effect, or to the action of a specific chemical component was discussed. (Auth.)

1724 Tsochev, T.N. BIOLOGICAL PROPHYLLAXIS OF ACUTE RADIATION DISEASE WITH LYOPHILIZED ROYAL JELLY. Eksp. Med. Morfol. 3 (1964) 219-223. (Bulgarian? Russian?)

Studies using the lyophilized Bulgarian royal jelly apitonin and cystamine chloride in 280 rats irradiated with LD 90 to LD 100 (750-850 R) revealed that a dose of 0.8-1 g/kg daily for 6 d (with irradiation on day 3) protected rats more effectively than an optimal (nearly toxic) dose of cystamine; 55% survival ($p < 0.05$), compared with 50% for cystamine. Only 10% of the untreated controls survived. (NSA 19: 1965, 19629)

3. ADDENDUM

3.1. TECHNIQUES

3.1.1. Autoradiography

1725 Paul, J.S. QUANTITATIVE BIOPHYSICAL AND CYTOCHEMICAL STUDIES OF POLYTENE CHROMOSOMES. Diss. Abstr. 27, 1 (1966) 45-B - 46-B.

Quantitative studies on the cytochemical and cytophysical properties of the polytene chromosomes of the salivary gland (1st, 2nd, and 3rd instar) of Drosophila melanogaster were undertaken using interference microscopy and microspectrophotometry in order to elucidate some aspects of fundamental chromosome structure. The refractive indices of nucleoplasm, nuclei, bands and interbands of distal and proximal salivary glands and Malpighian tubules of the 3rd-instar larvae were determined. A new method of automated autoradiograph grain counting was developed. This method was characterized by its extreme accuracy and rapidity, even for small areas within a single cell. It was applied to labelled (in vivo) 3rd-instar salivary glands. A lessening of the rate of incorporation of isotopes with increasing ploidy was observed. Among the experiments carried out were the extraction of salivary chromosomes with DNase, and RNase; treatment of chromosomes with trypsin and pepsin; removal of DNA and RNA with trichloroacetic and perchloric acid; cold shock applied to larvae; and densitometric studies. RNA concentrations in the puffs of living salivary gland cells were found to be not much higher than those in some bands; the total volume was, however, much higher due to the large volume. Quantitative cytochemical studies by microspectrophotometry were performed and correlated with interference microscopy. The data obtained from combined interferometric and microspectrophotometric studies indicated that DNA was present in both bands and interbands. RNA was present in variable degrees in certain bands. The absolute mass was greater in the bands than in interbands. The distribution of DNA did not correlate,on a proportional basis, with the protein distribution. It was, therefore, evident that simple coiling of the chromonemata could not entirely explain the distribution of nucleic acids and protein. The interband regions appeared to contain high levels of non-histone proteins which were probably not directly associated with the nucleohistone component.

1726 Salpeter, M.M. ELECTRON MICROSCOPE RADIOAUTOGRAPHY AS A QUANTITATIVE TOOL IN ENZYME CYTOCHEMISTRY. I. THE DISTRIBUTION OF ACETYLCHOLINESTERASE AT MOTOR END PLATES OF A VERTEBRATE TWITCH MUSCLE. J. Cell Biol. 32, 2 (1967) 379-389.

^{3}H-diisopropylfluorophosphate (DFP) was used to phosphorylate acetylcholinesterase (AChase) in the motor end plate of mouse sternomastoid muscle, and its distribution within the end plate was evaluated quantitatively by electron microscope radioautography. With the use of emulsion layers whose sensitivity to ^{3}H had been calibrated, the density of AChase in different components of the end plate was calculated. The AChase was primarily localized (85%) in the junctional fold region. The concentration of AChase there was more than 20 000 active sites per cubic micron of tissue. The resolution of the technique was not sufficient to determine whether there was some AChase in the nerve end bulb; however, if there is any there, the concentration must be less than 10% of that at the junctional fold region. (Auth.)

See also:

275 Influence of the physical state of chromatin on nucleic acid and protein synthesis and on radiation sensitivity of cell division. Progress report. (Gaulden, M.E., 1967)

455 Application of the autoradiographic technique to the study of the excretion in the coleopterous insect Tenebrio molitor L. (Marcuzzi, G. et al., 1964)

572 Radiometric detection of exposure to insecticides. (Disney, R. W., 1965)

663 Application of radiochemistry techniques in food processing research. Radioisotopic tracer techniques in evaluation and improvement of industry practices for removal of pesticide residues from foods. Annual report No. 4. (Mercer, W. A., Ed., 1964)

671 Use of radioisotope techniques to detect and measure pesticide residues in and on foods and to evaluate commercial food preparation practices. (Ralls, J. W., 1965)

1791 "Proceedings of FAO/IAEA Training Course on Use of Radioisotopes in Entomology, Gainesville, Fla., 4 Oct. - 26 Nov. 1965". (International Atomic Energy Agency, Vienna, Austria et al., 1965)

3.1.2. Dosimetry

1727 Roti Roti, J. L., Kaye, S. V. CALIBRATION OF $^{90}Sr + ^{90}Y$ PLANES FOR IRRADIATING INSECTS. ORNL-TM-1921, Oak Ridge National Lab., Tenn. 18 Jul. 1967, 22p.

Calibration dose-rate measurements were made above two 34 cm diameter plane-disk sources containing approx. 75 mCi and 750 mCi of $^{90}Sr + ^{90}Y$, respectively. The contact dose rate in the centre of the 75 mCi source was 656 rad/h and the measured dose rate at contact in the centre of the 750 mCi source was 4950 rad/h. The data presented are intended to be useful in the planning of experiments for investigation of the effects of radiation on insects. (Auth.)

1728 Schlagbauer, A. EINE RATIONELLE MESS- UND AUSWERTUNGSMETHODE ZUR ERFASSUNG DER BIOLOGISCHEN HALBWERTSZEIT VON RADIOISOTOPEN UND IHRE ANWENDUNG IN DER ENTOMOLOGIE. (A rational method of measurement and evaluation for the determination of the biological half-life of radioisotopes, and its application in entomology.) Int. J. appl. Radiat. Isotopes 18, 8 (1967) 595-603. (In German, with English, French and Russian summaries)

The decay curves were determined from measurements of the pulse rate of radioactively labelled compounds on live insects by means of a FORTRAN 7090 computer programme. The biological half-lives are thence calculated on the basis of formulae which are given. An exact mathematical method with rational data processing produced reproducible results. The method was tested with various kinds of bugs, including Pyrrhocoris apterus L., Rhinocoris iracundus Pd., and Oncopeltus fasciatus Dall., using ^{32}P, ^{86}Rb, and ^{131}I. Water bugs (Notonecta glauca L., Corixa punctata Ill., Gerris lacustris (L.)) secrete the tracers used more quickly than bed bugs. For phosphate and iodide the biological half-life for bed bugs amounted to about 50 d and for water bugs to 3 d. Half of the rubidium chloride, on the other hand, was eliminated by bed bugs within $1\frac{1}{2}$ d.

3.1.3. Isotope Dilution

1729 Bogner, R. L. DEVELOPMENT OF DOUBLE ISOTOPE DERIVATIVE ASSAYS FOR MEASUREMENT OF PESTICIDE RESIDUES. p. 67-77 of "Radioisotopes on the Detection of Pesticide Residues. Proceedings of a Panel. Vienna, 12-16 Apr. 1965". STI/PUB/123, International Atomic Energy Agency, Vienna (Austria). 1966, 118p.

A discussion on the principles of radioisotope dilution procedures and the development of double isotope derivative analysis for pesticide residues, such as DDT and dieldrin. (CA 68: 1968, 20979h)

See also:

1737 Development of double isotope derivative dilution analyses for selected food additives. Final Report. (Bogner, R. L. et al., 1963)

3.1.4. Labelled Pool Technique

See :

307 Formation of tritium pools during mitosis. (Leach, W.M., 1964)

3.1.5. Neutron Activation Analysis

1730 Bogner, R.L. POTENTIAL OF NEUTRON ACTIVATION ANALYSIS OF PESTICIDES AND METABOLITES. p. 78-89 of "Radioisotopes on the Detection of Pesticide Residues. Proceedings of a Panel. Vienna, Austria. 12-16 Apr. 1965". STI/PUB/123, International Atomic Energy Agency, Vienna (Austria). 1966, 118p.

The special merits and limitations inherent in activation analysis procedures as they apply to pesticide analysis are reviewed. The technique is admirably suited for the measurement of pesticides containing Hg, As, Cl, Br, Zn, and Cu. The combination of chromatographic separation with neutron activation, particularly of activatable derivatives, greatly extends the scope of activation technique. Tracer studies dependent upon activation analysis are potentially valuable for several varieties of pesticides provided that non-radioactive or quasi-stable isotopes of the elements of interest are available in highly enriched forms.

1731 Buchanan, J.D., Guinn, V.P. ANALYSIS OF FOODS BY NEUTRON-ACTIVATION TECHNIQUES. Fd Technol. 17 (1963) 17-22.

A most useful application of neutron activation to the analysis of foods has been in determination of chlorinated or brominated residues in foods. The chlorinated pesticides that have been determined include DDT and toxaphene. Generally, the analyses have been performed on organic extracts, which have been used to separate these insecticides from inorganic chloride and from other elements (principally Na and Mn) whose activation products would tend to mask ^{38}Cl in the γ-ray spectrum of the activated sample. Small amounts of Na and Mn are often seen, even in the organic extracts, and electronic subtraction of their contribution to the observed γ-ray spectrum is used to minimize their interference with the chlorine determination. Total Br concentration has been used as a measure of residual amounts of methyl bromide in wheat, wheat products, walnuts, lentils, and spices.

1732 Fourcy, A. LES APPLICATIONS DE L'ANALYSE PAR ACTIVATION AUX PRODUITS AGRICOLES ET ALIMENTAIRES. Bull. Inf. Sci. Tech. No. 99 (1965) 57-70.

Various potential uses of activation analysis are indicated, among them efficacity studies of pesticides and analysis of pesticide residues.

1733 Fourcy, A. BIOLOGY AND NEUTRON RADIATION: AGRONOMICAL APPLICATIONS OF RADIO-ACTIVATION ANALYSIS. Inds atom. 11 (1967) 11-12; 39-46.

The general method of neutron activation is outlined, including preparation of organic samples and radiochemical separation. Elements utilised in agronomy studies are Cl, Mn, Na, As, W, Mo, Co, Fe, Zn, Rb, Cs, Ca, Sr, Ba, Sc, Ru, Mg, P, Si, Al, F, and the lanthanides. More specific studies are outlined in the areas of the physiology of mineral nutrition, trace element analyses of vegetable matter, pesticide residues, industrial pollution, and indication of radioactive pollution. (CA 68: 1968, 57328w)

1734 Guinn, V.P. ACTIVATION ANALYSIS. Encycl. Ind. Chem. Anal. 1 (1966) 52-77.

A review on this method of elemental analysis that is based on nuclear reactions, including types of nuclear particles employed (neutrons, charged particles, and photons), neutron sources, theory, radioactive decay schemes, x-ray spectrometry, experimental procedures, statistical considerations, the speed, precision and accuracy, sensitivity, and errors of the method, and applications in the determination of O, analysis of high-purity materials for trace impurities, determination of pesticides in food, and applications in the petroleum, chemical, rubber, and plastics industries. (CA)

See also:

665 The determination of chlorinated hydrocarbons in the atmosphere by activated analysis. (Morgan, D.J. et al., 1965)

3.1.6. Miscellaneous (including Radiography)

1735 Andrews, F.N., Christian, J.E. THE LARGE VOLUME LIQUID SCINTILLATION DETECTOR AND ITS USE IN STUDYING THE PHYSIOLOGY, GENETICS AND NUTRITION OF FARM ANIMALS. p. 189-198 of "Use of Radioisotopes in Animal Biology and the Medical Sciences. Vol. 1". New York, Academic Press. 1962.

A large volume 2-π liquid scintillation detector, Sinco-P, was constructed at Purdue University under a grant from the Atomic Energy Commission. This instrument is capable of measuring extremely low level γ-activity of large inanimate objects and live animals weighing up to 250 lb. The detector is also being used in connection with isotopes such as ^{22}Na, ^{42}K, ^{131}I, ^{60}Co, ^{59}Fe, ^{137}Cs, ^{134}Cs, and other γ-emitters. It can play a vital role in the measurement of radioactivity in animal feedstuffs and human food, is of value in studying residue problems involving insecticides, herbicides and pesticides in general, and in studying intermediary metabolism in properly labelled drugs. (From auth.)

1736 Berryman, A.A. ESTIMATION OF Dendroctonus brevicornis (COLEOPTERA: SCOLYTIDAE) MORTALITY CAUSED BY INSECT PREDATORS. Canad. Ent. 99, 10 (1967) 1009-1014.

Laboratory and field experiments were designed to determine the effect of insect predators on immature broods of D. brevicornis LeConte. Twenty pieces of ponderosa pine bark, each ~40 sq.in., were selected from a large number of samples from trees infested with Dendroctonus. Samples were chosen to include as many different densities of predator and prey as possible. The bark samples were radiographed 4 times in 2 weeks. In the field 6 trees containing first generation Dendroctonus broods were sampled, by removing 4-in. wide circumferential bark strips every 5 ft up the infested bole and repeating at ~10-d intervals. A total of 366 was collected and the number of beetle and predator larvae determined radiographically for each sample. Data were analysed by graphical and regression methods. The results indicate that predation is dependent on the predator density and the time predator and prey are exposed together. Prey density was generally very high and had little effect on the rate of predation. The corroboration of laboratory and field experiments give confidence to the conclusion that the constant predation rate (0.261 prey/predator/d) can be used to estimate western pine beetle mortality from predation, provided temperatures remain within the 60° to 70°F range.

1737 Bogner, R.L., Domek, N.S., Eleftheriou, S., Ross, J.J., Jr. DEVELOPMENT OF DOUBLE ISOTOPE DERIVATIVE DILUTION ANALYSES FOR SELECTED FOOD ADDITIVES. Final Report. NSEC-85, Nuclear Science and Engineering Corp., Pittsburgh, Pa. 15 May 1963, 105p.

Results of initial investigations designed to demonstrate the feasibility of double isotope derivative dilution analyses for selected chemical residues in foods are presented. Four compounds were selected as representatives of commonly employed pesticides of different chemical structures that would necessitate the exploration of a variety of isotope derivative procedures. In this way, it was anticipated that the feasibility of radioisotope procedures could be demonstrated and further investigations of the techniques could be stimulated. The four pesticides studied were DDT, dieldrin, systox, and diazinon. A double isotope derivative dilution analysis for DDT was devised based on the tetranitration of DDT and added ^{14}C - DDT, subsequent formation of the dianilide derivative with ^{3}H-aniline, purification of the double-labelled derivative by paper chromatography, and simultaneous counting of the ^{3}H - and ^{14}C - content of the derivative in a liquid scintillation spectrometer. One- to 10-μg quantities of DDT were determined by using ^{14}C-DDT and ^{3}H-aniline of specific activities which are readily available and easily prepared. Simultaneous determination of DDE is discussed and the expected advantages of the isotope dilution procedure are reviewed. Dieldrin was shown to be amenable to analysis by a double isotope derivative dilution procedure which involved derivatization of dieldrin and ^{14}C-dieldrin with ^{3}H-acetic anhydride to form a double-labelled derivative and purification by multiple recrystallizations with carrier non-labelled dieldrin

derivative. A potential isotope derivative procedure for systox was suggested by the demonstration that hydrolytic cleavage of the thiono and thiol isomers yielded ß-hydroxydiethyl sulfide and ß-mercaptodiethyl sulfide, respectively, which could be derivatized with dinitrobenzoyl chloride, a reagent that can readily be ^{3}H-labelled. (Auth.)

1738 Bourke, J.B., Faust, M., Massey, L.M., Jr. A MULTIPLE UNIT RADIOMETRIC RESPIROMETER FOR THE MEASUREMENT OF THE METABOLISM OF ^{14}C LABELLED SUBSTRATES. Int. J. appl. Radiat. Isotopes 18 (1967) 619-623.

An improved radiometric respirometer is described which permits periodic sampling of both the evolved $^{14}CO_2$ and the activity remaining in the substrate solution, as well as the complete recovery of added radioactivity. The system, although described for use with plant tissue may be used with insects or small animals. A procedure for the use of the system is described, and a typical experiment utilizing irradiated carrot tissue is discussed. (Auth.)

1739 Eldefrawi, M.E. LIQUID SCINTILLATION COUNTING OF ^{3}H AND ^{14}C COMPOUNDS IN ANIMAL TISSUES. Analyt. Biochem. 17 (1966) 353-355.

A procedure using nitric acid for tissue digestion is described, which gives a high counting efficiency for ^{3}H and ^{14}C water-soluble non-volatile compounds. This technique was applied to small pieces of different tissues from the rat and the American cockroach, including the rat skin and roach cuticle. The counting efficiency for ^{3}H ranged from 9.3 - 11% compared to 12.5% for counting ^{3}H standards in Bray's dioxane cocktail, and was 60% for ^{14}C, which is the max. efficiency obtained with ^{14}C in this cocktail. Increasing the amount of rat brain and roach muscle hardly affected the counting efficiency of ^{14}C but ^{3}H counting efficiency was reduced by increasing the amount of tissue. (NSA 21: 1967, 5809)

1740 George, J.A., Howard, M.G.A. WAXED-PAPER LABORATORY CAGE FOR STERILIZATION STUDIES WITH THE ORIENTAL FRUIT MOTH, Grapholitha molesta (Busck) (LEPIDOPTERA: TORTRICIDAE). Proc. ent. Soc. Ont. 95 (1964) 146-147. Published 1965.

Females of G. molesta deposit eggs readily on waxed paper. The construction of a very satisfactory yet simple cage from wax paper is described in detail. The moths are introduced or removed through a hole in the cage by aspirator. Cages of various sizes can be made for accommodating different numbers of insects. Various ratios of males to females can be replicated without a change in the density of the moths. A satisfactory method for collecting all eggs over the lifetime of a female was needed for testing the effects of γ-radiation and chemosterilants on the fertility and vitality of the moth. The collected eggs are incubated for 3 d in a warm humid atmosphere, and the number of eggs hatched determined subsequently. Optimum conditions that can be replicated are provided for the mating and max. longevity of adults. By using transparent waxed paper dead moths could be detected and removed daily.

1741 Hayes, T.L., Pease, R.F.W., Camp, A.S. STEREOSCOPIC SCANNING ELECTRON MICROSCOPY OF LIVING Tribolium confusum. J. Insect Physiol. 13 (1967) 1143-1145.

The scanning electron microscope has been used to produce stereoscopic pictures of living T. confusum at magnifications up to 1300 times. The physiological implications of survival in the environment of electron beam scanning are discussed. Larval, pupal, and adult forms are capable of surviving the vacuum and the electron beam bombardment involved in the scanning. Local elevation of temperature due to the bombardment has been estimated as only 0.005°C but the dose rate of ionizing radiation may reach 10^{7} rad/sec. Observations times of ~ ½ h were tolerated. 25 keV electrons and a beam current of ~ 10^{-11} A were used.

1742 Kamra, S.K. DETECTION OF MECHANICAL DAMAGE AND INTERNAL INSECTS IN SEED BY X-RAY RADIOGRAPHY. Svensk. bot. Tidskr. 61, 1 (1967) 43-48.

Fourteen species of agricultural seed were used. The external mechanical damage to seed (e.g. cracks or breaks in the testa, etc.) as well as the internal mechanical damage (to parts enclosed by the seed coat) could be seen on x-ray pictures. The radiographs revealed the occurrence of larvae (or adult insects) and/or holes bored by them in the seeds. Thus, larvae of Trogoderma granarium Ev. in Triticum aestivum were clearly seen in some cases. Sometimes only the

empty coat was left. Tunnels bored into seed (Lens esculenta) by larvae of Bruchus sp. are distinctly visible. A few adults have also been seen in some cases. In Phaseolus mungo, most of the seeds were seen to show big holes, some containing insects (Bruchus sp.). Various views of tunnels bored by members of the Bruchus sp. were also observed in P. aureus and Cicer arietinum. Larvae of different sizes (Bruchus sp.) were visible in Vicia faba, sometimes in the same seed. Many seeds of Triticum aestivum were found to contain larvae of Sitophilus granarius. Illustrations of the above are given. - The radiographical method can evidently be reliably used for detecting mechanical damage and internal insects in seed. Various other uses and advantages of the method, which make it suitable for routine seed testing and research are pointed out. Soft x-rays (Grenz rays) were used: kV = 14, mA = 10, focus 25 cm, 6 sec-exposures, with x-ray industrial film type L (CEA works, Strängnäs, Sweden).

1743 Kovoor, J. ETUDE RADIOGRAPHIQUE DU TRANSIT INTESTINAL CHEZ UN TERMITE SUPERIEUR. Experientia 23, 10 (1967) 820-821. (With English summary)

Termites (Microcerotermes edentatus Wasmann, Amitermitinae) were fed some $BaSO_4$, and were subsequently exposed to x-rays. It was possible to study the animals continuously for 24 and even 48 h. Intestinal transit is greatly influenced by variations in temperature and humidity, accelerating with rising temperature. Intestinal transit normally lasts ~24 h. It is uni-directional and rapid up to the 1st pouch of the hindgut. The 2nd pouch, which takes up to 8-12 h to traverse, is undoubtedly equivalent to the "rectal pouch" of the lower termites.

1744 Lippold, P.C. AN IMPROVED TUBE CLOSURE FOR BIOLOGICAL TESTS. J. econ. Ent. 59 (1966) 626-628.

Plastic industrial-machine closures were modified to substitute for conventional rolled cotton plugs in bioassay tests. This plastic plug with a cotton dental-wick insert was found to provide a more effective seal of tubes, and enabled adult Drosophila melanogaster Meigen to be held for longer exposure periods with significantly less natural mortality. In disulfoton evaluation tests, greater mortality of Drosophila was obtained in tubes stoppered with plastic caps as opposed to cotton plugs. This increased activity, resulting from more effective closure and possible fumigant action, indicated increased sensitivity could be obtained with compounds where vapour pressure must be considered. These plastic caps were non-toxic and not repellant to adult flies, as indicated in feeding uptake studies using Karo solution fortified with ^{32}P.* The many advantages and versatility of this type of closure should result in its adoption in numerous applications. (Auth.)

* in the form of 1.0 μCi of carrier-free $H_3{}^{32}PO_4$/ml of solution.

1745 Lippold, P.C. PLASTIC ENCLOSURES FOR IN VIVO RADIOASSAY OF INSECTS. Int. J. appl. Radiat. Isotop. 18, 9 (1967) 656-658.

Plastic planchet covers, as well as custom "form-fitted" covers were moulded* for immature and adult insect stages. Data indicated that plastic covers or moulds could be successfully employed with insects labelled with ^{32}P or more energetic radionuclides. Thus, a reduction in numerical counts of 22-34% was encountered in covered ^{32}P-labelled insects. Counts of ^{14}C, with a max. β-ray energy of only 0.155 MeV as compared with 1.707 of ^{32}P, dropped to an insignificant level. ^{137}Cs, with β-ray energies of 0.514 and 1.2 MeV; γ-rays of 0.622 MeV were not affected. Thickness of plastic enclosures approximated 33 mg/cm^2.

* Vac-U-Form Molding Kit; Mattel, Inc., Toymakers, New York City. - Approx. cost. $16.00.

1746 Malich, C.W. THIN WINDOW HOLDER FOR PARTICLE IRRADIATION OF Drosophila. Drosoph. Inf. Serv. 40 (1965) 99.

A simple holder has been devised which makes irradiation convenient and uniform for particles having ranges between a few mm and a few cm. The construction is described in some detail. The thick lucite construction is adequate for most particle irradiations. The nuclear properties of H^1 and C^{12} minimize neutron production and bremsstrahlungen, and tests have shown that such secondary reactions contribute less than 1% to the dose in these holders. It is important to have the diameter of the window larger than the beam, so that forward scattering will not contribute to the dose. A double thin window holder has been constructed for comparison, and is preferable for highly

penetrating radiations. The double window design is also better for use with x-rays, since the back scatter from thick lucite significantly increases the dose absorbed from the incident radiation and its effective linear energy transfer. We are developing a more sophisticated design which will improve ventilation, increase compression of the flies and permit partial body irradiation. This should be useful with UV as well as charged particles, but the simplicity of the present design makes it preferred for routine work.

1747 Oatley, C. W., Nixon, W. C., Pease, R. F. W. SCANNING ELECTRON MICROSCOPY. Adv. Electronics Electron Phys. 21 (1965) 181-247.

The principle of the instrument consists of focussing an electron beam on the surface of a specimen, the diameter of the beam, after passing through several electron lenses, being ~ 100 Å. A portion of the current leaving the specimen is collected by a plate and conveyed to an amplifier, and hence to a cathode ray tube. The principles of design (schematic arrangement, fundamental limitations, factors affecting contrast, effects of electron penetration on the specimens, and practical limits of resolution (in practice ~200 Å for average specimens) are discussed, followed by a section on techniques and applications. The examination of biological materials is described. Direct examination is possible without any change in appearance of the specimen when the cell walls remain unbroken on being placed in a vacuum. Photos are shown of the ocelli at the vertex of a fly's head, the compound eye of Musca domestica, and a bristle on Tenebrio molitor at 20 000 X magnification). Under suitable conditions, a more readily interpreted 3-dimensional image may be obtained than in the ordinary transmission electron microscope, while using a very much smaller mean current density.

1748 Pease, R. F. W., Hayes, T. L., Camp, A. S., Amer, N. M. ELECTRON MICROSCOPY OF LIVING INSECTS. Science, N. Y. 154 (1966) 1185-1186.

A scanning electron microscope, in which the electron current is very much lower than in the conventional electron microscope, was used. Electron micrographs of living specimens of the various developmental stages of Tribolium confusum have been obtained. Samples of eggs, larvae, pupae, and adults were kept for 30 min in a chamber evacuated to a pressure of 10^{-5} torr; all developmental stages survive this vacuum. Periods of exposure to the vacuum and to the electron beam in the scanning microscope ranged from 2 min to 1 h. The electron current ranged from 2×10^{-11} to 2×10^{-10} amp, at an electron energy of 25 keV. The magnification used here was only 670 times but can certainly be increased a great deal where necessary. The possibilities of the system are discussed. The energy or current could be raised, so that the biological effects of irradiation on selected areas as small as 10^{-6} cm^2 in living specimens could be studied.

1749 Pesson, F. P., Ozer, M. APPLICATION OF AN ACTOGRAPHIC RECORDING METHOD TO THE STUDY OF THE EFFECTS OF IRRADIATION ON Calandra granaria LARVAE. Fd Irrad. 6, 1-2 (1965) A15.

G. Busnel, Director of the I. N. R. A. "Laboratoire de la Physiologie acoustique à Jouy-en-Josas" has constructed an apparatus for us that enables the noise made by Calandra larvae to be picked up by a microphone, followed by amplification and continuous recording. The apparatus is sufficiently sensitive to record the activity of a single larva in a grain of wheat. Only preliminary tests have so far been performed. Over three consecutive weeks, we have recorded the activity of a larva from hatching to emergence of the adult. We have also compared the activity of larvae before and after irradiation. In this way it is possible to assess the effects of irradiation immediately after exposure, and at varying intervals of time thereafter. The lethal effects of the doses used can thus be rapidly determined, without incubating the irradiated wheat and waiting for any adults to emerge. Results of these experiments are in press.* (Cited verbatim)

* (1965)

1750 Robbins, J. D., Bakke, J. E. A METHOD FOR COLLECTING $^{14}CO_2$ FROM A HYDROGEN FLAME DETECTOR. J. Gas. Chromat. 5, 10 (1967) 525-526.

A method was developed for determining radioactivity in the effluent from a gas chromatographic column. The method permitted rapid determination of the radioactive metabolites from ^{14}C-labelled compounds, such as pesticides. Gases from an enclosed H flame detector are passed through

a 15-ml pipette coated with ethanolamine to trap $^{14}CO_2$ from labelled herbicides.* Recovery of $^{14}CO_2$ is 42-66% when tested with ^{14}C-labelled propazine (2-chloro-4,6-bis(isopropylamino)-s-triazine) uniformly ring labelled and previously passed through a column composed of 5% Carbowax 20 M or Chromosorb W at 210°C with N at 30 ml/min. (CA 68:1968, 766h)

* Applicable to other pesticides. (Comp.)

1751 Russel, M.P. RICE WEEVIL BIOLOGY AS AFFECTED BY GRAIN STORAGE CONDITIONS. Bull. ent. Soc. Am. 12 (1966) 279. Abstr. 322. Presented at "Portland Meeting. Portland, Oreg., USA. 28 Nov. - 1 Dec. 1966".

Six varieties of sorghum stored for periods of 6-16 yr, were infested with fixed numbers of the rice weevil, Sitophilus oryzae. The oviposition rate was measured by berberine staining and x-ray counts, and the number of emerging adults was noted. Relative grain hardness, not storage time, influenced the reproductive rate. (Abstr.)

1752 Smith, G.N. A SIMPLE METHOD FOR COMBUSTING TISSUES FOR CHLORINE-Cl^{36} ANALYSIS. Analyt. Biochem. 17, 1 (1966) 24-37.

A simple apparatus and method is described for the combustion of biological samples containing ^{36}Cl-labelled compounds. The samples are combusted in a mixture of nitric and sulphuric acids and the liberated chloride trapped as silver chloride, which can be dissolved and counted in a scintillation counting system. With these techniques it is possible to detect chlorine-labelled compounds with specific activity of 0.02 mM in concentrations of 0.02 to 0.05 ppm in tissue. (Auth. summary)

1753 Taimr, L., Dirlbek, J. ZJIŠTĚNÍ VHODNOSTI POUŽITÍ MIKRODÁVKOVAČE PRO TOPIÁLNÍ APLIKACI INSEKTICIDU NA BROUKY MANDELINKY BRAMBOROVÉ. (Determination of the suitability of a microdoser for topical application of insecticides to the Colorado potato beetle.) Věd. Pr. výzk. Úst. rostl. Výroby Praze-Ruzyni 11 (1967) 201-206. (In Czech, with Russian, German and English summaries)

The apparatus was tested for accuracy and suitability at the Central Research Institute for Plant Production at Prague-Ruzyne. A radiometric method was used for determining the drop size of the deposit of triolein-^{131}I oil solution amounting to 6.40×10^{-4} ml. The mean square error amounted to 1.90×10^{-5} ml. On the 3rd day after application of the triolein oil solution cleaning movements of the beetles had transferred 18.87% of the deposit to the hind pair of legs, 14.67% to the front and central pairs, and 1.41% to the antennae. At the original place of deposit only 65.05% of the substance remained.

1754 Wickman, B.E. USE OF RADIOGRAPHY TO DETECT MORTALITY OF CALIFORNIA FLATHEADED BORERS IN PINE BARK. J. econ. Ent. 59, 4 (1966) 1028-1030.

During a field test of lindane to control the California flatheaded borer, Melanophila californica Van Dyke, in Jeffrey pine, Pinus jeffrei Grev. and Balf., x-radiography was used to check for mature larval winter holdover in the bark after most of the insects had emerged. An attempt was also made to identify late larval-instar mortality. Bark samples ½-1 in. thick were radiographed after adult emergence was completed. A General Electric LC-90 (set at 5 mA, 25-30 kVp, for 15 sec at 24 in. FD) and Kodak industrial-type AA x-ray film in ready packs were used. Dead larvae and pupae were easily distinguished on radiographs, and the results confirmed by dissection.

See also:

94 Control of crop emptying in the blowfly. (Gelperin, A., 1966)
576 Distribution measurements for testing new devices of insecticide and fungicide spreading. (Helbig, W. et al., 1967)
1526 Ecological methods with particular reference to the study of insect populations. (Southwood, T.R.E., 1966)
1703 Damage to biscuits caused by Lasioderma serricorne (F.) (and data on its biology as shown by radiographs). (Calderon, M. et al., 1960)
1704 Criteria for radiographic examination of internal insect infestation. (Freeman, C.C., 1965)

1705 Laboratory studies of the biology and behavior of the Angoumois grain moth, Sitotroga cerealella (Oliver). (Mills, R.B., 1965)

1706 Radiographic studies of Angoumois grain moth development in wheat, corn, and sorghum kernels. (Mills, R.B. et al., 1967)

3.2. BIBLIOGRAPHIES AND GENERAL SURVEYS

3.2.1. Bibliographies

1755 Binggeli, M.-H. RADIOISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. VOL. III (1964-1965). International Atomic Energy Agency, Vienna (Austria). 1967, 454p. Bibliographical Series No. 24.

Fully annotated bibliography for the 2-yr period 1964-1965, a follow-up of the 2nd volume (Bibliographical Series No. 15) which covered the 3-yr period 1961-1963. Approximately 1100 references on radioisotopes and radiations in entomology from reports and articles in journals and books are given, complete with abstracts. Author and updated affiliations, subject, and insecticide indexes are given. A special feature of the subject index is the citation, alongside each reference, of the relevant radioisotope or radiation employed in the study. Of the 454p, a total of 76p is devoted to tables, consisting of (1) a systematic listing of insects and related arthropods, (2) lethal radiation effects, (3) sterilization data, and (4) radiotracer studies on insecticides.

1756 Deleted.

1757 Dedek, W. RADIOAKTIVE NUKLIDE IN DER CHEMIE DER PESTIZIDE (II). (Radioactive nuclides in pesticide chemistry. II.) Atompraxis 13, 3 (1967) 126-129. (In German)

Continuation of the literature review of 1964. The article contains 177 references dealing with surveys and analytical studies, and sections on ^{32}P-labelled substances (phosphates, phosphonates, thiophosphates and dithiophosphates), ^{35}S-labelled substances (thio- and dithiophosphates, fungicides, nematocides, and others), and halogen-labelled substances, especially ^{36}Cl-labelled substances (insecticides and herbicides).

1758 Franz, J.M., Simon, H.R. BIBLIOGRAPHIE CONCERNANT LA LUTTE BIOLOGIQUE. Entomophaga 12, 1 (1967) 5-80.

Continuation of bibliographical listing without abstracts, in separate sections, section 9 dealing with autocidal measures (p. 66-73): 129 references are cited, including work on chemosterilants. References in any one section are arranged alphabetically by senior author. For reference to earlier listings, see III/1054-5.

1759 Ingram, M. BIOLOGICAL EFFECTS OF IONIZING RADIATION. An Annotated Bibliography. TID-3097, Division of Biology and Medicine (AEC), Washington, D.C. Dec. 1966, 286p.

The 12 726 references, mostly with an abstract, are arranged numerically in the order in which they were collected. The subject index is of a hierarchial type consisting of general categories, each followed by one or more subdivisions. There is also an author index.

1760 International Atomic Energy Agency, Vienna (Austria). INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS. No. 7. WP/31/7. May 1966. 49p.

The circular is aimed at disseminating research information to workers in the field. An author index is included in this circular which contains 5 review articles and 1 bibliography, 1 ecological study, 17 on the effects of ionizing radiation, including disinfestation, 21 on rearing techniques, 8 on radiation sterilization theory and application, and 28 on chemosterilants.

1761 Klement, A. W., Jr., Schultz, V. TERRESTRIAL AND FRESHWATER RADIOECOLOGY. A Selected Bibliography - Supplement 3. TID-3910 (Suppl. 3), Division of Biology and Medicine (AEC), Washington D.C. Feb. 1965, 115p.

References are (title-)listed alphabetically, by senior author. No author or subject indexes.

1762 Klement, A. W., Jr., Schultz, V. TERRESTRIAL AND FRESHWATER RADIOECOLOGY. A Selected Bibliography - Supplement 4. TID-3910 (Suppl. 4), Division of Biology and Medicine (AEC), Washington D.C. Apr. 1966, 128p.

References are (title-) listed alphabetically, by senior author. No author or subject indexes.

1763 Rossouw, S.F., comp. RADIOISOTOPES AND RADIATION IN HELMINTHOLOGY. A Bibliography. PEL-130, Atomic Energy Board, Pelindaba, Pretoria (South Africa). Oct. 1966, 29p.

87 references, often with abstracts, are presented to literature published between 1948 and 1966 on the use of radiation and radioisotopes in the control of helminthic diseases in man and animals. Several references are relevant also in the overall context of the present bibliography.

1764 Ward, H.L., comp. RADIOISOTOPES IN THE BIOLOGICAL SCIENCES. TID-3585, Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Apr. 1967, 120p.

A collection of 959 references, largely with abstracts, has been assembled for the period 1958-1964, dealing with broad fields such as general studies in biology, cell physiology, ecology, entomology, genetics, immunology, microbiology, nutrition, and plant physiology. An author index, report number and availability index, and an isotope index are included. No subject index.

See also:

571 Radioactive nuclides and pesticide chemistry. III. (Dedek, W., 1967)

3.2.2. Surveys

1765 Andreev, S.V., Martens, B.K. AU LABORATOIRE DE BIOPHYSIQUE. Zashch. Rast. No.11 (1967) 25-27. (In Russian, with French summary)

Insectes, matériel végétal, micro-organismes; γ, isotopes radioactifs, méthodologie nucléaire; éradication insectes, sélection microorganismes utiles, métabolisme et toxicité pesticides, défense culture. - Programme recherche Institut supérieur protection végétale URSS. (BB 6: 1968, 5378)

1766 Bhambahani, G. RADIATION AND RADIOISOTOPES. Rajasthan Vet. 1, 3 (1966) 9-13.

Brief survey of applications in pest control. *

* Original not available.

1767 Boczek, J. ZASTOSOVANIE IZOTOPOW W BADANIACH ENTOMOLOGICZNYCH. (Radioisotopes in Entomological Research). Ogrodn. 2 (1965) 245-247. (In Polish)

1768 Burden, G.S. COCKROACH CONTROL, PAST PRESENT FUTURE. Pest Control 35, 9 (1967) 20, 22, 24, 26.

The potential uses of γ-radiation and biocontrol measures are discussed in addition to the more conventional methods in use at present.

1769 Cadahia, D. LAS RADIACIONES IONIZANTES EN LA ENTOMOLOGIA APLICADA. (Ionizing radiations in applied entomology.) Boln Serv. Plagas for. 8, 15 (1965) 15-27. (In Spanish)

General review. Sterilizing and lethal effects of radiations are discussed, and the data collected in two tables.

1770 Cadahia, D. IONIZING RADIATION IN APPLIED ENTOMOLOGY. Montes 22 (1966) 159-168. (In Spanish)

A review is given of the present state of experimentation and application of radioisotopes in entomology. Studies on genetics, sterilisation, and lethal effects of radiation are included. The practical uses of radiation in the control of insects are summarized under four headings: release of sterile males, development and release of insect races with inferior or lethal genetic characteristics, irradiation of products affected by insects, and irradiation of plants for the production of useful mutations. (NSA 22: 1968, 10881)

1771 Carleton, W.M. et al. PEST CONTROL BY PHYSICAL MEANS. Paper presented at the AAAS Meeting, Washington, D.C., USA. 26-31 Dec. 1966". n.p.

Techniques using radiation, sound, electrostatic charges, or other physical methods are described; hazards due to chemical and biological agents are minimized.

1772 Cavalloro, R. UTILIZZAZIONE DELLE RADIOAZIONI IONIZZANTI NELLA LOTTA CONTRO INSETTI AGRARIAMENTE DANNOSI. (The use of ionizing radiations in the fight against harmful agricultural insects.) Boll. Ist. Ent. agr. Oss. Fitopath. Palermo 7, 56 (1967) 101-112. (In Italian)

Survey article.

1773 Gerrard, M. RADIOISOTOPE PROGRAM OF THE INTERNATIONAL ATOMIC ENERGY AGENCY. Isotopes Radiat. Technol. 4 (1967) 430-431.

The International Atomic Energy Agency uses large radioisotope sources as well as tracers in its work. Among the programmes currently being sponsored by the IAEA is the use of radioisotope sources for disinfestation of grain and processing of other foods, sterilisation of pharmaceuticals and medical supplies, remote therapy of cancer, and insect control by the sterile-male-release technique. Tracer studies include those in hydrology, fertilizer utilisation, and nutrition. (Auth.)

1774 Hoffman, C.H. et al. THE FIGHT AGAINST INSECTS. Yb. Agric. U.S. Dep. Agric. (1966) 25-38.

Review of control techniques: chemical, sterilisation, biocontrol and integrated measures.

1775 Jenkins, D.W. RADIOISOTOPES IN ECOLOGICAL AND BIOLOGICAL STUDIES OF AGRICULTURAL INSECTS. AD-636895, Army Biological Labs., Frederick, Md. 1960, 19p.

For abstract, see II/4.

1776 Kloft, W. ÜBER DIE VERWENDUNG VON RADIOAKTIVEN ISOTOPEN IN DER MODERNEN BIOLOGIE. (On the application of radioactive isotopes in modern biology.) Prax. Biol. 6 (1957) 125-130.

The survey also considers the use of radioisotopes in entomology.

1777 Labrador, J.R. APPLICACION DE LOS RADIOISOTOPOS EN ENTOMOLOGIE. (Application of radioisotopes in entomology.) Ingenieria agron. 11 (1963) 19-25. (In Spanish)

1778 Marais, P.G. THE USE OF RADIOISOTOPES AND IONIZING RADIATION IN AGRICULTURAL RESEARCH. S. Afr. J. Sci. 59 (1963) 319-324. (In Afrikaans)

Applications of radioisotopes in agriculture and food research are described. In South Africa, the greatest interest was shown in the possibility of preserving fruit by γ-irradiation. For this purpose, a 500-Ci ^{60}Co irradiation centre was installed. With this high intensity radiation, male insects are sterilised so that insect pests can be eventually eradicated.

1779 Mia, M.M. ATOMIC ENERGY FOR AGRICULTURE. Nucleus, Lahore 2, 1 (1965) 30-34.

The importance of using in agricultural fields the latest research tools - radioisotopes and radiation sources - in Pakistan is discussed. A brief survey is presented of the activities of the Agricultural Research Centre, Dacca in plant genetics, plant physiology, soil chemistry, and entomology. The IAEA-PAEC coordinated programme is also briefly discussed. (NSA 19: 1965, 33726)

1780 Montgareuil, P. G., de LES RECHERCHES FRANCAISES EN AGRONOMIE NUCLEAIRE. CEA-R-2524, Commissariat à l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucléaires. Jul. 1964, 12p.

Work in the field of nuclear agronomy carried out in France since 1958 is reviewed. Topics discussed include applications of radiation in studies of plant genetics, pest eradication, food processing, measurements of soil humidity and density, and the use of radioisotopes as tracers in studies of plant physiology, agronomy, pathology, agricultural entomology, and metabolism in domestic animals. (NSA 19: 1964, 8720)

1781 Nagy, B., Pozsár, B., Szalay-Marzsó, L. "Sugárzások alkalmazása állati kártevők elleni védekezésben". (The use of ionizing radiations for the control of harmful animals.) Budapest, Országos Atomenergia Bizottság. Izotóp Intézet. 1965, 83p. (In Hungarian)

This monograph was compiled on behalf of the Institute of Isotopes of the Hungarian Atomic Energy Commission, the authors being scientists of the Hungarian Research Institute for Plant Protection. After indicating the expected advantages of using radiations in integrated pest control, some fundamental concepts are outlined. The biochemical effects of irradiation at the cellular level, on animal behaviour, populations, and the relation between the effects of radiations and some abiotical factors are treated in separate sections. Pest control techniques employing radiations, and other potential applications against insects are discussed. In an appendix the effects of radiations on the chemical composition of food-stuffs, radiation protective substances and their application, and radiation facilities and radiation health requirements in radioentomology are treated in individual sections. Proposals are made for the use of ionizing radiations in pest control in Hungary. 251 references are cited.

1782 Nagy, B. POSSIBILITIES OF USING IONIZING RADIATION IN THE CONTROL OF INSECTS IN HUNGARY. Atomtech. Tajek. 10 (1967) 1-6. (In Hungarian)

The uses of ionizing radiation and radioisotopes in entomology are reviewed. Radioisotope application to the study of food dispersion, hibernation, and migration of insects is considered. Techniques for eradication of insects by irradiation are compared, and the application of sublethal doses in the sterile male flooding method for control of May cockchafers in Hungary is discussed. (tr-auth)

1783 Nelson, S.O. NEW WAYS TO CONTROL INSECTS. Farm Ranch Home Q. No. 132 (1966) 15-16.

Survey article. The use of electromagnetic, sonic, and ultrasonic energy to control insect pests is discussed. γ- and x-radiation have already been used in applications of the sterile-male technique, the examples quoted being the screw-worm and the melon fly. Insect light traps were used to control the tobacco hornworm populations. Grain beetles were killed by γ-rays, radio frequency electric fields or infrared radiation without damaging effects to the nutritional qualities of the grain. The possibility of using sound and ultrasound for insect control through influencing behaviour is suggested.

1784 Nelson, S.O. ELECTROMAGNETIC ENERGY. Pest Control Biol., Phys. Sel. Chem. Methods (1967) 89-145.

Radio, u.v., visible, infrared, ionizing radiation effects on insects, products and applications.

1785 Price, C. E. FRUIT FLY MUTANT DATA STORAGE AND RETRIEVAL SYSTEM. K-DP-1711, Oak Ridge Gaseous Diffusion Plant, Tenn. 8 Aug. 1966, 27p.

A computer-based system is described that maintains a master data file on Drosophila melanogaster mutants and that can provide output lists in various arrangements. More than 9000 mutants are on file. Flow charts are given, and the programme phases are described in detail. The programmes are written in the COBOL language with some MAP routines for the IBM 7090/7094 and 1401 computers. (NSA 21: 1967, 39377)

1786 Price-Jones, D. NEW HORIZONS IN INSECT CONTROL. Chem. Inds, Lond. No. 19 (1967) 770-774.

Some of the newer methods for insect control are discussed. These include microbial insecticides, integrated control, behaviour determinants, biological control, and sterility and genetic manipu-

lation. For example, Bacillus thuringiensis can be produced commonly by culturing on axenia media and is pathogenic to a wide range of caterpillars and to only a few other insects. Integrated control is synonymous with ecological or bio-environmental control. Methyl eugenol is a behaviour determinant which has been employed to control fruit flies. The use of parasites and predators and the development of insect pathogens are examples of biological control of insects. γ-Irradiation from ^{60}Co sterilizes the screw-worm pupae and other insects. (CA 67: 1967, 20959f)

1787 *Robredo, F. USE OF RADIOACTIVE ISOTOPES AND IONIZING RADIATIONS IN ENTOMOLOGY. Boln Serv. Plagas for. 7, 13 (1964) 42-51. (In Spanish)

Use of radiation in controlling insect pests is surveyed. A brief review on the methods of labelling insects with radioisotopes is given, as well as examples showing how radioisotopes have been of value in studying the dispersal and movement, life history, and behaviour of insects. Ecological studies on food chains, nutrition cycles, and population dynamics have been carried out on radioisotope-tagged insects. Application of the first method, exemplified by work on Callitroga hominivorax, is limited to very few species by several biological requirements. Direct treatment could have wider application for the control of all species infesting stored food products. The most favourable products for radiation disinfestation are those handled in bulk such as grain. Some fundamental and applied problems in using radiation for this purpose are discussed and the relative merits of chemical fumigation and irradiation methods are compared. Radiation induces dominant lethal mutations in sperm; therefore, monogamy is not requisite for eradicating a population through the introduction of irradiated males. Possible effects on populations of release of males containing recessive lethal mutations are discussed, and the possibility of genetic induction of population extinction is explored. (NSA 21: 1967, 32770)

* Originally cited without abstract, as III/1073.

1788 Suess, A. USE OF RADIOISOTOPES AND IONIZING RADIATION IN AGRICULTURAL SCIENCE. p. 351-357 of "Atomstrahlung in Medizin und Technik". Munich, Federal Republic of Germany, Verlag Karl Thiemig KG. 1964. (In German)

The studies made at the Bayr. Landesanstalt für Bodenkultur, Pflanzenbau, und Pflanzenschutz on the use of radioisotopes and radiation in agricultural science are reviewed. Among the studies discussed are the spread of insect pests, early detection of virus infection, tracing growth patterns, germination, production of mutations, and uptake of nutrients. Examples of the results obtained are given to indicate the type of information that can be obtained with the use of radioisotopes and radiation. (NSA 18: 1964, 35912)

1789 Watters, F. L. PHYSICAL METHODS OF INSECT CONTROL. Proc. ent. Soc. Manitoba 21 (1965) 18-27.

This paper reviews the major physical agents presently being used or studied as methods of insect control. Included in the discussion are: electromagnetic radiation, ionizing radiation, temperature, sound, mechanical force, air movement, atmospheric ions, insect-proof containers, and sanitation. The possibility of integrating these methods with chemical control is discussed and the use of radiation in programmes of sterile-male release is explained. (BA)

1790 Zeleny, V. INTERNATIONAL EXPERIENCE IN THE USE OF RADIOISOTOPES. CONF-9-21, International Atomic Energy Agency, Vienna (Austria). "International Conference on Future Development of Power Reactors and on Radioisotopes. Montreal, Canada. May 1963, 12p.

Applications of radioisotopes in agriculture, medicine, and industry on an international basis are discussed. Programmes described include: Isotope techniques in rice cultivation, the use of radiation for control of harmful insect populations, and radiation disinfestation of grain.

See also:

40 Some biochemical aspects of insect metamorphosis. (Gilbert, L. I. et al., 1961)
564 Radioisotopes in entomological studies of endemic and tropical diseases. (Jenkins, D. W. 1960)
565 Radioisotopes in entomology and tropical medicine. (Jenkins, D. W., 1961)
1283 Institut national de génétique du Japon. (Tokin, B. P., 1967)
1551 Research activities of the association EURATOM-ITALY. (Zeeuw, D. de., 1966)

3.2.3. Training Courses

1791 International Atomic Energy Agency, Vienna (Austria) and Food and Agriculture Organization of the United Nations, Rome (Italy). "Proceedings of FAO/IAEA Training Course on Use of Radioisotopes in Entomology, Gainesville, Fla., 4 Oct. - 26 Nov. 1965". Gainesville, University of Florida. 1965, 171p.

A list of participants and lecturers is given. Abstracts of the lectures are included. Part I of the lectures gave a background to the whole course: the fundamentals of tracer methodology in theory and practice (C.H. Schmidt); counting statistics, and laboratory work on autoradiography (D.S. Anthony); fundamentals of radiobiology, and medical applications of isotopes and radiation (H. L. Cromroy); fly eradication projects (J. C. Keller); neutron activation analysis (R.G. Cockrell); and on the use of various types of instruments available commercially. Part II dealt with the use of radioisotopes for the study of systemic insecticides in plants (D. L. Bull); metabolism of chlorinated hydrocarbon insecticides by insects (A. S. Perry); use of tritiated water for continuous registration of insect transpiration; use of radioisotopes in research on social insects; principles of internal and external tagging of insects under special consideration of physiological and ecological aspects; use of radioisotopes with plant sucking insects; some aspects on phytopathology (all four by W. J. Kloft); use of radioisotopes in dispersion studies: part A--Flies, part B--mosquitoes and cockroaches (H. F. Schoof); eradication of the screw-worm fly from Southern United States (A. H. Baumhover); laboratory and field studies of ticks labelled with radioisotopes (B. J. Smittle); chemosterilants as a potential weapon for insect control (C. N. Smith); application of chemosterilants (G. C. LaBreque); cytological effects of chemosterilants on house fly ovaries (P. B. Morgan); use of gamma radiation and sterilization techniques for control of fruit and vegetable insect pests (A. K. Burdett, Jr.); dispersion studies of <u>Culex pipiens fatigans</u> Wied. tagged with ^{32}P in the Kemmendine Area of Rangoon, Burma (from WHO/Vector Control/157.65); sterile male release studies with <u>Drosophila melanogaster</u> Meigen (T. J. Henneberry); fundamental principles of radiation-induced insect sterility (L. E. LaChance); the effects of γ-radiation on the soil (C. F. Eno); projecting laboratory rearing of insects to mass-scale factory-type project (C. N. Husman). Laboratory exercises were divided into metabolism of ^{14}C malathion in the house fly (F. W. Plapp, Jr.); the use of radioisotopes for the study of systemic insecticides in plants (D. L. Bull); laboratory exercises for studying the metabolic fate of insecticides by use of isotope-labelled compounds (A.S. Perry); laboratory exercises on insect sterilization (LaBrecque, G.C., Morgan, P.B., Glancey, B.M., Meifert, D.W.); tracer experiments on uptake and social distribution of food in ants; two more or less extended tracer experiments with ants; tagging of mosquitoes as larvae; biological half-life in cockroaches using ^{32}P and ^{131}I separately; tagging adult house flies for estimation of population density by "isotope dilution" method; topical application of ^{32}P as phosphate in water solution on the pronotum of German cockroaches; determination of the speed of haemolymph circulation in insects by injected tracers; artificial feeding of bloodsucking insects; tracer experiments with aphids (all by W.J. Kloft).

1792 International Atomic Energy Agency, Vienna (Austria). LABORATORY TRAINING MANUAL ON THE USE OF ISOTOPES AND RADIATION IN ENTOMOLOGY. Technical Reports Series No. 61. Vienna, International Atomic Energy Agency. 1966, 144p.

The Food and Agriculture Organization of the United Nations and the International Atomic Energy Agency, in cooperation with the United States Department of Agriculture and the Department of the University of Florida, Gainesville, Fla., USA, have jointly sponsored two international training courses on the use of isotopes and radiation in entomology. Scientific authorities from several countries have contributed lectures and, together with the IAEA Secretariat, devised laboratory exercises embracing many and varied entomological techniques. The present manual consists of two parts: a basic part containing general information and laboratory exercises on the properties of radiation and the principles of use of radioactive tracers, and an applied part consisting of detailed laboratory exercises in the use of isotopes and radiation in entomology. (From the foreword)

1793 International Atomic Energy Agency, Vienna (Austria) and Food and Agricultural Organization of the United Nations, Rome (Italy). "Proceedings of FAO/IAEA Training Course on Use of Radioisotopes in Entomology. Gainesville, Fla., USA, 2 Oct. - 24 Nov. 1967". Gainesville, Fla., University of Florida. 51p.

The training course was held at the University of Florida, Gainesville from Oct. 2 - Nov. 24, 1967. Similar training courses had been held at the University of Florida in 1963 and 1965. Objectives of the course were to teach and train entomologists in the theories and nature of radiation, radioisotope methodology, and the applications of radioisotopes to research in entomology. The course was divided into lectures given by invited specialists in the field. The proceedings give a list of the lecturers, abstracts of the lectures, and the laboratory exercises. These were primarily those in the IAEA "Laboratory Manual on The Use of Isotopes and Radiation in Entomology" (see 1792). 16 countries were represented.

4. TABLES

TABLE 1. SYSTEMATIC LISTING OF INSECTS AND RELATED ARTHROPODS

Class	Order	Family	Systematic Code	Scientific Name
ARACHNIDA	Araneida		Ar	
		Agelenidae	Ar. 1	
				Agelena consociata (Denis)
				Tegeneria derhamii
		Avidulariidae	Ar. 1/2	Avicularia avicularia
		Gnaphosidae	Ar. 2/3	gnaphosids
		Lycosidae	Ar. 4	
				Lycosa punctulata (Hentc)
	Acarina		Ac	
		Acaridae	Ac. 1	
				Acarus siro Linnaeus
				Tyrophagus dimidiatus (Hermann)
				Tyrophagus longior (Gerv.)*
		Argasidae	Ac. 2	
				Ornithodoros papillipes (Bir.)
				Ornithodoros tholozani (Lab. & Mégn.)
		Arrenuidae	Ac. 2/3	
				Arrenurus papillator (O. F. Müll)
		Gamasidae	Ac. 7/8	
				Ornithonyssus (Liponyssus) bacoti (Hirst)
		Ixodidae	Ac. 8	
				Amblyomma americanum (Linnaeus)
				Boophilus microplus (Canestrini)
				Dermacentor andersoni (Stiles)
				Dermacentor occidentalis Marx
				Dermacentor variabilis (Say)

* see Tyrophagus dimidiatus (Hermann)

Common Name(s)	Reference No.
spiders	507, 525-6, 556
funnel-web weavers	
	481
	230
	408
	73
wolf-spiders	73, 543
	73
mites and ticks	514
acarid mites	
grain mite	1339, 1468, 1677
	1352, 1435-7, 1535
	1436
soft-backed ticks	
	17, 1387
	1387, 1622
	432
	1313
hard-backed ticks	
Cayenne tick; lone star tick	503, 568, 1297, 1791
Southern cattle tick	569, 614, 676, 780, 782, 1267
Rocky Mountain wood tick	568
Pacific Coast tick	1397
American dog tick	568

Class	Order	Family	Systematic Code	Scientific Name
ARACHNIDA	Acarina	Tetranychidae	Ac. 14	
				Panonychus ulmi (Koch)
				Tetranychus telarius (Linnaeus)
				Tetranychus urticae (Koch)
INSECTA	Thysanura		B	
		Lepismatidae	B. 1	
				Lepisma saccharina Linnaeus
	Ephemeroptera		E	
		Heptageniidae	E. 6	
				Heptagenia hebe (McDunnough)
				Stenonema fuscum (Clemens)
				Stenonema interpunctatum (Say)
	Odonata		F	
		Aeshnidae	F. 1	
				Aeschna cyanera (Müll.)
				Aeschna grandis (Linnaeus)
				Aeschna viridis Eversm.
				Anax imperator (Leach)
				Boyeria irene (Fonscolombe)
		Agrionidae	F. 2	
				Platyenemis pennipes
		Calopterygidae	F. 2/3	
				Calopteryx splendens
		Coenagrionidae	F. 3	
				Argia translata

Common Name(s)	Reference No.
spider mites	1128
European red mite	APX. 9
two-spotted spider mite	799
two-spotted spider mite	213, 487, APX. 9
bristletails	
firebrats, silverfish	
silverfish	1463
mayflies	
	631
	631
	631
damselflies and dragonflies	433-4, 531
	435
a dragonfly	62, 435
	435
	435
	435
a dragonfly	432
a dragonfly	432
	1394

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Odonata	Cordulegastridae	F. 4	
				Cordulegaster boltonii (Donovan)
		Lestidae	F. 7	
				Lestes sponsa Hans.
		Libellulidae	F. 8	
				Libellula depressa
				Libellula quadrimaculatus
				Somatochlora flavomaculata
				Sympetrum danae
				Sympetrum depressiusculum (Sel.)
				Sympetrum vulgatum
	Plecoptera		G	
	Orthoptera		H	
		Acrididae	H. 1	
				Chorthippus elegans
				Chorthippus longicornis
				Chorthippus parallelus
				Chortophaga
				Chortophaga viridifasciata (De Geer)
				Chrotogonus incertus Bolivar
				Encoptopholus sordidus (Burmeister)
				Gomphocerus maculatus
				Locusta migratoria Linnaeus
				Mecostethus grossus

Common Name(s)	Reference No.
	435
	432
	435
	432
	432
	432
	510
	432
stoneflies	524
cockroaches, grasshoppers and allies	51, 525
grasshoppers	1, 54, 185, 307, 614, 929, 936, 952, 996-7, 1386, 1534
	973
	1088
	973
	275
green-striped grasshopper	252, 274, 308, 1016-7
	1032
	1017
	973
migratory locust	137, 152, 194, 199, 251, 301-2, 362, 385, 403-4, 417, 536
	973

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Orthoptera	Acrididae	H. 1	
				Melanoplus biliteratus
				Melanoplus bivittatus (Say)
				Melanoplus differentialis (Thomas)
				Melanoplus femurrubrum (De Geer)
				Oedipoda coerulescens Linnaeus
				Omocestus viridulus
				Podisma sapporense
				Schistocerca gregaria Forsk
		Blaberidae	H. 1/2	
				Blabera fusca Br.
		Blattidae	H. 2	
				Blaberus sp.
				Blaberus craniifer Burmeister
				Blaberus discoidalis
				Blaberus giganteus
				Blattella germanica (Linnaeus)
				Leucophaea maderae (Fabricius)
				Eurycotis floridana
				Nauphoeta cinerea
				Periplaneta americana (Linnaeus)
				Periplaneta australasiae (Fabricius)
		Conocephalidae	H. 2/3	
				Homorocoryphus

Common Name(s)	Reference No.
grasshoppers	
	556
two-striped grasshopper	87
differential grasshopper	197
red-legged grasshopper	547, 556
	53
	973
	1020
desert locust	47, 139, 158, 177, 362, 385, 558, 599, 600, 938, 981, 1001-3, 1347, 1441
	1328, 1329
cockroaches	766, 1324, 1768
	362
Florida tropical cockroach	1326
	95
	821
German cockroach	175, 189, 359, 387, 393-4, 637-8, 657, 848, 1100, 1791
Madeira cockroach	105-7, 235, 374, 401, 446
	364, 382-3
	1125
American cockroach	61, 70, 84-5, 87, 103, 168, 175, 207, 229, 349, 362, 372, 381, 383, 387, 401, 412-3, 420, 429, 537, 622-3, 638, 658-9, 690, 700, 767, 788, 848, 1193, 1739, 1791, APX. 8
Australian cockroach	362
grasshoppers	51, 53, 55

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Orthoptera	Conocephalidae	H. 2/3	Homorocoryphus nitidulus Scop.
		Gryllidae	H. 4	
				Acheta domesticus (Linnaeus)
				Gryllus bimaculatus (De Geer)
				Gryllus campestris Linnaeus
				Gryllus domesticus Linnaeus
				Gryllus firmus
				Oecanthus celerinictus
		Gryllotalpidae	H. 5	
				Gryllotalpa gryllotalpa Linnaeus
		Mantidae	H. 6	
				Mantis religiosa (Linnaeus)
				Tenodera aridifolia sinensis (Saussure)
		Phasmatidae	H. 7	
				Anisomorpha buprestoides
				Carausius morosus Br.
		Tettigoniidae	H. 9	
				Ephippiger ephippiger Fieb.
				Orchelimum fidicinum
				Tettigonia viridissima
	Dermaptera		I	
		Labiidae	I. 3	
				Chelisoches morio
	Isoptera		K	
		Kalotermitidae	K. 2	
				Cryptotermes brevis (Walker)
				Kalotermes flavicollis (Grassé & Noirot)

Common Name(s)	Reference No.
	53, 55
crickets	54, 507
brown cricket; European brown cricket; house cricket	281, 283, 431, 515-6, 538, 543
	186, 265, 456
	53
domestic cricket	418, 966
field cricket	556
tree cricket	556
mole crickets	54
	53
praying mantis	
European praying mantis	199, 547
Chinese mantis	543
walkingsticks	
stick insect	388
stick insect	85, 390, 409
longhorn grasshoppers and katydids	54
	53
	526
	1463
earwigs	
an earwig	1327
termites	
	494
drywood termite	469, 488, 979

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Isoptera	Rhinotermitidae	K. 3	
				Reticulitermes flavipes (Kollar)
		Termitidae	K. 4	
				Microcerotermes edentatus Wasmann
	Hemiptera			
	(Heteroptera)		Q	
		Belostomatidae	Q. 3	
				Hydrocyrius columbiae
				Lethocerus cordofanus
		Cimicidae	Q. 5	
				Cimex lectularius Linnaeus
		Coreidae	Q. 6	
				Harmostes reflexulus
		Corixidae	Q. 7	
				Corixa geofroy
				Corixa punctata Ill.
				Micronecta minutissima
		Geocoridiae	Q. 8/9	
				Ischnodemus badius
				Trigonotylus sp.
		Gerridae	Q. 9	
				Gerris buenoi (Kirk.)
				Gerris locustris (Linnaeus)
		Lygaeidae	Q. 10	
				Elasmolomus sordidus (Fabricius)
				Nysius raphanus

Common Name(s)	Reference No.
Eastern subterranean termite	1715, 1721
	1743
	525
true bugs	1522
giant water bugs	
	56
	56
bat, bed, and bird bugs	1728
bed bug	801
coreid bugs	
grass bug	556
water boatmen	
	531
	1728
	531
	526
	526
water striders	
	545
	1728
lygaeid bugs	
peanut litter bug	192-3
	556
milkweed bugs	507

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Hemiptera (Heteroptera)	Lygaeidae	Q.10	Oncopeltus fasciatus (Dallas)
		Miridae	Q.11	
				Lygus oblineatus
		Nepidae	Q.13	
				Ranatra linearis Linnaeus
		Notonectidae	Q.14	
				Notonecta glauca Linnaeus
		Pentatomidae	Q.15	
				Eumecopus punctiventris (Stål)
				Perillus bioculatus (Fabricius)
		Pyrrhocoridae	Q.17	
				Dysdercus peruvianus
				Pyrrhocoris apterus Linnaeus
		Reduviidae	Q.18	
				Rhinocoris iracundus Pd.
				Rhodnius prolixus (Stål)
				Triatoma infestans
	Hemiptera (Homoptera)		QQ.	
		Aleyrodidae	QQ.1	
				Chrysomphalus aonidum (Linnaeus)
				Trialeurodes vaporariorum (Westwood)
		Aphididae	QQ.2	
				Aphidina ovipara
				Aphis fabae (Scopoli)
				Chaetophoria xanthomelas (Koch)
				Cinara larvicola

Common Name(s)	Reference No.
large milkweed bug	87, 149, 157, 282, 430, 454, 610, 690, 797, 1728
plant bugs	
	560
waterscorpions	
	510
backswimmers	
	510, 1728
stink bugs	
	192-3
two-spotted stink bug; Canadian bug	489
pyrrhocorid bugs	
Peruvian cotton stainer	1290
	1728
assassin bugs	
	1728
	497
	104, 110, 112, 163, 562, 625
aphids, leafhoppers, planthoppers, scale insects, and allies	525
whiteflies	
Florida red scale	13
greenhouse whitefly	802, APX. 9
aphids	452
	1463
bean aphid	454, 473-4, 478, 482, 622
	549
	480

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Hemiptera (Homoptera)	Aphididae	QQ. 2	Macrosiphum pelargonii (Kaltenbach)
				Macrosiphum pisi
				Megoura viciae (Buckt.)
				Myzocallis discolor
				Myzodes persicae (Sulzer)
				Myzus ascalonicus
				Myzus persicae Sulz.
				Tuberolachnus salignus
		Cercopidae	QQ. 4	
				Clastoptera xanthocephala Germar
		Cicadellidae	QQ. 6	
				Aceratagallia sanguinolenta (Provancher)
				Calligypona pellucida (Fabricius)
				Carneocephala flaviceps (Riley)
				Cuerna costalis
				Empoasca sp.
				Javesella pellucida (Fabricius)
				Scaphytopius acutus
		Coccidae	QQ. 8	
				Coccus hesperidum Linnaeus
		Delphacidae	QQ. 10	
				Perkinsiella saccharicida Kirkaldy
		Fulgoridae	QQ. 13	
				Delphacodes sp.
				Pissonotus delicatus

Common Name(s)	Reference No.
	802
pea aphid	799
	322, 476, 940
	1530
	470-1
	560, 1791
green peach aphid	19, 175, 475, 486, 560, 1791
willow aphid	84
spittlebugs	
sunflower spittle bug	556
leafhoppers	739
clover leafhopper	556
leafhopper	504
yellow-headed leafhopper	556
leafhopper	556
leafhopper	556
leafhopper	18, 498
leafhopper	556
soft scales	
brown soft scale	1306
delphacid planthoppers	
sugar cane leafhopper	1144, 1149, 1573
fulgorid planthoppers	
planthopper	556
	556

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Hemiptera (Homoptera)	Fulgoridae	QQ. 13	Prokelisia marginata
		Jassidae	QQ. 14/15	
				Macrosteles fascifrons
				Orosius argentatus
		Pseudococcidae	QQ. 18	
				Planococcus citri (Risso)
				Pseudococcus gahani Green
				Pseudococcus njalensis (Laing)
				Pseudococcus obscurus Essig
		Psyllidae	QQ. 19	
				Psylla pyricola Foerster
	Neuroptera (Planipennia)		RRR.	
		Chrysopidae	RRR. 1	
				Chrysopa perla
	Mecoptera		S.	
		Panorpidae	S. 3	
				Panorpa communis
	Trichoptera		T.	
				Brachycentrus

Common Name(s)	Reference No.
	526
	560
	560
mealybugs	
citrus mealybug	802, 1402
	1402
mealybug	59
	1402
jumping plantlice or psyllids	
pear psylla	108, APX. 9
green lacewings	
	280
scorpionflies	
scorpionfly	154
caddisflies	496, 523-4, 529
caddisfly	523

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Trichoptera	Hydropsychidae	T. 1	
				Hydropsyche
	Lepidoptera		U.	
		Arctiidae	U. 2	
				Hyphantria cunea Drury
		Bombycidae	U. 3	
				Bombyx mori (Linnaeus)
		Cossidae	U. 7	
				Zeuzera aesculi
		Crambidae	U. 8	
				Chilo suppressalis (Walker)
				Diatraea saccharalis (Fabricius)
				Tryporyza incertulas
		Galleriidae	U. 12	
				Galleria mellonella (Linnaeus)
		Gelechiidae	U. 13	
				Pectinophora gossypiella (Saunders)
				Pectinophora malvella Herbst
				Sitotroga cerealella (Olivier)
		Hesperiidae	U. 19	
				Calpodes ethlius (Stoll)

Common Name(s)	Reference No.
caddisfly	523
butterflies, moths, skippers	51, 453, 556, 1133, 1317, 1677
tiger moths and allies	
fall webworm	57, 1338
silkworm moths	
silkworm	43, 195, 299, 300, 924, 928, 933, 954, 956-8, 964, 972, 974-5, 987, 1089, 1091, 1094, 1107-8, 1213, 1238, 1271, 1283, 1368-70, 1708, 1719
	81, 86, 93a, 98, 117, 122, 134, 148, 155, 178-9, 184, 196, 206, 211, 219, 220-2, 233, 236, 258-9, 260-1, 319, 329, 351-3, 377, 395, 397, 423-7, 437, 440, 725, 912, 923, 1061, 1093, 1199, 1279, 1287, 1305, 1356, 1363, 1399, 1400-1, 1450, 1536, 1709
carpenterworm moths	
	1132
grass moths	
Asiatic rice borer	724, 788, 1385, 1442, 1559
	1156, 1157-9, 1621, 1688
	1559
wax moths	
greater wax moth	330, 359, 390-1, 405-7, 1103, 1316, 1357
gelechiid moths	
pink bollworm	1559
hollyhock-seed moth; mallow moth	1123, 1392, 1618
Angumois grain moth	1342, 1376-7, 1396, 1705-6
skippers	
large canna leaf roller	140-1, 187, 419

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Lepidoptera	Lasiocampidae	U. 22	
				Dendrolimus pini
				Macrothylacia rubi Linnaeus
				Malacosoma
				Malacosoma americanum (Fabricius)
				Malacosoma neustria Linnaeus
		Leucopteridae	U. 22/23	
				Leucoptera coffeella Guer.
		Lymantriidae	U. 25	
				Lymantria dispar
				Lymantria monacha (Linnaeus)
				Ocneria dispar Linnaeus
				Porthetria dispar (Linnaeus)
		Noctuidae	U. 29	
				Agrotis orthogonia Morrison
				Agrotis segetum
				Barathra brassicae
				Heliothis armiger
				Heliothis virescens (Fabricius)
				Heliothis zea (Boddie)
				Laphygma frugiperda (J. E. Smith)
				Peridroma saucia (Hübner)
				Phytometra gamma Linnaeus
				Prodenia eridania (Cramer)
				Prodenia litura Fabricius
				Rhyacia* c-nigrum Linnaeus
				Scoliopteryx

* Amathes

Common Name(s)	Reference No.
tent caterpillar moths and allies	54
pine spinner	499
	53
	359
Eastern tent caterpillar	1443
	416
coffee leaf miner	1131, 1545
tussock moths	
gipsy moth	1146
nun moth	499
unmatched gipsy moth	1360
gipsy moth	878, 1559
owlet moths and underwings	52, 54, 1476
pale Western cutworm	175
a cutworm	1412
	314
	1577
tobacco budworm	685-7, 700, 702, 813-4, 1127, 1355, 1559
bollworm; corn earworm; tomato fruitworm	699, 700, 702, 799, 807, 814, 1559
fall armyworm	1303
variegated cutworm	462
	53
Southern armyworm	411
cotton leaf worm	732, 823, 847, 1148, 1239
	53
	484

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Lepidoptera	Noctuidae		Scotia segetum Schiff.
				Spodoptera frugiperda (J. E. Smith)
				Trichoplusia ni (Hübner)
				Trigonophora meticulosa Linnaeus
				Triphaena pronuba Linnaeus
		Olethreutidae	U. 33	
				Carpocapsa pomonella (Linnaeus)
				Grapholitha molesta (Busck)
				Rhyacionia buoliana (Schiffermütter)
		Papilionidae	U. 34	
				Papilio machaon Linnaeus
		Phycitidae	U. 36	
				Anagasta
				Anagasta kuehniella (Zeller)
				Elasmopalpus lignosellus (Zeller)
				Ephestia
				Ephestia cautella
				Ephestia* kuehniella Zeller
				Paramyelois transitella (Walker)
		Pieridae	U. 37	
				Colias eurytheme Boisduval
				Pieris brassicae Linnaeus
		Psychidae	U. 39	
				Thyridopteryx ephemeraeformis (Haworth)
		Pyralidae	U. 41	
				Corcyra cephalonica

* see Anagasta

Common Name(s)	Reference No.
	53, 55
fall armyworm	879, 884
cabbage looper	889, 1142
	53
	53, 55
olethreutid moths	
codling moth	1145, 1307, 1555, 1559, 1569, 1590, 1605-6, 1620
oriental fruit moth; leaf roller moth	30, 1302, 1559, 1740
European pine shoot moth	1281, 1332
swallowtail butterflies	54
	53
	1298
Mediterranean flour moth	1344
lesser cornstalk borer	1277
	29, 248-9
	1668
Mediterranean flour moth	1336, 1362, 1367, 1436, 1684
navel orangeworm	1153, 1569
white and sulphur butterflies	54
alfalfa caterpillar	234
white cabbage butterfly	53, 218, 223, 224, 303, 442, 467, 539, 540, 541, 993
bagworm moths	
evergreen bagworm	79, 532
pyralid moths	
rice moth	392

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Lepidoptera	Pyralidae	U. 41	Plodia interpunctella (Hübner)
		Pyraustidae	U. 42	
				Ostrinia nubilalis (Hübner)
		Saturniidae	U. 43	
				Antheraea eucalypti Scott
				Antheraea pernyi
				Antheraea polyphemus (Cramer)
				Eudia pavonica Linnaeus
				Hyalophora cecropia (Linnaeus)
				Philosamia cynthia
				Philosamia cynthia ricini (Donovan)
				Samia cynthia pryori (Drury)
		Sphingidae	U. 46	
				Celerio euphorbia
				Manduca sexta (Johannson)
				Protoparce sexta (Johannson)
				Sphinx ligustri
		Tischeriidae	U. 48	
				Thaumetopoeidae
				Thaumetopoea pithyocampa Schiff.
		Tortricidae	U. 49	
				Argyrotaenia velutinana (Walker)
	Coleoptera		V.	
		Anobiidae	V. 1	
				Lasioderma serricome (Fabricius)

Common Name(s)	Reference No.
Indian meal moth	1342
pyraustid moths	
European corn borer	903, 934, 1379, 1559
giant silkworm moths	54, 321
	90
oak silkworm; Japanese oak moth	121, 206
polyphemus moth	244
	53
cecropia (silk) moth	64, 65, 66, 95, 100, 101, 105, 191, 225, 243-4, 269, 332, 346, 355, 356, 375, 401, 402, 453
	363, 993
	348
cynthia moth	99, 128, 243-4, 295-6, 346
sphinx moths	
hawk moth	202, 1305
tobacco hornworm	399, 400, 1553, 1559
tobacco hornworm	1565
	120
	52
pine processionary	53, 55, 905
leaf roller moths	
red-banded leaf roller	212
beetles	51, 593, 596, 1677
deathwatch and drugstore beetles	
cigarette beetle	1391, 1445, 1703

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Coleoptera	Bostrichidae	V. 5	
				Rhyzopertha dominica (Fabricius)
		Bruchidae	V. 7	
				Acanthoscelides obtectus (Say)
				Bruchus sp.
				Bruchus obtectus
				Callosobruchus chinensis Linnaeus
		Buprestidae	V. 8	
				Melanophila californica Van Dyke
		Carabidae	V. 11	
				Bembidion frontale
				Bembidion muscicola
				Carabus granulatus Linnaeus
				Carabus canellatus Ill.
				Pterostichus (Feronia) niger Schall
				Selenophorus ellipticus
				Selenophorus palliatus
				Triplectrus rusticus
		Cerambycidae	V. 12	
				Hylotrupes bajulus Linnaeus
		Chrysomelidae	V. 13	
				Altica marvegans
				Chrysomela decemlineata Say
				Chrysomela knabi Brown
				Hispa
				Dicladispa (Hispa) armigera (Ol.)

Common Name(s)	Reference No.
false powder-post beetles	
lesser grain borer	1391, 1668
seed beetles	
bean weevil	1344, 1684
	1742
	1577
pea weevil	1444
flatheaded or metallic wood borers	
California flatheaded borer	1754
ground beetles	
	11
	11
	416
	416
	418
	556
	556
	556
long-horned beetles or roundheaded wood borers	
European house borer; old-house borer	1293, 1656
leaf beetles	
leaf beetle; flea beetle	556
	1340
willow leaf beetle	48, 548
	1137
	1291

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Coleoptera	Chrysomelidae	V.13	Leptinotarsa decemlineata (Say)
		Cleridae	V.15	
				Necrobia
		Coccinellidae	V.16	
				Chilocorus bipistulatus Linnaeus
				Coleomegilla maculata (De Geer)
				Epilachna varivestis Mulsant
		Curculionidae	V.19	
				Anthonomus grandis Boheman
				Apion sp.
				Cylas formicarius elegantulus (Summers)
				Hypera postica (Gyllenhal)
				Sitophilus granarius (Calandra granaria) (Linnaeus)
				Sitophilus oryzae (Linnaeus)
				Sitophilus zeamais Motschulsky
				Sternochetus mangiferae (Fabricius)
		Dermestidae	V.20	
				Attagenus piceus (Olivier)
				Dermestes
				Dermestes vulpines
				Trogoderma glabrum (Herbst)
				Trogoderma granarium Everts
				Trogoderma versicolor

Common Name(s)	Reference No.
Colorado (potato) beetle	5, 311, 535, 1337, 1577, 1753
checkered beetles	
- ham beetle	1627, 1649
lady beetles	
a lady beetle	13
	114
Mexican bean beetle	1258
snout beetles or weevils	
boll weevil	371, 414, 448, 700, 702, 806, 807, 813-15, 881-2, 1136-8, 1141, 1268, 1331, 1439, 1553, 1579
a snout beetle	556
sweetpotato weevil	1320
alfalfa weevil	1124
omnivorous leaf roller	1555
granary weevil	1247, 1344, 1433, 1454, 1684, 1742
rice weevil	789, 815, 1341, 1344, 1361, 1391, 1403, 1426-7, 1668, 1684, 1751
	1460-1
mango seed weevil	1650, 1696
dermestid beetles	
black carpet beetle	1390
	1627, 1649
hide beetle	175
	1390, 1477
khapra beetle	1462, 1656, 1668, 1742
	APX. 8

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Coleoptera	Dytiscidae	V. 21	
				Acilius sulcatus Linnaeus
				Asynarchus sp.
				Callicorixa audeni (Hung.)
				Copelatus
				Dytiscus sp.
				Dytiscus marginalis
				Ilybius discedens (Shp.)
		Elateridae	V. 22	
				Conoderus vespertinus (Fabricius)
				Ctenicera destructor
		Gyrinidae	V. 23	
				Gyrinus natator
		Hydrophilidae	V. 25	
				Hydrophilus piceus Linnaeus
		Lampyridae	V. 26	
		Mordellidae	V. 33	
				Mordellistena
		Nitidulidae	V. 35	
				Meligethes aeneus (Fabricius)
		Phalacridae	V. 39	
				Olibrus sp.
		Scarabaeidae	V. 41	
				Amphimallon majalis (Razoumowsky)
				Amphimallon solstitialis
				Melolontha melolontha Linnaeus

Common Name(s)	Reference No.
predaceous diving beetles	
	418
	545
	545
	529
	545
	245, 418, 510, 1463
	545
click beetles, wireworms	
tobacco wire worm; click beetle	556
prairie grain wireworm	175
whirligig beetles	
	1463
water scavenger beetles	
	510
fireflies	231
tumbling flower beetles	
flower beetle	556
sap beetles	
	498
shining fungus beetles	
flower beetle	556
scarabs	52
European chafer	1365, 1578
	56
	1582

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Coleoptera	Scarabaeidae	V.41	Melolontha vulgaris Fabricius
				Oryctes rhinoceros
				Xylotrupes dichotomus (Linnaeus)
		Scolytidae	V. 42	
				Dendroctonus brevicornis LeConte
				Ips confusus (LeConte)
		Silphidae	V. 43	
				Necrophorus sp.
		Staphylinidae	V. 44	
				Pelecyphorus sp.
		Tenebrionidae	V. 46	
				Alphitobius diaperinus (Panzer)
				Eleodes armata
				Eleodes hispilabris
				Eleodes longicollis
				Gnathocerus cornutus (Fabricius)
				Lathridius (Enicmus) minutus Linnaeus
				Tenebrio molitor (Linnaeus)
				Tribolium sp.
				Tribolium castaneum (Herbst)
				Tribolium confusum Jacquelin duVal

Common Name(s)	Reference No.
cockchafer	91, 1559, 1569, 1580-1
	1561
horn beetle	724-5
bark beetles	
western pine beetle	1736
California five-spined ips	1479
carrion beetles	54
carrion beetles	53
rove beetles	
darkling beetle	496
darkling beetles	
lesser mealworm	1436
	534
	509
Arizona desert beetle	190, 214
broad-horned flour beetle	1436
grain beetle	1783
salami pest	1436, 1693
yellow mealworm	144, 216, 288, 311, 455, 599, 600, 1418, 1436, 1463, 1747
flour beetles	67, 1161, 1172, 1286, 1389, 1411
red flour beetle	1056, 1163-4, 1299, 1300-1, 1345, 1350, 1410, 1428, 1430, 1451, 1455, 1487, 1538, 1668
confused flour beetle	129, 250, 1163-4, 1300-1, 1319, 1346, 1348-9, 1351-2, 1391, 1398, 1410, 1434-7, 1440, 1458, 1535, 1538, 1741, 1748

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Hymenoptera		W.	
		Apidae	W. 3	
				Apis mellifera (Linnaeus)
				Apis mellifica Linnaeus
				Bombus lucorum
				Bombus terrestris
		Argidae	W. 4	
				Arge pagana Panz.
		Braconidae	W. 5	
				Bracon hebetor
				Habrobracon, Habrobracon juglandis
				Habrobracon serinopae
				Microbracon hebetor (Say)
		Cephidae	W. 6	
				Cephus cinctus Norton
		Chalcididae	W. 7	
				Mormoniella vitripennis (Walker) (= Nasonia brevicornis)
		Diprionidae	W. 12	
				Diprion hercyniae (Hartig)
				Neodiprion pratti (Dyar, Rohwer)
		Formicidae	W. 14	
				Acanthomyops claviger (Rogers)
				Camponotus
				Camponotus herculeanus (Linnaeus)

Common Name(s)	Reference No.
ants, bees, sawflies, wasps, and allies	51
bumble, carpenter, honey and stingless bees	
honey bee	69, 188, 209, 410, 444, 508, 550, 551, 554, 1289, 1722-4
honey bee	146-7, 468, 492, 518-9, 1294, 1463
bumble bee	56
bumble bee	498
argid sawflies	54
	53
braconids	
	63, 1456
	918, 935, 941, 968-9, 982, 1121-2, 1150, 1182-3, 1216-7, 1274, 1304, 1417, 1457, 1488, 1496, 1511-2
	1409
	127
stem sawflies	
wheat stem sawfly	175
chalcids	
	1060, 1114-5, 1129, 1408
conifer sawflies	
European spruce sawfly	240
Virginia pine sawfly; jack-pine sawfly	175
ants	520, 556, 1466, 1791
smaller yellow ant	376
	479
carpenter ant	552

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Hymenoptera	Formicidae	W. 14	Camponotus ligniperda (Latr.)
				Crematogaster clara
				Crematogaster striatula Emery
				Dolichoderus quadripunctatus
				Dorymyrmex pyramicus (Roger)
				Formica
				Formica cineraea (Mayr)
				Formica integra
				Formica polyctenea (Forster)
				Formica rufa
				Lasius neoniger
				Myrmica l. fracticornis
				Pogonomyrmex californicus (Buckly)
				Solenopsis molesta (Say)
		Ichneumonidae	W. 16	
				Devorgilla
				Nemeritis canescens (Gravenhorst)
		Mutillidae	W. 18	
		Pamphiliidae	W. 19	
				Acantholyda nemoralis (Thoms.)
		Siricidae	W. 23	
				Sirex spp.
		Sphecidae	W. 24	
				Dahlbominus fuscipennis (Zetterstedt)
		Vespidae	W. 29	
				Vespa

Common Name(s)	Reference No.
carpenter ant	552
	526
	59
	1318
pyramid ant	517, 556
	479
	495
	1467
	415, 416, 472, 483-4, 491, 493
	1463
	490
	11
California harvester ant	1473
thief ant	490
ichneumons	
	1104
	1298
velvet ants	1523
web-spinning sawflies	
sawfly	135, 409
horntails	
wood wasps	1656
cicada killers, mud daubers, and sand wasps	
	1053-5
hornets, yellow jackets, and potter wasps	
	485

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera		X.	
		Calliphoridae	X. 5	
				Calliphora sp.
				Calliphora erythrocephala (Meigen)
				Callitroga hominivorax (Coquerel)
				Cochliomiya hominivorax (Coquerel)
				Lucilia spp.
				Lucilia cuprina (Wied.)
				Lucilia sericata Meig.
				Phormia regina (Meigen)
				Protophormia terrae-novae R. D.
		Cecidomyiidae	X. 6	
				Thomasiniana ribis Mar.
		Ceratopogonidae	X. 7	
				Culicoides variipennis (Coq.)
		Chironomidae	X. 9	
				Chironomus plumosus
				Chironomus tentans
				Chironomus thummi
				Chironomus (Parachironomus) varus
				Glyptotendipes barbipes
				Smittia sp.
				Smittia parthenogenetica

Common Name(s)	Reference No.
flies	43, 254, 267, 290, 298, 337, 347, 556, 994, 1101, 1171, 1310
beet fly	948, 1482
blowflies	89, 460
blowfly	182, 215, 365
	32, 203-5, 361
screw-worm fly	1568, 1583, 1604
	927, 1079, 1504, 1542, 1559, 1586, 1615
blowfly	809
	156, 161-2, 369
	596, 1569
black blowfly	94, 132-3, 142, 175, 268, 386, 389, 458-9, 1431
Northern blowfly; carrion fly	1166
gall midges	
	1716
biting midges	
	1309
midges	257, 263, 524, 528, 531
	1494
	72, 169, 180-1, 253, 256, 266, 284, 309, 324, 449, 450, 1492-4, 1513
	71-2, 180, 273, 293-4, 324, 922
	68
	294
	291
	342-5

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera	Chloropidae	X. 10	
				Hippelates pusio Loew
				Oscinella frit (Linnaeus)
		Culicidae	X. 11	
				Aedes
				Aedes aegypti (Linnaeus)
				Aedes cataphylla (Dyar)
				Aedes communis
				Aedes dorsalis (Meigen)
				Aedes nigromaculis
				Aedes stimulans
				Aedes taeniorrhynchus (Wiedemann)
				Aedes trichurus
				Aedes vexans
				Anopheles maculipennis atroparvus
				Anopheles pharoensis Theobald
				Anopheles quadrimaculatus (Say)
				Anopheles stephensi mysorensis (Sweet & Rao)
				Culex fatigans
				Culex nigripalpus
				Culex pipiens
				Culex pipiens fatigans Wiedemann
				Culex pipiens molestus Forsk.
				Culex pipiens quinquefasciatus Say

Common Name(s)	Reference No.
chloropid flies	
eye gnat	1471
frit fly	555
mosquitoes	22, 901-2, 1569, 1713
	529, 901-2
yellow fever mosquito	11, 37, 82, 226, 387, 422, 585, 621, 646, 656, 863, 926, 963, 1000, 1111, 1167-8, 1181, 1249, 1292, 1333, 1343, 1472, 1486, 1791
	318
	545
	318
	759
	545
black salt-marsh mosquito	1791
	11, 545
	78
	1364
	1544, 1583-5, 1595, 1600, 1610-2
common malaria mosquito	585, 1066
	501-2
	1607
	6
	83
	8, 500, 796
	25
Southern house mosquito	76, 822, 1791

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera	Culicidae	X.11	Culex tarsalis Coquillet
				Culiseta impatiens (Walker)
				Culiseta inornata (Williston)
				Haplodiplosis equestris (Wagn.)
				Psorophora confinnis
				Psorophora signipennis
		Cuterebridae	X.12	
				Dermatobia hominis (Linnaeus, Jr.)
		Dolichopodidae	X.13	
				Chaetopsis aenea
				Chaetopsis apicalis
		Drosophilidae	X.14	
				Drosophila
				Drosophila affinis
				Drosophila ananassae
				Drosophila birchii
				Drosophila buskii
				Drosophila hydei Sturtevant
				Drosophila melanogaster *

* See p. 522.

Common Name(s)	Reference No.
	318
	318
	318
wheat-stem-gall mosquito	467
	1791
	318
rabbit bots, rodent bots	
human bot fly	1545, 1559
long-legged flies	525
	526
	526
vinegar flies	
pomace or vinegar fly	16, 28, 34, 36, 46, 75, 200-1, 239, 279, 303-4, 316-7, 320, 333, 357-9, 507, 908, 915, 931-2, 939, 946-7, 950-1, 953, 961-2, 970, 976, 980, 992, 1008, 1010, 1022-3, 1027, 1033, 1036-7, 1049, 1050, 1065, 1071, 1080, 1083, 1087, 1089, 1094, 1096, 1098, 1109, 1121, 1126, 1173, 1176-7, 1187, 1197, 1200, 1215, 1220, 1234-7, 1241-2, 1244-5, 1248, 1255-6, 1260, 1263, 1265-6, 1269, 1272, 1276, 1283, 1285, 1371, 1383, 1416-7, 1425, 1483, 1498, 1506
	1112
	945, 1011-2, 1513
	1404
	334, 450
	115-6, 237, 241-2, 262, 285, 328, 451, 1005, 1130
	*

* See p. 523.

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera	Drosophilidae	X. 14	Drosophila melanogaster (Meigen)
				Drosophila nebulosa
				Drosophila pseudoobscura
				Drosophila serrata
				Drosophila simulans
				Drosophila subobscura
				Drosophila tropicalis
				Drosophila virilis
				Drosophila willistoni
		Ephrididae	X. 15/16	
		Anthomyiidae	X. 18	
				Hylemya antiqua (Meigen)
				Pegomya hyoscyami (Panzer)
		Muscidae	X. 19	
				Fannia canicularis (Linnaeus)
				Glossina spp.
				Glossina, Glossina morsitans
				Haematobia irritans (Linnaeus)

Common Name(s)	Reference No.
	12, 20, 21, 26, 31, 33, 35, 74, 102, 118-9, 145, 150, 151, 153, 159, 160, 165-6, 183, 198, 210, 216, 227, 238, 241, 247, 264, 272, 276, 286-7, 292, 327, 335, 339, 350, 354, 378-9, 439, 447, 453, 465, 477, 782, 788, 917, 920-1, 937, 940, 942-5, 949, 955, 960, 965, 967, 977-8, 983-6, 989, 991, 998-9, 1004, 1006-7, 1009, 1013-4, 1018, 1021, 1024-6, 1028-9, 1030, 1034-5, 1038-9, 1040-5, 1048, 1057-9, 1062-4, 1067-9, 1070, 1073-6, 1081-2, 1084, 1086, 1090, 1092, 1095, 1097, 1099, 1105-6, 1110, 1139, 1140, 1147, 1151-2, 1155, 1174-5, 1178, 1180, 1185-6, 1188-9, 1190-1, 1194-6, 1198, 1201-12, 1214, 1218-9, 1221-9, 1230, 1232, 1240, 1243, 1246, 1250-1, 1253-4, 1259, 1261-2, 1264, 1270, 1273, 1278, 1280, 1282, 1284, 1500, 1502-3, 1507-9, 1510, 1513, 1515-9, 1520, 1613, 1725, 1744, 1785, 1791
	1505
	441, 1031, 1047, 1513
	1404, 1520
	336, 1464-5
	136, 1415, 1494, 1513
	1494
	143, 201, 277-8, 325-6, 952, 1323
	995, 1505, 1513
	525
antomyiid flies	
onion maggot	467, 1366
spinach leaf miner	911
house flies, stable flies, and allies	453
little house fly	1373
	124, 1559, 1565, 1712
tsetse fly	124, 126, 1559, 1565, 1712
horn fly	1591

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera	Muscidae	X. 19	Musca domestica Linnaeus
				Musca domestica nebulo
				Phorbia brassicae Bouché
				Stomoxys calcitrans (Linnaeus)
		Mycetophilidae	X. 20	
				Sciara coprophila (Lintner)
		Oestridae	X. 21	
				Hypoderma
				Hypoderma bovis (Linnaeus)
		Phoridae	X. 23	
				Megaselia scalaris (Rondani 1856)
		Psychodidae	X. 27	
				Lutzomyia (Phlebotomus) longipalpis (Lutz and Neiva, 1912)
				Plebotomus longipalpis
		Sarcophagidae	X. 29	
				Sarcophaga bullata
				Sarcophaga peregrina Robineau-Desvoidy
		Sciaridae	X. 29a	
				Rhynchosciara angelae
		Simuliidae	X. 30	
				Simulium

Common Name(s)	Reference No.
house fly	9, 10, 92, 111, 138, 176, 232, 359, 365-8, 370, 380, 417-8, 437, 445, 459, 463, 466, 593-4, 596, 614-5, 624, 667, 670, 674, 680-1, 690, 698, 700, 702, 735, 750, 767, 797, 799, 806, 814-5, 836-7, 841, 843-4, 848-9, 851-2, 870, 874-7, 885, 887, 891-3, 896-7, 1046, 1113, 1162, 1169, 1170, 1233, 1295-6, 1303, 1314, 1380-1, 1421-2, 1501, 1569, 1747, 1791
	1372
cabbage fly	1608
stable fly	677, 815
fungus gnats	
	15, 270-1, 294, 331
bot and warble flies	
cattle grub	708, 784
Northern cattle grub; warble grub	174-5
humpbacked flies	
	1019
moth flies	
sandflies	7, 464
	563
flesh flies	
flesh fly	113, 398, 421
	1315, 1382
	263, 294, 305-6, 312-3, 323, 341
black flies	4, 24
	359

Class	Order	Family	Systematic Code	Scientific Name
INSECTA	Diptera	Tephritidae	X. 35	
				Anastrepha ludens (Loew)
				Ceratitis capitata (Wiedemann)
				Dacus ciliatus
				Dacus cucurbitae Coquillet
				Dacus dorsalis Hendel
				Dacus oleae (Gmelin)
				Dacus tryoni (Frogg)
				Dacus zonatus
				Rhagoletis pomonella (Walsh)
				Strumeta tryoni
		Tipulidae	X. 36	
				Tipula oleracea
	Siphonaptera		Y.	
		Pulicidae	Y. 2	
				Xenopsylla gerbilli (Rothschild)

Common Name(s)	Reference No.
fruit flies	1052, 1179, 1568-9, 1697
Mexican fruit fly	1559, 1603
Mediterranean fruit fly; medfly	2, 3, 14, 27, 557, 559, 1119, 1120, 1325, 1327, 1335, 1354, 1359, 1459, 1474, 1544-5, 1551, 1556, 1559, 1562, 1589, 1594-6, 1598-9, 1600-2, 1609, 1616-7, 1647, 1656, 1702
	1559
melon fly	1559, 1571, 1592, 1647, 1650, 1656
oriental fruit fly	1559, 1647, 1650, 1656
olive fruit fly	905, 1154, 1325, 1335, 1551, 1559, 1614
Queensland fruit fly	1587, 1597, 1623, 1679
	1559, 1593
apple maggot	754
Queensland fruit fly	1670, 1690
crane flies	
a crane fly	310
fleas	542
pulicid fleas	
	546, 566-7

TABLE 2. RADIOTRACER STUDIES ON INSECTICIDES[1, 2]

Data have been assembled in the following categories:

A. ACTIVATORS OR SYNERGISTS

B. BOTANICALS AND DERIVATIVES

C. CHLORINATED ARYL HYDROCARBONS (containing 6 or more chlorines)

D. DDT RELATIVES (diphenyl aliphatics)

F. FUMIGANTS

N. NICOTINE ALKALOIDS (including ANABASINE and related compounds)

P. PHOSPHORUS-CONTAINING COMPOUNDS

  A. ALIPHATIC DERIVATIVES

  C. ARYL (PHENYL) DERIVATIVES

  H. HETEROCYCLIC DERIVATIVES

R. CHEMOSTERILANTS

X. CARBAMATES

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[1] Chemical names and "other designations" for compounds cited in the bibliography have been compiled following the general lines of E.E. Kenaga's "Commercial and Experimental Organic Insecticides" (1963 Revision) in Bull. ent. Soc. Am. 9: 2, 1963, 67-103 and (1966 Revision) in ibid. 12: 2, 1966, 161-217, and in announcements of the Insecticide Terminology Committee published ibid. 12,3 (1966) 356-7, 13,4 (1967) 342, and 14,4 (1968) 289. The chemical categories have been maintained, apart from slight modifications. – Two indexes (i) Common and Manufacturers' Names Index, and (ii) Letter-and-Number Index have been prepared.

[2] The chemical name used in accordance with the principles of Chemical Abstracts nomenclature is generally marked with an asterisk, *.

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis**	Metabolism	Residues
ACTIVATORS OR SYNERGISTS FOR INSECTICIDES					
A.1	* a-[2-(2-butoxyethoxy)ethoxy]-4,5-methylenedioxy-2-propyltoluene butylcarbitol-6-propylpiperonyl ether	piperonyl butoxide Butocide	^{14}C [896]	Musca domestica Baygon synergist ^{14}C [897] carbamate synergist ^{14}C [897	
A.2	* piperonal bis[2-(2-butoxyethoxy)ethyl]acetal	Tropital			
	piperonal bis[2-(2-butoxyethoxy)ethyl] acetal-methylene	Tropital-methylene		rat ^{14}C [894]	rat (bile, urine) ^{14}C [894]
A.3	* acetaldehyde-2(2-ethoxyethoxy)ethyl 3,4-methylenedioxyphenyl acetal 2-(3,4-methylenedioxyphenoxy)-3,6,9-trioxaundecane	sesamex Sesoxane ® ENT 20871		Musca domestica sesamex-suppressible DDT-resistance ^{14}C [667]	
A.4	* 1,2-methylenedioxy-4-[2-(octylsulfinyl)propyl]benzene n-octyl sulfoxide of isosafrole	sulfoxide Sulfox-Cide ®	diastereoisomers ^{14}C [896]		

** If no other indication

A.5	dimethyl sulfoxide			pear tree penetration and distribution ^{35}S [895]	
A.6	methylenedioxyphenyl compounds		^{14}C [896]	Musca domestica ^{14}C [892, 893] rat ^{14}C [892]	
A.7	4-allyl-1,2-methylenedioxybenzene	safrole	4-allyl-1,2-methylene-^{14}C-dioxybenzene ^{14}C [896]		
A.8	4-propyl-1,2-methylenedioxybenzene	dihydrosafrole	4-propyl-1,2-methylene-^{14}C-dioxybenzene ^{14}C [896]		
A.9	5-allyl-1-methoxy-2,3-methylene-dioxybenzene	myristicin	5-allyl-1-methoxy-2,3-methylene-^{14}C-dioxybenzene ^{14}C [896]		
A.10	2,3-methylenedioxynaphthalene				Musca domestica synergistic action ^{3}H [840] ^{14}C [840] mammals synergistic action ^{3}H [840] ^{14}C [840]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
BOTANICALS AND DERIVATIVES					
B.1	rotenone (from plant species Derris and Lonchocarpus)	cubé derris rotenone powder and resins		Musca domestica ^{14}C [870] inhibition sites of amytal and peiricidin A ^{14}C [871] reaction sites respiratory chain soluble DPNH-coenzyme Q reductase ^{14}C [872] respiratory chain binding characteristics ^{14}C [871] reaction sites ^{14}C [872] mouse ^{14}C [851]	
B.2	pyrethrum (principally from plant species Chrysanthemum cinariaefolium)	pyrethrin I	^{14}C (natural ester plus diastereoisomer) [851]	Musca domestica in vivo and in vitro ^{14}C [852] sorption of synthetic pyrethrin I ^{14}C [851]	

		pyrethrin II pyrethrins cinerin I cinerin II cinerins		Musca domestica oxidation products ^{14}C [852] general studies ^{14}C [850] general studies ^{14}C [850]	
B.3	* 2,2-dimethyl-3-(2-methylpropenyl)cyclopropanecarboxylic acid ester with 2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one dl-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esters of cis and trans dl-chrysanthemummonocarboxylic acids 3-allyl-2-methyl-4-oxo-2-cyclopenten-1-yl chrysanthemumate 2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one ester of 2,2-dimethyl-3-(2-methylpropenyl)-cyclopropanecarboxylic acid	allethrin allyl homologue of cinerin I synthetic pyrethrins Pynamin ENT 17510	labelled in ketol or acid portion ^{14}C [850]	Musca domestica in vivo and in vitro ^{14}C [852] metabolism ^{14}C [849]	
B.4	* 2,4-dimethylbenzyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate 2,4-dimethylbenzyl chrysanthemumate 2,4-dimethylbenzyl ester of cis trans chrysanthemumic acid	dimethrin ENT 21170		Musca domestica in vivo and in vitro ^{14}C [852]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
B.5	* 3,4,5,6-tetrahydrophthalimidomethyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate 2,3,4,5-tetrahydrophthalimidomethyl chrysanthemate 3,4,5,6-tetrahydrophthalimidomethyl cis and trans dl chrysanthemummonocarboxylic acid	Neo-pynamin ® phthalthrin ENT 27339 SP-1103		Musca domestica in vivo and in vitro ^{14}C [852]	
B.6	nicotine l-1-methyl-2-(3-pyridyl)-pyrrolidine l-3-(1-methyl-2-pyrrolidyl)-pyridine	Black leaf 40 ® nicotine (sulphate)	biosynthesis ^{14}C [675, 856-862, 868] ^{3}H [862] ^{3}H, ^{14}C [869] inhibition of ^{3}H, ^{14}C [867] effects of nutrient deficiencies on ^{3}H, ^{14}C [869] biosynthesis nicotine-2-^{3}H ^{3}H [863] synthesis DL-2-^{14}C-nicotine ring-labelled ^{14}C [853, 854] methyl-labelled ^{14}C [853, 854]	Aedes aegypti metabolism and toxicity ^{3}H [863] Arthrobacter oxidans metabolism of $^{14}CH_3$-L-nicotine ^{14}C [855] metabolism of 2'-^{14}C-DL-nicotine ^{14}C [855] dog ^{14}C [864] frog (sartorius muscle) contracture ^{14}C [866] effects on ^{45}Ca-movement rabbit ^{14}C [853]	

				rat ^{14}C [864] metabolism (system not specified) ^{14}C [857] tobacco leaves stereospecific demethylation ^{14}C [860]	
CHLORINATED ARYL HYDROCARBONS (containing 6 or more chlorines)					
C.0		organochlorine pesticides			plant ^{36}Cl [633]
C.1	* 1,2,3,4,5,6-hexachlorocyclohexane, mixed isomers	benzene hexachloride hexachloro-cyclohexane gammexane BHC HCH 666	analysis γ-HCH contents in HCH r.i. [1717] production and processing monitoring ^{36}Cl [679]	Boophilus decoloratus ^{14}C [614] mammals distribution in tissues (♂,♀) ^{14}C [683] rat distribution in tissues ^{14}C [683]	
C.2	* 1,2,3,4,5,6-hexachlorocyclohexane, 99% or more gamma isomer	lindane gamma BHC		fish elimination from ^{14}C [630] uptake ^{14}C [629]	

Index Codex	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
C.2 (ctd.)				microflora (soils, tropical) degradation by ^{14}C [655] soil decomposition by ^{14}C [692] soils, tropical -, degradation by ^{14}C [655]	soils persistence in tropical sub-merged -, ^{14}C [655]
C.3	* 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene 1,2,4,5,6,7,10,10-octachloro-4,7,8,9-tetrahydro-4,7-endomethyleneindane	chlordane Octa-Klor ® Octachlor ® Velsicol 1068 1068		Aedes aegypti (*l*) ^{14}C [646] fungi (Aspergillus niger Penicillium notatum) ^{14}C [646] monkey chlordane: digoxin metabolism ^{3}H [651] mouse ^{14}C [646] rat ^{14}C [646]	
	α-chlordane			rabbit ^{14}C [654]	

C.4	* 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene 1(3a),4,5,6,7,8,8-heptachloro-3a(1),4,7,7a-tetrahydro-4,7-methanoindene 1,4,5,6,7,10,10-heptachloro-4,7,8,9-tetrahydro-4 : 7 endomethyleneindene 4,5,6,7,9,10,10-heptachloro-4,7,8,9-tetrahydro-4,7-methanoindene	heptachlor Velsicol 104 ® E-3314		Aedes aegypti (ℓ) ^{14}C [646] fungi (Aspergillus niger Penicillium notatum) ^{14}C [646] mouse ^{14}C [646] rat ^{14}C [646]	
C.5	chlorinated camphene, containing 67-69% chlorine	toxaphene 3956 Melipax	synthesis semi-micro scale ^{36}Cl [640]	rape reinfestation by Meligethes aeneus after treatment ^{32}P [506]	honey ^{36}Cl [641] rape seed oil ^{36}Cl [641]
C.6	not less than 95% of * 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene hexachlorohexahydro-endo, exo-dimenthanonaphthalene	aldrin Octalene HHDN compound 118	decomposition products (non-metabolic) radiation [617] ozonation reaction on aldrin ^{14}C [612]	Aedes aegypti ^{14}C [646] dieldrin-R-: ^{14}C [585] Anopheles quadrimaculatus dieldrin-R-: ^{14}C [585] mouse ^{14}C [646] rabbit ^{14}C [645, 648] rat ^{14}C [645-7] distribution and elimination ^{14}C [645, 647] clays absorption ^{14}C [691]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
				soils ^{14}C absorption ^{14}C [691] fungi (Aspergillus niger, Penicillium notatum) ^{14}C [646]	
C.7	not less than 85% of * 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,-endo-exo-5,8-dimethanonaphthalene hexachloroepoxyoctahydro-endo, exo-dimethanonaphthalene	dieldrin Octalox HEOD compound 497	decomposition products (non-metabolic) radiation [617] double isotope derivative dilution analysis $^{3}H/^{14}C$ DBA † [609, 1729]	Aedes aegypti (ℓ) ^{14}C [646] Blattella germanica binding, interaction (nerve cord) ^{14}C [657] dieldrin: ion movement (CNS) ^{22}Na, ^{45}Ca [638] Musca domestica application method: toxicity and distribution ^{14}C [680, 681] R- and S- (CNS), uptake and metabolism ^{14}C [674]	residue analysis $^{3}H/^{14}C$ DBA † [609] rat retention ^{36}Cl [639] forage crops ^{14}C [688] ^{36}Cl [688]

†DBA = 6-acetoxy-7-bromo-6,7-dehydroaldrin

				Oncopeltus fasciatus (e) uptake ^{14}C [610] Periplaneta americana dieldrin: ion movement (CNS) ^{22}Na, ^{45}Ca [638] birds dieldrin: steroid metabolism ^{14}C [669] HeLa S cells DDT: NA synthesis, protein synthesis ^{14}C [613] mouse ^{14}C [646] rabbit ^{14}C [654] transport in pregnancy ^{14}C [636] rat ^{36}Cl [639] ^{14}C [646, 647, 678] distribution and elimination ^{14}C [647] toxicity ^{36}Cl [639] fish uptake ^{14}C [629]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
C.7 (ctd.)				fish elimination ^{14}C [630] forage crops root uptake and accumulation ^{36}Cl [666] soil microorganisms ^{14}C [660] Pseudomonas melophthora (apple maggot symbiont) ^{14}C [754] fungi (Aspergillus niger Penicillium notatum) ^{14}C [646] wool absorption r.i. [689] fastness properties r.i. [689]	
C.8	* 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthalene hexachloroepoxyoctahydro-endo, endo-dimethanonaphthalene	endrin compound 269		Aedes aegypti (l) ^{14}C [646] fungi (Aspergillus niger Penicillium notatum) ^{14}C [646]	

				mouse ^{14}C [646] rat ^{14}C [644, 646]	
C.9	* 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin 3-oxide	endosulfan Thiodan ® Malix BIO-5462 Hoe 2671 Niagara 5462	properties autoradiolysis ^{14}C [626]	fish ^{14}C [675] mouse ^{14}C [619] storage and excretion ^{14}C [619]	fish ^{14}C [675]
C.10	* 1,3,4,5,6,7,8,8-octachloro-3a,7,7a-tetrahydro-4,7-methanophthalan	Telodrin SD 4402 CP-14957		Aedes aegypti ^{14}C [646] Aspergillus niger ^{14}C [646] Penicillium notatum ^{14}C [646] mouse ^{14}C [646] rat ^{14}C [646]	
DDT RELATIVES					
D.1	* 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane dichloro diphenyl trichloroethane	DDT Chlorophenothene	DDT-1-^{14}C [621] DDT-2-^{14}C [621] o-Cl-DDT-^{14}C [621]	Insects Aedes aegypti (ℓ) ^{14}C [621] Boophilus microplus ^{14}C [676]	Analysis $^{3}H/^{14}C$ [609] Insects Musca domestica retention ^{14}C [690]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
D.1 (ctd.)			DDT-^{3}H [618] double isotope derivative dilution analysis $^{3}H/^{14}C$ [609,1729] production monitoring ^{36}Cl [672]	cockroaches binding (nerve cord) ^{14}C [635] Blattella germanica (CNS) R- and S- ^{14}C [637] Periplaneta americana ^{14}C [690] (CNS) ^{14}C [622, 623, 658, 659] Heliothis virescens (ℓ) ^{14}C [685, 686] distribution ^{14}C [685] penetration rate ^{14}C [685-7] Heptagenia hebe DDT-resistance ^{14}C [631] Musca domestica ^{14}C [690] ^{3}H [670] DDT: glucose utilization, protein synthesis, glutathione turnover ^{14}C [111, 615]	Oncopeltus fasciatus retention ^{14}C [690] Periplaneta americana retention ^{14}C [690]

				Musca domestica DDT: formate- and proline metabolism ^{14}C [138] sesamex-suppressible resistance ^{14}C [667] DDT and substituted derivatives, comparative toxicity ^{3}H [670] DDT-resistance ^{36}Cl [624] Oncopeltus fasciatus ^{14}C [690] uptake (e) ^{14}C [610] Stenonema interpunctatum DDT-resistance ^{14}C [631] Stomoxys calcitrans R- and S- ^{14}C [677] Triatoma infestans DDT: protein biosynthesis ^{14}C [110] toxicity ^{14}C [625] DDT: glutathione turnover ^{14}C [163]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
D.1 (ctd.)				Triatoma infestans DDT: glucose incorporation (protein; soluble intermediates) ^{14}C [104] <u>Birds</u> excretion by ^{14}C [634] ^{36}Cl [620] DDT: steroid metabolism ^{14}C [669] waterfowl ^{36}Cl [620] <u>Mammals</u> guinea pig DDT: cortisol production and metabolism ^{14}C [607] HeLa S cells DDT: cell biochemistry, NA synthesis, protein synthesis ^{14}C [613] monkey DDT: digoxin metabolism ^{3}H [651]	waterfowl ^{36}Cl [620] <u>Animals</u> (various) crayfish ^{36}Cl [662] fish ^{14}C [616] ^{36}Cl [661, 662] frog (tadpoles) ^{36}Cl [661, 662] rabbit ^{14}C [682] snails ^{14}C [616] snake (water-) ^{36}Cl [661, 662] vertebrates ^{36}Cl [661]

				mouse tolerance ^{14}C [608] rabbit resorption and excretion ^{14}C [682] DDT: plasmocytosis ^{198}Au: [627] rat binding (liver, muscle, brain) ^{14}C [635] DDT: plasmocytosis ^{198}Au: [627] DDT: dieldrin metabolism ^{14}C [678] DDT: protein metabolism (liver, cell-free) ^{14}C [673] animals DDT: plasmocytosis ^{198}Au: [628] Fish uptake ^{14}C [629] elimination ^{14}C [630] Animals (various) blood-sucking leeches (Hirudineria manillensis Hirudo nipponia)	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
D.1 (ctd.)				blood-sucking leeches absorption and dehydrochlorination ^{14}C [643]	
				Miscellaneous bacteria ^{14}C [677] yeast dechlorination by ^{14}C [642] soil distribution in ^{14}C [663] anaerobic degradation in ^{14}C [632] marsh ecosystem cycling ^{36}Cl [661, 662] field tests ^{36}Cl [586]	Miscellaneous food chains ^{36}Cl [661] mud ^{14}C [616] soil ^{14}C [616, 649] field tests ^{36}Cl [586]
				Plants barley R- and S-, DDT: photosynthesis ^{14}C [652] carrots ^{14}C [663, 671]	plants ^{36}Cl [661] carrots ^{14}C [663, 671] potatoes ^{14}C [649] weeds ^{36}Cl [662]

				rape reinfestation by Meligethes aeneus after aerosol treatment ^{32}P [506]	
D.2	* 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane dichlorodiphenyl dichloroethane tetrachlorodiphenylethane	TDE Rhothane ® DDD			carrots ^{14}C [671]
D.3	* isopropyl 4,4'-dichlorobenzilate	Chloropropylate ® G 24163		soil microorganisms ^{14}C [664] Trichoderma viride (soil fungus) ^{14}C [664]	
		FUMIGANTS			
F.1	* carbon tetrachloride	tetrachloromethane CCl_4		rat ^{14}C [668] effect of diet on CCl_4-metabolism ^{14}C [603]	
F.2	cyanide		^{14}C [592, 595, 604, 605]	Lotus arabicus ^{14}C [592] Lotus tenuis ^{14}C [592]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
F.3	* naphthalene			Musca domestica R- and S-, detoxication ^{14}C [594]	
F.4	* sulfuryl fluoride	Vikane ®	^{35}S [601]	insect eggs ^{35}S [601] Schistocerca gregaria uptake and metabolism (e) ^{35}S [599,600] Tenebrio molitor uptake (e) ^{35}S [599,600]	
PHOSPHORUS CONTAINING COMPOUNDS ALIPHATIC DERIVATIVES					
PA.1	* dimethyl (2,2,2-trichloro-1-hydroxyethyl)-phosphonate	trichlorfon Dipterex ® Dylox ® Neguvon ® chlorophos Trichlorphon Tugon Bayer L13/59 ENT 19763	^{32}P [743] ^{35}S [743] via chloral ^{3}H [618]	insects absorption and metabolism ^{32}P [701] chewing- ^{32}P [739] sucking- ^{32}P [739]	

				cattle ^{32}P [708, 786] resorption (percutaneous) ^{32}P [713, 784] (udder) ^{32}P [706, 787] excretion ^{32}P [709] metabolism in serum ^{32}P [715] milk ^{32}P [709] veterinary medicine applications in metabolic studies Rev., r.i. [710] fungus (Fusarium sp.) ^{14}C [732] cotton plant ^{14}C [732]	
PA.2	(Systox-type of compound)	tinox	protective materials permeability ^{32}P [707]	cattle ^{32}P [708] tomato metabolism of tinox-isomers ^{32}P [711]	cattle ^{32}P [708]
PA.3	*2,2-dichlorovinyl dimethyl phosphate O,O-dimethyl 2,2-dichlorovinyl phosphate	dichlorvos Vapona ® Herkol DDVP	protective materials permeability ^{32}P [707]	Oncopeltus fasciatus uptake (e) ^{14}C [610]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PA.3 (ctd.)				cattle polymer/insecticide as feed additive ^{14}C [752] resorption (udder) ^{32}P [706] rat absorption after oral administration ^{32}P [653] Pseudomonas melophthora (apple maggot symbiont) ^{14}C [754]	
PA.4	* dimethyl phosphate, ester with cis 3-hydroxy-N-methylcrotonamide dimethyl phosphate of 3-hydroxyl-N-methyl-cis-crotonamide dimethyl 1-methyl-2-(methylcarbamoyl) vinyl phosphate, cis	Azodrin® SD 9129	^{14}C [698]	Anthonomus grandis (a) ^{14}C [700] ^{32}P [700] Heliothis virescens (l5) ^{14}C [700] ^{32}P [700] Heliothis zea (l5) ^{14}C [700] ^{32}P [700] Musca domestica (a) ^{14}C [700] ^{32}P [700]	

				Periplaneta americana (a) ^{14}C [700] ^{32}P [700] rat ^{14}C [700] ^{32}P [700] cotton plant ^{32}P [751] distribution in ^{32}P [775] systemic activity in ^{32}P [775]	cotton plant ^{32}P [775]
PA.5		Bidrin® SD 3562	methoxy-labelled ^{14}C [698]	cotton plant ^{32}P [751]	
PA.6	* dimethyl phosphate, ester with 2-chloro-N,N-diethyl-3-hydroxycrotonamide 2-chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate 1-chloro-1-diethylcarbamoyl-1-propen-2-yl dimethyl phosphate	phosphamidon Dimecron® ML-97 OR-1191	^{32}P [702] carbonyl-labelled ^{14}C [702] methyl-vinyl-labelled ^{14}C [702]	Anthonomus grandis (a) ^{14}C [702] ^{32}P [702] Heliothis virescens (ℓ5) ^{14}C [702] ^{32}P [702] Heliothis zea (ℓ) ^{14}C [702] ^{32}P [702] Musca domestica (a) ^{14}C [702] ^{32}P [702]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PA.6 (ctd.)				goats ^{32}P [704] rat ^{32}P [704] cotton plants ^{14}C [702] ^{32}P [702]	
PA.7	* O,O-diethyl S-(ethylthio)methyl phosphorodithioate O,O-diethyl S-ethylmercaptomethyl dithiophosphate	phorate Thimet ® AC 3911 L 11/6		maize ^{32}P [798]	millet seed ^{35}S [742]
PA.8	* O,O-diethyl S-2-(ethylthio)ethyl phosphorodithioate	disulfoton Di-Syston ® FRUMIN AL ® SOLVIREX ® dithiodemeton Thiodemeton Bayer 19639		Heliothis zea ^{32}P [699] cotton plant effectiveness (field) ^{32}P [776] cotton seed effectiveness (field) ^{32}P [776]	
PA.9	* diethyl mercaptosuccinate, S-ester with O,O-dimethyl phosphorodithioate O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate O,O-dimethyl S-(1,2-dicarbethoxyethyl) dithiophosphate	malathion Malathon 4049	^{32}P [741, 743] ^{35}S [743]	Musca domestica ^{14}C [1791] Oncopeltus fasciatus uptake ^{14}C [610]	

	S-[1,2-bis(ethoxycarbonyl)-ethyl]O,O-dimethyl phosphorodithioate O,O-dimethyl phosphorodithioate ester with diethyl mercaptosuccinate			cattle (heifer) ^{32}P [794] hen nematodes elimination ^{32}P [794] man (liver) ^{14}C [835] rat (liver) ^{14}C [835] Pseudomonas sp. ^{14}C [757] Trichoderma viride (soil fungus) ^{14}C [757] soil degradation in ^{14}C [757] field tests ^{35}S [586]	cattle (heifer) (thymus, thyroid, meat, pancreas, liver, bone) ^{32}P [794] cotton persistence in ^{14}C [695] field tests ^{35}S [586]
PA.10	O,O-dimethyl S-[2-(1-methylcarbamoylethyl)-thio]ethyl phosphorothioate	vamidothion Vamidothion Vamidoate RP-9895		insects in vivo and in vitro ^{32}P [763] Periplaneta americana (fat body, gut, muscle) ^{32}P [763] mouse in vivo and in vitro ^{32}P [763] plants ^{32}P [763]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PA.11	O,O-dimethyl-1-butyryloxy-2,2,2-trichlorethylphosphonate dimethyl (2,2,2-trichloro-1-hydroxyethyl)-phosphonate butyrate	Butonate ENT 20852	protective materials permeability ^{32}P [712]	blood (lactating cow) ^{32}P [706] cattle ^{32}P [706, 716] resorption (udder) ^{32}P [706] toxicity ^{32}P [716] apples ^{32}P [715] plums ^{32}P [715] wheat ^{32}P [715]	blood (lactating cow) ^{32}P [715, 716] milk (cow) ^{32}P [715, 716] apples ^{32}P [715] plums ^{32}P [715] wheat ^{32}P [715]
PA.12	* O,O-dimethyl S-(methylcarbamoylmethyl) phosphorodithioate O,O-dimethyl S-(N-methylcarbamoylmethyl) phosphorodithioate O,O-dimethyl S-α-mercapto-N-methylacetamido dithiophosphate methyl dimethyl dithiophosphoryl acetamide	dimethoate Cygon ® PERFEKTHION ® Rogor ® Roxion ® AC 12880 ENT 24650 NC-262		insects in vivo and in vitro ^{32}P [763] Musca domestica ^{3}H [797] -/EPN: metabolism ^{3}H [797] Oncopeltus fasciatus ^{3}H [797]	apples ^{32}P [696, 769] apricots ^{32}P [769] cacao beans ^{32}P [717] cherry ^{32}P [769] grapefruit ^{32}P [769]

				-/EPN: metabolism ^{3}H [797] uptake (e) ^{3}H [610] Periplaneta americana (fat body, gut, muscle) ^{32}P [763] cattle resorption (per- cutaneous) ^{32}P [713] (udder) ^{32}P [706] application and metabolism ^{32}P [714] guinea pig ^{3}H [797] -/EPN: metabolism ^{3}H [797] mouse ^{3}H [797] -/EPN: metabolism and toxicity ^{3}H [797] in vivo and in vitro ^{32}P [763] plants ^{32}P [763] apples ^{32}P [769] apricots ^{32}P [769]	grapes ^{32}P [769] olives ^{32}P [769] olive oil ^{32}P [696] peaches ^{32}P [769] spinach ^{32}P [777, 778] r.i. [779] tangerines ^{32}P [769]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
				bean plants ^{14}C [753] ^{32}P [753] cherry ^{32}P [769] grapefruit ^{32}P [769] grapes ^{32}P [769] olives ^{32}P [769] peaches ^{32}P [769] tangerines ^{32}P [769] Theobroma cacao (cacao tree) translocation in ^{32}P [717] soil movement in ^{32}P [781]	
PA.13	* tetramethylphosphorodiamidic fluoride bis(dimethylamino)fluorophosphine oxide	dimefox Terra Sytam ® Hanane DMF Pestox 14	^{32}P [748]	hops ^{32}P [748]	hop leaves ^{32}P [748]

PHOSPHORUS ARYL (PHENYL) DERIVATIVES					
PC.1	* O,O-dimethyl O-p-nitrophenyl phosphorothioate O,O-dimethyl O-p-nitrophenyl thiophosphate dimethyl p-nitrophenyl thionophosphate dimethyl p-nitrophenyl phosphorothionate	methyl parathion Metron methyl homologue of parathion Nitrox Bayer E-601		Bombyx mori (ℓ) (midgut) ^{32}P [725] Chilo suppressalis (ℓ) ^{32}P [724, 788] Musca domestica ^{32}P [735] Periplaneta americana (a) ^{32}P [788] Xylotrupes dichotomus (ℓ) ^{32}P [724, 725] mouse ^{32}P [734, 736] toxicity ^{32}P [736] rat ^{32}P [724] liver ^{32}P [725] liver homogenates ^{32}P [788] carrots distribution and hydrolysis ^{32}P [719] cauliflower ^{32}P [788]	carrots ^{32}P [718]

Code Index	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PC. 2	* O,O-diethyl O-p-nitrophenyl phosphorothioate O,O-diethyl O-p-nitrophenyl thiophosphate diethyl p-nitrophenyl thionophosphate diethyl p-nitrophenyl phosphorothionate	parathion Alkron ® Niran ® THIOPHOS ® Amer. Cyan. 3422 Bayer E-605	^{32}P [741]	Aedes aegypti R- and S- ^{32}P [759] Chilo suppressalis (ℓ) ^{32}P [788] cockroach (fat body) ^{35}S [766] Periplaneta americana (a) ^{35}S [766, 788] Macrosiphum pelargonii ^{35}S [802] Musca domestica ^{35}S [766] Planococcus citri uptake ^{35}S [802] Trialeurodes vaporariorum ^{35}S [802] cat ^{32}P [723] guinea pig (liver microsomes) ^{32}P [768] man ^{32}P [723]	Macrosiphum pelargonii after 24 h ^{35}S [802] Planococcus citri after 24 h ^{35}S [802] Trialeurodes vaporariorum after 24 h ^{35}S [802]

				rabbit ^{32}P [723] liver microsomes ^{32}P [768] ^{35}S [766] rat ^{32}P [723, 765, 768] ^{35}S [765] liver homogenates ^{32}P [788] liver microsomes ^{32}P [768] ^{35}S [766] fish ^{14}C [761] fresh-water mussels (Elliptio complanatus) ^{14}C [761] water translocation in ^{14}C [761] Pseudomonas melophthora (apple maggot symbiont) ^{3}H [754] bean plant ^{35}S [802] uptake, translocation, accumulation ^{35}S [802] cauliflower ^{32}P [788]	
PC.3	mixture of parathion and methyl parathion	metafos	production monitoring r.i. [1717]		

Code Index	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PC. 4	dimethyl p-nitrophenyl phosphate O,O-dimethyl O-p-nitrophenyl phosphate	methyl paraoxon			Chilo suppressalis (ℓ) ^{32}P [788] Periplaneta americana (a) ^{32}P [788] rat (liver homogenates) ^{32}P [788] cauliflower ^{32}P [788]
PC. 5	* diethyl p-nitrophenyl phosphate O,O-diethyl O-p-nitrophenyl phosphate	paraoxon oxygen analogue of parathion Bayer E-600			cat ^{32}P [723] man ^{32}P [723] rabbit ^{32}P [723] rat ^{32}P [723]
PC. 6	* O-ethyl O-p-nitrophenyl phenylphosphonothioate ethyl p-nitrophenyl benzene thiophosphonate O-ethyl O-p-nitrophenyl benzenethiophosphonate	EPN EPN-300		Musca domestica effect on dimethoate metabolism ^{3}H [797] Oncopeltus fasciatus effect on dimethoate metabolism ^{3}H [797]	

				guinea pig effect on dimethoate metabolism and toxicity ^{3}H [797] mouse effect on dimethoate metabolism and toxicity ^{3}H [797]	
PC. 7	* O,O-dimethyl O-(4-nitro-m-tolyl) phosphorothioate O,O-dimethyl O-(3-methyl-4-nitrophenyl) phosphorothioate	Folithion® Sumithion® fenitrothion Bayer 41831 Sumitomo S-1102A		Bombyx mori (ℓ) (midgut) ^{32}P [725] Chilo suppressalis (ℓ) ^{32}P [788] Musca domestica ^{32}P [735] Periplaneta americana (a) ^{32}P [788] Xylotrupes dichotomus (ℓ) ^{32}P [725] mouse ^{32}P [734, 736] toxicity ^{32}P [736] rat liver ^{32}P [725] liver homogenates ^{32}P [788]	rice ^{32}P [762]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PC. 7 (ctd.)				cauliflower ^{32}P [788]	
PC. 8	* O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate	ronnel Etrolene® fenchlorphos Korlan® Nankor® Ronnel® Trolene® Viozene® Dow ET-14 Dow ET-57	^{32}P [746]		cattle (lactating cow) ^{32}P [746] meat ^{32}P [758] milk ^{32}P [746, 758]
PC. 9	* O-(4-bromo-2,5-dichlorophenyl) O,O-dimethyl phosphorothioate O,O-dimethyl-O-2,5-dichloro-4-bromophenyl thionophosphate O,O-dimethyl-O-2,5-dichloro-4-bromophenyl phosphorothioate	bromophos Nexion® S-1942 Cela S-2225		rat ^{3}H [795] ^{32}P [795] absorption, distribution ^{3}H [795] ^{32}P [795] plants penetration and effectiveness ^{32}P [738]	
PC. 10	* O-4-tert-butyl-2-chlorophenyl O-methyl methylphosphoramidate	Dowco® 132 Ruelene®			meat ^{32}P [758] milk ^{32}P [758]

PC.11	* O,O-dimethyl O-[4-(methylthio)-m-tolyl] phosphorothioate O,O-dimethyl O-(3-methyl-4-methylmercaptophenyl) phosphorothioate O,O-dimethyl O-4-(methylmercapto)-3-methylphenyl thiophosphate	fenthion BAYTEX ® ENTEX Lebaycid TIGUVON Bayer 29493 ENT 25540 S 1752		Cimex lectularius ^{35}S [801] absorption ^{35}S [801] Culex fatigans (ℓ) absorption ^{32}P [796] resistance mechanism ^{32}P [796] Stomoxys calcitrans ^{35}S [801] absorption ^{35}S [801] cattle (lactating cow) ^{32}P [747]	cattle (lactating cow) ^{32}P [747] milk ^{32}P [747]
PC.12	* O,O-diethyl O-p-(methylsulfinyl) phenyl phosphorothioate	Dasanit TERRACUR-P ® fensulfothion Bayer 25141 ENT 24945		cotton plant ^{32}P [745]	
PC.13	* O-p-(dimethylsulfamoyl)phenyl O,O-dimethyl phosphorothioate	famphur WARBEX ® Famophos CL 38023		Oncopeltus fasciatus uptake (e) ^{3}H [610] cattle (calf) ^{3}H [727] polymer/insecticide as feed additive ^{14}C [752]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PC.13 (ctd.)				sheep ^{3}H [727]	
PC.14	* ethyl mercaptophenylacetate, O,O-dimethyl phosphorodithioate ethyl ester of O,O-dimethyldithiophosphoryl α-phenyl acetic acid	PAPTHION ® Cidial ® Phenthoate BAY 33051 ENT 27386 L 561			apples ^{32}P [696] olive oil ^{32}P [696]
PC.15	* α-methylbenzyl 3-hydroxycrotonate dimethyl phosphate dimethyl phosphate of α-methylbenzyl 3-hydroxy-cis-crotonate alpha-methylbenzyl 3-hydroxycrotonate dimethyl phosphate	Ciodrin ® SD-4294			meat ^{32}P [758] milk ^{32}P [758]
PC.16	* 2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate	compound 4072 SD-7859	β - isomer ^{14}C [698]	Musca domestica (head homogenates) sorption ^{14}C [698] dog ^{14}C [737] mammals (blood) sorption ^{14}C [698] rat ^{14}C [737]	cattle after spraying ^{32}P [740] meat ^{32}P [758] milk ^{32}P [758]

PC.17	* 2-chloro-1-(2,3,5-trichlorophenyl)vinyl dimethyl phosphate	SD 8447	β-isomer of 1,2-^{14}C-SD 8447 [698]	Heliothis zea toxicity [799] Macrosiphum pisi toxicity ^{32}P [799] Musca domestica toxicity ^{32}P [799] sorption (head homogenates) ^{14}C [698] Sitophilus oryzae ^{32}P [799] Tetranychus telarius ^{32}P [799] dog ^{14}C [694] mammals (blood) sorption ^{14}C [698] rat ^{14}C [694] ^{32}P [799] toxicity ^{32}P [799]	
PC.18	2-chloro-1(2',4'-dichlorophenyl) vinyl diethyl phosphate	chlorfenvinphos Birlane® (Shell Reg. Trade Mark)			cabbage ^{14}C [697] carrots ^{14}C [697] onion ^{14}C [697]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
					soil ^{14}C [697]
PC.19	O-methyl O-p-methylthiophenyl methylphosphonothionate			cotton plant ^{32}P [705, 774] uptake and translocation ^{32}P [705, 774]	
PC.20	O-O-diethyl O-[^{35}S-4-(methylthio)-3,5-xylyl] phosphorothioate	Bayer 9017	^{35}S [801]	cattle (dairy calves) ^{35}S [801]	cattle (dairy calves) ^{14}C, ^{35}S [801]
PHOSPHORUS HETEROCYCLIC DERIVATIVES					
PH.1	* O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl) O,O-diethyl phosphorothioate O,O-diethyl O-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl-phosphorothioate O-(3-chloro-4-methylumbelliferone) O,O-diethyl phosphorothioate O,O-diethyl O-(3-chloro-4-methyl-7-coumarinyl) phosphorothioate 3-chloro-4-methylumbelliferone, O,O-diethyl thiophosphate	coumaphos ASUNTOL® CO-RAL® MUSCATOX® Resistox Bayer 21/199 ENT 17957		Boophilus microplus (ℓ) ^{32}P [780]	meat ^{32}P [758] milk ^{32}P [758]

PH. 2	* S-S'-p-dioxane-2,3-diyl O,O-diethyl phosphorodithioate (cis and trans isomers) 2,3-p-dioxanedithiol S,S-bis (O,O-diethyl phosphorodithioate) p-dioxane-2,3-diyl ethyl phosphorodithioate)	dioxathion Delnav® Navadel ENT 22897 Hercules AC-528	analysis separation of components ^{32}P [783]		meat ^{32}P [758] milk ^{32}P [758]
PH. 3	* S-((2-methoxy-5-oxo-Δ^2-1,3,4-thiadiazolin-4-yl)methyl) O,O-dimethyl phosphorodithioate O,O-dimethyl-S-[2-methoxy-1,3,4-thiadiazole-5-(4H)onyl-(4)-methyl]dithiophosphate	GS-13005		bean plant foliage ^{14}C [720]	
PH. 4	* O,O-dimethyl S-phthalimidomethyl phosphorodithioate N-(mercaptomethyl)-phthalimide S-(O,O-dimethyl phosphorodithioate) phthalimidomethyl O,O-dimethyl phosphorodithioate	Imidan® Prolate® R-1504 Stauffer R-1504		rat ^{14}C [722]	rat ^{14}C [722]
PH. 5	* O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate	Dursban® Dowco® 179	synthesis semi-micro scale ^{14}C [764]	fish ^{14}C [789, 790] ^{36}Cl [789] rat ^{14}C [789] ^{36}Cl [789, 792] bean plants uptake and translocation ^{14}C [791] ^{36}Cl [791] corn plants uptake and translocation ^{14}C [791] ^{36}Cl [791] plants absorption, translocation, metabolism ^{14}C [789,790,793] ^{36}Cl [789, 793]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PH.5 (ctd.)				soil ^{14}C [790]	
PH.6	* O,O-diethyl O-2-pyrazinyl phosphorothioate	Nemafos® NEMAPHOS® ZINOPHOS® Cynem AC 18133		soil ^{14}C [729]	soil persistence in ^{14}C [728]
PH.7	* O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidyl) thiophosphate	diazinon Diazinon® Basudin G-24480		Boophilus microplus (ℓ) ^{14}C [782] distribution ^{14}C [782] Musca domestica (ℓ) permeability ^{32}P (?) [750] cattle polymer/insecticide as feed additive ^{14}C [752] fish ^{14}C [761] fresh-water mussels (Elliptio complanatus) ^{14}C [761] water translocation in ^{14}C [761]	

				Pseudomonas melophthora (apple maggot symbiont) ^{14}C [754] bean plant ^{14}C [744] absorption ^{14}C [744] distribution ^{14}C [730] wheat grain ^{14}C [744] absorption ^{14}C [744] soil ^{14}C [729] distribution in ^{14}C [730] degradation by ^{14}C [749]	bean plant ^{14}C [730, 744] soil ^{14}C [728, 730] wheat grain ^{14}C [744]
PH.8	* O,O-dimethyl S-4-oxo-1,2,3-benzotriazin-3 (4H)-ylmethyl phosphorodithioate O,O-dimethyl-S-(benzaziminomethyl) dithiophosphate S-(3,4-dihydro-4-oxo-1,2,3-benzotriazin-3-ylmethyl) O,O-dimethyl phosphorodithioate 3-(mercaptomethyl)1,2,3-benzotriazin-4-(3H)-one O,O-dimethyl phosphorothioate benzotriazine derivative of a methyl dithiophosphate O,O-dimethyl phosphorodithioate S-ester with 3-(mercaptomethyl)-1,2,3-benzotriazin-4(3H)-one	azinphosmethyl Gusathion® Guthion® AZINPHOS-methyl Bayer 9027 Bayer 17147 17/147			cattle (tissue) from treated forage ^{32}P [721] milk ^{32}P [721]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
PH. 9	* S-(4,6-diamino-s-triazin-2-ylmethyl) O,O-dimethyl phosphorodithioate S-(4,6-diamino-1,3,5-triazin-2-ylmethyl) dimethyl phosphorothiolothionate	menazon Saphos ® Saphizon PP 175		rat ^{14}C [703, 726] ^{32}P [703] toxicity ^{14}C [703] ^{32}P [703] plants ^{14}C [703] ^{32}P [703]	
	CHEMOSTERILANTS				
R. 1	* 2,2,4,4,6,6-hexakis (1-aziridinyl)-2,2,4,4,6,6-hexahydro-1,3,5,2,4,6-triazatriphosphorine 2,2,4,4,6,6-hexahydro-2,2,4,4,6,6-hexakis (1-aziridinyl)-1,3,5,2,4,6-triazatriphosphorine hexakis (1-aziridinyl)phosphonitrile	apholate ENT 26316 OM 2174 SQ 8388		Musca domestica effect on NA metabolism (e) ^{14}C [887] chromosome aberrations (species not specified) ^{14}C [883] ^{32}P [883]	
R. 2	* tris(1-aziridinyl)phosphine oxide	tepa aphoxide APO ENT 24915		Anthonomus grandis absorption and translocation ^{14}C [881] turnover ^{14}C [882]	

				Musca domestica ^{14}C [875] sterilization ^{14}C [875] Porthetria dispar (a, ♂) ^{14}C [878] Spodoptera frugiperda distribution in ^{14}C [884] chromosome aberrations (species not specified) ^{14}C [883] ^{32}P [883]	Spodoptera frugiperda persistence in ^{14}C [879]
R.3	* tris(1-aziridinyl)phosphine sulphide	thiotepa		Musca domestica effect on NA metabolism (e) ^{14}C, ^{32}P [887] rat breast cancer, concentration in tissue ^{14}C [880] chromosome aberrations (species not specified) ^{14}C [883] ^{32}P [883]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
R. 4	hexamethylphosphoric triamide	hempa HMPA ENT 50882	analysis, purification ^{14}C [890]	Trichoplusia ni (f5) ^{14}C [889] Musca domestica ^{14}C [874, 877] sterilization ^{14}C [874, 877]	
R. 5	triphenyltin			rat ^{113}Sn [639] guinea pig ^{113}Sn [639]	rat retention ^{113}Sn [639] guinea pig retention ^{113}Sn [639]
R. 6	2-imidazolidinone			Musca domestica biochemical effects (various) ^{14}C [891]	
R. 7	5-fluorouracil			Musca domestica sterilization ^{14}C [885]	

CARBAMATES					
X.1	* o-isopropoxyphenyl methylcarbamate 2-isopropoxyphenyl methylcarbamate	Baygon® UNDEN® propoxur Bayer 9010 Bayer 39007	^{14}C [827] carbonyl-labelled ^{14}C [827] methyl-labelled ^{14}C [827]	Musca domestica ^{14}C [837] $NADPH_2$ system ^{14}C [843, 844] albumin enhancement of oxidative metabolism ^{14}C [844] Baygon + piperonyl butoxide ^{14}C [897] Oncopeltus fasciatus uptake (e) ^{14}C [610] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803] persistent glucoside metabolites in ^{14}C [830] foliage ^{14}C [804]	rat ^{14}C [827]
X.2	* 4-(methylthio)3,5-xylyl methylcarbamate	MESUROL® mercaptodimethur Bayer H-321 Bayer 9026 Bayer 37344 ENT-25726	carbonyl-labelled ^{14}C [827]	Musca domestica ^{14}C [837] albumin enhancement of oxidative metabolism ^{14}C [844]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
X.2 (ctd.)				NADPH$_2$ system ^{14}C [843, 844] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804]	rat persistence in ^{14}C [827]
X.3	* 4-dimethylamino-m-tolyl methylcarbamate	MATACIL® aminocarb arprocarb Bayer 44646 ENT-25784		Culex pipiens quinquefasciatus resistance ^{14}C [822] Musca domestica ^{14}C [837] albumin enhancement of oxidative metabolism ^{14}C [844] NADPH$_2$ system ^{14}C [843, 844] rat ^{14}C [827, 828, 839]	rat persistence in ^{14}C [827]

X.3 (ctd.)				bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804, 805]	
X.4	* 4-dimethylamino-3,5-xylyl methylcarbamate	Zectran® Dowco 139® ENT 25766	carbonyl-labelled ^{14}C [827, 830] methyl-labelled ^{14}C [827]	Musca domestica $NADPH_2$ system ^{14}C [843] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804, 805]	
X.5	* 1-naphthyl methylcarbamate 1-naphthyl N-methylcarbamate α-naphthyl N-methylcarbamate	carbaryl Sevin® 7744	carbonyl-labelled ^{14}C [827] methyl-labelled ^{14}C [827] reaction conditions ^{14}C [842]	acetylcholinesterase inhibition ^{14}C [846] Anthonomus grandis ^{14}C [807, 815] absorption ^{14}C [815] Heliothis zea (ℓ, a) ^{14}C [807]	residues r.i. [819] cattle (lactating cow) ^{14}C [817]

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
X.5 (ctd.)			gas chromatographic results, verification of ^{14}C [842]	Musca domestica absorption and metabolism ^{14}C [815] albumin enhancement of oxidative metabolism ^{14}C [844] $NADPH_2$ system ^{14}C [843, 844] with synergist ^{3}H, ^{14}C [840] Oncopeltus fasciatus uptake (e) ^{3}H [610] Prodenia litura ^{14}C [823, 847] Pseudomonas melophthora (apple maggot symbiont) ^{3}H [754] Sitophilus oryza absorption and metabolism ^{14}C [815] Stomoxys calcitrans absorption and metabolism ^{14}C [815]	

				cattle (lactating cow) ^{14}C [817] mammals with synergist ^{3}H, ^{14}C [840] man (liver) ^{3}H [835] ^{14}C [835] mouse ^{14}C [832] rabbit ^{14}C [832] rat ^{14}C [827, 828, 832] liver ^{3}H [835] ^{14}C [835] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804] cotton plant translocation and metabolism ^{14}C [838]	
X.6	* 1-(dimethylcarbamoyl)-5-methyl-3-pyrazolyl dimethylcarbamate	dimetilan Dimetilan ®		Blattella germanica ^{14}C [848]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
	2-dimethylcarbamyl-3-methylpyrazolyl-(5)-dimethylcarbamate 2-dimethylcarbamoyl-3-methyl-5-pyrazolyl dimethylcarbamate	Dimetilane GS-13332		Musca domestica ^{14}C [848] Periplaneta americana ^{14}C [848] cattle polymer/insecticide as feed additive ^{14}C [752] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [829] persistent glucoside metabolites ^{14}C [830]	
X.7	* 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate 2,3-dihydro-2,2-dimethylbenzofuranyl-7-N-methylcarbamate	ENT 27164 NIA 10242 Furadan		cattle (lactating cow) ^{14}C [824]	
X.8	* 2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime	Temik® ENT 27093 UC 21149	S-methyl-labelled ^{14}C [812] N-methyl-labelled ^{14}C [812] tert-labelled ^{14}C [812]	Anthonomus grandis ^{14}C [806, 813, 814] ^{35}S [806, 813, 814] Heliothis virescens (ℓ) ^{14}C [814] ^{35}S [814]	

				Heliothis zea (ℓ) ^{14}C [813, 814] ^{35}S [813, 814] Musca domestica ^{14}C [759, 806, 814, 837] ^{35}S [806, 814] cattle (lactating cow) ^{35}S [818] rat ^{14}C [808, 826] ^{35}S [806, 808] cotton plant r.i. [834] ^{14}C [836] leaves ^{14}C [816] ^{35}S [816] soil r.i. [834] ^{35}S [816]	milk ^{35}S [818] rat ^{14}C [826]
X.9	* 1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate dimethyl 5-(1-isopropyl-3-methylpyrazolyl)-carbamate	Isolan® G 23611	carbonyl-labelled ^{14}C [830]	Musca domestica $NADPH_2$ system ^{14}C [843] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [829] persistent glucoside metabolites ^{14}C [830]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
X.10	6-chloro-3,4-xylyl methylcarbamate(1) 6-chloro-4,5-xylyl methylcarbamate (2) 2-chloro-4,5-xylyl methylcarbamate (2) (1) cited officially in Bull.Ent. Soc. Am. 12: 1966, 357. (2) as cited in various publications	Banol® Sok Upjohn U-12927	carbonyl-labelled ^{14}C [827, 830] N-methyl-labelled ^{14}C [820, 827]	Blaberus giganteus (fat body) ^{14}C [821] Musca domestica ^{14}C [837] $NADPH_2$ system ^{14}C [843] rat ^{14}C [810, 811, 827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 820, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804]	
X.11	4-benzothienyl-N-methylcarbamate benzo [b] thien-4-yl methylcarbamate	asulan MCA-600 Mobam® Mobil MC-A-600		Musca domestica ^{14}C [841] microsomes ^{14}C [841] alfalfa ^{14}C [831] barley ^{14}C [831]	

X.12	3-isopropylphenyl methylcarbamate	UC 10854	carbonyl-labelled ^{14}C [827, 830]	Musca domestica albumin enhancement of oxidative metabolism ^{14}C [844] $NADPH_2$ system ^{14}C [843, 844] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804]	
X.13	3,5-diisopropylphenyl methylcarbamate	HRS-1422	carbonyl-labelled ^{14}C [827, 830]	Musca domestica $NADPH_2$ system ^{14}C [843] rat ^{14}C [827, 828] liver microsomes ^{14}C [839] bean plant ^{14}C [803, 829] persistent glucoside metabolites ^{14}C [830] foliage ^{14}C [804]	

Index Code	Chemical name	Other designations for chemical and its compositions	Synthesis	Metabolism	Residues
X.14	3,5-diisopropylphenyl N-methylcarbamate	DIP		Oncopeltus fasciatus uptake (e) ^{3}H [610]	
X.15	3,5-di-t-butylphenyl-N-methylcarbamate	Butacarb	^{3}H [809] ^{14}C [809] ^{3}H, ^{14}C [809]		sheep (meat, fat, kidney, liver) ^{3}H, ^{14}C [809]

5. INDEXES

5.1. INSECTICIDE INDEXES

5.1.1. Common and Manufacturers' Names Index

Insecticide	Category	Insecticide	Category
Furadan	X. 7	piperonyl butoxide	A. 1
gamma BHC	C. 2	Prolate ®	PH. 4
gammexane	C. 1	propoxur	X. 1
Gusathion ®	PH. 8	Pynamin	B. 3
Guthion ®	PH. 8	pyrethrin I	B. 2
Hanane	PA. 13	pyrethrin II	B. 2
hempa	R. 4	Resistox	PH. 1
heptachlor	C. 4	Rhothane ®	D. 2
Hercules AC-528	PH. 2	Rogor ®	PA. 12
Herkol	PA. 3	ronnel	PC. 8
Imidan ®	PH. 4	Ronnel ®	PC. 8
2-imidazolidinone	R. 6	rotenone powder and resins	B. 1
Isolan ®	X. 9	Roxion ®	PA. 12
Korlan ®	PC. 8	Ruelene ®	PC. 10
Lebaycid	PC. 11	safrole	A. 7
lindane	C. 2	Saphizon	PH. 9
malathion	PA. 9	Saphos ®	PH. 9
Malathon	PA. 9	sesamex	A. 3
Malix	C. 9	Sesoxane ®	A. 3
MATACIL ®	X. 3	Sevin ®	X. 5
Melipax	C. 5	Sok	X. 10
menazon	PH. 9	SOLVIREX ®	PA. 8
mercaptodimethur	X. 2	Stauffer R-1504	PH. 4
MESUROL ®	X. 2	Sulfox-Cide ®	A. 4
metaphoxide	PH. 10	sulfoxide	A. 4
methylenedioxyphenyl compounds	A. 6	sulfuryl fluoride	F. 4
2, 3-methylenedioxynaphthalene	A. 10	Sumithion ®	PC. 7
methyl homologue of parathion	PC. 1	Sumitomo S-1102A	PC. 7
methyl parathion	PC. 1	synthetic pyrethrins	B. 3
Metron	PC. 1	TDE	D. 2
Mobam ®	X. 11	Telodrin	C. 10
Mobil MC-A-600	X. 11	Temik ®	X. 8
MUSCATOX ®	PH. 1	tepa	R. 2
myristicin	A. 9	TERRACUR-P ®	PC. 12
Nankor ®	PC. 8	Terra Sytam ®	PA. 13
Navadel	PH. 2	Thimet ®	PA. 7
Neguvon ®	PA. 1	Thiodan ®	C. 9
Nemafos ®	PH. 6	Thiodemeton	PA. 8
NEMAPHOS ®	PH. 6	THIOPHOS ®	PC. 2
Neo-pynamin	B. 5	thiotepa	R. 3
Nexion ®	PC. 9	TIGUVON	PC. 11
nicotine (sulfate)	B. 6	tinox	PA. 2
Niran ®	PC. 2	toxaphene	C. 5
Nitrox	PC. 1	trichlorfon	PA. 1
Octachlor ®	C. 3	Trichlorphon	PA. 1
Octa-Klor ®	C. 3	triphenyltin	R. 5
Octalene	C. 6	Trolene ®	PC. 8
Octalox	C. 7	Tropital	A. 2
PAPTHION ®	PC. 14	Tugon	PA. 1
Parathion	PC. 2	UNDEN ®	X. 1
PERFEKTION ®	PA. 12	Upjohn U-12927	X. 10
Pestox 14	PA. 13	vamidothion	PA. 10
Phenthoate	PC. 14	Vamidothion	PA. 10
phorate	PA. 7	Vamidoate	PA. 10
phosphamidon	PA. 6	Vapona ®	PA. 3
phthalthrin	B. 5	Velsicol 104 ®	C. 4

Insecticide	Category	Insecticide	Category
Velsicol 1068	C. 3	WARBEX ®	PC. 13
Vikane ®	F. 4	Zectran ®	X. 4
Viozene ®	PC. 8	ZINOPHOS ®	PH. 6

5.1.2. Letter and Number Index

Letter/Number		Chemical classification code
AC	8911	PA. 7
	12880	PA. 12
	16133	PH. 6
Am. Cyan.	3422	PC. 2
APO		R. 2
BAY	33051	PC. 14
Bayer	L13/59	PA. 1
	21/199	PH. 1
	9010	X. 1
	9017	PC. 20
	9026	X. 2
	9027	PH. 8
	17147	PH. 8
	19639	PA. 8
	25141	PC. 12
	29493	PC. 11
	39007	X. 1
	41831	PC. 7
	44646	X. 3
Bayer	E-600	PC. 5
	E-601	PC. 1
	E-605	PC. 2
	H-321	X. 2
BHC		C. 1
BIO-5462		C. 9
Black Leaf	40 ®	B. 6
Cela	S-1942	PC. 9
CL	38-23	PC. 13
Compound	118	C. 6
	269	C. 8
	497	C. 7
	4072	PC. 16
CP-14957		C. 10
DDE		D. 2

Letter/Number		Chemical classification code
DDT		D. 1
DDVP		PA. 3
DIP		X. 14
DMF		PA. 13
Dowco	132 ®	PC. 10
	139 ®	X. 4
	179 ®	PH. 5
DOW	ET-14	PC. 8
	ET-57	PC. 8
E-3314		C. 4
ENT	17510	B. 3
	17957	PH. 1
	19763	PA. 4
	20852	PA. 11
	20871	A. 3
	21170	B. 4
	22897	PH. 2
	24650	PA. 12
	24915	R. 2
	24945	PC. 12
	25540	PC. 11
	25726	X. 2
	25766	X. 4
	25784	X. 3
	26316	R. 1
	27093	X. 8
	27164	X. 7
	27339	B. 5
	27386	PC. 14
	50882	R. 4
EPN		PC. 6
EPN-300		PC. 6
G	23611	X. 9
	24163	D. 3
	-24430	PH. 7

Letter/Number		Chemical classification code
GS	-13005	PH. 3
	-13332	X. 6
gamma BHC		C. 2
HCH		C. 1
HEOD		C. 7
Hercules	AC-528	PH. 2
HHDN		C. 6
HMPA		R. 4
Hoe	2671	C. 9
HRS-1422		X. 13
L	11/6	PA. 7
	561	PC. 14
MCA-600		X. 11
ML-97		PA. 6
Mobil	MC-A-600	X. 11
NC-262		PA. 12
NIA	10242	X. 7
Niagara	5462	C. 9
OM	2174	R. 1
OR-1191		PA. 6
PP	175	PH. 9
Prestox	14	PA. 13
R-1504		PH. 4

Letter/Number		Chemical classification code
RP-9895		PA. 10
S	1752	PC. 11
	-1942	PC. 9
SD	3562	PA. 5
	-4294	PC. 15
	4402	C. 10
	-7859	PC. 16
	8447	PC. 17
	9129	PA. 4
SP-1103		B. 5
SQ	8388	R. 1
Stauffer	R-1504	PH. 4
Sumitomo	S-1102A	PC. 7
TDE		D. 2
UC	10854	X. 12
	21149	X. 8
Upjohn	U-12927	X. 10
Velsicol	104®	C. 4
Velsicol	1068	C. 3
17/147		PH. 8
666		C. 1
1068		C. 3
3956		C. 5
4049		PA. 9
7744		X. 5

5.2. AUTHOR INDEX

5.2.1. Corporate Author Index

The Author is single or first author where references are underlined.

5.2.2. Personal Author and Affiliation Index

Abdul Matin, A.S.M.
1117, 1291, 1403, 1426, 1427, 1428
(1967) Atomic Energy Centre, Dacca, Pakistan

Abeleva, E.A.
1068, 1069, 1175, 1176, 1177
(1966) Institute of Biological Physics, Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR

Abendroth, C.
748
(1966) Institut für Biophysik der Deutschen Akademie der Wissenschaften zu Berlin, Aussenstelle Leipzig, Abteilung Toxikologie, 20 Johannisallee, 701 Leipzig, German Democratic Republic

Abrahamson, S.
932
(1966) Department of Zoology, University of Wisconsin, Madison 6, Wis. 53706, USA

Abrol, Y.P.
592
(1966) University of California, Davis, Calif. 95616, USA

Adler, A.
1061

Affeltranger, C.E.
1715, 1721
(1966) Department of Entomology, West Virginia University, Morgantown, Va., USA

Aggarwal, S.K.
453
(1964) Northwestern University, Evanston, Ill., USA

Agosin, M.
110, 111, 112, 163, 625
(1967) University of Chile, Santiago, Chile

Ågren, G.
693
(1963) Institute of Medical Chemistry, University of Uppsala, Uppsala, Sweden

Ahmed, H.
1592
(1966) Radioisotope and Radiation Laboratory, Department of Locust Warning and Plant Quarantine, Karachi, Pakistan

Aidley, D.J.
47
(1965) Oxford University, Oxford, England

Ailam, G.
1554
(1966) Israel Institute for Biological Research, Ness-Ziona, Israel

Akai, H.
176, 236
(1967) Sericultural Experiment Station, Wada, Suginami-ku, Tokyo, Japan

Akamine, E.K.
1624, 1636, 1647
(1966) College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii

Akhalaya, Y.G.
933, 987, 1450
(1966) Academy of Sciences of the Georgian SSR, Tbilisi, Georgian SSR

Akintonwa, D.A.A.
694, 737
(1967) Tunstall Laboratory, 'Shell' Research, Ltd., Sittingbourne, Kent, England

Akov, S.
1249, 1292
(1966) Israel Institute for Biological Research, Ness-Ziona, Israel

Alaverdyan, E.B.
1393

Albanus, L.
904

(1965) Research Institute of National Defense, Sundberg, Sweden

Alderson, T.
1197

(1966) Cambridge University, Cambridge, England

Alexander, J.
149

(1966) Department of Zoology, University of Texas, Austin 12, Tex. 78712, USA

Alexander, M.L.
1178, 1250, 1251

(1967) Genetics Foundation, University of Texas, Austin 12, Tex. 78712, USA

Alexe, G.
1719

Alford, C.F.
35, 36

(1967) University of Texas, Austin 12, Tex. 78712, USA

Alibert, J.
469

(1965) Laboratoire d'Evolution des Etres Organisés, Paris 6e, France

Allais, J.P.
360

(1966) Faculté des Sciences, Corbeil, France

Allen, J.R.
4

(1966) Department of Microbiology, College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Canada

Allen, R.R.
113

(1966) Oregon State University, Corvallis, Oreg., USA

Alley, D.A.
1586

(1966) Entomology Research Division, ARS, USDA, Mission, Tex., USA

Altenburg, E.
1051, 1256

(1965) University of St. Thomas, 3812 Montrolse Blvd., Houston, Tex., USA

Amaducci, L.
597

(1967) Department of Neurology and Psychiatry, University of Florence, Florence, Italy

Amer, N.M.
1451, 1748

(1966) Donner Laboratory, Lawrence Radiation Laboratory, University of California, Berkeley, Calif. 94720, USA

Amy, R.L.
988

(1966) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Anderson, B.S.
379

(1967) Biology Department, University of Oregon, Eugene, Oreg., USA

Anderson, C.A.
721, 745

(1967) Chemagro Corporation, Kansas City, Mo., USA

Anderson, V.L.
1487

(1966) Population Genetics Institute, Purdue University, Lafayette, Ind., USA

Andrawes, N.R.
806, 807, 808

(1967) Department of Entomology, Texas A and M University, College Station, Tex., USA

Andreev, S.V.
1118, 1577, 1637, 1765

(1967) All-Union-Scientific-Research Institute for Plant Protection, Leningrad, USSR

Andrewartha, H.G. 1587	(1966) Department of Zoology, University of Adelaide, Adelaide, Australia
Andrews, A.K. 642	(1963) Fish-Pesticide Research Laboratory, Denver Federal Centre, Denver 25, Colo., USA
Andrews, F.N. 1735	(1962) Purdue University, Lafayette, Ind., USA
Anil, Y.D. 26	(1964) University of Istanbul, Bayezit, Istanbul, Turkey
Anonymous 1, 38, 1052, 1531, 1555, 1615, 1616, 1617, 1625, 1638, 1639, 1640, 1641, 1642, 1643, 1644, 1645, 1646	
Anonymous 443	(1964) International Atomic Energy Agency, 11 Kärntner Ring, A-1011 Vienna, Austria
Anthony, D.S. 1791	(1964) Botany Department, University of Florida, Gainesville, Fla., USA
Antipov, V.V. 1101, 1179, 1180, 1223 1231, 1232, 1452, 1453	(1966) Institute of Biological Physics, Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR
Apitzsch, U. 1136	(1966) Kernforschungszentrum, Karlsruhe, Federal Republic of Germany
Aravena, L. 110, 111	(1966) Department of Parasitology, School of Medicine, University of Chile, Santiago, Chile
Armstrong, D.E. 749	(1967) University of Wisconsin, Madison 6, Wis. 53706, USA
Arnesen, J.F. 1206	(1966) Department of Biological Sciences, Northern Illinois University, Dekalb, Ill. 60115, USA
Arnheim, N., Jr. 989, 1039	(1966) Lawrence Radiation Laboratory, Department of Zoology and Department of Genetics, University of California, Berkeley, Calif. 94720, USA
Arnold, D.G. 237	(1963) Columbia University, Morningside Heights, New York 27, N.Y., USA
Arnold, G. 328	(1964) Department of Zoology, Columbia University, Morningside Heights, New York 27, N.Y., USA
Arroyo, M. 2, 3, 27, 1119, 1120	
Arroyo Varela, M. 1556	(1965) Estación Central de Fitopatología, Instituto Nacional de Investigaciónes Agronómicas, Madrid, Spain
Arsenyeva, M.A. 1179	(1966) Institute of Biological Physics, Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR

Arthur, B.W. 746, 747, 815	(1967) Department of Zoology-Entomology, Agricultural Experiment Station, Auburn University, Auburn, Ala., USA
Ascher, K.R.S. 1252	(1964) Department of Toxicology, Volcani Institute of Agricultural Research, Institute of Agriculture, Beit-Daga, Rehovoth, Israel
Asman, M. 990, 1333	(1965) University of Notre Dame, Notre Dame, Ind., USA
Asman, S.M. 1181	(1967) Mount Alverno College, Redwood City, Calif., USA
Atallah, Y.H. 114	(1967) Department of Entomology and Nuclear Science Center, Louisiana State University, Baton Rouge, La., USA
Aten, A.H.W., Jr. 595	(1951) Institute for Nuclear Research, Amsterdam, The Netherlands
Atwood, K.C. 16, 335, 336, 350	(1966) Department of Microbiology, University of Illinois, Urbana, Ill., USA
Aubele, A.M. 1253	(1966) Ohio State University, Columbus 10, Ohio, USA
Aubele, S.M. 1097	(1965) Ohio State University, Columbus 10, Ohio, USA
Auerbach, S.I. 48, 507, 528, 1334	(1967) Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Avivi, A. 1622	(1967) Israel Institute for Biological Research, Ness-Ziona, Israel
Awad, T.M. 695	(1967) Department of Entomology, Mississippi Agricultural Experiment Station, State College, Miss., USA
Ayala, F.J. 1404, 1520	(1967) Rockefeller University, New York, N.Y., USA
Ayres, R.U. 1521	(1964) Hudson Institute, Croton-on-Hudson, N.Y., USA
Azaryan, C.K. 1618	(1965) Armenian Agricultural Research Institute, Yerevan, Armenian SSR
Baarli, J. 1081	(1967) CERN European Organization for Nuclear Research, 1211 Geneva 23, Switzerland
Babayan, V.V. 1618	(1965) Armenian Agricultural Research Institute, Yerevan, Armenian SSR
Baccetti, B. 905, 1335	(1965) University of Siena, Siena, Italy
Bachher, K.S. 1032	(1966) University of Allahabad, Allahabad, U.P., India
Bahig, M.R.E. 823	(1966) Department of Radiobiology, Atomic Energy Establishment, National Research Centre, Dokki, Cairo, UAR

Baillie, D. 1280	(1967) Department of Zoology, University of British Columbia, Vancouver, B.C., Canada
Baines, B.D. 1701	(1966) Nuclear Chemical Plant Ltd., London, England
Baker, M.W. 809	(1967) Boots Pure Drug Co., Ltd., Chemical Sciences Building, Research Department, Station Street, Nottingham, England
Baker, W.K. 1323, 1330	(1967) University of Chicago, Chicago 37, Ill., USA
Bakke, J.E. 1750	(1967) Metabolism and Radiation Research Laboratory, USDA, Fargo, N. Dak., USA
Balazs, T. 607	(1966) Department of Pharmacological Research, Experimental Therapy Research Section, Lederle Laboratories Division, American Cyanamid Co., Pearl River, N.Y., USA
Balboni, E.R. 444	(1967) Department of Biological Sciences, Hunter College, New York City University, New York 3, N.Y., USA
Balcar, J. 550, 551, 554	(1966) Institute of Experimental Botany, Czech Academy of Science, Prague-Vokovice, CSSR
Baldwin, W.F. 4, 1053, 1054, 1055	(1966) Chalk River Nuclear Laboratories, Atomic Energy of Canada Ltd., Chalk River, Ont., Canada
Ball, H.J. APX2	(1967) University of Nebraska, Lincoln, Nebr., USA
Ball, R.C. 523	(1966) Department of Fisheries and Wildlife, Michigan State University, East Lansing, Mich., USA
Balock, J.W. 1647	(1966) Entomology Research Division, ARS, USDA, Honolulu, Hawaii
Banerjee, D. 70	(1967) Saha Institute of Nuclear Physics, Calcutta, India
Barabas, B. 508	(1967) Disciplina de Chimie Fisica, Tîrgu Mures, Roumania
Baraldi, C. 755, 756	(1965) Centro Universitario di Ricerca ed Applicazione di Medicina Nucleare, Ospedale di Circolo, Varese, Italy
Barańska, J. 405	(1966) Department of Biochemistry, M. Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland
Barbier, M. 199, 360	(1966) Centre National de la Recherche Scientifique (C.N.R.S.), Gif-sur-Yvette, France
Barigozzi, C. 238	(1966) University of Milan, Milan, Italy
Barker, P.S. 608	(1966) Department of Entomology, MacDonald College, McGill University, Montreal 2, P.Q., Canada

Baroche, C. 1173	(1965) Institut du Radium, 11, Rue Pierre-Curie, Paris, France
Baron, R.L. 810, 811	(1967) Division of Food Chemistry, Bureau of Science, Food and Drug Administration, Washington, D.C. 20204, USA
Baroughi-Bounab, H. 1336	
Barr, H.J. 239	(1966) Department of Zoology, University of Wisconsin, Madison 6, Wis. 53706, USA
Barry, B.D. 934	(1967) Entomology Research Division, ARS, USDA, Wooster, Ohio, USA
Bart, C.A. 34	(1966) University of Texas, Austin 12, Tex. 78712, USA
Barthel, W.F. 849	
Bartlett, A.C 882, 1056, 1487	(1967) Entomology Research Division, ARS, USDA, State College, Miss., USA
Bartley, W.J. 812	(1966) Union Carbide Corporation, South Charleston, Va., USA
Basile, R. 323	(1966) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Basu 70	(1967) Saha Institute of Nuclear Physics, Calcutta, India
Bateman, A.J. 991, 992	(1965) Paterson Laboratories, Christie Hospital and Holt Radium Institute, Withington, Manchester 20, England
Bauer, H. 993	(1967) Max-Planck-Institut für Meeresbiologie, Tübingen, Federal Republic of Germany
Baumhover, A.H. 1588, 1791	(1965) Fruit and Vegetable Insects Research Branch, Entomology Research Division, ARS, USDA, Oxford, N.C., USA
Baumiller, R.C. 1254	(1967) Johns Hopkins School of Medicine, Moore Clinic, Baltimore, Md., USA
Baxter, R.C. 1240, 1282, 1405, 1406, 1407	(1967) Department of Radiation Biology and Biophysics, School of Medicine and Dentistry, University of Rochester, Rochester, N.Y., USA
Bazzi, B. 696, 769	(1965) Istituto di Ricerche Agrarie, Società Montecatini, Milan, Italy
Beal, R.H. 1721	(1966) U.S. Forest Service, Gulfport, Miss., USA
Beard, R.L. 1532, 1708	(1966) Connecticut Agricultural Experiment Station, New Haven, Conn., USA
Beard, W.E. 632	(1967) Soil and Water Conservation Research Division, ARS, USDA, Fort Collins, Colo., USA

Becker, G.
1293

Beer, M.
576

Beermann, W. — (1965) Max-Planck-Institut für Biologie, 34 Spemann Strasse, 74 Tübingen, Federal Republic of Germany
254, 994

Beischer, D.E. — (1962) Naval School of Aviation Medicine, Pensacola, Fla., USA
1185

Bell, A.E. — (1966) Population Genetics Institute, Purdue University, Lafayette, Ind., USA
1056, 1487

Belozerskiĭ, A.N. — (1966) Moscow M.V. Lomonosov State University, Leninskie Gory, Moscow 5, USSR
267

Belyatskaya, O.Y. — (1967) Leningrad 'A.A. Zhdanov' State University, 7/9 Universitetskaya Nab., Leningrad, USSR
1038

Ben-Zeev, N. — (1966) Hebrew University, Jerusalem, Israel
1057, 1063

Bender, H.A. — (1967) Department of Biology and Radiation Laboratory, University of Notre Dame, Notre Dame, Ind., USA
1058

Bennett, A.F. — (1966) Louisiana State University, Baton Rouge, La., USA
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593 — (1966) Department of Chemistry, Victoria University, Wellington, New Zealand

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Bogner, R.L.
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(1964) Institut für Biophysik, Universität Bonn, 1 An der Immenburg, 53 Bonn, Federal Republic of Germany

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(1959) University of Stockholm, 116 Drottninggatan, Stockholm, Sweden

Boontiam Disyam
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(1966) Biological Science Division, Office of the Atomic Energy for Peace, Bangkok, Thailand

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Bořkovec, A.B. 873, 875, 877	(1966) Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA
Borstel, R.C. von 918, 919, 982, 988, 1121, 1122, 1150, 1182, 1183	(1967) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Bos, B.G. van den 595	(1951) Laboratory of Organic Chemistry, State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands
Bosma, G.C. 1345, 1434	(1967) Department of Physiology and Biophysics, University of Illinois, Urbana, Ill., USA
Bosman, T. 204	(1966) Entomology Department, University of Natal, King George V Avenue, Durban P.O.B. 375, Pietermaritzburg, South Africa
Botstein, C. 1255	(1965) Montefiore Hospital, New York, N.Y., USA
Bourdeau, P. 510	(1965) Biology Service, Joint Research Centre, EURATOM, Casella Postale 1, Ispra, Italy
Bourke, J.B. 1720, 1738	(1967) New York State Agricultural Experiment Station, Geneva, N.Y., USA
Boush, G.M. 660, 664, 757	(1967) Department of Entomology, University of Wisconsin, Madison 6, Wis. 53706, USA
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Bowman, J.T., Jr. 1059	(1966) Utah State University, Logan, Utah, USA
Bowman, M.C. 879	(1967) Entomology Research Division, ARS, USDA, Tifton, Ga., USA
Boyd, J.B. 118, 119, 727	(1967) Agricultural Division, American Cynamid Co., Princeton, N.J.,
Boyd, J.E. 727	(1967) Agricultural Division, American Cynamid Co., Princeton, N.J., USA
Boyer, A.C. 698	(1967) 'Shell' Development Company, Modesto, Calif., USA
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Brak, J.A.W. 361	(1966) State University, 29 Kromme Nieuwe Gracht, Utrecht, The Netherlands
Brazzel, J.R. 686, 695, 1141	(1966) Department of Entomology, Mississippi Agricultural Station, State College, Miss., USA

Brewbaker, J.L. 1636, 1650, 1696, 1697	(1966) College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii
Bricteux-Grégoire, S. 86, 120	(1965) Institut Léon Frédéricq, Biochimie, Université de Liège, 7 Place du XX-Août, Liège, Belgium
Brindley, T.A. 903	(1966) Entomology Research Division, ARS, USDA, Ankeny, Iowa, USA
Brito da Cunha, A. 995	(1964) Departamento de Biología General, Universidade de São Paulo, Cidade Universitária 'Armando de Salles Oliveira', Caixa Postal 8191, São Paulo, Brazil
Broadbent, L. 560	(1966) University of Bath, Bath, England
Broce, A.B. 1324	(1967) Department of Entomology and Radiology, University of Florida, Gainesville, Fla., USA
Brookes, V.J. 121, 446	(1967) Department of Entomology, Oregon State University, Corvallis, Oreg., USA
Brooks, G.T. 611, 1174	(1967) Ohio State University, Columbus 10, Ohio, USA
Brower, G.R. 612	(1967) Washington University, Saint Louis 30, Mo., USA
Brower, J.H. 1466, 1467, 1530	(1968) Stored-Products Insects Laboratory, 3401 Edwin Avenue, Savannah, Ga., USA
Brown, A.W.A. 631, 796	(1967) Department of Zoology, University of Western Ontario, London, Ont., Canada
Brown, G.A. 1468	(1967) Department of Entomology, University of Georgia, Athens, Ga., USA
Brown, R.W. 613	(1967) Carver Research Foundation, Tuskegee Institute, Ala. 36088, USA
Brownell, L. 1626	(1961) Department of Chemical and Metallurgy Engineering, University of Michigan, Ann Arbor, Mich., USA
Browning, L.S. 1051, 1256	(1965) University of St. Thomas, 3812 Montrolse Blvd., Houston, Tex., USA
Brunel, C. 122	(1965) Faculty of Science, University of Science, University of Lyon, Lyon, France
Brust, R.A. 78	(1966) Department of Entomology, University of Manitoba, Winnipeg, Man., Canada
Buchanan, J.D. 1731	(1963) Hazelton Nuclear Corporation of Palo Alto, Palo Alto, Calif., USA
Buckhold, M. 1398	(1967) Lawrence Radiation Laboratory, University of California, Berkeley, Calif. 94720, USA
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Chaudhary, K.D. 129, 250	(1967) Department of Biochemistry, Faculty of Medicine, Laval University, Quebec, P.Q., Canada
Chauvin, R. 472, 491	(1965) Laboratoire de Psychophysiologie, Faculté des Sciences, Strasbourg, France
Chefurka, W. 87, 88, 130, 232	(1967) Department of Zoology, University of Western Ontario and Canada, Department of Agriculture, London, Ont., Canada
Cheldelin, V.H. 89	(1961) Oregon State University, Corvallis, Oreg., USA
Chen, P.S. 131, 132, 133	(1966) Institute of Zoology and Comparative Anatomy, Universität Zürich, Zurich, Switzerland
Chesters, G. 749	(1967) University of Wisconsin, Madison 6, Wis. 53706, USA
Chettachai Baditsing 1341	(1966) Biological Science Division, Office of the Atomic Energy for Peace, Bangkok, Thailand
Chiang, J.J.H. 906	
Chiba, M. 692	(1967) Canada Agriculture Research Station, Vineland, Ont., Canada
Chigarev, G.A. 5	
Childress, C.C. 458	(1966) Department of Pathology, School of Hygiene and Public Health, Johns Hopkins University, Baltimore 18, Md., USA
Chino, H. 363	(1967) Biological Institute, College of General Education, University of Tokyo, Komaba, Meguro, Tokyo, Japan
Chitra, C. 134	(1967) Fermentation Technology Laboratory, Indian Institute of Science, Bangalore 12, India
Chmurzyńska, W. 135	(1965) Biochemistry Department, M. Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland
Cho, W.K. 1311	(1964) Department of Zoology, Seoul National University, Seoul, Korea
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Choi, S.Y. 1442	
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Christian, J.E. 1735	(1962) Purdue University, Lafayette, Ind., USA

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Cook, B.J. 420	(1967) Metabolism and Radiation Research Laboratory, Entomology Research Division, ARS, USDA, Fargo, N. Dak., USA
Cope, O.B. 616	(1964) Fish-Pesticide Research Laboratory, U.S. Bureau of Sport Fisheries and Wildlife, Denver, Colo., USA
Coppedge, J.R. 813, 814, 816, 834	(1967) Entomology Research Division, ARS, USDA, College Station, Tex., 77841, USA
Corbel, J.C. 536	(1965) Laboratoire de Biologie Animale du S.P.C.N., 12, Rue Cuvier, Paris 5e, France
Cornwell, P.B. 59, 1653, 1654, 1655, 1656, 1657	(1964) Rentokil Laboratories Ltd., Felcourt, East Grinstead, Sussex, England
Cortes, A. 770	(1966) Research Foundation, National Canners Association, Berkeley, Calif., USA
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Courtois, J.E. 91	(1967) Laboratoire de Chimie Biologique, Faculté de Pharmacie, 4 Avenue de l'Observatoire, Paris 6e, France
Cox, H.C. 879	(1967) Entomology Research Division, ARS, USDA, Tifton, Ga., USA
Craig, G.B., Jr. 1111, 1343	(1964) University of Notre Dame, Notre Dame, Ind., USA
Craig, R. 462	(1967) University of California, Berkeley, Calif. 94720, USA
Crampton, E.L. 809	(1967) Boots Pure Drug Co. Ltd., Chemical Sciences Building, Research Department, Station Street, Nottingham, England
Crombie, L. 850	
Cromroy, H.L. 1193, 1324, 1791	(1967) Departments of Entomology and Radiology, University of Florida, Gainesville, Fla., USA
Crone, H.D. 365, 366, 367, 368, 421	(1966) Biochemistry Department, A.R.C. Pest Infestation Laboratory, London Road, Slough, Bucks., England
Cronin, R.T. 422	(1966) Fordham University, East Fordham Road, New York 58, N.Y., USA
Crosby, D.G. 617	

Cross, W.G. 1053	(1966) Chalk River Nuclear Laboratories, Atomic Energy of Canada Ltd., Chalk River, Ont., Canada
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Crouse, H.V. 15	(1966) Institute of Molecular Biophysics, Florida State University, Tallahassee, Fla. 32306, USA
Cruz, A.A. de la 517	(1967) Department of Zoology, University of the Philippines, Dilliman Rizal, Philippines
Cutcomp, L.K. 1559	(1967) Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, Minn., USA
Czaplicki, E. 489, 535	(1966) Institute of Plant Protection, Poznam, Poland
D'Ascoli, A. 497	(1966) Departamento de Ecología, Instituto Venezolano de Investigaciónes Científicas (IVIC), Apartado 1827, Caracas, Venezuela
D'Costa, M. 369	(1967) Department of Biochemistry, University of Sheffield, Sheffield 10, England
Daget, J. 1627	(1964) Chad Research Centre, Fort-Lamy, Chad, Africa
Dahm, P.A. 765, 766, 767	(1967) Iowa State University, Ames, Iowa, USA
Dailey, E.F., Jr. 534	
Daillie, J. 258, 259, 260, 261, 329, 423, 424, 425, 426, 427	(1967) Section de Biologie Générale et Appliquée, Laboratoire Associé au C.N.R.S., Faculté des Sciences de Lyon, 69 Villeurbanne, France
Dale, P.S. 1590	(1965) Zoology Department, Massey University of Manawatu, P.O. Palmerston North, New Zealand
Dalebroux, M.A. 1488, 1496	(1966) North Carolina State University, Raleigh, N.C., USA
Dame, D.A. 1712	(1964) Entomology Research Division, ARS, USDA, Gainesville, Fla., USA
Daneholt, B. 266	(1967) Department of Histology, Karolinska Institute, Stockholm 60, Sweden
Daniel, G. 932	(1966) Department of Zoology, University of Wisconsin, Madison 6, Wis. 53706, USA
Danieli, G.A. 262	(1967) University of Padua, Padua, Italy
Daniels, F.J.A. 361	(1966) State University, 29 Kromme Nieuwe Gracht, Utrecht, The Netherlands

Deema, P. — (1966) Pesticide Residue Laboratory, Plant Industry Division, Central Experiment Station, Bangkok, Thailand
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Deproost, M. — n.d. Centre d'Etude de l'Energie Nucléaire, Mol, Belgium
<u>1344</u>

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741

Descamps, M. — (1966) Laboratoire d'Entomologie Générale et Appliquée, Section Acridiens, Musée National d'Histoire Naturelle, Paris, France
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730

Devine, R.L. — (1966) Argonne National Laboratory, Argonne, Ill., USA
929

Devlin, R.M. — (1966) Cranberry Experiment Station, University of Massachusetts, East Wareham, Mass., USA
802

Dhillon, T.S.
<u>1000</u>

Dickerman, R.C. — (1967) Division of Biological and Medical Research, Argonne National Laboratory, Argonne, Ill., USA
<u>1188</u>, <u>1189</u>

Dickerman, R.L.
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<u>1658</u>, <u>1659</u>

Dinamarca, M.L. — (1966) Department of Parasitology, Biochemistry Section, School of Medicine, University of Chile, Santiago, Chile
<u>142</u>

Dindal, D.L. — (1967) Ohio University, Athens, Ohio, USA
<u>620</u>

Dinu, M.
<u>1061</u>

Dion, A.S. — (1967) University of New Hampshire, Durham, N.H., USA
<u>264</u>

Dirlbek, J. — (1967) Central Research Institute for Plant Production, 507 Prague Ruzyne, CSSR
555, 1753

Disney, R.W. 572, 589	(1967) Biochemistry Department, A.R.C. Pest Infestation Laboratory, London Road, Slough, Bucks., England
Dispons, P. 1522	
Dixon, S.E. 188	(1967) Department of Zoology, University of Guelph, Guelph, Ont., Canada
Dlabola, J. 18, 498, 504	(1963) Central Research Institute for Plant Production, 507 Prague Ruzyne, CSSR
Dobrogosz, W.J. 268	(1967) Department of Microbiology, North Carolina State University, Raleigh, N.C., USA
Dobrovsky, T.M. 1628	
Dobyns, B.M. 561	n.d. School of Medicine, Western Reserve University, Cleveland 6, Ohio, USA
Dobzhansky, T. 1497, 1498	(1966) Rockefeller University, New York, N.Y., USA
Dockal, J. 550, 551, 554, 1629	(1966) Central Research Institute for Plant Protection, 507 Prague Ruzyne, CSSR
Doe, F., S.J. 143	(1964) Department of Biology, Brandeis University, Waltham, Mass., USA
Doherty, J.D. 811	(1967) Division of Food Chemistry, Bureau of Science, Food and Drug Administration, Washington, D.C. 20204, USA
Dolfini, S. 238	(1966) University of Milan, Milan, Italy
Dollinger, E.J. 934	(1967) Agronomy Department, Ohio Agricultural Research and Development Center, Wooster, Ohio, USA
Domek, N.S. 1737	(1963) Nuclear Science and Engineering Corporation, Pittsburgh, Pa., USA
Dominas, H. 409	(1967) Department of Biochemistry, M. Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland
Domon, M. 1086	(1967) Rikkyo University, Tokyo, Japan
Donnellan, J.F. 537	(1967) 'Shell' Research Ltd., Woodstock Agricultural Research Centre, Sittingbourne, Kent, England
Dorough, H.W. 164, 807, 808, 816, 817, 818, 824, 834	(1967) Department of Entomology, Texas A and M University, College Station, Tex., USA
Doschek, E. 1019	(1967) University of Vienna, A-1010 Vienna, Austria
Douault, P. 492, 518, 519	(1966) Station de Recherches sur l'Abeille et les Insectes Sociaux, 91 Bures-sur-Yvette, France

Dutky, R.C.
370
(1967) Insect Physiology Laboratory, Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA

Duxbury, G.
665
(1965) University of Sheffield, Sheffield 10, England

Dyck, W. van
APX1
(1965) Catholic University of Louvain, 4 Rue Kraeken, Louvain, Belgium

Dyer, K.F.
1470
(1966) Medical Research Council, Radiobiological Research Unit, Harwell, Didcot, Berks., England

Dzhagatspanyan, R.V.
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Dzhimelin, A.A.
1038
(1967) Leningrad 'A.A. Zhdanov' State University, 7/9 Universitetskaya Nab., Leningrad, USSR

Earle, N.W.
371
(1965) Entomology Research Division, ARS, USDA, 4115 Gourrier Avenue, Baton Rouge, La., USA

Early, R.C.
528
(1963) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Eaton, J.L.
622, 623
(1967) Department of Biology, Kalamazoo College, Kalamazoo, Mich., USA

Ebeling, W.
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(1962) Technische Hochschule Darmstadt, Hochschulstrasse, Darmstadt, Federal Republic of Germany

Eddington, L.C.
420
(1967) Entomology Department, North Dakota State University, Fargo, N. Dak., USA

Edigaryan, S.E.
1393

Edmonds, E.
9, 10
(1966) Orange County Health Department, Anaheim, Calif., USA

Edwards, A.M.
364, 383
(1963) Conant Chemical Laboratory, Harvard University, Cambridge 38, Mass., USA

Egan, H.
819
(1967) Laboratory of the Government Chemist, Cornwall House, Stamford St., London S.E.1, England

Ehrhardt, P.
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(1967) Institut für Angewandte Zoologie der Universität Bonn, 1 An der Immenburg, 53 Bonn, Federal Republic of Germany

Eisenberg, E.
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(1966) Soreq Nuclear Research Centre, Yavne, Israel

Eisner, T.
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(1966) Department of Chemistry, Cornell University, Ithaca, N.Y., USA

El-Miniawi, S.F.
558, 1347
(1964) Plant Protection Department, Ministry of Agriculture, Dokki, Cairo, UAR

El Basheir, S.
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(1967) Faculty of Agriculture, University of Khartoum, Khartoum, North Sudan, Africa

Eldefrawi, M.E. (1966) Faculty of Agriculture, Alexandria University, Alexandria, UAR
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Eldridge, J.M. (1967) Mellon Institute, Pittsburgh, Pa., USA
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Eleftheriou, S. (1963) Nuclear Science and Engineering Corporation, Pittsburgh, Pa., USA
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Elequin, F.T. (1966) University of Texas, Austin 12, Tex. 78712, USA
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Ellgaard, E.G. (1967) Department of Zoology, University of Iowa, Iowa City, Iowa, USA
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Elliott, M.
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Emmerich, H. (1966) Freie Universität Berlin, 4 Boltzmannstrasse, Berlin-Dahlem, Federal Republic of Germany
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Engel, J.L. (1966) Division of Entomology, University of California, Berkeley, Calif. 94720, USA
892

Engels, W. (1967) Westfälische Wilhelms-Universität Münster, 2 Schlossplatz, Münster, Federal Republic of Germany
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206

Enns, T.
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Eno, C.F. (1965) Department of Soils, University of Florida, Gainesville, Fla., USA
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Erasmus, U. (1967) Department of Zoology, University of British Columbia, Vancouver, B.C., Canada
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Eschrich, W.
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Esghi, N. (1966) Institute of Parasitology, Tropical Medicine and Hygiene, Teheran, Iran
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Espinola, H.N. 7, 464	(1965) Department of Parasitology, Faculty of Medicine, University of Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
Essac, E.G. 892, 893	(1966) Division ov Entomology, University of California, Berkeley, Calif. 94720, USA
Esser, O. 720	(1965) Abteilung für Forschung- und Schädlingsbekämpfung, J.R. Geigy AG, Basel, Switzerland
Eudy, W.W. 268	(1967) Department of Microbiology, North Carolina State University, Raleigh, N.C., USA
Everett, L.J. 721	(1966) Chemagro Corporation, Kansas City, Mo., USA
Faghih, M.A. 501, 502	(1966) Institute of Parasitology, Tropical Medicine and Hygiene, Teheran, Iran
Fahmy, M.J. 1260, 1261	(1966) Chester Beatty Research Institute of Cancer Research, Royal Cancer Hospital, London S.W.3, England
Fahmy, O.G. 1260, 1261	(1966) Chester Beatty Research Institute of Cancer Research, Royal Cancer Hospital, London S.W.3, England
Fairbanks, L.D. 465, 477	(1966) Department of Medicine, Tulane University of Louisiana, New Orleans, La., USA
Falk, H.L. 894	(1967) Biogenetics Research Laboratory, Falls Church, Va., USA
Falk, R. 1057, 1063, 1064, 1065, 1499, 1500	(1967) Laboratory of Genetics, The Hebrew University, Jerusalem, Israel
Fanning, T. 327	(1966) University of Wisconsin, Madison 6, Wis. 53706, USA
Farias, G.J. 1474	(1966) Entomological Research Division, ARS, USDA, Honolulu, Hawaii
Farkas, J. 1352, 1353, 1435, 1436 1437, 1693, 1694, 1695	(1966) Central Food Research Institute, Budapest, Hungary
Farrior, W.L., Jr. 723	(1961) Toxicology Section, Technology Branch, Communicable Disease Center, Public Health Service, US Department of Health, Education, and Welfare, Atlanta, Ga., USA
Faust, M. 1738	(1967) Cornell University, Ithaca, N.Y., USA
Favard-Sereno, C. 265	(1966) Collège de France, Paris, France
Fawkes, J. 894	(1967) Biogenetics Research Laboratory, Falls Church, Va., USA
Fazio, C. 520, 1660	

Federbush, M. 143	(1964) Department of Biology, Brandeis University, Waltham, Mass., USA
Feinendegen, L.E. 28	(1966) Brookhaven National Laboratory, Upton, N.Y., USA
Feir, D. 430	(1965) Biology Department, Saint Louis University, Saint Louis, Mo., USA
Fenn, W.O. 1240, 1282	(1966) Departments of Physiology and Radiation Biology, Medical Center, University of Rochester, Rochester, N.Y., USA
Ferguson, W.E. 1523, 1692	(1967) San José State College, San José, Calif., USA
Feron, M. 1354	(1966) Directeur de la Station de Zoologie Agricole, Centre de Recherches Agronomiques du Sud-Est, Montfavet (Vaucluse), France
Ferrer, F. 1459	(1967) Inter-American Institute of Agricultural Sciences, Tropical Centre for Research and Graduate Training, Turrialba, Costa Rica
Ficq, A. 263	
Finch, L.R. 162	(1967) Russel Grimwade School of Biochemistry, University of Melbourne, Parkville N.2, Melbourne, Australia
Fine, B.C. 111, 625, 851	(1966) London School of Hygiene and Tropical Medicine, Tropical Products Institute, Grays Inn Road, London, W.C.1, England
Finlayson, D.G. 573	(1965) Canada Agriculture Research Station, 6660 N.W. Marine Drive, Vancouver 8, B.C., Canada
Finsinger, F.X. 1438	(1964) Schweizerisches Serum- und Impfinstitut, Berne, Switzerland
Firshein, W. 269	(1967) Department of Biology, Wesleyan University, Middletown, Conn., USA
Fischer, F.S. 790, 791, 792, 793	(1966) Biomechanism Group, E.C. Britton Laboratory, The Dow Chemical Company, Midland, Mich., USA
Fishbein, L. 894	(1967) Biogenetics Research Laboratory, Falls Church, Va., USA
Fleeker, J.R. 856	(1966) Michigan State University, East Lansing, Mich., USA
Fleisher, J.H. 731	(1966) Biochemistry Branch, Medical Research Laboratory, U.S. Army, Edgewood Arsenal, Md. 21010, USA
Fletcher, T.E. 880	(1952) Department of Surgery, Medical School, University of Oregon, Portland, Oreg., USA
Flint, H.M. 1127, 1331, 1355, 1439, 1471	(1967) Radiation Biology and Insect Genetics Section, Metabolism and Radiation Research Laboratory, Entomology Research Division, ARS, USDA, Fargo, N. Dak., USA
Florkin, M. 86, 93, 120, 148	(1965) Institut Léon Frédéricq, Biochimie, Université de Liège, 7 Place du XX-Août, Liège, Belgium

Foa, E. 1702	(1966) Soreq Nuclear Research Center, Yavne, Israel
Ford, I.M. 722	(1966) Stauffer Chemical Corporation, Agricultural Research Center, Mountain View, Calif., USA
Ford, J.B. 485	(1967) Department of Agricultural and Forest Zoology, University of College of North Wales, Bangor, Caemarvonshire, Wales
Forman, S.E. 626	(1964) FMC Corporation, Central Research and Development Center, Princeton, N.J., USA
Forrest, H.S. 149, 153, 157, 282	(1967) Genetics Foundation, University of Texas, Austin, Tex. 78712, USA
Fourcy, A. 1732, 1733	(1965) Laboratoire de Biologie Végétale du Centre d'Etudes Nucléaires, Grenoble, France
Fowler, E.E. 1535	(1966) Atomic Energy Commission, Washington, D.C., USA
Fowler, G. 931, 1049	(1966) Brown University, Providence, R.I., USA
Fowler, K.S. 846	(1966) Biochemistry Department, A.R.C. Pest Infestation Laboratory, London Road, Slough, Bucks., England
Fox, A.S. 150, 286, 357, 358	(1967) Department of Genetics, University of Wisconsin, Madison 6, Wis. 53706, USA
Fox, D.P. 938, 1001, 1002, 1003	(1967) Department of Genetics, Marischal College, Aberdeen University, Aberdeen, Scotland
Fraccaro, M. 238, 939	(1966) University of Milan, Milan, Italy
Franklin, B.A. 1710	(1963) c/o Cantwell G.C., Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA
Franz, J.M. 1758	(1967) Institut für Biologische Schädlingsbekämpfung, 62 Kranichsteiner Strasse, Darmstadt, Federal Republic of Germany
Frear, D.E.H. 666, 688	(1967) Pesticide Research Laboratory, Pennsylvania State University, University Park, Pa., USA
Fredriksson, T. 723	(1961) Department of Dermatology, Karolinska Institute, Stockholm 60, Sweden
Freeman, C.C. 1704	(1965) Food and Drug Administration, 423 Canal Street, New Orleans, La. 70130, USA
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Freimanis, Y.F. 1210, 1270	(1965) Institute of Organic Chemistry, Riga, USSR
Freitas, J.R. 562, 563	(1960) Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil

French, A.L. — (1966) Michigan State University, East Lansing, Mich., USA
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French, W.L. — (1963) Department of Zoology, University of Illinois, Urbana, Ill., USA
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820

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Gerstenberg, V. 1190	(1965) University of Texas, Austin, Tex. 78712, USA
Getsova, A.B. 62, 83, 522	(1967) Institute of Zoology, Academy of Sciences of the USSR, 1 Universitetskaya Nab., Leningrad, USSR
Getzin, L.W. 728, 729	(1966) Western Washington Research and Extension Center, Puyallup, Wash., USA
Ghelelovitch, S. 31	(1966) Laboratoire Pasteur de l'Institut du Radium, 26 Rue d'Ulm, Paris 5e, France
Ghosh, D. 153	(1967) Genetics Foundation, University of Texas, Austin, Tex. 78712, USA
Gibson, N.H.E. 541	
Giess, M.C. 1374, 1375, 1484	(1967) Laboratoire d'Histologie de la Faculté de Médecine, 378 Allée Jules-Guesdes, Toulouse, Haute-Garonne, France
Gilbert, L.I. 40, 106, 107, 373, 374, 401, 402	(1967) Department of Biological Sciences, Northwestern University, Evanston, Ill., USA
Gilby, A.R. 95	(1967) Division of Entomology, Commonwealth Scientific and Research Organization, Canberra, Australia
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Gillot, S. 329	(1967) Section de Biologie Générale et Appliquée, Faculté des Sciences, Lyon, France
Gillott, C. 137, 251	(1966) Department of Biology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
Gilmore, D.R. 770	(1966) Research Foundation, National Canner Association, Berkeley, Calif., USA
Giordano, D. 627, 628	(1964) Department of Genetics, School of Medicine, University of Bari, Bari, Italy
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Glass, H.B. 1263	(1966) Johns Hopkins University, Baltimore, Md. 21218, USA
Glassman, E., 160	(1967) University of North Carolina, Chapel Hill, N.C., USA
Glembotskiĭ, Y.L. 1068, 1069	(1967) Institute of General Genetics, Moscow, USSR

Glogowski, K. 489, 535	(1966) Institute of Plant Protection, Poznan, Poland
Gloor, E. 1072	(1964) Laboratory of Genetics, State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands
Gloor, H. 1130	(1966) State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands
Glotov, N.V. 1004	(1967) Institute of Medical Radiology, Obninsk, USSR
Glover, S.J. 1303	(1967) Department of Entomology, University of Georgia, Athens, Ga., USA
Glynn, J.P. 865	(1966) Department of Biochemistry, University of Leeds, England
Goates, M.A. 1524	(1963) Brigham Young University, Provo, Utah, USA
Godin, P.J. 851	(1966) London School of Hygiene and Tropical Medicine, Tropical Products Institute, Grays Inn Road, London, W.C.1, England
Goins, D.J. 1150	(1966) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Gold, A.H. 475	
Goldblith, S.A. 1630	(1967) Massachusetts Institute of Technology, Cambridge 38, Mass., USA
Goldin, H. 1022	(1967) University of Oregon, Eugene, Oreg., USA
Goldman, L.J. 1193, 1324	(1967) Departments of Entomology and Radiology, University of Florida, Gainesville, Fla., USA
Golumbic, C. 1662	(1966) Market Quality Research Division, ARS, USDA, Hyattsville, Md., USA
Gómez-Núñez, J.C. 497	(1966) División de Endémias Rurales, Dirección de Malariología y Saneamiento Ambiental, M.S.A.S., Venezuela
Gonçalves, J.M. 316, 317	(1967) Medical School of Riberão Preto, University of São Paulo, São Paulo, Brazil
Goodfellow, R.D. 375	(1966) Northwestern University, Evanston, Ill., USA
Goodman, L.J. 1147	(1967) Radiological Research Laboratory, Columbia University, Morningside Heights, New York 27, N.Y., USA
Goosens, H.J. 1631	
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Hajdu, E.
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(1965) School of Medicine, Tulane University of Louisiana, New Orleans, La., USA

Halkka, O.
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(1967) Department of Genetics, University of Helsinki, Finland

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(1953) Department of Chemistry, University of Wisconsin, Madison 6, Wis. 53706, USA

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(1967) Pesticide Research Laboratory, Pennsylvania State University, University Park, Pa., USA

Hampton, R.E.
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(1964) Fruit and Good Technology Research Institute, Stellenbosch, South Africa

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(1967) Central Research Institute for Plant Protection, 507 Prague Ruzyne, CSSR

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(1966) Zoologisches Institut, Ruprecht-Karl-Universität, 1 Grabengasse, Heidelberg, Federal Republic of Germany

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(1967) Department of Agricultural Chemistry, University of Tokyo, Motofuji-cho, Bunkyo-Ku, Tokyo, Japan

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(1966) Biochemistry Branch, Medical Research Laboratory, U.S. Army, Edgewood Arsenal, Md. 21010, USA

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(1967) Zoology Department, University of Texas, Austin 12, Tex. 78712, USA

Harrison, I.R.
809
(1967) Boots Pure Drug Co., Ltd., Chemical Sciences Building, Research Department, Station Street, Nottingham, England

Harshbarger, J.C.
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(1966) Division of Biological Sciences, University of California, Irvine, Calif., USA

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Harte, C.
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Hartisch, J.
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Hascoet, M. 684	(1966) Institute of National Research and Agronomy, Laboratory of Phytopharmacology, Versailles, France
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Hashim-Ahmed, M.S. 944	(1965) Leningrad 'A.A. Zhadanov' State University, 7/9 Universitetskaya Nab., Leningrad, USSR
Haskell, J.A. 43, 65, 66	(1966) Zoology Department, University of Massachusetts, Amherst, Mass., USA
Haskell, P.T. 1441	
Hassan, A. 732, 823, 838, 847	(1966) Department of Radiobiology, Atomic Energy Establishment, National Research Centre, Dokki, Cairo, UAR
Hassanein, M.E. 558	
Hatanaka, A. 635	(1967) Section of Neurobiology and Behavior, Cornell University, Ithaca, N.Y., USA
Hathaway, D.O. 1307, 1560	(1966) Entomology Research Division, ARS, USDA, Yakima, Wash., USA
Hathway, D.E. 636, 737	(1967) Tunstall Laboratory 'Shell' Research Ltd., Sittingbourne, Kent, England
Havin, E. 1194	(1965) Norsk Hydro's Institute for Cancer Research, The Norwegian Radium Hospital, Montebello, Norway
Hawkins, C.S. 1674	(1964) Fruit and Good Technology Research Institute, Stellenbosch, South Africa
Hayakawa, A. 1664	(1964) Ministry of Agriculture and Forestry, Tokyo, Japan
Hayashi, M. 637, 638, 656, 657	(1967) Department of Entomology, University of Wisconsin, Madison 6, Wis. 53706, USA
Hayashi, S. 1280	(1967) Department of Zoology, University of British Columbia, Vancouver, B.C., Canada
Hayashi, Y. 232	(1967) Insect Pathology Laboratory, Sault Ste. Marie, Ont., Canada
Haye, M.L. 1150	(1966) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Hayes, T.L. 1741, 1748	(1967) Donner Laboratory, Lawrence Radiation Laboratory and Electronics Research Laboratory, University of California, Berkeley, Calif.94720, USA

Heath, D.F. 639	(1965) Medical Research Council Laboratories, Carshalton, Surrey, England
Heddle, J.A. 1008	(1966) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Hedin, P.A. 881, 882	(1967) Entomology Research Division, ARS, USDA, State College, Miss., USA
Heenan, M.P. 593, 596	(1966) Department of Chemistry, Victoria University, Wellington, New Zealand
Heilbronn, E. 904	(1965) Research Institute of National Defense, Sundberg, Sweden
Heinen, W. 578	(1965) Department of Botany, Roman Catholic University of Nijmegen, 13 Wilhelminasingel, Nijmegen, The Netherlands
Heinonen, L. 283, 431, 538	(1967) Department of Genetics, University of Helsinki, Helsinki, Finland
Helbig, W. 576	
Held, P. 640	(1966) Research Institute of Plant Protection, Magdeburg, Federal Republic of Germany
Helle, K. 604	(1954) Laboratory for Organic Chemistry, University of Amsterdam, 21 Spui, Amsterdam, The Netherlands
Hendriks, H. 504	(1954) Laboratory for Organic Chemistry, University of Amsterdam, 21 Spui, Amsterdam, The Netherlands
Henke, H. 1284	(1966) Strahlenbiologisches Institut, Universität Hamburg, 1 Edmund-Siemers-Allee, Hamburg 13, Federal Republic of Germany
Henneberry, T.J. 1308, 1358, 1613, 1791	(1967) Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA
Hennessey, D.J. 670	(1967) Department of Chemistry, Fordham University, New York 58, N.Y., USA
Hennig, E. 478	(1965) Institut für Pflanzenzüchtung der Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin, Entomologische Abteilung, Quedlinburg, Democratic Republic of Germany
Hennig, W. 284, 285	(1967) Max-Planck-Institut für Biologie, 34 Spemann-Strasse, 74 Tübingen, Federal Republic of Germany
Herbst, E.J. 264	(1967) University of New Hampshire, Durham, N.H., USA
Herrlich, P. 216	(1967) Philipps-Universität, 10 Biegenstrasse, Marburg, Federal Republic of Germany
Heslop, J.P. 32, 158	(1967) Department of Biochemistry, A.R.C. Pest Infestation Laboratory, London Road, Slough, Bucks., England

Heywood, D.L. 812	(1966) Union Carbide Corporation, South Charleston, Va., USA
Hicklin, J.E. 166	(1962) Universität Zürich, Zurich, Switzerland
Hickman, C. 9, 10	(1966) Orange County Health Department, Anaheim, Calif., USA
Hightower, B.G. 1586	(1966) Entomology Research Division, ARS, USDA, Mission, Tex., USA
Hildreth, P.E. 1073	
Hilker, D. 1636	(1966) College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii
Hill, S.O. 503	(1967) Plant Pest Control Division, ARS, USDA, Gulfport, Miss., USA
Hilton, B.D. 635	(1967) Section of Neurobiology and Behavior, Cornell University, Ithaca, N.Y., USA
Himoe, E. 932	(1966) Department of Zoology, University of Wisconsin, Madison 6, Wis. 53706, USA
Hinkle, P.C. 364	(1963) Conant Chemical Laboratory, Harvard University, Cambridge 38, Mass., USA
Hinton, C.W. 1009	(1950) Biology Division, California Institute of Technology, Pasadena, Calif., USA
Hitchcock, M. 614	(1966) Department of Biochemistry, Medical School, St. Mary's Hospital, London, England
Hochmann, B. 1072, 1264	(1964) Department of Zoology and Entomology, University of Tennessee, Knoxville, Tenn., USA
Hodge, L.D. 159, 160	(1966) University of North Carolina, Chapel Hill, N.C., USA
Hodgson, E. 380, 386	(1967) Physiology Laboratory, Department of Entomology, University of North Carolina, Raleigh, N.C., USA
Hoffman, C.H. 1774	
Hoffman, R.A. 740, 1591	(1966) Entomological Research Division, ARS, USDA, Kerrville, Tex., USA
Hogan, G.R. 1458	(1966) Northern Illinois University, De Kalb, Ill., USA
Holerca, J. 1719	
Hollander, F.M. 306	(1966) Universidade de São Paulo, Cidade Universitária 'Armando de Salles Oliveira', Caixa Postal 8191, São Paulo, Brazil

Hollingsworth, R.M. 733, 734, 735, 736	(1967) Department of Entomology, Purdue University, Lafayette, Ind., USA
Hollstein, U. 604	(1954) Laboratory for Organic Chemistry, University of Amsterdam, 21 Spui, Amsterdam, The Netherlands
Holt, G.G. 925	(1967) Entomology Research Division, ARS, USDA Fargo, N. Dak., USA
Hooper, F.F. 523	(1966) Institute for Fisheries Research, Ann Arbor, Mich., USA
Hoopingarner, R. 574, 883	(1967) Michigan State University, East Lansing, Mich., USA
Hopkins, D.E. 1079, 1504	(1965) North Dakota State University, Fargo, N. Dak., USA
Hopkins, T.L. 466	(1967) Department of Entomology, Kansas State University, Manhattan, Kans., USA
Horber, E. 1580, 1581	(1966) Eidgenössische Landwirtschaftliche Versuchsanstalt, Zurich-Oerlikon, Switzerland
Horgan, D.J. 871, 872	(1967) Department of Biochemistry, School of Medicine, University of California, San Francisco, Calif. 94121, USA
Horie, Y. 97	(1965) Sericultural Experiment Station, Wada, Suginami-ku, Tokyo, Japan
Horikawa, M. 286	n.d. Department of Experimental Radiology, Faculty of Medicine, University of Kyoto, Japan
Horne, T. 1626	(1963) Curtiss-Wright Corporation, Princeton, N.J., USA
Hossain, M. 1440	
Hossain, M.M. 1195, 1196, 1440, 1632, 1709	(1967) Radiobiology Division, Atomic Energy Centre, Dacca, Pakistan
Hotchkiss, D.K. 1379	(1967) Statistical Laboratory, Iowa State University, Ames, Iowa, USA
House, H.L. 44	
Howard, E.F. 287	(1967) Department of Zoology, University of Wisconsin, Madison 6, Wis. 53706, USA
Howard, M.G.A. 1740	(1964) Research Station, Canada Department of Agriculture, Vineland Station, Ont., Canada
Howells, A.J. 151, 162	(1967) Department of Biology, Yale University, New Haven, Conn., USA
Hoyer, R.F. 1501	(1966) Entomology Research Division, ARS, USDA, Corvallis, Oreg., USA

Huang, I.L.
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Hughes, A.M.
<u>1073</u>

(1967) University of California, Berkeley, Calif. 94720, USA

Hungate, F.P.
<u>67</u>, <u>1286</u>, <u>1411</u>

(1966) General Electric Co., Hanford Atomic Products Operation, Richland, Wash., USA

Hunt, G.L., Jr.
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Hunter-Jones, P.
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Huque, H.
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Husman, C.N.
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(1965) Administrative Services, ARS, USDA, Gainesville, Fla., USA

Hussein, T.M.
847

(1966) Department of Radiology, Atomic Energy Establishment, National Research Centre, Dokki, Cairo, UAR

Hutchinson, P.B.
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(1966) C.S.R. Research Laboratories, Roseville, N.S.W., Australia

Hutson, D.H.
694, <u>737</u>

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Hylin, J.W.
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Hyun, J.S.
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Ikeda, H.
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(1967) Tokyo Metropolitan University, Tokyo, Japan

Ikekawa, N.
<u>377</u>, 395

(1966) University of Tokyo, Motofuji-cho, Bunkyo-Ku, Tokyo, Japan

Ikeshoji, T.
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Il'in, G.S.
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Ilan, J.
<u>288</u>

(1966) McGill University, Montreal 2, P.Q., Canada

Ilan, Judith
288

(1966) McGill University, Montreal 2, P.Q., Canada

Ilivicky, J.
111, 112, <u>163</u>

(1967) Department of Parasitology, School of Medicine, University of Chile, Santiago, Chile

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738

Inagaki, E. (1966) National Institute of Radiological Sciences, Chiba, Japan
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Ingle, S. (1966) Entomological Research Division, ARS, USDA, Weslaco, Tex., USA
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Inkowa, J.N.
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Ishiguro, I. (1966) Max-Planck-Institut für Biochemie, und Zoologisches Institut, Ludwig-Maximilians-Universität, Munich, Federal Republic of Germany
184

Ishizaka, S. (1967) Rikkyo University, Tokyo, Japan
1086

Ishizaki, H. (1966) Kyoto University, Kyoto, Japan
290

Ito, T. (1967) Rikkyo University, Tokyo, Japan
1086

Ives, P.T. (1967) Biology Department, Amherst College, Amherst, Mass., USA
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* Clearly the same author, although initials not always cited in full.

Maynard-Smith, J.
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Montalenti, G. 913	(1964) Consiglio Nazionale Delle Ricerche, Rome, Italy
Montgareuil, P.G. de 1780	(1964) Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires, Cadarache, France
Mook, L.J. 547	(1967) Forest Research Laboratory, Department of Forestry, Maritimes Region, P.O. Box 4000, Fredericton, N.B., Canada
Moore, B.S. 1357	(1966) Division of Biological Sciences, University of California, Irvine, Calif., USA
Moos, W.S. 898	(1966) University of Illinois, Chicago, Ill., USA
Morey, M. 955	(1965) Center Invest. Biol., Madrid, Spain
Morgan, D.J. 665	(1965) Health Physics and Medical Division, Atomic Energy Research Establishment, Harwell, Didcot, Berks., England
Morgan, P.B. 1791	(1965) Insects Affecting Man and Animal Research Branch, Entomology Research Division, ARS, USDA, Gainesville, Fla., USA
Morikawa, O. 763	(1966) Nagoya University, Euro Cho, Chikusa-Ku, Nagoya, Japan
Morikawa, D. 1090	(1967) Tokyo Metropolitan University, Tokyo, Japan
Morley, H.V. 692	(1967) Analytical Chemistry Research Service, Research Branch, Canada Agriculture, Ottawa, Canada
Morozov, V.S. 1101	
Morris, O.N. 314	(1966) Forest Research Laboratory, Victoria, Canada
Morrison, F.O. 608	(1966) Department of Entomology, MacDonald College, McGill University, Montreal, P.Q., Canada
Morton, M.R. 1685	(1965) Vitro Laboratory, West Orange, N.J., USA

Mortreuil-Langlois, M. (1963) Laboratoire d'Anatomie Comparées, Faculté des Sciences, Paris, France
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Mosely, J. (1966) Radiation Dynamics Ltd., London, England
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Moses, M.J. (1966) Institute of Genetics, University of Lund, Lund, Sweden
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Mosnaim, D. (1967) School of Medicine, University of Chile, Santiago, Chile
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Moss, J.A. (1967) Tunstall Laboratory, 'Shell' Research Ltd., Sittingbourne, Kent, England
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Mostafa, I.Y. (1966) Department of Radiobiology, Atomic Energy Establishment, National Research Centre, Dokki, Cairo, UAR
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Moulder, B.C. (1967) University of Tennessee, Knoxville, Tenn. 37916, USA
73

Mouton, R. (1964) Free University of Brussels, 50 Avenue Franklin Roosevelt, Brussels, Belgium
1678

Muckenthaler, F.A. (1966) Johns Hopkins University, Baltimore, Md. 21218, USA
315

Muelder, W.W. (1967) Radiochemistry Research Laboratory, The Dow Chemical Co., Midland, Mich., USA
764

Mueller, I. (1966) Universität zu Köln, Albertus-Magnus-Platz, Cologne, Federal Republic of Germany
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Muhammed, A. (1967) Pakistan Atomic Energy Centre, Lahore, Pakistan
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Mukai, T. (1966) National Institute of Genetics, Misima, Japan
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Mukherjee, A.B. (1966) University of Utah, Salt Lake City, Utah, USA
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Mukherjee, R.N. (1967) Department of Radiation Genetics, Institute for Radiopathology and Radiation Protection, State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands
1211, 1212, 1236

Muller, H.J. (1963) Indiana University, Bloomington, Ind., USA
1417

Müller, P.W. (1965) Abteilung für Forschung und Schädlingsbekämpfung, J.R. Geigy AG, Basel, Switzerland
720

Mumma, R.O. (1967) Pesticide Research Laboratory, Pennsylvania State University, University Park, Pa., USA
666, 688

Münchberg, P. (1965) 477 Soest, Windmühlenweg 93, Westfalen, Federal Republic of Germany
432, 433, 434, 435

Mundy, B.P.
861
(1967) Lawrence Radiation Laboratory, Department of Chemistry, University of California, Berkeley, Calif. 94720, USA

Municio, A.M.
1295, 1296
(1965) Institute of Chemistry, Madrid, Spain

Muñoz, E.R.
1007
(1966) Department of Radiobiology, Argentine Atomic Energy Commission, Buenos Aires, Argentina

Murakami, A.
956, 1091, 1213, 1271, 1368, 1369, 1370
(1966) National Institute of Genetics, Misima, Japan

Muramatsu, M.
195
(1966) Tohoku University, Katahiracho, Sendai, Japan

Murin, G.F.
1101, 1223

Murphy, C.G.
1371
(1966) University of California, Berkeley, Calif. 94720, USA

Murphy, G.
1689
(1966) Nuclear Engineering Department, Iowa State University, Ames, Iowa, USA

Murphy, T.A.
100, 101
(1964) Medical Research Laboratory, U.S. Army, Edgewood Arsenal, Md. 21010, USA

Musatti, C.C.
1140
(1966) Departamento de Biología General, Universidade de São Paulo, São Paulo, Brazil

Mussokin, A.P.
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Myasnyankina, E.N.
1068, 1069
(1966) Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR

Myszewski, M.E.
1022
(1967) University of Oregon, Eugene, Oreg., USA

Myttenaere, C.
510
(1965) Biology Service Joint Research Centre Euratom, Casella Postale 1, Ispra, Italy

Nabi, N.
1632
(1966) Atomic Energy Centre, Dacca, Pakistan

Nadel, D.
1589

Nadel, D.J.
13, 1601
(1965) International Atomic Energy Agency, 11 Kärntnerring, A-1011 Vienna, Austria

Nag, B.D.
70
(1967) Saha Institute of Nuclear Physics, Calcutta, India

Nagy, B.
1546, 1582, 1781, 1782
(1967) Research Institute for Plant Protection, Budapest, Hungary

Nair, K.K.
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Nakagawa, S.
1474 — (1966) Entomological Research Division, ARS, USDA, Honolulu, Hawaii

Nakanishi, Y.H.
924, 1020

Nakao, Y.
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Nakase, Y.
180 — (1964) Department of Biology, Johns Hopkins University, Baltimore, Md.21218, USA

Nakashima-Tanaka, E.
1024 — (1966) University of Osaka, Prefecture, Japan

Nakatsugawa, T.
765, 766, 767 — (1967) Iowa State University, Ames, Iowa, USA

Nash, D.
327 — (1966) University of Wisconsin, Madison 6, Wis.53706, USA

Nasrat, G.E.
1214 — (1967) Cairo University, Cairo, U.A.R.

Nation, J.L.
229, 349 — (1966) University of Florida, Gainesville, Fla., USA

Neal, R.A.
768 — (1966) Department of Biochemistry, School of Medicine, Vanderbilt University, Nashville 5, Tenn., USA

Nedergaard, S.
64 — (1964) Department of Zoology, University of Massachusetts, Amherst, Mass., USA

Neel, W.W.
1715, 1721 — (1966) Department of Entomology, West Virginia University, Morgantown, West Virginia, USA

Neghme, A.
110

Nei, M.
1515 — (1965) National Institute of Radiological Sciences, Chiba, Japan

Nelson, D.J.
528 — (1963) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Nelson, S.O.
1547, 1548, 1783, 1784, APX2, APX4 — (1967) Electrical Conditioning, Preservation, and Protection Investigations, Farm Electrification Research Branch, Agricultural Engineering Division, ARS, USDA, Nebr., USA, and the University of Nebraska, Lincoln, Nebr., USA

Nelson, T.E.
1373 — (1966) Entomological Research Division, ARS, USDA, Corvallis, Oreg., USA

Newburgh, R.W.
113, 389, 421 — (1967) Department of Biochemistry and Biophysics, Oregon State University, Corvallis, Oreg., USA

Newcombe, C.L. 1514	(1966) San Francisco State College, San Francisco, Calif., USA
Newsom, L.D. 1159	(1967) Department of Entomology, Louisiana State University, Baton Rouge, La., USA
Newton, J.R. 1605, 1606	(1967) Research Station, Canada Department of Agriculture, Summerland, B.C., Canada
Newton, W.H. 1604	(1962) Texas A and M University, College Station, Tex., USA
Nigon, V. 319	(1961) Laboratoire de Zoologie Expérimental, Faculté des Sciences de Lyon, Lyon, France
Nishizawa, T. 196	(1966) Chiba University, 1 Yayoicho, Chiba City, Japan
Nixon, W.C. 1747	(1965) Engineering Department, Cambridge University, Cambridge, England
Nonnenmacher, J. 319	(1961) Laboratoire de Zoologie Expérimental, Faculté des Sciences de Lyon, Lyon, France
Noordink, J.P.W. 467, 539, 540	
Norgren, R.L. 802	(1966) Cranberry Experiment Station, University of Massachusetts, East Wareham, Mass., USA
Norland, J.F. 1268	(1967) Metabolism and Radiation Research Laboratory, Fargo, N.Dak., USA
Norman, C. 197	(1954) Department of Biology, West Virginia University, Morgantown, West Virginia, USA
Norris, K.R. APX10	(1967) C.S.I.R.O. Division of Entomology, Canberra, Australia
North, D.T. 925, 1133, 1142	(1967) Entomology Research Division, ARS, USDA, Fargo, N.Dak., USA
Novitski, E. 1022	(1967) University of Oregon, Eugene, Oreg., USA
Nur, U. 1402	(1967) Department of Biology, University of Rochester, Rochester, N.Y. 14627, USA
O'Brien, R.D. 61, 84, 372, 429, 582, 583, 635, 610, 658, 659, 797, 899	(1967) Section of Neurobiology and Behaviour, Department of Entomology, Cornell University, Ithaca, N.Y., USA
O'Conner, G. 430	(1965) Biology Department, Saint Louis University, Saint Louis, Mo., USA
O'Loughlin, G.T. 1679	(1964) Biology Branch, Department of Agriculture, Victoria, Queensland, Australia

Oatley, C.W.
1747 — (1965) Engineering Department, Cambridge University, Cambridge, England

Oberlander, H.
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Ochinskaya, G.K.
1433, 1454 — (1965) Central Scientific-Research Institute of Roentgen-Radiology, Leningrad, USSR

Oden, C.K.
34 — (1966) University of Texas, Austin 12, Tex. 78712, USA

Odum, E.P.
556 — (1967) Institute of Radiation Ecology, University of Georgia, Athens, Ga., USA

Oeth, D.
651 — (1967) Department of Pharmacology, University of Iowa, Iowa City, Iowa, USA

Oftedal, P.
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Ogaki, M.
1024 — (1966) Osaka University, 36 Joancho, Kita-Ku, Osaka, Japan

Ohba, S.
1090 — (1967) Tokyo Metropolitan University, Tokyo, Japan

Ohnishi, E.
103 — (1966) Tokyo Metropolitan University, Tokyo, Japan

Oishi, K.
964 — (1966) National Institute of Genetics, Misima, Japan

Okada, T.
198 — (1965) Department of Chemistry, Gakushuin University, Toshima-Ku, Tokyo, Japan

Okanoue, S.
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Olivieri, A.
1025 — (1964) University of Rome, Rome, Italy

Olivieri, G.
1025 — (1964) University of Rome, Rome, Italy

Oltmann, A.
1672 — (1963) Brookhaven National Laboratory, Upton, N.Y., USA

Olvera, O.
1096 — (1963) Mexico

Onimaru, K.
1238 — (1966) National Institute of Genetics, Misima, Japan

Onodera, S.
221, 222 — (1966) Sericultural Experiment Station, Suginami-Ku, Tokyo

Oonnithan, E.S.
839 — (1966) Department of Entomology, University of California, Berkeley, Calif. 94720, USA

Oppenoorth, F.J. 667	(1967) Laboratory for Research on Insecticides, Wageningen, Netherlands
Orlando, E. 322	(1966) Istituto di Zoologia, University of Modena, Modena, Italy
Ortega, A. 1258	
Ortin Sune, N. 1698	(1965) Junta de Energia Nuclear, Madrid, Spain
Osborn, A.W. 1144, 1149, 1575	(1966) University of New South Wales, P.O.B. 1, Kensington (Sydney), N.S.W., Australia
Osburn, W.S., Jr. 529	(1964) University of Colorado, Boulder, Colo., USA
Osman, M.F. 836, 837	(1967) Faculty of Science, University of Cairo, Cairo, U.A.R.
Osmun, D.E. 1409	(1967) Department of Biological Sciences, University of Delaware, Newark, Del., USA
Ossipow, W.A. 581	
Oster, I.I. 1275	(1966) University of Minnesota, Minneapolis, Minn., USA
Otagaki, K.K. 1682	(1967) Board of Agriculture, Hawaii, USA
Otomo, K. 195	(1966) Tohoku University, Katahiracho, Sendai, Japan
Outram, I. 599, 600, 601	(1967) Imperial College Field Station, Sunninghill, Berks., England
Owen, W.L. 776	(1967) South Plains Research and Extension Center, Texas A and M University, Lubbock, Tex., USA
Ozer, M. 1749	(1965) Faculty of Agriculture, Ankara, Turkey
Painter, R.R. 884, 885, 887	(1966) Agricultural Toxicology and Residue Research Laboratory, University of California, Davis, Calif. 95616, USA
Palmer, J.S. 740	(1966) Entomology Research Division, ARS, USDA, Kerrville, Tex., USA
Pantaleo, R. 627, 628	(1964) Department of Genetics, School of Medicine, University of Bari, Bari, Italy
Papageorgiou, M. 1154	(1966) 'Democritus' Nuclear Research Center of the Greek Atomic Energy Commission, Athens, Greece
Parfenov, G.P. 1179, 1180	(1966) Institute of Biological Physics, Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR

Parfyonov, G.P. 1452, 1453	(1965) Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR
Parkash, O. 1218, 1219	(1967) Institut für Allgemeine Biologie, Universität Wien, A-1010 Vienna, Austria
Parke, D.V. 584	(1965) Medical School, St. Mary's Hospital, London, England
Parker, D.R. 960, 961, 962	(1966) Department of Life Sciences, University of California, Riverside, Calif., USA
Parker, J.S. 1603	(1967) Plant Pest Control Division, ARS, USDA, Monterrey, Mexico
Parks, G.L. 727	(1967) Agricultural Division, American Cynamid Co., Princeton, N.J., USA
Parry, W.H. 486	(1967) Department of Forestry, University of Aberdeen, Aberdeen, Scotland
Passama-Willaume, M. 199	(1966) Centre National de la Recherche Scientifique (C.N.R.S.), Gif-sur-Yvette, France
Patterson, R.S. 76	(1967) Entomological Research Division, ARS, USDA, Gainesville, Fla., USA
Paul, B.B. 668	(1963) Department of Biochemistry, McGill University, Montreal 2, P.Q., Canada
Paul, J.S. 1725	(1965) New York University, New York 3, N.Y., USA
Pavan, C. 323, 341, 995	(1966) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Payne, J.A. 1525	(1966) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Peakall, D.B. 669	(1967) Upstate Medical Center, New York, N.Y., USA
Pearce, G.W. 138, 615	(1966) Biology and Chemistry Section, Technology Branch, National Communicable Disease Center, Public Health Service, U.S. Department of Health, Education and Welfare, Atlanta, Ga., USA
Pease, R.F.W. 1741, 1747, 1748	(1967) Donner Laboratory, Lawrence Radiation Laboratory and Electronics Research Laboratory, University of California, Berkeley, Calif. 94720, USA
Peleg, B.A. 13, 1359, 1589, 1601	(1965) Biological Control Institute, Citrus Marketing Board of Israel, Rehovoth, Israel
Pelerents, C. 1319	
Pelling, C. 324	(1966) Max-Planck-Institut für Biologie, 34 Spemann Strasse, 74 Tübingen, Federal Republic of Germany
Pentz, S. 1367	(1966) Universität zu Köln, Albertus-Magnus-Platz, Cologne, Federal Republic of Germany

Pietri-Tonelli, P. de 769	(1965) Istituto di Ricerche Agrarie, Laboratorio di Signa, Florence, Italy
Piternik, L.K. 1280	(1967) Department of Zoology, University of British Columbia, Vancouver, B.C., Canada
Plaine, H.L. 1097	(1965) Ohio State University, Columbus 10, Ohio, USA
Planel, H. 1374, 1375, 1484	(1967) Laboratoire d'Histologie de la Faculté de Médecine, 37, Allée Jules-Guesdes, Toulouse, Haute-Garonne, France
Plapp, F.W.,Jr. 1791	(1965) Insects Affecting Man and Animal Research Branch, Entomology Research Division, ARS, USDA, Corvallis, Oreg., USA
Platova, T.P. 326	(1967) Institute of Atomic Energy, Moscow, USSR
Plaut, W. 239, 247, 287, 327	(1967) Department of Zoology, University of Wisconsin, Madison 6, Wis.53706, USA
Plummer, G.L. 77	(1966) Georgia University, Athens, Ga., USA
Po-Chedley, D.S. 1418	(1966) Biology Department, D'Youville College, 320 Porter Avenue, Buffalo 1, N.Y., USA
Podolyan, V.Y. 1166	
Pohl, E. 1527	(1967) Institut für Allgemeine Biologie, Universität Wien, A-1010 Vienna, Austria
Poleshchuk, V.D. 1169, 1170	(1966) Central Science-Research Disinfectory Institute, Moscow, USSR
Pollister, A.W. 328	(1964) Department of Zoology, Columbia University, Morningside Heights, New York 27, N.Y., USA
Popa, A. 1061, 1146	
Pora, E. 531	
Porembska, Z. 202	(1966) Medical School, Warsaw, Poland
Potgieter, L. 1674	(1964) Fruit and Good Technology Research Institute, Stellenbosch, South Africa
Powers, J.J. 1683	(1967) Department of Food Sciences, University of Georgia, Athens, Ga., USA
Pozsár, B. 1546, 1781	(1965) Research Institute for Plant Protection, Budapest, Hungary
Pravdina, G.M. 1469	(1966) Ministry of Public Health of the USSR, Moscow, USSR

Reesor, J.B. 772	(1960) Chemistry Section, Defence Research Board of Canada, Suffield Experimental Station, Ralston, Alto., Canada
Rehbinder, D. 795	(1967) Department of Biochemistry, C.H. Böhringer Sohn, Ingelheim, Federal Republic of Germany
Reiback, E. 1685	(1965) Vitro Laboratory, West Orange, N.J., USA
Reichle, D.E. 79, 80, 532, 533	(1967) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Reistrup, J.V. 1722	
Reller, J. 773	(1966) Eidgenössische Technische Hochschule, Zurich, Switzerland
Rembold, H. 209, 210	(1964) Max-Planck-Institut für Biochemie, Munich, Federal Republic of Germany
Reynolds, H.T. 774, 836	(1966) Department of Entomology, University of California, Riverside, Calif., USA
Řežábová, B. 437, 1570	(1966) Institute of Entomology, Czechoslovak Academy of Sciences, Prague, CSSR
Rezzonico Raimondi, G. 238	(1966) University of Milan, Milan, Italy
Ribbert, D. 245, 418	(1967) Zoologisches Institut, Westfälische Wilhelms-Universität, 2 Schlossplatz, Münster, Federal Republic of Germany
Riccardi, A. 755, 756	(1965) Centro Universitario di Ricerca ed Applicazione di Medicina Nucleare, Ospedale di Circolo, Varese, Italy
Richards, A.G. 1316	(1965) Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, Minn. 55101, USA
Richardson, N. 1587	(1965) Department of Zoology, University of Adelaide, Adelaide, Australia
Riddert, D. 457	(1967) Zoologisches Institut, Westfälische Wilhelms-Universität Münster, 9 Badestrasse, Münster, Federal Republic of Germany
Ridgway, R.L. 775, 776	(1967) Entomology Research Division, ARS, USDA, College Station, Tex. 77841, USA
Riedel, M. 1608	(1967) Fakultät für Landwirtschaft und Gartenbau, Technische Hochschule München, 21 Arcisstrasse, Munich, Federal Republic of Germany
Rieffel, S.M. 15	(1966) Institute of Molecular Biophysics, Florida State University, Tallahassee, Fla. 32306, USA
Riemann, J.G. 448, 927, 1331	(1967) Radiation Biology and Insect Genetics Section, Metabolism and Radiation Research Laboratory, Entomology Research Division, ARS, USDA, FARGO, N. Dak., USA

Rinehart, R.R.
1027, 1099, 1220, 1221, 1222
(1967) Biology Department, San Diego State College, 5402 College Avenue, San Diego 15, Calif., USA

Ritossa, F.
333

Ritossa, F.M.
16, 334, 335, 336
(1966) International Laboratory of Genetics and Biophysics, Naples, Italy

Ritter, F.J.
393
(1967) Central Laboratory, T.N.O., Delft, The Netherlands

Robbins, J.D.
1750
(1967) Metabolism and Radiation Research Laboratory, ARS, USDA, Fargo, N. Dak., USA

Robbins, W.E.
370, 394, 399, 400
(1967) Insect Physiology Laboratory, Entomology Research Division, ARS, USDA, Beltsville, Md.20705, USA

Roberts, F.L.
1104
(1965) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Roberts, P.
1028
(1964) Oak Ridge National Laboratory, Oak Ridge, Tenn.,USA

Roberts, P.A.
1034, 1035
(1965) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Robredo, F.
1787
(1964) Servicio de Plagas Forestales, Madrid, Spain

Robson, A.
211
(1967) University of Leeds, Leeds 2, England

Rock, G.C.
212
(1967) V.P.I., Blacksburg, Va., USA

Rockford, D.
1424
(1964) Rutgers University, Newark, N.J., USA

Rockstein, M.
1314, 1380, 1381, 1421, 1422
(1967) Department of Physiology, School of Medicine, University of Miami, Coral Gables, Fla.33134, USA

Roda Santos, M.L.
557

Roderbourg, J.
777, 778, 779
(1965) C.A.M.I.R.A. Laboratoire Central Gembloux (I.R.S.I.A.), Gembloux, Belgium

Rodino, E.
262
(1967) University of Padua, Padua, Italy

Rodman, T.C.
337
(1967) Department of Biological Sciences, Columbia University, Morningside Heights, New York 27, N.Y., USA

Rodriguez, J.
1258

Rodriguez, J.G. 213, 487	(1966) Department of Entomology, University of Kentucky, Lexington, Ky., USA
Roels, H. 338	(1966) Department of Pathology, University of Ghent, Ghent, Belgium
Rogers, A.H. 541	
Rogers, J.E., Jr. 190, 214	(1967) Cornell University, Ithaca, N.Y., USA
Rogers, L.J. 652	(1967) Department of Biochemistry and Agricultural Biochemistry, University College of Wales, Aberystwyth, Wales
Romm, R.F. 672	
Rose, J.A. 636	(1967) Tunstall Laboratory, 'Shell' Research Ltd., Sittingbourne, Kent, England
Rosefield, I. 728	(1966) Western Washington Research and Extension Center, Puyallup, Wash., USA
Rosenthal, G.M. 528	(1963) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Ross, H.B. 880	(1952) Saint Bartholomew's Hospital, London, England
Ross, J.J., Jr. 1737	(1963) Nuclear Science and Engineering Corporation, Pittsburgh, Pa., USA
Ross, M.H. 1100	(1967) Department of Entomology, V.P.I., Blacksburg, Virginia, USA
Rossi, H.H. 1147	(1967) Radiological Research Laboratory, Columbia University, Morningside Heights, New York 27, N.Y., USA
Rossouw, S.F., Comp. 1763	(1966) Atomic Energy Board, Pelindaba, Pretoria, South Africa
Roti Roti, J.L. 1727	(1967) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Roulston, W.J. 780	(1966) C.S.I.R.O., Division of Entomology, Yeerongpilly, Queensland, Australia
Roy, A. 70	(1967) Saha Institute of Nuclear Physics, Calcutta, India
Rubin, P.G. 1125	(1963) University of Pavia, Pavia, Italy
Rubinstein, D. 668	(1963) Department of Biochemistry, McGill University, Montreal 2, P.Q., Canada
Rudenchik, Y.V. 567	
Rudkin, G.T. 339	(1962) Institute for Cancer Research, Philadelphia, Pa., USA

Sankaranarayanan, K.
965, 1224, 1236, 1243, 1485, 1510
(1967) Department of Radiation Genetics, State University of Leyden, 62 Wassenaarseweg, Leyden, The Netherlands

Sano, K.
1507
(1966) National Institute of Genetics, Misima, Japan

Santi, R.
769
(1965) Istituto di Ricerche Agrarie, Societa Montecatini, Milan, Italy

Santos, L.R.
14

Saovanee Chakpitak
1708
(1966) Biological Science Division, Office of the Atomic Energy for Peace, Bangkok, Thailand

Sarma, D.S.R.
392
(1963) Institute of Science, Department of Biochemistry, Bangalore 12, India

Sarma, P.S.
392
(1963) Institute of Science, Department of Biochemistry, Bangalore 12, India

Sasaki, S.
1315, 1382
(1966) Tohoku University, Katahiracho, Sendai, Japan

Sato, C.
1315
(1966) Tohoku University, Katahiracho, Sendai, Japan

Sato, Y.
762, 781
(1965) Sumitomo Chemical Co., Osaka, Japan

Sauer, H.W.
281
(1966) Zoologisches Institut, Ruprecht-Karl-Universität, 1 Grabengasse, Heidelberg, Federal Republic of Germany

Scaramelli, N.
111
(1966) Department of Parasitology, School of Medicine, University of Chile, Santiago, Chile

Schaefer, C.H.
674, 680, 681
(1967) Agricultural Research Division, 'Shell' Development Company, Modesto, Calif., USA

Scherney, F.
1609
(1967) Bayerische Landesanstalt für Bodenkultur, Munich, Federal Republic of Germany

Schlagbauer, A.
1288, 1728
(1967) Institut für Angewandte Zoologie, Universität Bonn, 1 An der Immenburg, Bonn, Federal Republic of Germany

Schmialek, P.
451
(1966) Physiologisch-Chemisches Institut, 4 Boltzmannstrasse, Berlin-Dahlem, Federal Republic of Germany

Schmidt, C.D.
1591
(1966) Entomological Research Division, ARS, USDA, Kerrville, Tex., USA

Schmidt, C.H.
889, 890, 1569
(1967) Insects Affecting Man and Animals Research Branch, Research Division Entomology, USDA, ARS, Beltsville, Md. 20705, USA

Schmidt, G.H.
396
(1966) Institute for Applied Zoology, Julius-Maximilians-Universität, 2 Sanderring, Würzburg, Federal Republic of Germany

Schneider-Minder, A.
1383, 1384
(1966) Zoologisches Institut, Eidgenössische Technische Hochschule, Zurich, Switzerland

Schneiderman, H.A. 40, 243, 244, 295, 296, 297, 321	(1967) Department of Biology and Developmental Biology Center, Western Reserve University, Cleveland, Ohio 44106, USA
Schnell, J.H. 556	(1967) Institute of Radiation Ecology, University of Georgia, Athens, Ga., USA
Schnitzerling, H.J. 676, 780, 783	(1967) Division of Entomology, C.S.I.R.O., Veterinary Parasitology Laboratory, Yeerongpilly, Queensland, Australia
Schoettger, R.A. 675	(1966) Colorado State University, Fort Collins, Colo., USA
Schonbrod, R.D. 841	(1966) Oregon State University, Corvallis, Oreg., USA
Schoof, H.F. 1791	(1965) Biology-Chemistry Section, Technology Branch, Communicable Disease Center, U.S. Public Health Service, Department of Health, Education, and Welfare, Savannah, Ga., USA
Schuching, S. von 602	(1956) Johns Hopkins School of Medicine, Martinsburg, Va., USA
Schultz, V. 1761, 1762	(1966) Department of Zoology, Washington State University, Pullman, Wash., USA
Schulz, R.J. 1255	(1965) Montefiore Hospital, New York, N.Y., USA
Schulze, E.F. 454	(1967) Institut für Angewandte Zoologie, Universität Bonn, 1 An der Immenburg, 53 Bonn, Federal Republic of Germany
Schuntner, C.A. 676, 780, 782, 783	(1966) C.S.I.R.O., Division of Entomology, Yeerongpilly, Queensland, Australia
Schurin, M. 143	(1964) Department of Biology, Brandeis University, Waltham, Mass., USA
Schütte, H.R. 587	(1966) Department of Organic Chemistry, Martin-Luther-University, Halle-Wittenberg, German Democratic Republic
Schwach, G. 499	(1966) Institut für Biologie und Landwirtschaft, Reaktorenzentrum Seibersdorf, Seibersdorf, N.Ö., Austria
Schwalm, F.E. 966	(1965) Zoologisches Institut, Philipps-Universität, 63 Ketzerbach, 355 Marburg, Federal Republic of Germany
Schwartz, J.L. 864	(1962) Department of Pharmacology, Medical College of Virginia, Richmond 19, Va., USA
Schwarz, H. 706, 709, 710, 713, 714, 716, 784, 785, 786, 787	(1967) Institut für Biophysik der Deutschen Akademie der Wissenschaften zu Berlin, Aussenstelle Leipzig, Abteilung Toxikologie, 20 Johannisallee, 701 Leipzig, German Democratic Republic
Scossiroli, R.E. 1511, 1512	(1963) University of Pavia, Pavia, Italy
Scott, T.A. 865	(1966) Department of Biochemistry, University of Leeds, England

Scott, W.J.
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(1962) Commonwealth Scientific and Industrial Research Organization, Ryde, Australia

Scriba, M.E.L.
1029
(1964) Institute of Zoology, Phillips-Universität, 63 Ketzerbach, Marburg, Federal Republic of Germany

Seawright, A.A.
603
(1967) Department of Veterinary Pathology, University of Queensland, Brisbane, Australia

Seay, T.N.
487
(1966) Department of Entomology, University of Kentucky, Lexington, Ky., USA

Šedivý, J.
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(1967) Central Research Institute for Plant Production, 507 Prague Ruzyne, CSSR

Seecof, R.
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(1966) City of Hope Medical Center, Duarte, Calif., USA

Seeley, B.A.
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Sega, G.A.
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(1967) University of Texas, Austin 12, Tex. 78712, USA

Seidler, H.
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(1966) Institut für Ernährung, Potsdam, German Democratic Republic

Sekeris, C.E.
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(1966) Philipps-Universität, 10 Biegenstrasse, Marburg, Federal Republic of Germany

Sen-Sarma, P.K.
488
(1965) Forest Research Institutes, Dehra Dun, India

Seo, S.T.
1647
(1966) Entomology Research Division, ARS, USDA, Honolulu, Hawaii

Sethi, G.R.
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(1966) Indian Agricultural Research Institute, New Delhi, India

Sevastiyanova, G.A.
340
(1966) Paedagogic Institute, V.I. Lenin, Moscow State, Moscow, USSR

Shanks, M.H.
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(1966) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Sharma, R.P.
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(1966) Genetics Division, Indian Agricultural Research Institute, New Delhi, India

Shashkov, V.S.
1101, 1223

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Shea, T.E.
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(1961) Regional Office of the World Health Organization, Washington, D.C., USA

Sheldon, H.
230
(1964) Department of Pathology, McGill University, Montreal 2, P.Q., Canada

Shellenberger, T.E. 799	(1966) Stanford Research Institute, Menlo Park, Calif., USA
Shen, S.K. 1332	(1967) Washington State University, Pullman, Wash., USA
Sherlock, E. 772	(1960) Imperial Chemical Industries, Wokingham, Berks., England
Shigematsu, H. 219, 220, 221, 222	(1966) Sericultural Experiment Station, Wada, Suginami-Ku, Tokyo, Japan
Shilenko, B.V. 1102, 1423	(1965) Institute of Biological Physics, Moscow, USSR
Shim, J.W. 1385, 1442	
Shimabukuro, R.H. 831	(1967) Metabolism and Radiation Research Laboratory, ARS, USDA, State University Station, Fargo, N.Dak., USA
Shimura, K. 195	(1966) Tohoku University, Katahiracho, Sendai, Japan
Shinn, A.F. 1334	(1967) Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Shiomi, T. 1227, 1228, 1229	(1966) Laboratory of Radiation Genetics, Research Institute for Nuclear Medicine and Biology, Hiroshima University, Hiroshima, Japan
Shipman, W.H. 1289, 1723	(1966) Naval Radiological Defense Laboratory, San Francisco, Calif., USA
Shipp, E. 1144, 1149, 1575	(1966) School of Biological Sciences, University of N.S.W., Kensington, New South Wales, Australia
Shiroishi, M. 1664	(1964) Ministry of Agriculture and Forestry, Tokyo, Japan
Shishido, T. 724, 725, 788	(1966) Division of Agricultural Sciences, Nishigahara, Tokyo, Japan
Shortino, T.J. 370, 394	(1967) Insect Physiology Laboratory, Entomology Research Division, ARS, USDA, Beltsville, Md.20705, USA
Shrivastava, S.C. 1316	(1965) Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, Minn.55101, USA
Shyamala, M.B. 81, 134	(1967) Fermentation Technology Laboratory, Indian Institute of Science, Bangalore 12, India
Sieber, K. 640, 641	(1967) Wissenschaftlich-Technisches Zentrum für Pflanzenschutz, Magdeburg, Federal Republic of Germany
Sigurbjoernsson, B. 1549	(1966) International Atomic Energy Agency, 11 Kärntnerring, A-1011 Vienna, Austria
Silva, J.E. da 7, 464	(1965) Department of Parasitology, Faculty of Medicine, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil

Slizynska, H. 1273	
Slizynski, B.M. 967	(1965) Institute of Animal Genetics, West Main Road, Edinburgh, Scotland
Smirnoff, W.A. 1711, 1443	(1967) Forest Research Laboratory, Sillery, Quebec, Canada
Smith, C.N. 1552, 1791, APX11	(1965) Insects Affecting Man and Animal Research Branch, Entomology Research Division, ARS, USDA, Gainesville, Fla., USA
Smith, D.A. 364	(1963) Conant Chemical Laboratory, Harvard University, Cambridge 38, Mass., USA
Smith, G.N. 789, 790, 791, 792, 793, 1752	(1966) Biomechanism Group, E.C. Britton Laboratory, The Dow Chemical Company, Midland, Mich., USA
Smith, J.C. 1317, 1476	(1966) Department of Psychology, Florida State University, Tallahassee, Fla., USA
Smith, J.M. 136	(1966) School of Biological Sciences, University of Sussex, Stanmer, Brighton, England
Smith, J.N. 593, 596, 614	(1966) Department of Biochemistry, Medical School, St. Mary's Hospital, London, England
Smith, R.H. 935, 968, 969, 982, 1122, 1150, 1274	(1967) Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Smith, T.L. 1103	(1967) The College of the Oazarks, Clarksville, Ark., USA
Smittle, B.J. 76, 503, 1233, 1791	(1967) Entomology Research Division, ARS, USDA, Gainesville, Fla.39501, USA
Smoler, M.H. 1272	
Smolin, A.N. 340	(1966) Pedagogic Institute, V.I. Lenin, Moscow State, Moscow, USSR
Smyth, T. 381	(1966) Pennsylvania State University, University Park, Pa., USA
Snyder, L.A. 1275	(1966) University of Minnesota, Minneapolis, Minn., USA
Sobels, F.H. 970, 1234, 1235, 1236, 1237, 1276	(1966) Department of Radiation Genetics, State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands
Soleilhavoup, J.P. 1374, 1375, 1484	(1967) Laboratoire d'Histologie de la Faculté de Médecine, 37, Allée Jules-Guesdes, Toulouse, Haute-Garonne, France
Sonenshine, D.E. 568	(1966) Old Dominion College, Norfolk, Va., USA

Sonnenblick, B.P. 1424, 1425	(1967) Rutgers University, Newark, N.J., USA
Southwood, T.R.E. 1526	(1966) University of London, Imperial College of Science and Technology, Prince Consort Road, South Kensington, S.W.7., England
Souza, H.L. de 995	(1964) Departamento de Biología General, Universidade de São Paulo, Cidade Universitária 'Armando de Salles Oliveira', Caixa Postal 8191, São Paulo, Brazil
Speicher, B.R. 1104	(1965) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Speicher, K.G. 1104	(1965) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
Spencer, J.B. 346	(1965) Western Reserve University, Cleveland 6, Ohio, USA
Spenger, R.E. 633	(1966) Department of Entomology, University of California, Riverside, Calif., USA
Sperlich, D. 1031, 1513, 1527	(1967) Institut für Allgemeine Biologie, Universität Wien, A-1010 Vienna, Austria
Spiegelman, S. 16, 335	(1966) Department of Microbiology, University of Illinois, Urbana, Ill., USA
Spiller, D. 794	
Spratt, J.L. 651	(1967) Department of Pharmacology, University of Iowa, Iowa City, Iowa, USA
Springhetti, A. 1125	(1963) University of Pavia, Pavia, Italy
Srapenyants, R.A. 1669	
Sreenivasan, A. 1668	(1966) Atomic Energy Establishment, Trombay, Bombay, India
Sridhara, S. 397	(1966) Indian Institute of Science, Bangalore, India
Srihari, T. 1239	(1967) Regional Research Centre, Indian Agricultural Research Institute, Hyderabad, India
Srisan Ruangopas 1444, 1445	(1966) Biological Science Division, Office of the Atomic Energy for Peace, Bangkok, Thailand
Srivastava, M.D.L. 1032	(1966) University of Allahabad, Allahabad, U.P., India
Srivastava, P.N. 1314	(1967) Department of Physiology, School of Medicine, University of Miami, Coral Gables, Fla. 33134, USA

Street, J.C. 678	(1967) Utah State University, Logan, Utah, USA
Strømnaes, Ø. 971, 1078, 1105, 1106, 1151, 1152, 1278	(1965) Institute of General Genetics, University of Oslo, Oslo, Norway
Strongin, G.M. 650, 679	
Stumper, R. 415	(1964) 16 Avenue Alphonse Munchen, Luxembourg
Subrahmanyam, U. 1153	(1967) University of California, Berkeley, Calif. 94720, USA
Sudo, A. 363	(1967) Biological Institute, College of General Education, University of Tokyo, Komaba, Meguro, Tokyo, Japan
Suess, A. 42, 1788	(1966) Bayerische Landesanstalt für Bodenkultur, Pflanzenbau und Pflanzenschutz, Munich, Federal Republic of Germany
Sugai, E. 972, 1279	(1967) Faculty of Agriculture, Tokyo University of Agriculture and Technology, Fuchu-Shi, Tokyo, Japan
Sugihara, M. 1680, 1681	
Sugiura, K. 227	(1967) Japan Academy, Veno Park, Tokyo, Japan
Sullivan, A.H. 1081	(1967) CERN European Organization for Nuclear Research, 1211 Geneva 23, Switzerland
Sullivan, L.J. 826, 842	(1967) Mellon Institute, Pittsburgh, Pa., USA
Sun, A.Y.K. 460	(1967) Oregon State University, Corvallis, Oreg., USA
Sun, G.Y.C. 398	(1967) Oregon State University, Corvallis, Oreg., USA
Sun, Y.P. 674, 680, 681, 799	(1967) Agricultural Research Division, 'Shell' Development Company, Modesto, Calif., USA
Sundwall, A. 904	(1965) Research Institute of National Defense, Sundberg, Sweden
Suomalainen, H.O.T. 973	(1966) Department of Radiobiology, University of Turku, Turku, Finland
Sushkin, A.G. 1004	(1967) Institute of Medical Radiology, Obninsk, USSR
Suzuki, D.T. 1280	(1967) Department of Zoology, University of British Columbia, Vancouver, B.C., Canada

Suzuki, M.
377
(1966) University of Tokyo, Motofuji-Cho, Bunkyo-Ku, Tokyo, Japan

Svoboda, J.A.
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(1967) Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA

Swift, H.
347
(1962) Whitman Laboratory, University of Chicago, Chicago 37, Ill., USA

Swindlehurst, M.
269
(1967) Department of Biology, Wesleyan University, Middletown, Conn., USA

Swoboda, A.R.
691
(1967) Department of Soil and Crop Sciences, Texas A and M University, College Station, Tex., USA

Szalay-Marzsó, L.
1546, 1781
(1965) Research Institute for Plant Protection, Budapest, Hungary

Tabusse, E.
1187
(1964) Centre d'Etudes et de Recherches de Médicine Aéronautiques, Paris, France

Tadahiko, I.
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(1967) Faculty of Agriculture, Tokyo University of Agriculture and Technology, Fuchu-Shi, Tokyo, Japan

Tahmisian, T.N.
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(1966) Argonne National Laboratory, Argonne, Ill., USA

Taimr, L.
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(1967) Central Research Institute for Plant Production, 507 Prague Ruzyne, CSSR

Tak-Ming, C.
440
(1966) Institute of Zoology, Academia Sinica, Peking, China

Takahashi, S.
348
(1966) Department of Biology, College of Liberal Arts, Kobe University, Rokko, Nada-Ku, Kobe, Japan

Takahashi, S.Y.
103
(1966) Tokyo Metropolitan University, Meguro-Ku, Tokyo, Japan

Takeshita, H.
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(1966) Sericultural Experiment Station, Wada, Suginami-Ku, Tokyo, Japan

Talhouk, A.S.
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(1964) American University of Beirut, Beirut, Lebanon

Tallant, M.J.
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(1966) Mellon Institute, Pittsburgh, Pa., USA

Tamaki, E.
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(1964) Central Research Institute, Japan Monopoly Corporation, Tokyo, Japan

Tamura, S.
867

Tanaka, Y.
1107

Thomas, G.W. 691	(1967) Department of Soil and Crop Sciences, Texas A and M University, College Station, Tex., USA
Thomas, J.J., Jr. 1240, 1282	(1966) Departments of Physiology and Radiation Biology, Medical Center, University of Rochester, Rochester, N.Y., USA
Thomas, K.K. 229, 349, 401, 402	(1967) Department of Biological Sciences, Northwestern University, Evanston, Ill., USA
Thomas, R.E. 1034, 1035	(1965) Pfeiffer College, Misenheimer, N.C., USA
Thompson, E. 619	(1966) Department of Zoology and Entomology, Ohio State University, Columbus 10, Ohio, USA
Thompson, M.J. 394, 399	(1967) Entomology Research Division, ARS, USDA, Beltsville, Md. 20705, USA
Thompson, P.E. 1036	(1967) Iowa State University, Ames, Iowa, USA
Thompson, P.G. 782	(1966) Division of Entomology, Commonwealth Scientific and Industrial Research Organisation, Veterinary Parasitology Laboratory, Yeerongpilly, Queensland, Australia
Thompson, R.C. 1389	(1967) Battelle-Northwest Laboratory, Richland, Wash., USA
Thompson, S. 894	(1967) Biogenetics Research Laboratory, Falls Church, Va., USA
Thornley, M.J. 1241	(1963) Low Temperature Research Station, Cambridge, England
Thorpe, B. 206	(1964) Australian National University, P.O.B.4, Canberra, A.C.T., Australia
Threadgold, J. 230	(1964) Department of Pathology, McGill University, Montreal 2, P.Q., Canada
Thygesen, T. 19	
Tiepolo, L. 939	(1963) University of Pavia, Pavia, Italy
Tietz, A. 403, 404	n.d. Israel Institute for Biological Research, Ness-Ziona, Israel
Tigyi-Sebes, A. 69	(1967) University of Pecs, Pecs, 48-AS Ter I, Hungary
Tikhomirova, M.M. 976, 1037, 1038, 1109	(1967) Leningrad 'A.A. Zhdanov' State University, 7/9 Universitetskaya Nab., Leningrad, USSR
Tilton, E.W. 1339, 1342, 1390, 1391, 1477	(1966) Market Quality Research Division, Dried Fruit and Tree Nut Insects Investigations, ARS, USDA, Fresno, Calif., USA

Travis, J. — 231
(1966) Johns Hopkins University, Baltimore, Md. 21218, USA

Treherne, J.E. — 85, 438, 461, 930
(1967) A.R.C. Unit of Insect Physiology, Department of Zoology, University of Cambridge, Cambridge, England

Troitskiĭ, I.A. — 682

Trosko, J.E. — 316, 317
(1967) Natural Science Department, Michigan State University, East Lansing, Mich., USA

Trout, W.E., III — 20, 21
(1965) Indiana University, Bloomington, Ind., USA

Truckenbrodt, W. — 979
(1965) Heiligenberg-Institut, Baden, Federal Republic of Germany

Tsiapalis, C.M. — 232
(1967) Cancer Research Laboratory, Faculty of Medicine, University of Western Ontario, London, Ont., Canada

Tsitsipis, J.A. — 1154
(1966) 'Democritus' Nuclear Research Center of the Greek Atomic Energy Commission, Athens, Greece

Tsochev, T.N. — 1724
(1964) Scientific Institute for Research in Radiology and Radiation Hygiene, Sofia, Bulgaria

Tsuda, K. — 377
(1966) University of Tokyo, Motofuji-Cho, Bunkyo-Ku, Tokyo, Japan

Tsukamoto, M. — 843, 844
(1967) Research Institute of Tropical Medicine, Nagasaki University, Ohashi-Machi 200, Nagasaki, Japan

Tulchin, N.W. — 439
(1966) New York City University, New York 3, N.Y., USA

Tupitsyna, E.M. — 1110
(1965) Institute of Biological Physics, Moscow, USSR

Turbin, N.B. — 1209

Turnbull, S.B. — 864
(1962) Department of Pharmacology, Medical College of Virginia, Richmond 19, Va., USA

Tzanakakh, M.E. — 900
(1963) Aghia Paraskevi Attikis, 'Democritus' Nuclear Research Centre, Athens, Greece

Tzanakakis, M.E. — 1154
(1966) 'Democritus' Nuclear Research Centre of the Greek Atomic Energy Commission, Athens, Greece

U, R. — 1205, 1206, 1207, 1044
(1966) Department of Biological Sciences, Northern Illinois University, De Kalb, Ill. 60115, USA

Ucer, E. — 1446
(1965) Istanbul University, Istanbul, Turkey

Uchida, T. — 797
(1966) Agricultural Chemicals Division, Sankyo Company, Ltd., Yasu, Shiga, Japan

Ullberg, S.
683
(1964) Royal Veterinary College of Sweden, Stockholm 50, Sweden

Umeda, K.
1664
(1964) Ministry of Agriculture and Forestry, Tokyo, Japan

Upadhya, M.D.
1696, 1697
(1966) College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii

Val Cob, M. del
1698
(1965) Junta de Energia Nuclear, Madrid, Spain

Valder, S.A.
466
(1967) Department of Entomology, Kansas State University, Manhattan, Kans., USA

Valencia, J.I.
1516
(1966) Biology Department, University of Buenos Aires, Buenos Aires, Argentina

Valencia, R.M.
1516, 1517
(1966) Genetics Division, Atomic Energy Commission, Buenos Aires, Argentina

Van den Anker, C.A.
539, 540

Van der Geest, L.P.S.
462
(1967) University of California, Berkeley, Calif. 94720, USA

Van Hoeck, F.
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Vandehey, R.C.
1111
(1962) University of Notre Dame, Notre Dame, Ind., USA

Vann, E.
1518
(1966) Cornell University, Ithaca, N.Y., USA

Vann, E.G.
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Vargas, L.
22
(1964) Lab. de Entomol., Inst. de Salubr. y Enferm. Trop., Mexico

Vas, K.
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(1959) Budapest, Hungary

Vashkov, V.I.
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(1966) Central Science-Research Disinfectory Institute, Moscow, USSR

Vasilyan, V.V.
1392, 1393, 1618
(1965) Armenian Agricultural Research Institute, Yerevan, Armenian SSR

Vatti, K.V.
980, 1045
(1966) Leningrad 'A.A. Zhdanov' State University, 7/9 Universitetskaya Nab., Leningrad, USSR

Vaughan, W.R.
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(1954) Department of Chemistry, University of Michigan, Ann Arbor, Mich., USA

Vereecke, A.
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Verfaillie, G. (1965) Biology Service, Joint Research Centre, Euratom, Ispra, Italy
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Verly, W.G.
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Vermeulen, C.W. (1965) Department of Microbiology, University of Illinois, Urbana, Ill., USA
<u>350</u>

Vervier, R. (1965) Centre de Recherches de Phytopharmacie, Gembloux, Belgium
777, 778, 779

Vesely, V. (1966) Central Research Institute for Plant Protection, 507 Prague, Ruzyne, CSSR
550, 551, 554

Vichuda Krithayakiern (1966) Entomology Section, Department of Agriculture, Bangkok, Thailand
<u>1447</u>

Vickers, D.A. (1967) Department of Biology, Southeastern Louisiana College, Hammond, La., USA
882

Viel, G. (1966) Institute of National Research and Agronomy, Laboratory of Phytopharmacology, Versailles, France
<u>684</u>

Vilenchik, M.M.
APX7

Villar, E. del (1967) School of Medicine, University of Chile, Santiago, Chile
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Vinson, S.B. (1967) Department of Entomology, Mississippi Agricultural Experiment Station, State College, Miss., USA
<u>685</u>, <u>686</u>, <u>687</u>, 695

Voelker, R.A. (1967) University of Nebraska, Lincoln, Nebr., USA
<u>1112</u>

Volchkok, Y.A.
<u>1155</u>

Volkov, M.N.
1248

Volkova, G.A. (1967) Institute of Zoology, Academy of Sciences of the USSR, 1 Universitetskaya Nab., Leningrad, USSR
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Vonk, H.J. (1966) State University, 29 Kromme Nieuwe Gracht, Utrecht, The Netherlands
361

Vorobtsova, I.E.
1155

Voroshtsov, N.N.
<u>606</u>

Vroman, H.E. (1967) Department of Dermatology, School of Medicine, 1600 Northwest 10th Avenue, Miami, Fla., USA
370

Vysotskiy, V.G. (1966) Institute of Biological Physics, Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR
1130

Vystoky, V.G.
1452, 1453
(1965) Academy of Sciences of the USSR, 33 Leninsky Prospekt, Moscow, USSR

Wacker, H.
223
(1962) Technische Hochschule München, 21 Arcisstrasse, Munich, Federal Republic of Germany

Wagner, R.O.
495
(1964) Department of Entomology, University of Wisconsin, Madison 6, Wisc.53706, USA

Wagoner, D.E.
1046, 1113
(1967) Radiation Biology and Insect Genetics Section, Metabolism and Radiation Research Laboratory, Entomology Research Division, ARS, USDA, Fargo, N. Dak., USA

Wakid, A.M.
1583, 1584, 1585, 1610, 1611, 1612
(1967) Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo, UAR

Walker, A.B.
371
(1965) Entomology Research Division, ARS, USDA, 4115 Gourrier Avenue, Baton Rouge, La., USA

Walker, D.W.
1156, 1157, 1158, 1448, 1621
(1967) University of Puerto Rico, Nuclear Centre, Mayaguez, Puerto Rico

Walker, H.J.
776
(1967) Department of Entomology, Texas A and M University, College Station, Tex., USA

Walker, J.R.
1320
(1966) Department of Entomology, Louisiana State University, Baton Rouge, La., USA

Walker, P.T.
798
(1965) Tropical Pesticides Research University, Porton Down, Salisbury, England

Walker, R.W.
730
(1966) Institute of Agricultural and Industrial Microbiology, Amherst, Mass., USA and Cranberry Experiment Station, East Wareham, Mass., USA

Wallace, B.
1047
(1966) Cornell University, Ithaca, N.Y., USA

Walling, M.V.
487
(1966) Department of Entomology, University of Kentucky, Lexington, Ky., USA

Wallis, B.
150
(1965) Department of Genetics, University of Wisconsin, Madison 6, Wis.53706, USA

Walsh, M.M.
1208
(1967) Northern Illinois University, De Kalb, Ill., USA

Walter, J.
223
(1962) Technische Hochschule München, 21 Arcisstrasse, Munich, Federal Republic of Germany

Wan-Yuen, C.
440
(1966) Institute of Zoology, Academia Sinica, Peking, China

Warburg, M.
1622
(1967) Israel Institute for Biological Research, Ness-Ziona, Israel

Ward, A.H.
717
(1965) University of Zambia, Lusaka, Zambia, Africa

Ward, C.T.
835 — (1966) Department of Entomology, University of Wisconsin, Madison 6, Wis. 53706, USA

Ward, H.L., Comp.
1764 — (1967) Oak Ridge National Laboratory, Oak Ridge, Tenn., USA

Ward, L.F., Jr.
799 — (1966) Agricultural Research Division, 'Shell' Development Company, Modesto, Calif., USA

Ware, G.W.
619, 1162, 1171 — (1967) Department of Entomology, University of Arizona, Tucson, Ariz., USA

Warters, M.
1048 — (1966) Department of Biology, Centenary College, Shreveport, La., USA

Wass, M.N.
764 — (1967) Radiochemistry Research Laboratory, The Dow Chemical Co., Midland, Mich., USA

Watanabe, H.
233, 351, 352, 353 — (1967) Laboratory of Sericulture, Faculty of Agriculture, University of Tokyo, Motofuji-Cho, Bunkyo-Ku, Tokyo, Japan

Watkins, T.I.
609 — (1967) Boots Pure Drug Co., Ltd., Chemical Sciences Building, Research Department, Station Street, Nottingham, England

Watson, B.S.
790, 791, 792, 793 — (1966) Biomechanism Group, E.C. Britton Laboratory, The Dow Chemical Company, Midland, Mich., USA

Watson, W.A.F.
1236, 1242, 1243, 1244 — (1967) Department of Radiation Genetics, State University of Leyden, 67-73 Rapenburg, Leyden, The Netherlands

Watt, W.B.
234 — (1967) Yale University, New Haven, Conn., USA

Watters, F.L.
1699, 1789 — (1966) Canada Department of Agriculture, Winnipeg, Man., Canada

Wattiaux, J.M.
354 — (1967) Catholic University of Louvain, 4 Rue Kraeken, Louvain, Belgium

Wave, H.E.
1613 — (1967) University of Massachusetts, Amherst, Mass., USA

Weaver, N.
410

Wegorek, W.
489, 535 — (1963) Institute of Plant Protection, Poznan, Poland

Weidhaas, D.E.
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Weidinger, N.
23, 499 — (1966) Institut für Biologie und Landwirtschaft, Reaktorenzentrum Seibersdorf, Seibersdorf, N.Ö., Austria

Weill, F.
1071 — (1962) Hospices Civiles, Strasbourg, France

Weinbren, M.P.
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