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 decrease from the overwintered to the F1 generation was greater than that from the F1 to the F2 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 indication of population build-up was observed, indicating possible future success with this method of control. (From DA)

**Note:** The text contains a symbol that is not clear. It might be a mathematical symbol or a special character that needs further clarification.

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1501 Horben, E. MARKÄR GEGEN MARKÄRFER: EIN VERSSCH ZUR TILGUNG EINES EINGRÜNDUNGS- 
HEIDES DES FELDMARKÄFS (Mebolophtha volgare Tab.) MIT RÖNTGENBESTRAHLUNG MÄNNCHEN, 
(Cockchafer against cockchafer! An attempt to eradicate a larval population of Melolontha 
volgare by the release of X-irradiated males.) Waiblingen, 8 (1967) 105-119. (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 20-ha area. Gradation in that area as well as in three control areas, C, continued to be checked since 1953. In 1959, for the 1st treatment, 1,1 of sterilized males were released over A, representing 32% of the male population. White grub infestation sampled in gravelly sand subsequently dropped to 1/10 of that in the other areas. Reproduction rates remained 1/10 in A only. Further reduction of the population in A to 1/10 of that in C was observed when the number of surviving cockchafer was estimated in spring 1962. The greatest mortality between 1959 and 1962 occurred in A. In 1962, for the 2nd treatment, a total of 17,22,23 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 2nd flight period in 1962 no treatment was necessary since only a few cockchaferer 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 1-9. The results indicate 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 past mate several times, the artificial breeding in large quantities is not feasible because of long developmental stages and the most voracious and destructive stages of the insect live hidden in the soil.

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1581 Horben, E. USE OF ALTERNATIVE BIOLOGICAL CONTROL SCHEMES. p. 107-183 of "Proceedings 

Among the topics discussed in this review are biogeneric control measures such as the use of flooding 
radiation. (His own work on Melolontha volgare is quoted by the author, where small-scale field 
experiments with irradiated white grubs on gravelly sand resulted in eradication.) The use of chemo-

terrements, anti-herbicides, and acetylating agents is discussed. The use of selective agents is described. They are divided into attractants (sex attractants, attractants and attractants associated 
with host plants), repellents, antifeeding compounds, and hormones (ecdysteroids, juvenile hormones, 
and competition and coordination between hormone activities).

1589 Jermy, T., Nagy, B. LABORATORY EXPERIMENTS TO CONTROL THE COCKCHAFER (Melolontha 
volgare L.) BY THE STERILE MALE TECHNIQUE. Acta phytoph. hung. 5, 2 (1967) 231-247. (In English)

Cockchafer adults dug out from the soil just before emergence were irradiated with x- and y-rays, 
respectively. The sterilizing dose was found to be > 1,5 i.e., 3 i.e giving 90-100% sterility. x-rays 
and y-rays showed the same sterilizing effect at the dose rates used in the experiments (9,68 i.e/min

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427
for x-rays, 3.68/h and 2.82 k/8/h at 38 and 100 cm, respectively, for y-rays). Feeding before irradiation seems not to affect sterilization. Irradiated (3.68) males were fully competitive with normal males in cage experiments. High locomotor activity of males was observed during irradiation even at 20°C. (Colling, T. A. P., showed the same reaction.) Longevity of cockchafer males was not shortened by irradiation. (From auth.)

See also

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

1220 Reproductive potential of the sweetpotato weevil after exposure to low-dose radiation.
(Walker, J. B., 1969)

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

1550 Radiation-induced sterilization. (Lachance, E. E., et al., 1957)

2.4.2.1.2. Diptera


Pupae of A. pharoensis Theobald were subjected to Co-60 γ-radiation from 500 to 7000 R with 300 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 1600 and 2400 R, after which a highly significant decline was observed. Percentage of hatchability was greatly affected at all doses, falling below 10% at 8000 R, above which it remained constant. Percentages of population 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., Wahid, A. M. STUDIES ON THE ERADICATION OF Anopheles pharoensis Theobald 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.

Pupae of A. pharoensis Theobald were subjected to various doses of γ-rays from Co-60, i.e., 1000-24000 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 (10000 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 fractions when pupae aged 16-20 h were used. (Auth.)

1380 Abdel-Malek, A. A., Tantawy, A. O., Wahid, A. M. STUDIES ON THE ERADICATION OF Anopheles pharoensis Theobald BY THE STERILE-MALE TECHNIQUE USING COBALT-60. VI. SPERM ACTIVITY IN MALES IRREGAZIATED WITH THE STERILIZING DOSE.

Matings between untreated females A. pharoensis Theobald and either normal or irradiated males (13,000 R) were carried out in breeding cages to investigate the sperm activity in 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 notify insemination by irradiated males. Sterilization of males with 10,000 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 m
opulation with normal males. Delaying the mating of males for 5 d after irradiation did not restore viability of the sperm. 


The anticipated length of sterile male release programs 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 mating, irradiation, and release techniques on the mating behavior of released male flies. Tests were conducted to evaluate some of the changes in mating behavior that occur among colonized flies in laboratory-adapted flies with increased time in culture. The effects of differences in strain and size on the mating frequency of males 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 numbers of the Florida strain of flies were reared by mating the flies in 2 different artificial media. Flies comparable in size to wild flies were reared in artificial wounds on roach. Ancillary studies required sterilization of the males by exposure to \( \gamma \)-irradiation. Differences in mating frequency among male flies that were attributable to strain disappeared after the Mexican strain had been colonized for 20 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.


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 infected with maggots of the fruit fly. In one of the treated towns, where the overwhelming population had already been reduced to an unusually low level by pre-treatment with insecticide during the previous summer, the wild population was eradicated 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 neighboring 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 in 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 infected with maggots of D. tryoni throughout the summer. The pupae were reared at the University of Sydney, Department of Zoology, and sterilized at Lucas Heights. The mean weekly production of sterile pupae during eight months was 250,000, varying between 150,000 and 750,000.


Development of the radiosterilized male technique for elimination of the screw-worm fly and other parasitic insects is reviewed. Eradication of the screw-worm from Caracas by this method is considered from the point of view of mass production, sterilization, release, and field evaluation of the project. For irradiation, a 430 Ci \( ^{60} \)Co unit was used for a 2000 square mile test with an initial dose rate varying from 198 to 810 R/min. To completely sterilize the screw-worms, 8900 R was delivered to pupae at 4.5-6.7 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 25,000 mi², and peak employment totaled 200. Irradiation studies showed that a sterilizing dose of radiation could be administered to screw-worms without seriously affecting longevity or male competitiveness. Economic aspects of the programme are discussed. (NASA 91: 1907, 6740)
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 850 rads 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, 1986.


In fruit-growing areas in New Zealand the codling moth population has been estimated at 4 months/tree/year, a number multiplied by the use of conventional insecticides. Treatments of the main apple-growing areas (Havelock 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.


Co-irradiation of horn fly pupae resulted in high mortalities at the treatment levels but newly emerged flies were sterilised by and survived 5000-6000 rad. Sterilised males were released onto a isolated bee yard alone and in integrated insecticide-sterile-fly studies. The integrated tests provided the necessary promoting horn fly control. (Abstract)


The results of a preliminary study on Dacus constrictor in the Karachi area are reported. A standardised rearing technique has been developed and laboratory cultures maintained. Pupae were irradiated by y-rays just prior to emergence. A dose of 7000-9000 R from a 137C0-56 Co source ensured sterilisation. The role of nitrogen in the irradiation chamber is discussed.


The tests were done for sterilising males of D. constrictor irradiated at the late pupal stage was found to be 1.96 kg, without involving any adverse effects on pupal survival, adult emergence, longevity or sexual aggressiveness. There was no decrease in oviposition when irradiated males were coated 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 careerus.


Germadi capricornis was isolated by adding MeCN to the larval food in concentrations of 10% to 10% g/g. Resulting 5-week-old adults were subjected to a film density of 1 x 107 g2 min/mg rad. in the Stockenrode reactor for 20 min. at 5.5 MW. Improvements in rearing methods (automatic egg collection, cages, larval media) were discussed into special device for dispersing adults from aeroplanes. - Some trial releases of the Modfly were made in three areas of Vienna in the (in fortunate unfavourable) summer of 1965, a low dose (1.8 rad) being given to 8- to-10-day pupae. No eggs were laid in proved spacious. 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 these flies. - A nearly satisfactory laboratory larval medium has been developed for the olive fly, and interest now focuses on deriving an economic larval food.


The scientific programme is the eradication of Anop from a Co56-source (p. 14 Carminis caprae Wied. 1826)
CONTROL OF THE MEDITER-
RALISATION OF LABORATORY-
he Period January-December
Nuclear Research Center, 533p.

areas in order to evaluate the
ity of the Biological Control Institute,
ence. The dose of 3-8 lead
per week. A total of 50 million

STERILE MALE TECHNIQUE.

As been estimated at 4 months/ 2
tional insemination. Three
Co) are naturally isolated
ods and detailed ecological
ibilities for New Zealand.

FIELD STUDIES WITH Co.
221, Presented at "Portland

ation levels but newly emerged
es were released onto an isolated
the integrated area provided the

-rays.

area are reported. A standardized
pupa were irradiated with
Co-source emitted sterilization.

Saunders BY GAMMA-RAYS.

stage was found to be
or emergence, longevity or
lar males were crossed with
from treated pupae showed
be produced. Adult longevity
promise for Drosa annulata.

RADIOACTIVE AND PEST CONTROL

concentrations of 10^4 to 10^7 g/g.
10^-1 to 10^-3 g/cm^2 in the
methods (automatic egg collection,
ads from axepanes. -
a in the (unfortunately un-
egg were laid on
fruit in places where standing
up self-mating
um has been developed for the

1595 International Atomic Energy Agency, Vienna (Austria). THE MIDDLE EASTERN REGIONAL RADIO-
ISOTOPE CENTRE FOR THE ARAB COUNTRIES, CAIRO. p. 121-122 of "IAEA Laboratory Activities,
157p. ST/DOC/10/55.

The scientific programme is outlined. Among the projects already under study and given first priority
is the eradication of Aedes aegypti in Egypt. The sterile male technique using γ-irradiation from a
60Co-source (p. 146-147). Field studies are under way. Similar studies on the eradication of
Culex pipiens Wied. in the Arab region are part of a new project (p. 147-149).

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 USING RADIATION.
Research Contract 199. p. 94-96 of "IAEA Research Contracts, Sixth Annual Report", Technical Reports

Research Institution: Organismo Internacional de Sanidad Agropecuaria (OISB), San Salvador, El Salvador.

Principal scientific investigator: E. Morales,

Period of contract: 1 Mar, 1963 - 28 Feb, 1965,

Methods of mass rearing, γ-sterilization, 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
release, the pupae were mixed with tropical almond leaves. The cured leaves kept the pupae from
parching and provide extra parching 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 (Froggatt)
PART OF A CO-ORDINATED PROGRAMME OF INSECT CONTROL USING RADIATION.
Research Contract 524. p. 68-100 of "IAEA Research Contracts, Sixth Annual Report", Technical Reports

Research Institution: University of Adelaide, Department of Zoology, South Australia.

Principal scientific investigator: H. G. Anderson,


During the spring of 1962 and the summer of 1963/64, 20 million pupae were sterilized by γ-irradiation
and distributed through two towns in western New South Wales. It was estimated that adults
emerged from 6% of pupae about half the adults were males. Two comparable towns were left
unirradiated as controls. Results were measured by collecting, at fortnightly intervals, samples of
fruit from all these bearing fruit ripe enough to be infected 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 pests by eliminating local populations of the Queensland fruit fly.

1598 Karna, K. P. DETERMINATION OF THE STERILIZATION DOSE OF THE MEDITERRANEAN FRUIT
FLY USING THE OISB Co-60 RADIANTR. p. 106-109 of "The Application of Nuclear Energy to Agriculture,

19 Mv was found to reduce male fertility to 0.04%.


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

1600 Addis Ababa Regional Radiotope Centre for the Arab Countries, Cairo (Egypt). ANNUAL REPORT,
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-serratulation techniques is reported, amongst other studies. A list of 28 references to papers published on work performed at the cause is included.


Investigations in Israel on the influence of feeding on the attraction of C. capitata to trimedur showed that starved females are attracted preferentially to yeast hydrolysate, whereas starved males are attracted to trimedur. When no food was supplied, both newly emerged and sexually mature females were found to be attracted to trimedur. The rate of attraction of females to this male base 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 trimedur to females. This phenomenon may be useful in monitoring irradiated-fly releases. (From auth. summary)


Sterile fly releases continued in the pilot test area of Puruaveras. During this quarter small sterile releases were initiated in Izique and Corinto, Republic of Nicaragua, and in Boaco, 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 infection of the larval media was successfully controlled by certain treatments using tecogen and sodium benzoate.


Sterilized Mexican fruit flies have been used in place of insects used along the California-Arizona-Mexico border for the 4th year to prevent infestations from becoming established in the United States. More than 10 million flies are reared and sterilized at Monterrey, Mexico, and flown to the target area for release each year. (Abstr.)


Screw-worm control by the use of the sterile-male technique is discussed in detail. Chemical control is recommended with Co-Rat as a 5% dust, 0.25-0.25% spray, or 0.25% dip, rumen as a 0.5% spray, 5% smear, or 5% aerosol spray, Lindane as a 3% smear, or diphenylamine as a 3% smear. (CA 66: 1966, 1874G)


Sterile male codling moths, exposed in paper to 40 load of y-radiation and released in an abandoned 26-tree apple orchard for 3 yr, reduced the percentage of fruits injured by mature or almost mature 2nd-brood larvae from 4.94 to 0.56. Numbers of sterile males released, ratio of sterile to fertile males during peak emergence of 1st-brood moths, and numbers of overwintering larvae were: 1961 (6 PDT sprays applied) 0, 0.1, 400; 1962 - 17.3, 684; 1963 - 87.3, 227; 1964 - 90.0, 218.4; 1965 - 1, 6. (Auth.)


Larval pre-emergence of Carpotapa in 1969 was caged in the 1 irradiated males to one as orchard, release of 1'1'1'00 reduced the numbers of adults in 1964 to 0.2% of 1963.


Coles' technique is the only practical way for control in the control of this pest. (From abstr.)

1608 Riedel, M. ZUR BIOLOGIE UNTER BESONDERER BEUZG, biology, beating and molt of the insect in field culture in the beginning of June. The original parasite species in the sterile-male technique presented. (From abstr.)

1609 Schencky, F., Haasch, A. FLICKE Ceratitis capitata W. and sterilization of the Male Technique. J. Bayer. Landwirtschaft 1986: 10, 30 d. • The application of mating conditions is considered to be a further step in the study of the sterile-male technique.

1610 Tamaway, A.G., Abdell-Ma phorhism and the Sterile Male Lethal in the IMMATU. An experiment was designed to assess the effect of the F1 generation on the success of the F2 generation. Results from 600 R to 6000 R clearly show that the percentage of successful males increased linearly with dose. On the other hand, the dominant lethals in the F2 generation were more effective than in the F1 generation. (Abstr.)

1611 Tamaway, A.G., Abdell-Ma phenology by the Sterile Male Lethal. This study was conducted to determine the frequency of the F1 generation in the IMMATU. The results obtained showed that the frequency of the F1 generation in the IMMATU is higher than in the F2 generation. (Abstr.)
Larval propoxy of Carrapatea prominella (L.), was reduced 8% when adult moths, exposed to 25 ppm in CO₂, were caged in the laboratory with untreated males 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 ppm) male and female moths in 1964, and 476,000 in 1965, reduced the numbers of eggs hatched by codling moth at harvest from approx. 60% in 1963 to 1.2% in 1964 and to 0.3% in 1965. (Authors.)

2087


Culex fatigans is the only known vector of Bancroft 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.)

1908

Riedel, M. ZUR BIOLOGIE, ZUCHT UND STERILISATION DER KOMPLEXEN Phorbia brassicae Borg, UNTER BESONDERER BEWUSSTSEINSBEUGUNG IHRES VORKOMMENS IM KETTENRADELL. (Study of the biology, breeding and sterilization of the cabbage fly, Phorbia brassicae Borg, with special reference to its occurrence in radish cultures.) Bayer, Landw. R. 44, 4 (1967) 837-839. (In German)

Ph. brassicae proved highly sensitive to radiation. Doses of > 2 keV caused complete sterility in both sexes. The optimum male pupal stage for irradiation proved to be during the last 4 days before adult emergence. Prior irradiation caused visible somatic injury (reduced longevity, inability to fly, rise in pupal mortality). Sexual competitiveness is only adequate if the dose is < 3 keV. At 2-2.5 keV full competitiveness of the sterilized 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.

1909

Scheuny, F., Pichl, A. ÜBER Massezucht UND Sterilisation DER mitteleuropäischen FLIEGE Carbula putoni (Bunth. EINBEITAG ZUR AUTOTOMIE-METHODE). (Study on mass breeding and sterilization of the Mediterranean fruit fly Carbula putoni (Bunth.). (A contribution to the autotomic technique.) Bayer, Landw. R. 44, 6 (1967) 749-756. (In German)

Sterilization by ionizing radiation was preferred to chemosterilisation. A 137Cs-source of 1100 Ci was available, giving relatively soft γ-radiation. A dose rate of 75 Ci/min was given. Doses of from 4000-15000 R were tested, in steps of 1000 R. The aim must be to find an optimal dose which will produce max. sterility and min. somatic injury. A dose of 10,000 R was used in field releases. Flight range determinations were carried out by means of releasing sterilized γ-labelled pupae which had been labelled as larvae. 3,905 pupae were labelled. The average range was 38 m, the max. 548 m within 10 h. - The application of the method to local control or eradication of the flyfly under prevailing conditions is considered feasible.

1910


An experiment was designed to study the percentage of induced dominant lethals in the immature stages of the F₁ 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 lethal in eggs of A. pharoensis irradiated by γ-rays increased linearly with increasing doses. 100% lethality in the F₁ generation appeared at 5000 R γ-rays. On the other hand, the results showed from parental pupae irradiated with γ-rays demonstrate that dominant lethals in the egg, larval, and pupal stages of F₁ offspring resulting from irradiated pupae are more effective during the egg stage followed by the larval stage complete lethality was achieved at 4600 R and 5600 R, respectively. γ-rays showed no significant effects on the F₁ pupal trage, i.e. adults would emerge from most of the pupae in spite of high doses of γ-irradiation. (Authors.)

1911

Late 3rd-instar larvae from the laboratory colony were reared in Nika water containing 0.1%, 0.5%, 1.0%, and 2.0% CI^-1 Pr. 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 mating labelled pupae were irradiated with a 15,000 r dose of y-rays (the sterilizing dose). The adult males were then allowed to mate with non-radioactive normal females. It was possible to detect the radioactive source of males treated with 0.2% CI^-1 Pr in the progeny of 3rd and 4th generation 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 copiously as wild males, if each was confined to the same number of females.

A study of mating competitiveness between sterilized males and normal males of A. pharaonis Theobald showed that males treated with 20,000 r (the sterilizing dosage of y-rays) were slightly less competitive than normal males when present in the population cages in ratios of 1:1:1 and 2:1:1 (irradiated males + normal males + normal females). But at ratios of 16:1:1 and 15:1:1, the competitiveness of the irradiated sterile males was increased. Normal males exposed 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.)

Laboratory tests were made at Beltsville with sterile males of Drosophila to determine the effectiveness of some of their main techniques. In suppressing populations, y-irradiation or feeding with apholate was used. Irradiated flies were exposed about 24 hours before release by 16 hours of y-irradiation from a 220 source delivering about 200 kGy. All flies, irradiated or apholate-fed, were 4-5 days old when they were released. The two methods of sterilization, at the indicated degrees, have been shown to produce no viable eggs when the treated males, at 2, 5, or 10 d of age, were mated to untreated females. 24 h after treatment, male flies exposed to 16 hours are as reproductively competitive as untreated males. In the first experiment, newly emerged, untreated virgin flies were aged 56 pairs placed in each cage. One cage received irradiated, another apholate-treated males. The initial release of sterile males, made immediately after the untreated flies were introduced, were made at a rate of 50 sterile to one untreated (1950/1950). The two lasted 97 d. About 6 generations. Temperatures during the test ranged from 17-20°C, with an overall average of 20°C. Additional releases of 9200 and 9000 apholate-treated each were made 10 and 20 d, respectively, after the start of the experiment. A final release of 1500 irradiated or was made the 34th day. The fly population in the check cage increased noticeably during the first 77 d, increase in the cages containing irradiated and apholate-sterile males was not apparent until after 67 h. The number of nylon and nylon in the medium in the two cages of treated flies was markedly less than that in the check cage. After 57 d the fly population in the cage containing irradiated males was 88% less, and that in the cage containing the apholate-sterile males 77% 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 sterile males. The 2nd experiment consisted of three cages, one receiving weekly releases of apholate-treated males, one receiving weekly releases of y-irradiated males and one check, receiving no releases. All initial releases were based on a ratio of 25 sterile to 1 untreated or. The cages were initially infested with 20 untreated pairs, and the 1st release of sterile males were made at the time of initial infestation with the untreated flies. Eight releases were made during the 57 d. Average daily releases varied between 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.

In experiment 2 no reproduction occurred when apholate-treated males or irradiated males were released weekly in the cages.

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THE EPIDEMIOLOGIC OF Anopheles V. MATING COMPETITIVENESS

male of A. quadrimaculatus (gamma-rays) were slightly less in number of 1:3:1 and 1:1:1:1 and 5:1:1:1; the complete capture of nature as competitiveness as males from the normal population, age (using irradiated males with

1. POPULATIONS OF Propopella 1726.

To determine the effectiveness of irradiated males to release of 10 lb of gamma-rays or apholate-fed, were 4-6 d of age, were used to 12-16, and are as reproductively compared, untreated virgin flies were fed another apholate-treated (the untreated flies were inoculated). The test lasted 77 d at 80°F, with an average temperature of 70°C. Insects were held for 20 d after irradiation, and they were reared on the same amount of food. The results showed that sterilized males had a lower mating rate compared to untreated males. The 2nd experiment consisted of ten resulting weekly tests. All test results were initially tested with 20 untreated males in the irradiation temperature ranging from 0°C to 50°C. No mating occurred when apholate-treated 67%, less than 20% of the untreated males and 3% of the untreated females. In the case of treated males was 40%.


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


The release of sterilized Ceratitis capitata on Capri is the last 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 ~1-10/million flies. A fly cannon was developed through which paper bags containing the flies and wood wind are dropped, dropped open, and released behind the hill stream of aircraft, enabling the flies better to survive the fall and to disperse. Pioneering work was done by the Biological Control Institute of the Citrus Marketing Board of Israel and the Agency's Entomology Laboratory in Sanktuar, 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 50,000 acres the feasibility of sterilizing the pest with the help of radiation. Other types of pests (flea beetle) studied for possible control by the sterile-male technique are indicated.


In entomology, the research has continued 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. 1. Tagging the fruit fly Ceratitis capitata Wied. with radioactive phosphores for the sterile male technique. (Saito and Nakayama, M., et al., 1965)
1129 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 gamma-rays. (Ariyoy, M., et al., 1965)
1220 Application of radioactive isotopes to the investigation of methods for the biological control of pests. IV. The effects of y-irradiation on C. capitata when the dose of irradiation is fractionated. (Ariyoy, M., et al., 1965)
1345 On the radioactive isotope utilization for fruit protection. (Popa, A., et al., 1965)
1551 Sterilization of la mosca mediterránea des frutos, Ceratitis capitata Wied., par irradiation des pupes aux rayons gamma. (Pérez, M., 1966)
1668 Sterilization of anther maggots by irradiation with cerium-187. (McClanahan, K.J., et al., 1965)
1631 Radiation sterilization of the black blow fly. (McClanahan, R.J., et al., 1960)
1654 Effect of radiation on males: an autogenous dominant mutation in the screwworm fly with recessive lethal effects. (LaChance, L.E., et al., 1960)
1668 Sterile technique - principles involved, current application, limitations, and future application. (Kamering, E.L., 1967)
1690 Irradiation-induced sterilization. (LaChance, L.E., et al., 1967)
1791 Integrating control of pest populations in large areas. (Lawson, F.R., 1960)
1797 Control of Queensland fruit fly. (O'Laughlin, G.T., 1960)
2.4.2.1.3. Lepidoptera


The biological effect of x-irradiation of the hollyhock seed moth is dependent on the age of the irradiated pupae for the dosage employed. Pupae 1-3 days old are the most sensitive to radiation. Mortality obtained from these pupae lay single eggs or are sterile. The greatest biological effect is obtained by irradiating 1-3 day old pupae with a radiation dose of 5,000 Ro. The moulting 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 winter and spring 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 sterile moths. The egg laying period is in shorter for moths obtained from irradiated pupae than for those from non-irradiated pupae. Life span is approximately the same for moths from irradiated and non-irradiated pupae and is not affected either by radiation dose or by the age of the pupae at the time of irradiation. (t-Auth.)

* Pectinophora giloella Hb.


Results of release of sterile moths in a commercial orchard were reported successful from both Summeerland, B.C., and Yakima, Washington. Both laboratories have found that it is not necessary to separate the sexes, and that release of sterilized mixed sex is given results equal to release of sterile males alone. The main difference in techniques between the two stations is that the moths are sterilized by x-radiation at Summeeland and by chemosterilants at Yakima. There is some evidence that moths mated sterile by chemosterilants are not as long-lived as those sterilized by x-radiation. An additional complication with chemosterilants is the variability of their effectiveness which requires constant monitoring.


Work on the suitability of Diatraea saccharalis (Fab.) for sterilization by x-radiation was started in 1963. The sterilizing dose for adults of both sexes is 50 brand, egg hatchability only, not egg number, is affected even at 10 brand. Behavioral changes in males irradiated with 100 brand did not prevent mating. Males irradiated at 2-4 brand 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., 1960)
1145 Sexual sterilization in the fight against codling moth in apples. (Ferruzhova, N.I., 1967)
1146 Exploratory studies on frequency of population in Prodenia litura F. (Lepidoptera: Noctuidae). (Shazil, A., 1965)
1158 Radiation-induced sterility for population control of the sugarcane borer (Diatraea saccharalis) in Puerto Rico. (Waller, D.W., 1960)
1207 Laboratory and field cage studies of the effects of gamma radiation on codling moths. (Hathaway, D.O., 1960)
1255 Gamma irradiation of pupae of the tobacco budworm. (Flint, H.M. et al., 1967)
1259 Radiation-induced sterilization. (LaChance, L.E. et al., 1967)
1277 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. (Rutishford, F.K., 1967)

11616 Galuz, H., Warburg, M., IN THE TICK Ommatodeso

The tick is an important vector of diseases in other parts of the world. It is considered to be an important vector in the Middle East, Syria, and Cyprus. It is known to carry the causative agents of tick-borne diseases such as tularemia, Rocky Mountain spotted fever, and others.

1267 Effects of gamma radiation on the tick. (Kisnitsa, S. et al., 1967)

2.0.2.3. MUSCIA. J. POPULATION (1965) 1965-1966.

In theory, population of insects is controlled by natural factors such as predation, parasitism, and environmental factors. However, in practice, these factors are difficult to control, and alternative methods such as biological control, chemical control, and genetic control are often used. Genetic control involves the use of genetic factors to control insect populations. For example, the use of insect-resistant crops can reduce the population of insects that feed on these crops. Genetic control can be effective in both the field and the laboratory.

1268 Genetic weapons, genes are off ppc 1964)
2.4.2.1.4. Hemiptera

See:

1144 Biology and radiation sterilization of sugar cane leafhopper. (Coburn, A. W. et al., 1966)
1149 Radiation sterilization of sugar-cane leafhoppers of the family Delphacidae. (Ship, E. et al., 1969)

2.4.2.1.5. Acarina


The tick is an important vector of human relapsing fever in Israel, and is also found in Jordan, 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 costumes. 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 60Co-source emitting 7700 r/min was used. Nymphs are prevented from molting at >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 15,000 R in order to induce 90% dominant lethality. They are effective in competing with normal males.

See also:

1267 Effects of gamma radiation and chemorepellants on the cattle tick, Boophilus microplus. (Khan, R. et al., 1967)

2.4.2.2. Overloading Resources


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. Female sterile flies were reared at 25°C and 8-4 old pupae sterilized with 3000 rad of γ-rays (60Co). After emergence they were held for 4 days, fed for 2 days on sucrose containing 3H (NatP·PO4) of a concentration of 100 μCi/g sugar, and then released into the treated populations. Three of four treated populations declined sharply within 2 days 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


Most of the papayas shipped out of Hawaii are heat-treated to control decay and then fumigated to meet official disinfection 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 semiquantitative experiment are shown in a table, in terms of storage decay, overall firmness and delay in senescence. In general, the edible life of the irradiated fruit was 2-3 days greater than that of the fumigated fruit. The irradiation dose was 75 krad. Irradiation as a quarantine measure has not yet been approved.


"Requests for proposals went out last Friday for 125,000 lb of canned wheat flour, treated with a disinfestatlon y-dose of 30-50 000 rad. Although more than 80 irradiation companies and Facilities were solicited directly, other companies may propose, by June 30, to the Subsistence Regional Head-

1626 Bowdell, L., Horne, T. BRADATION SHIP WOULD ELIMINATE GRAIN LOSS TO INSECTS IN TROPICS. Nuclear News 25, 8 (1964) 88-90.

A specially constructed grain irradiation ship is envisaged, with a 100,000 curie Co-60 source. Touring the world, it would call at ports where there was the greatest need. In order to irradiate grain supplies on site, the ship is equipped with a grain-irradiation unit and its own power plant. The ship carries a crew of 24, permitting operation at a rate of one 10,000-ton vessel a week. The ship would also carry one of the special grain dryers which are necessary to reduce the moisture content to 12% to 15% before irradiation.


Two 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 to 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 Necrophora and the damage is all the more serious since the fish is stored in large quantities. Chemical methods of disinfection involve serious disadvantages. An attracive 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.)


Review of the extent of dry natural enemies, and expedi-
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.


Development of processes utilizing 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.


Recent approval has been given to “gamma radiating” wheat and flour for insect control. “Gamma” 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 increased regulations. However, they have seriously studied this technique and feel, at this time, that there is insufficient data to guarantee y-radiation not having an adverse effect on the baking quality of the treated flour or wheat. (Bailly Geneve Card-916)


Exposure of stored rice to a dose of 10,000 rad of 60Co γ-irradiation 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)


A report to destroy the cotton fly in Florida using radiation sources are reviewed. The conditions under which sterilization 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, 6642)


A review of the current status of investigations on the radiation processing of foods. The fact that radiation processing of cereal grains, cereal products, and military rations components destroys adult insects, larvae, and eggs of insect pests that infest these foods is mentioned. Nonradioactivity is 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 is discussed.


γ-Irradiation at doses of not less than 21 rad 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 larvae to adult within the seeds. Irradiated mangoes could carry live adults to the mainland. If a mil. dose of ~26 rad 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.

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Use of the flowline method of radiation sources of tabulated coefficients are

ANONYMOUS. PROGRESS COUNTRIES. Int. Br. "

The status of research in Belgium, Canada, Denmark, Sweden, Switzerland, the studies on toxicity and means of quality improvement of foods. Foods include products, bacon, white peach, chicken, pork, bull, carrots, tomatoes, dehydrated grapes, bananas, and tress the radiosensitivity of certain microorganisms, and the con

ANONYMOUS. TWIN COB, ATOMIC ENERGY ESTAB "...will be supplied by (100,000-Ci) package irradiated 27 860-Ci device that can be used 5,800,000 and will be dist

ANONYMOUS. GRAIN RR. The first full-scale appi
te was installed in Turkey, barley, rice, and maize a grain are outlined. With grains at a rate of 30 lb., features and economic as

ANONYMOUS. LOCKHEED Maelstrom, Week 27, 21, on the irradiation side in wheat flour. Prince corn and Hawaiian Flour Mills mental irradiator. The S been operational for some milling companies bid on next month to four Defen

† See 1639.

ANONYMOUS. A 150,000 t Maelstrom, week 7, 30 (1... late this year under it Co unit available in the acquisition with the pe designed for Abe by Alpro. Use of the irradiator and qualified organization will did engage an outside

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See also:

1496 Study of the irradiation tolerance of some destructive storagehouse insects and technical and economic aspects of insect destruction by irradiation. (Parkes, J., 1965)

1498 Grain irradiation plant. (Anonymous, 1967)

1499 Lockhead-Georgia and the Hawaii development irradiator are winners. (Anonymous, 1967)

1500 The world's first large-scale continuous grain irradiation plant, Iskander, Turkey. (Anonymous, 1967)

1501 Design of the world's first industrial-scale grain-irradiation facility. (Carden, J.E., 1967)

1502 Radiation preservation of several fresh fruits and vegetables. (Hayakawa, A., et al., 1964)

1503 Food irradiation research and pilot facilities in operation or planned in India. (Kumta, U.S., et al., 1966)

1504 Control of the Queensland fruit fly by gamma irradiation. (MacFahse, J.I., 1966)

1505 Potential role of radiation in alleviating some world food problems. (MacQueen, K.F., 1967)

1506 Conceptual designs for Hawaiian irradiation and quarantine demonstration irradiators. (Masuvati, R., et al., 1963)

1507 Recent advances in food irradiation research in Japan. (Matsunaga, A., 1965)

1508 Applications of intense radiation sources to biotechnological development. Part III. (Moeur, R., 1964)

1509 Hawaii development irradiator - a new tool in tropical fruit processing. (Osugi, K.K., 1967)

1510 Irradiation of grain and potatoes. (Powern, J.I., 1967)

1511 L'effort belge en matière d'irradiation des aliments. (Pouret, M., 1965)

1512 Gamma-irradiation of grains and other foods for sterilizing and extirpating pests. (Rabinovitch, E.I., 1964)


1514 Food irradiation in Australia. (Scott, W.J., 1962)

1515 Prospects and needs for radiation disinfection of packed fruits and vegetables. (Tallonik, A.S., 1960)

1516 X-ray irradiation effects on storehouse destructive insects. (Tomie, G., et al., 1969)

1517 [null]

1518 Effects of gamma irradiation on the longevity and fertility of five species of stored-product insects. (Witham, P.E., 1968)

1519 Economics of grain irradiation. (Raines, R.D., et al., 1968)

1520 Economic aspects of the food irradiation programme in Israel. (Legorlot, M., et al., 1966)

1521 Rice weevil biology as affected by grain storage conditions. (Bassol, M.P., 1966)

2.4.3.2. Disinfection Measures (Sources. Conveyor Systems, etc.)


Food irradiation studies using the Hawaii Research Irradiator are reported. These investigations have been studied in detail: the papaya, mango, and pineapple. Evidence obtained for each fruit to the biological feasibility of γ-irradiation for insect disinfection. Associated studies suggest possible applications of γ-irradiation in commodity treatment of ginger, sweet potato, and even of Hawaiian radishes, while its successful application for disinfection of taro and avocados appears unlikely. Dosimetry studies were extended to include dose-response behavior when the central chamber was filled with water or potato juice. (NSA 31, 1967, 4929)

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


The status of research and development studies on food irradiation in 1985 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, hunchen 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 mangos. Related studies include studies on the radioactivity of certain bacteria involved in food poisoning, such as Clostridium botulinum and salmonellae, and the control of insect pests that infest foods by irradiation. (NSF 295 1968, 769)

1839 Anonymous. TWO COBALT IRRADIATORS FOR A FOOD-TREATMENT LAB AT INDIA'S TRISHNAYATOMIC ENERGY ESTABLISHMENT.... Nuclear Notes, 3, 2 (1967) 7.

"...will be supplied by Canada under the Colombo Plan aid plan. They include a 100,000-Ci package irradiation, capable of treating about 100 lb/h at 6,3 MeV, and a portable 27500-Cl device that can handle 500 lb of grain/h at 15 kV. The irradiators are valued at $300,000 and will be delivered by Atomic Energy of Canada Ltd.'s Commercial Products Div."


The first full-scale application of radiation from a 60Co source for insect disinfection 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 lb/h, with a dose sufficient to sterilize the insects in the grain are outlined. With the initial loading of 100,000 Ci of 60Co the plant can continuously treat gran at a rate of 50 lb/h. The grain irradiation facilities and the process used are described. Safety features and economic aspects of grain irradiation are also discussed. (NSF 21 1967, 1555).


on the irradiation side in the Defense Dept.'s test procurement of 150,000 lb of very disinfected wheat flour* pending contracts with Hella Milling Co., Portland, Ore., bidding with Lockheed, and Hawaiian Flour Mills of Honolulu, whose subcontractor will be the ABC-State of Hawaii experimental Irradiator. The $600,000 facility coincidentally was dedicated just last Monday, but has been operational for some weeks. The flour contract is its first non-ABC commitment, seven milling companies bid on the DOC procurement contract. Deliveries of the canned flour will begin next month for four Defense installations. (Cited verbatim)

* See 1859.

1842 Anonymous. A 550,000 CUORE CERIUM IRRADIATOR WILL BEGIN TOURING THE COUNTRY.... Nuclear Notes, 7, 30 (1967) 7.

...Late this year under the auspices of the ABC Div. of Interspace Development. By far the largest 137Cs 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 ABC by Vito Engineering Co. Bids for fabrication will be sought by DID next month. Use of the irradiator and the services of an ABC-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. Bids for this service will be sought by New York Operations. DID has only recently stepped up food-treatment research with

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... are on their way from Harwell, England. The prototype plant, designed to hold 170,000 Ci and to process 80 u/s of maize, barley, and oats, is located in Iskenderun. The $1.80 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 Wks, 16 Feb., '68, 7). The disinfestation plant is owned by the Turkish firm of Topaz Mahallesi Ofislo, but its 260-000-U. N. financing came from the Turkish government. (Cited verbatim)


A 60Co source is used. Designed to treat 50 m wheat/b, with an absorbed radiation dose of 18,000 rnd, its max. handling capacity is 50 t of wheat/b, and barley, oats, and maize can also be treated. The plant could accommodate 260,000 Ci instead of the present 260,000 Ci of 60Co. The irradiation facility comprises a concrete tower, with the irradiation plant at a low level, and two 356-t food hoppers at high level, with a covered way connecting the existing silo installation. The feed hoppers are supplied by a system of chutes, elevators, 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 6.25 $/t and for a 3 MeV Cyclotron installation 6.68 $/t. These costs correspond to throughputs of 150 and 460 t/h, respectively, for 3000 b 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 described.


- r-rays from a 60Co source were applied to egg and larval infestations of the oriental fruit fly, Dacus dorsalis Hendel; melon fly, D. cucurbitae Coquillett, and Mediterranean fruit fly, Ceratitis capitata (Wiedemann), in various fruits and vegetables to investigate such radiation as a quarantine treatment for fruit commodities. A dosage of 25 kG generally prevented immature stages of fruit flies from developing to adults. Damages over 40 kG failed to prevent pupal mortality. Mortalities were converted to pounds, and LD 95.6 and LD 99.6, respectively, for the oriental fruit fly and the melon fly. Soda papayas, tomatoes, cucumbers, bananas, lettuce, and grape mangoes tolerated damages between 25 kG and 40 kG without losing commercial acceptability. Most varieties of avocados and mature-green Haden mangoes were injured by 25 kG. (Auth.)


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 ensuring a constant absorbed dose. More closely examined activity of the central source of a cylindrical irradiator is cylindrical irradiator can be operated without absorbing air, reaching areas free from.


Fresh water fish are one of flesh is disinfested by drying or smoking and not insect infestation (mostly F. The irradiation was done for in dry food. The effectiveness of irradiation was determined for 1000 b. The results of the tests and the study of packing were also included in the costs.

1850 Bowersohn, J. L., DOSAGE TREATMENT OF FRUITS AND Vegetables with Gamma Irradiation. In: Food Irradiation, Division of Research Develop. Disinfestation and shell-fish tangerine, lime, pepper, o o, and applications for applications to Hawaii are mango used was for A suitable disinfestation (fly) (Dacus dorsalis and D. - weeds are sterilized by in.

1851 Carden, J. E. DESIGN OF STRUCTURAL RADIATION SOURCE FOR IRADIATING MATERIALS. J. Radio]. Techn. p. 7. (Auth.)

The design of the world's II is described. (Auth.)

1852 Clark, M. A. COBALT-60 Cell. 6, 4 (1967) 186.

1853 Currell, P. R., ed. 7th J 1966, 226p.

See III/1010. (For individual.

1854 Currell, P. R. CONTROL International Food Industry
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 90% 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. (NEA 51: 1897, 10675)


Fresh water fish are one of the major sources of protein in Africa. More than 300,000 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 50% of the fish are destroyed by insect infestation (mostly Dermestes and Nicros) and some 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 Hectrocoelus, 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 at between 15,000 and 40,000 rad. No radioactive changes were observed at 50,000 rad. The effects of doses of 20,000 to 50,000 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 50,000 to 100,000 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.


Disinfection and shelf-life extension studies have also included the lychee, ginger, avocado, tangerine, lime, peppers, eggplant, and papaya. 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 disinfection programme. A suitable disinfection (lethal) dose of 33 krad was established for the Oriental fruit fly and melon fly (Dacus dorsalis and D. cucucita) although considerably lower doses sterilize these flies. Mango weevils are sterilized by treatments of < 20 krad, and a petition has been made for clearance at that dose.


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


See IS 11610. (For individual papers see also IS 11611, 1181, 1182, 1183, 1189, and 1191.)

A review of the present state of knowledge and the steps being taken to encourage the application of ionizing radiation for disinfection 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 suggests that grain should be treated during gravity fall. The dose level for grain disinfection (18,000 rad) does not adversely affect the milling, baking or organoleptic properties of wheat, but 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 60Co plant and electron machines under conditions of commercial grain handling would require pilot operation for evaluation. (NSA 21: 1967, 24703)

1658 Cornwall, P.R., CONTROL OF INSECTS IN STORED FOOD BY IRRADIATION. PD Mf. 29, 6 (1964) 28.

Radiation disinfection by subjecting food to radiation from radionuclides or from an electron machine are discussed. It is shown that with the grain falling through a system or vertical annulus, 70% of the radiation from Co can be utilized. Such irradiation is not harmful to the consumer, and clearance has been given in the USA for the use of radiation energies 2, 2 MeV. Advantage of sterilization by irradiation over fumigation by ordinary methods including immediate reproductive sterilization, 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.


The author considers some suggested irradiation applications using 60Co 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 cucumisii, D. dorsalis, and Ceratitis capitata); also, the movement of fruit between states in Australia (Ceratitis capitata and D.tryoni). The treatment of timber imports into Australia (wood wasps, Strex spp. and European house borer, Ligrinus balsae) 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 sterilemale releases are discussed.


Research into the use 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 disinfection. 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 receiving 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 widely predicted that implementation of radiation disinfection into the grain-handling industry will.


1664 Hayakawa, A., Umetsu, Y., AND VEGETABLES, Plow.

The use of γ-radiation for the treatment of a 90Co source with a 40Co-113Co source, was used before irradiation.
To encourage the application of radiation treatment of food in motion, passing through the mill, and can be handled in the milling process and can be stored in the storage and handling facilities. Radiation treatment of grain is a viable alternative to chemical treatments and can be used to extend the shelf life of grains. The use of radiation in the food industry has been a topic of discussion for several decades, and its potential benefits have been widely explored. (Author)


The irradiation facilities that are being built in the USARC food irradiation programme are described. These facilities, which are designed for use in the production of food products, use Co-60 or Cs-137 as a source of radiation. Insecticidal characteristics such as source strength, production capacity, source dose rate, and cost are given for the research irradiation, Marine Products Development Irradiation, Grain Products Irradiation, Mobile Gamma Irradiator, Onboard Ship Irradiation, the Hawaii Development Irradiation, and the Portable Irradiation. (Author)


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

1060 Pasco, I. - IONIZING RADIATIONS FOR THE DISINFECTION OF STORED PRODUCTS. Agriculture Ital. 12, 4 (1968) 5-8. (In Italian)


Details of site, design, and irradiation capability, housing, and loading are given. The total cost of the irradiation system is $200,000. Specialized equipment such as source elevators and product conveyor was scheduled for completion by early Feb, 1967. (Author)


Current interest in radiation treatment of grains and seeds mainly revolves around its ability to control insect infestation in these products. The recent literature on this subject is reviewed and gaps that exist in current methods and potential for the development of practical systems is pointed out. Research programmes in the United States Department of Agriculture that are underway, or planned for the future, are described in detail. Current studies are being directed toward establishing the effectiveness of radiation treatments for insect infestation, and the development of biological resistance. In May 1966 the scope of the work expanded as a new grain products irradiation project became active and applied studies were initiated. An important part of this research is a study of the effects of radiation on the quality of food and grain products, and on cereal products, at the doses are for both insect control and fungal disinfection. This paper examines critically the results of research in this area and estimates future research needs. (Author)


The use of irradiation for increasing the stability of fresh fruits (oranges, pomegranate) was studied with a 100Cy, 66Co source. The storage life of these fruits was prolonged when polyethylene bags were used before irradiation. With doses of 1.00 x 10^6 to 0.4 x 10^7 rep., the storage life of
maturation was increased for at least 7 d. With doses from (1.3-5.6) x 10^5 rad, chrysanth showed no decrease in organoleptic acceptability, and the possibility of controlling insects in chrysanth by radiation was indicated.

The use of radionuclides and Soreq's large 13C carbon sources for application in both industry and agriculture is reviewed. Authorization for using radiation for insect eradication in wheat has been requested.

The Israel program on the irradiation of agricultural produce is being coordinated by a committee set up by the Israel National Scientific Research Council, consisting of representatives of the Israel Atomic Energy Commission (IAEC), The Ministry of Agriculture, and the various growers and marketing associations. The programme is 3-fold: to obtain Government approval and to build a facilities (potatoes, onions), to work on local problems (apetite, pests) and on items of export importance (citrus, bananas, avocados). - A 30 000 Ci source was installed in a variable irradiation of novel design. Objects ranging from a few grams to 50 kg are treated with 20 to 5 x 10^3 rad dose at dose rates of 1.3-2.0 krad/h. For citrus, the effects of growing conditions, maturity, irradiation conditions and storage temperature were investigated. 7 x 10^6 Me/atom (Geraldi, Stapples) were released per week in a test programme. The initial 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 yielding and will probably constitute a sufficient dose for quarantine purposes.

1867 Kuru, I.A. AMBAR ZARALIKARI VE SAYASTA RADY ASTONDAN YARASLANMA VE TURK TEKE YAPILOGAÇI UYGULANMA (Grain irradiation and the pilot plant to be built in Turkey.) Ankaer Univ. Zit. Feb. VIII. 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 Kandian grain terminal. A 30 000 Ci source was installed, the irradiation unit was then set up and calibrating 10 000 rad to the grain (bulk). The dose, too low to kill in a very short time, however, protect grain against contamination by back contamination of the insect. This will be the first commercial project, and will allow a detailed study of the 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.

Irradiation facilities, present and planned, are described. The Food Irradiation and Processing Laboratory is to house a 30 000 Ci package irradiator (160 000 Ci), a 30 000 Ci portable grain irradiator (28 000 Ci) and other facilities for food processing, analytical and research laboratories. The irradiator is designed for a throughput of 100 lb/h at 50.6 rad/h, and the portable irradiator could handle 500 lb/h of grain at 15 krad. Irradiation and pest control aspects have received considerable attention at the Biology Division of the Trombay Establishment. Since a wide spectrum of insects cause damage to stored grains, detailed investigations have been carried out on the effects of irradiation on developmental stages (eggs, larvae, adult), with special reference to viability, larval mortality, sterilization dose, and the use of radionuclides in the disinfection of stored products.


The lethal effect of g-ray irradiation to (Trogoderma granarium), was insensitive to dose at 25°C. No recent temperature, or in a scale the first 64 after pupation mortality increased rapidly for quarantine purposes. To Queensland fruit fly, (Altomyia curculionoidea) and "International Co California". Applications of radiation p.

The proposed Haitian laptop irradiator are described. It contains two 25 in. high, by 10" in. wide, by 20" in. deep, and 10 in. thick, and 10 in. thick aluminum tanks. The unit is under 75 individual, double-ended one of 85 000 Ci and one of 45 000 Ci. The function of the vertical separator, lead shield is to make advantage of the source material. Mechanism in the post-type irradiator, shielding above the source.


1874 Maran, P.G., Pogisser, L. CULTURAL RESEARCH, 9.
viability, larval mortality, pupation rate and adult emergence. Considerable differences in the sterilization dose were noted among the females (8000 rad) and males (14,000 rad) of the rice blast beetle (Cercospora oryzae), a pest on wheat grain. The effective lethal dose for rice weevils of all age groups was found to be 6000 rad. The flour beetle (Tribolium castaneum), the fig moth (Ephestia cautella), and the lesser grain borer (Oryzaephilus surinamensis) appeared to be relatively resistant, the sterilizing dose being near 10,000 rad. γ-Radiation has advantages over chemical fumigation in being able to sterilize eggs as well as adult insects and in not leaving any toxic residues.


The lethal effect of γ-radiation on the developmental stages of the Queensland fruit fly, Sarcophaga bullata (Froggatt), was investigated. A dose of 60 krad or more was required to kill within 3 d all eggs and larvae treated, but a dose of 6 krad prevented the emergence of adults under normal growing conditions at 25°C. Fractionation of the total radiation dose, or of 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 1.6 krad. Resistance increased rapidly as the pupae aged. The LD 50 exceeded 50 krad for pupae 16 d old.

1066 Applications of radiation processing discussed include the control of insect infestation of foods.


The proposed Hawaiian irradiators, and the two pool-type and one dry unit, are based on a demonstration irradiation and processing irradiation and processing irradiation irradiation unit. The demonstration unit is designed for a refrigeration unit and a packaged water treatment system. One of the pool-type irradiators has a 60Co plaque positioned vertically in a rectangular well inside the bottom plate of a cylindrical tank. The cylindrical portion of the tank is 1/4 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 60Co strips. Two 60Co source loadings are considered, one of 50.66 Ci and one of 42.60 Ci. The second pool irradiator uses an inclined tunnel rather than a vertical elevator, load shielding is provided on the underside of the pool, multiple passes are employed to take advantage of "shine through," and "open" 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 dock provides shielding above the source. The irradiator uses 50 Brookhaven source strips. (USA 21 1967, 36064)


The status of γ-irradiation design for the destruction of bacteria and insects and for the initiation of chemical reactions is reported. (USA 23 1966, 36066)

A 60Co irradiation unit is described and illustrated in detail that was designed for the irradiation of a wide range of materials. The 60Co source consists of two 2 x 37 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 distances of 5 cm to 2 meters from the source. An important feature of the source arrangement is that samples can be placed close to the source by a means of a turntable, so that irradiation of small samples at a dose rate of 500,000 rad/h is possible. (NSA 50: 1956, 697)


Radio-preservation 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. Radio-sensitivity 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: 1956, 3545)


Practical studies on food irradiation fall into three categories, depending on their purpo...s (3) radiation preservation, (2) the elimination of harmful biological and biochemical factors in foods, from the point of view of public health, and (2) the utilization of the chemical effects of radiation. At present, there are about 30 IC-radiation sources of radiocobalt, and almost the same number of electron generators, including some pilot-scale irradiation facilities, such as a 34C 60Co-source in Japan. A realistic dose for grain disinfection in Japan would be in the range of 10-50 krad, judging by results obtained to date, although definite conclusions as to the appropriate dose must await further investigations as part of the new national programme. Irradiation of the soybeans and amil beans have also been studied, to control insect and microbial spoilage: somewhat higher doses, 0.1 Mrad for soybeans and 0.2-1 Mrad for the amil bean, have been recommended.


A mobile unit (Atomic Energy of Canada Ltd.) was used for determining effects of r-irradiation on six beetles, two moths, and the grain millet. Resistance of beetles and moths to radiation increased with advance in life stages. With the moths, however, the most resistant stages were the adult, egg, and hoppers, with the larvae showing least resistance. - The whole-grain and packaged-commodity irradiation in Savannah avoids calibration and subsequent operation (at the time of writing), radiation exposure to 30-50 krad upset the development of grains-infesting species. Chemical bioassay analysis of grains treated at 50 and 200 krad indicate no noticeable degradation of malation residue during a storage period of six months. - A research programme is outlined.

1678 Monson, R. APPLICATIONS OF INTENSE RADIATION SOURCES TO BIOSYNTHETIC FOOD AND MEDICAMENTS. PART III. Indu stern, 2, 11 (1964) 79-89. (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 antibacterial and antibiotic 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: 1956, 13829)

1679 O’Laughlin, G.T. CONTR (1964) 201-201.

The discovery of the Queen Elizabeth II through the use of new tools for the study of the nucleus is described, including the study of the survival of the nuclei of the positive G, S, L, E, O, but is likely to take more time, if the large scale. Mention is made

1680 Ohanone, S., Fukumura, M. FOODS AND THE CHANG... Effects on the Red Cells. Studies were made on the p...ation. The optimum dose of 0.05 x 10^10 to 100, 0 x 10^10 air or nitrogen. After irradiation, appearance, tissue, some appear...remain, beams from getting badly, thus the mold growth. A of the samples were equally characteristic properties of the result of storage. This small quantities and carbon...tion of soybeans. (NSA 18: 1966, 451)

1681 Ohanone, S., Fukumura, M. FOODS AND THE CHANGE...TT, EFFECTS ON THE RED Cells. The prevention of moldy...irradiated W 60Co gamma at film bags in an atmosphere of red. Outward sp...relations between irradiation and the...t, brown and its density increased dose of more than 4.0 x 10...10 rice was not affected for eating. A effects of irradiation on the changeable by irradiation a specific gravity, reflective six months later, but after index and the l-number dec...the baked rice in...it is preferable for...18: 1966, 451)

1682 Ugaoka, K.Y. HAWAI... CESSING. Papers presented Nov. 13-16, 1967. AID

The prospects for commercial irradiation of tropical f...

The discovery of the Queensland fruit fly in Victoria in 1964 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 release is being carried out by the C.S.I.R.O., but it is likely to prove difficult if 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.


Studies were made on the preservation of mould growth and vermin damage on red beans by γ-irradiation. The optimum dose was determined. Red beans were irradiated by 20 Co γ-rays at a dose of 0.05 x 10^6 to 100.0 x 10^6 R in about 0.5 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 0.0 x 10^6 R could not keep red beans from getting mouldy, but irradiation at 10.0 x 10^6 to 100.0 x 10^6 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. Vermiculite were not found during storage. Therefore it was desirable to irradiate red beans that contained fats in small quantities and carboxylates in large quantities at a dose of 10.0 x 10^6 to 100.0 x 10^6 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, 26868)


The preservation of mould growth and vermin damage on rice by γ-irradiation was studied. Rice was irradiated by 20 Co γ-rays at a dose of 0.0 x 10^6 to 400.0 x 10^6 R in about 0.5 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 x 10^6 R caused the colouration of yellowish brown and its density increased with irradiation dose. Vermiculite was not formed in unirradiated rice, but over 40.0 x 10^6 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, sapothallic value, and #number were almost unchanged until six months later, but after 18 months' storage, the acid value increased and both the refractive index and the #number decreased with the irradiation dose. These changes were more remarkable in the polished rice than in the unpolished one. It was concluded that the preservation of rice, it is preferable to irradiate at a dose of 10.0 x 10^6 R on unpolished rice and polish it before cooking. (NSA 19 1965, 26994)


The prospects for commercial utilization of irradiation to achieve shelf-life extension and effective disinfection of tropical fruits are very encouraging. Doses of 25 krad prevent the development
of adult fruit flies in infested fruits and retard ripening and senescence, thus improving shelf-life of papayas, mangos, and other tropical fruits. Mango seed weevils, not affected by the commercial level of fumigation for papayas, are controlled by > 65 ppm. A 4Co-source of 252-000 Ci is available, with a throughput of 4000 lb of packaged papayas/h. If, however, designed for a 500-000 Ci capacity with a max. throughput of 16000 lb/h. The system can treat semi-commercial quantities at doses from 18 to > 1000 rad, doses suitable for pasteurization or disinfection. Details of the installation, economics, and projects are given.


Some mention is made of work in process on disinfection of grain, but details of radiation of bulk grain and of packaged grain products.


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 rad ou moins); (2) traitements à doses moyennes (50 000 rad à 1 Mrad); (3) traitements à doses hautes (2 à 3.5 Mrad). Parmi les traitements à faibles doses figurent la désinfection des insectes infestant les produits alimentaires. Une dose de 5 à 10 000 rad est suffisante pour désinfecter les denrées alimentaires entourées. Dans ce cas, la Station d'Entomologie de l'État à Ghent a effectué une série d'expériences sur des calamars. La réduction de divers stades de développement de Thysanus granarius L. et de Gryphaea L. aux irradiations a été vérifiée. (En collaboration avec le C.E.C.N., une étude sur la radio-résistance des Arachnéides et des blonds, un coléoptère infestant les haricots blancs, est en cours. Des expériences analogues sont effectuées au Laboratoire de Désinfection, Rijksinstituut voor Vleescontrole, Gand, sous la direction de la professeur, Edouard Kromhout Z.


A prototype irradiator designed by Vfro Engineering Co. to handle 5000 lb/h of grain at 50 000 rad is under construction at the USDA Experiment Station, Savannah, Ga. The grain flows in a square box, through a source array consisting of doubly encapsulated strips of Co. arranged in parallel rows in a horizontal plane. The grain is kept a min. distance from any 65 Co-source by an aluminum 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 perimeters, exhausting to 1 ft in depth above and below the source plane. Thus the flux of unabsorbed photons is minimized. These factors contribute to the unusually high efficiency for this irradiator, which is expected to exceed 90%. The nuclear analysis of the product distillation was made using a modified version of an 1856-1940 programme called Fudge-2A. Flow tests were made using transparent-sliced him to determine the flow profile of a variety of grains past the grid of source rods. Appropriate flow 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.


The author lists lethal and sterilizing doses of γ-rays for various insects and their larvae which damage grain, fruit, furniture, etc. Resistance to lethal and sterilizing actions of γ-rays increases, depending upon the extent to which insects have developed from egg to larva 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 (two or more exposures to sublethal or sterilizing doses which, taken together, equalled or slightly exceeded the lethal or sterilizing 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 sterilized but not killed, with divided doses of irradiation germ-cells were invariably 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 irradiation of grain and of

1867 Radiation. N. L. GA AND EXTERMINATING #5 (See 1866)

with fractionated doses, γ-rays injected into insects were sterilized but...

1868 Rushford, F.E., PURT-L SCIENTIFIC PROGRAM... The chief irradiation facility was also available... a sterile males technique, as under investigation. Vain

1883 Rawe, D.M., Murphy, G. GRAINS AND FORAGERS... Some γ-ray irradiation facilities in grains as it is transpor... and insect control has not... interaction of γ-rays with... seed accurately and the m... material and the number c... in determining the... of these materials have no

1880 Scott, W.J. FOOD IRADIAL At food irradiation presents at Los Alamos Height. Radiat... 30 500 Ci, a fi... Dandernong near Melb by disintegrating animal hair, i... investigated at a low do... interest is concentrated on... fly Sitisma tryson, produced noticeable organ... of potatoes under Australia... irradiation of food must be... with irradiated food


In countries with adequate the growth of particular or multiplication of many p... although cosmopolitan, p... are likely to be affected b... control are desired, and... disinfection... not the dried fruit mo... and Tribolium interstinctella. Fila reproduction unimportant... goods strictly unsuitable by
stationary) equipment used for γ-irradiation. He compares the effectiveness of γ-irradiation and fumigation for grains and other agricultural products. (3A)


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


The chief irradiation facility at the PNC is an AMP pool-type research reactor: a 10000 Ci 198Co 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 (Fah.) is under investigation. Various other programmes are discussed.


Some γ-ray irradiation facilities have been built and others are planned for the eradication of insects from grains as it is transported to and from storage. The in-storage irradiation of grains for mould and insect control has not been utilized, largely because of the lack of knowledge regarding the interaction of γ-rays with grains. 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 (0.586) 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.


All food irradiation research in Australia is carried out at the A.A.E.C. Research Establishment at Lucas Heights. Irradiation sources are an on-line 198Co irradiator which soon will have a strength of 10 000 Ci, a fuel element of 100 Mev/dec., and a small Van de Graaff accelerator. At Denison near Melbourne, a very large 158Co source (30 000 Ci), operated commercially for disinfesting animal hair, will also be available for food irradiation. Presently, food preservation (investigated at a low dosage of 10 krad and at which level no organoleptic changes are detectable) is concentrated on the preservation of fruits which are often infected with the Queensland fruit fly (Bactrocera tryoni). Dosages of 10 000 rad, which are necessary to kill the insect, have not produced noticeable organoleptic changes in citrus fruits. Dosages of 8000 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.)


In countries with adequate precipitation or irrigation water and high average yearly temperature 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, poses 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 disinfection would be very useful. Amongst the serious pests of packed fruits and nuts are the dried fruit moth, Ephesia cautella, E. cautella, and the polyphagous pyralis farinalis and Phyciodes meticilla. Owing to the lack of forced dispersal during their life cycle, these pests reproduce uncontrollably in the warehouses and ship holds, and often render the expensive goods utterly unsaleable 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 Curculio beetles of cosmopolitan distribution. These beetles, as well as the Calandra granaria and ovata, 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 Cerealis capillata, the red spider, Metatateranychus ulmi and Tetranychus urticae, and the potato tuber moth Phthorimaea operculella.

1692 Tape, N. W., Ferguson, W. E. QUALITY EVALUATION OF IRRADIATED PAKISTANI RICE. Fo.


1694 Deleted.


1698 Val-Cob, M. Dol., Orwell. PRESENT STATUS IN THE V. 61p. Translation of Report; Review article, with a relat.

1699 Warten, F. L. EFFECTS OF SPECIES OF STORED-FOOD.

1700 Woodton, C. B. OPERATIONAL FOOD IRRADIATION CONTRACTORS Division of holotope Develop (First operation of the unit 6.


After three years in which pr designed and is being built in plant construction are available, making for radiation installations.
Fruit flies attack all fresh pineapples but the larvae are generally restricted to the shell and often fail to penetrate. Preliminary studies indicate that discolouration in the dose range of 50-500 rad 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 rad inhibits rooting.)


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


A mobile X-ray source was used to irradiate larvae in wheat at doses of 820 - 156 000 rad. Results are presented on (1) initial and delayed mortality; (2) fertility of survivors; (3) germination, and milling and baking tests of wheat irradiated at 15 and 19% moisture content. (Abstr.)


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

See also:

1942 Gross effects of gamma radiation on the Indian-meal moth and the Angoumois grain moth. (Cogburn, B.R. et al., 1965)

1944 Dyes and their use in the control of pests in stored products. (DeBartolo, M., 1965)

1945 Influence of radiation on the development of stored products pests. (Kohn, R.S. et al., 1965)

1946 Study of the irradiation tolerance of some destructive storage pests and technical and economic aspects of insect destruction by irradiation. (Faris, I.A., 1965)

1951 The defense department is on its third test ready to use irradiation to control insects. (Anonymous, 1967)

1957 Delt. 800 rad of irradiated fruit and its effect on storage life. (Cotton, J.H., 1965)

1959 Advances in food preservation technology with special reference to the tropics. (Dobrevsky, M.T., 1965)

1960 Applications of pest control to stored products. (Goldblatt, S.B., 1965)

1961 Latest approaches to pest control. (Gossners, W.K., 1964)

1701 Economic aspects of food irradiation programme in Israel. (Apelblat, M. et al., 1966)


2.4.3.3. Economics


After three years in which preliminary designs were prepared, a grain irradiation plant has been designed and is being built into an existing silo. From this experience, actual costs of plant construction are available for a plant using 60Co, and this experience is incorporated in estimates for machine installations for high grain throughput. Costs are compared for plants of compa-
rabble 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 user. The methods employed are explained so that they can be applied to problems of a similar nature. (Auth.)


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 1966. 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, $^{137}$Cesium or x-ray sources were considered. The survey was useful in formulating the programme for detailed technological applications for the period up to 1971. - Disinfection problems could easily be solved by incorporating irradiation sources in the flow patterns of the food 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 disinfection of cereal products at an irradiation cost of less than 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 Ceratitis capitata shows great promise here.

See also:

1483 Study of the irradiation tolerance of some destructive storage insects and technical and economic aspects of insect destruction by irradiation. (Fischer, I., 1966)
1547 Towards better insect control. (Nelson, S.O., 1966)
1634 Preservation of food by low-dose ionizing energy. (Quartermaster Research and Engineering Center, Mitch, Tenn., 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 $100,000 cuttle cestrum irradiator will begin touring the country. (Anonymous, 1966)
1643 The world's first large-scale continuous grain irradiation plant, Lobudden, Turkey. (Anonymous, 1967)
1644 Control of insects in stored grain by irradiation. (Cotswell, P.S., 1964)
1648 1 - USAEC food irradiation program. (U.S. Geological Survey, 1968)
1651 Hawaii development irradiator (HDI). (Garber, H.L., 1966)
1668 Food irradiation research and pilot facilities in operation or planned in India. (Kutara, C.S., et al., 1968)
1876 Techniques of the future for the preservation of food products in deposits. (Marinus, A., 1964)
1892 Hawaii development irradiator - a new tool in tropical fruit processing. (Higashid, K.K., 1967)
1936 Bulk-grain-irradiation design. (Rehfeld, F. et al., 1965)

2.4.3.4

1705 Caldwell, M., Higashid, (AND DATA ON ITS ECOLOGY (in Hebrew, with English summary). A heavy infestation of the insect in the life cycle of insects was obtained, at 20°C as well as 28°C, it was shown that all was affected. (Kanae, 1962, 887, 890, 892) 100°C at 1.00 (147) d, carried out to obtain addi...
2.4.3.4. Detection and Damage Assessment


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 radiography is illustrated. Preliminary work on the biology of the insect in biscuits is described, aimed at determining the use of x-rays in the study of the life cycle of insects in particular foods in stored products. As a result, the following data were obtained. at 23°C and 65±3% R.H. (1) the size of L. serricorne ranged from 0.8 mm-0.8 mm (full size), Pupae are 2.4 ± 0.3 mm (standard deviation) mm long; (2) use generation (from adult to adult) takes 38.9 ± 1.09 (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.)


The insect tunnel is considered the most significant characteristic of 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: numbers of terminal ends, parallel walls, presence of insect excreta (small patches of granular material), uniform size, definite margins, and tunnels devoid of plant tissues. Coffee beans have certain characteristics which cannot be detected by inspection. In particular, the germ, especially in slow coffee beans that have lost moisture during storage, was not detected. However, with practice a rapid radiographic analysis is feasible.


In part of the study radiography was used. Daily x-ray radiographs were made of the larval-pupal development of T. enneatoma in wheat kernels, 44 in corn, and 36 in sorghum, using a G.E. X-ray unit. Study of the series of enlarged photomicrographs made from these radiographs revealed the typical larval-pupal periods if larvae fed on germ and after emergence of the kernels. Penultimate and last larval instars, preupal, and pupa could be distinguished in radiographs. Insects with longer larval periods spent more of their period in the larval stage than in the pupal stage. These differences were significant (with 0.05 significance level) in comparison with the earlier ones. The late-developers were in the endosperm without access to the germ during the early stages.


Daily x-ray radiographs were made of 73 wheat, 44 corn, and 86 sorghum kernels. Daily x-ray radiographs revealed the length of development and behaviour of larvae and pupae of Anchylus in wheat, corn, and sorghum. Lengths of larval periods were generally associated, because time of mothing to the penultimate and last instar usually could be determined. The ranges and means of the periods of hatching to penultimate instar were 8-38 d and 14.9 d in wheat, 9-38 and 33.9 d in corn, and 9-31 and 32.9 d in sorghum: the penultimate larval period was 4-10 and 8.3 d in wheat, 3-7 and 4.7 d in corn, and 3-7 and 4.5 d in sorghum; ultimate larval period (including prepupa) 8-12 and 8.3 d in wheat, 8-10 and 7.9 d in corn, and 8-6 and 6.4 d in sorghum: pupal period 11-13 and 9.8 d in wheat, 7-10 and 6.9 d in corn, and 7-10 and 9.3 d in sorghum. Ranges and means of the overall larval-pupal periods were 20-63 and 37.9 d in wheat, 20-32 and 35.3 in corn, and 25-34 and 33.5 d in sorghum. Insects with longer developmental periods spent disproportionately more time as larvae than the insects with shorter developmental periods. (Auth.)
2.4.  Sericulture

2.4.4. Biological Control

2.10  Caudwell, C. G., Franklin, B. A., INACTIVATION BY IRADIATION OF SPORES OF Bacillus thuringiensis VAR. thuringiensis. J. invertebrate Path., 8, 2 (1968) 258-265.

Sporos of B. thuringiensis var. thuringiensis on filters or glass slides were exposed to u.v. light, \gamma\-irradiation or sunlight. All treatments had deleterious effects. Nearly 80% of the spores were inactivated by exposure for 30 min to sunlight at temperatures of 70-92°F. \gamma\-irradiation effects might explain some of the discrepancies between laboratory and field tests of biological control of pests with B. thuringiensis. (RAF-A 55: 1067, 74)


Results are presented of experiments on the influence of \gamma\-irradiation on the growth of six entomopathogenic varieties of the Bacillus cereus Group. Growth of all six varieties was inhibited in the range, 250-300 to 450-500 rad and suppressed at 600-900 rad and over. Bacillus cereus var. cereuscides was the most sensitive. Up to 500-800 rad, no modification in multiplication and crystal formation appeared; the only observable change was the time required for lytic, which increased as the dose increased. (Auth.)
2.4.6. Disease Control


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


Review of the possible use of insecticides, biomethods, repellents, attractants, and sterilization in mosquito control.


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

See also

1586 Radiacion de los escarabajos: an agent of myiasis. (Baumhover, A.H., 1966)

2.4.7. Miscellaneous


Results of laboratory and field studies are reported. They indicate that radiation-processed wood-plastic combinations (produced by applying γ-radiation from a 60Co-source to wood previously preserved 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% methacrylate), whereas impregnation with polyvinyl acetate confers considerably less resistance. (Based on RAB-68: 1967, ref. 708.)

1716 Boldyrev, M.I. Thysanoptera tibetana AND ITS ERADICATION. Izv. timiriyazeva, set. 2907.

On p.182, it is pointed out that the application of γ-rays from a 60Co-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 Thysanoptera tibetana.
Utilization of various radioisotopic devices and methods in the oil and chemical industries, Conf-64/64-12, "Symposium on Use of Radioisotopes", Warsaw, Poland, n.d., 23p.

Radiocarbonates 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-sources in hexachlorocyclohexane, which determines its triodocephal properties, and to monitor the production of Metafo.


Industrial applications of nuclear radiation in connection with some chemical processes are outlined. The production of gammaexes (CpH2Cl) by irradiation-induced chlorination and sulphotreatment of hexene by means of γ-radiation from a Co-60 source are among them.


Feed supplemented with an irradiated industrial meal including silkworm pupae administered to piglets in progressive doses (starting with 500 mg/kg body weight) stimulated their growth and development rate. The supplement administered at a 6 mg/kg level, on the average, while the average daily gain in the 2nd lot was 60-70 g, as against the control. The treatment was more efficient during winter than in summer. The test observation period showed that the gains of the 1st lot had 8-10% stronger litter (as compared with the 6-8 strong litters of the controls) and that newly born piglets registered higher birth weights. (Abstr.)


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 analyze solutions. Decreases in concentration followed a 1st-order reaction. (Abstr.)


Treated and untreated blocks of maple, birch, and white pine measured 1 in. x 1 in. x 3 in. Radiation from a Co-60 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 treatment consisted of (2) irradiated blocks impregnated with (a) vinyl acetate, (b) methyl methacrylate, and (c) 90% methacrylic acid and 10% methyl methacrylate of different ratios: (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 seed contained, was exposed to approximately 500 exterior terms. Sterilized termite, 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 weight loss time of maple blocks impregnated with vinyl acetate was almost as much as the weight loss in the irradiated and the untreated control blocks. Results of the field tests showed that methyl methacrylate stains had fewer termite attacks than the vinyl acetate stains. 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 treatments. The length of this resistance over extended periods of time is being investigated.


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

Mice were injected with bee venom dissolved in a 0.2% 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.)


Studies using the lyophilized Bulgarian royal jelly aquaporin and cystamine chloride in 380 rad irradiated with LD 90 to LD 160 (750-850 R) revealed that a dose of 0.8-1 g/kg daily for 10 d (with irradiation on day 5) protected rats more effectively than an optimal (nearly toxic) dose of cystamine: 60% survival (p < 0.05), compared with 20% for cystamine. Only 10% of the untreated controls survived. (NAR 1968, 1969)
Quantitative studies on the
of the salivary gland (1st,
interference microscopy &
manual chromosome struct-
of distal and proximal sal-
ivary gland). A new method
was characterized by its:
It was applied to labelled
of isocyanate with increasing
traction of salivary chan-
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larvae; and deamination
were found to be not much
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and interferograms. RNA was
in the bands than in interb
with the protein distribution;
could not entirely explain
to contain high levels of a
and histone component.

Electrode cytometry
END PLATES OF A VERTE
2H-dilisopropylmercuri-
motor end plate of mouse
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whose sensitivity to 2H had
end plate was calculated.
The concentration of ACs
The resolution of the techn
the nerve end bulb; hence
that at the junctional field

Influence of the
radiation sensitivity
3. ADDENDUM

3.1. TECHNIQUES

3.1.1. Autoradiography


Quantitative studies on the cytochemical and cytophysiological properties of the polytheen chromosomes of the salivary gland (1st, 2nd, and 3rd instar) of Drosophila melanogaster were undertaken using interferometry microscopy and microspectrophotometry in order to elucidate some aspects of fundamental chromosome structure. The refractive indices of nucleoplasmin, nuclei, bands and interbands of distal and proximal salivary glands and nucleoplasmin tubules of the 3rd-instar larvae were determined. A new method of automated autoradiography 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 labeled (in vivo) 3rd-instar salivary glands. A removal of the rate of incorporation of isotopes with increasing acidity was observed. Among the experiments carried out were the extraction of salivary chromosomes with DNase, and RNase; treatment of chromosomes with trypsin and papain; removal of DNA and RNA with trichloroacetic acid and perchloric acid; and denaturative and densitometric studies. RNA concentrations in the cells 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 interferometry microscopy. The data obtained from combined interferometric and microspectrophotometric studies indicated that DNA was present in both bands and interbands. DNA 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 proportionate basis with the protein distribution. It was, therefore, evident that simple swelling of the chromosomes could not entirely explain the distribution of nucleic acids and proteins. The interband regions appeared to contain high levels of non-histone proteins which were probably not directly associated with the nucleohistone component.


The accuracy of the technique was not sufficient to determine whether there was any Achase in the nerve end bulb; however, if there is any there, the concentration must be less than 1% of that at the junctional fold region. (Auth.)

See also:

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

Calibration dose-rate measurements were made above two 3 cm-diameter plane-parallel sources containing approx. 70 mCi and 750 mCi of $^{90}Sr + ^{85}Y$, respectively. The contact dose rate in the center of the 750 mCi source was 650 rad/hr and the measured dose rate at contact in the center of the 750 mCi source was 480 rad/hr. The data presented are intended to be useful in the planning of experiments for investigation of the effects of radiation on insects. (Auth.)


The decay curves were determined from measurements of the pulse rate of radioactively labelled compounds on live insects by means of a FORTRAN 7000 computer programme. The biological half-lives are then 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., Mononectes trigons L., and Coccus facialis Dall., using $^{35}S$, $^{85}Sr$, and $^{85}Y$. Water bugs Cerceris glomerata L., Cressus marginatus Ill., Gerga lanestris L.) secreted the tracers used more quickly than the bugs. For phosphate and iodide the biological half-life for bed bugs amounted to about 50 d and for water bugs to 2 d. Half of the rubidium chloride, on the other hand, was eliminated by bed bugs within 14 d.

3.1.3. Isotope Dilution

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 98: 1988, 20371R)

See also:


307 Formulation of DDT

The specific merits and the pesticide analysis are now containing Hg, As, Cl, in formation activation, paracite technique. Tracer study varieties of pesticides potential interest are available in h

1793 Buchner, J. D., Golin, J. E. Technol. 17 (1969)
A most useful application is the functioning or brownstone include DDT and toxaphene, which have been used in a mixture of Na and Mg and the activated sample. In and electronic abundance for their interaction with the measurement of residual amounts in the air.

1792 Pouey, A. LES APPLET ET ALYMENTAIRES, Bio Various potential uses of a pesticides and analysis of

1793 Pouey, A. BIOLOGIE ET ACTIVATION ANALYSIS. The general method of the radiochemical separation. Fe, Zn, Ba, Cd, Ca, Sr, I are outlined in the area of matter, pesticide residues, 2762W

1784 Golin, V.F. ACTIVATED. A review on this method of nuclear particles employing radioactive decay schemes as the speed, precision and the determination of the analyte, analysis of food, and applications i
3.1.4. Labelled Pool Technique

See:

907 Formation of tritium pools during mixing. (Leach, W. M., 1964)

3.1.5. Neutron Activation Analysis


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 activable 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 form.

1781 Buchanan, J. D., Guin, V. P. ANALYSIS OF FOODS BY NEUTRON-ACTIVATION TECHNIQUE. 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 chlorides and from other elements (particularly Na and Mg) whose activation products would tend to make NaCl in the y-ray spectrum of the activated sample. Small amounts of Na and Mg are often seen, even in the organic extracts, and electronic subtraction of their contribution to the observed y-ray spectrum is used to minimize their interference with the chlorine determination. Total fr concentration has been used as a measure of total amounts of methyl bromide in wheat, wheat products, walnuts, lentils, and spices.


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


The general method of neutron activation is outlined, including preparation of organic samples and radiochemical separation. Elements utilized in agronomy studies are Cl, Al, Na, As, W, Mo, Co, Fe, Zn, Cu, Ca, Se, Sb, Be, Se, Mo, P, Si, Al, P, 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 65:1882, 5732b)


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, y-ray spectrometry, experimental procedures, statistical considerations, the speed, precision and accuracy, sensitivity, and some of the method, and applications in the determination of C, analysis of high-purity materials for trace impurities, determination of pesticides in food, and applications in the petroleum, chemical, rubber, and plastics industries. (CA)
3.1.6. Miscellaneous (including Radiography)


A large volume 2-liter liquid scintillation detector, Scint-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 foodborne objects and live animals weighing up to 250 lb. The detector is also being used in connection with isotopes such as 45Ca, 47Ca, 58Co, 59Fe, 51Cr, 131I, 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 isocyanates, herbicides and pesticides in general, and in studying intermediary metabolism in properly labelled drugs.


Laboratory and field experiments were designed to determine the effect of insect predators on immature broods of D. brevicomis. Twenty pairs of ponderosa pine bark, each, 40 sq. in., were selected from a large number of samples from trees infested with Dendroctonus. Samples were then exposed for 30 days to the daily hourly exposure of predators and prey as possible. The bark samples were reared 4 times in 3 weeks. In the field, 8 trees containing first generation Dendroctonus broods were sampled, by removing 4-in. wide circular wedges from 4 ft up the infested hole and repeating at 10×7 intervals. A total of 865 was collected and the number of beetles and predator larvae determined radiographically for each sample. Data were presented by (graphical) and regression methods. The results indicate that predation is independent of 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 correlation of laboratory and field experiment gives confidence to the conclusion that the mean predation rate (6.261 prey/predant/day) can be used to estimate western pine beetle mortality from predation, provided temperatures remain within the 30° to 70°F range.


Results of initial investigations designed to demonstrate the feasibility of double isotope derivative dilution analysis for selected chemical residues in foods were 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 study, it was anticipated that the feasibility of radioscintillation procedures could be demonstrated and further investigations of the techniques could be stimulated. The four pesticides studied were DDT, dieldrin, syny and diazinon. A double isotope derivative dilution analysis for DDT was devised based on the trituration of DDT and added 14C-D DDT, subsequent formation of the diisodiphenyl derivative with 3H-aniline, purification of the double-labelled derivative by paper chromatography, and simultaneous counting of the 3H- and 14C-content of the derivative in a liquid scintillation spectrometer. One to 10-mg quantities of DDT were determined by using 14C-DDT and 3H-aniline of specific activity which are readily available and easily prepared. Simultaneous determination of DDE is discussed and the expected advantages of the isotope dilution technique are reviewed. Dieldrin was shown to be amenable to analysis by a double isotope derivative dilution procedure which involved derivatization of dieldrin and 14C-derivatives with 3H-acetic anhydride to form a double-labelled derivative and purification by multiple recrystallizations with carrier non-labelled dieldrin derivative. A potential that hydrosol cleavage of the corresponding sulfoxide, a reagent that can read.

1788 Boudic, J. B., Faust, M. FOR THE MEASUREMENT OF THE RADIATION TREATMENT. Isotopes 18 (1)

An improved radiation evolved 4He and the s of added radioactivity, with insects or small and experiment utilizing the...

1789 Eidevall, M. E. LIQUID ANIMAL TISSUES. AOC

A procedure using nitric acid H and C water-soft of different tissues from the... The counting efficiency is Bray's dioxane cocktail; this cocktail, increasing efficiency of 14C... (NSA 80: 1967, 586)


Females of G. moletta, yet simple case from wa a hole in the cage by we numbers of insects. Vari... density of the moths. A was needed for testing th the moth. The collector of eggs hatched determin... for the mating and max... detected and removed.

1791 Hayes, T. L., Pease, R. OF LIVING Tribhun on

The scanning electron m... at magnifications up to 1 of electron beam scans in the vacuum and the electron beam... 101 and the beam current of...

1792 Kimura, S. K. DETECTI... RAYOGRAPHY.

Fourteen species of aglets cracks or breaks in the to. by the seed coat could b... larvae of adult insects...
derivative. A potential isotope derivative procedure for synos was suggested by the demonstration that hydrolytic cleavage of the thioand thiol isomers yielded 8-hydroxyethyl sulfide and 8-mercaptoethyl sulfide, respectively, which could be derivatized with dibromomethyl chloride, a reagent that can readily be $^3$H-labeled. (Auth.)


An improved radionucldic respirometer is described which permits periodic sampling of both the evolved $^3$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 cotton tissue is discussed. (Auth.)

1730 Edesfawzi, M.E. LIQUID SCINTILLATION COUNTING OF $^1$H AND $^{14}$C COMPOUNDS IN ANIMAL TISSUES. Anal. Biochem. 27 (1968) 353-355.

A procedure using nitric acid for tissue digestion is described, which gives a high counting efficiency for $^1$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 oystercatcher, including the rat skin and reach cuticle. The counting efficiency for $^1$H ranged from 0.3 - 11% compared to 10.9% for counting $^{35}$S 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 reach muscle hardly affected the counting efficiency of $^{14}$C but $^1$H counting efficiency was reduced by increasing the amount of tissue. (NSA $1$: 1967, 829)


Females of G. molesta deposit eggs readily on waxed paper. The construction of a very satisfactory yet simple cage form 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 number of insects. Various ratios of males to females can be reared 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 $y$-radiation and disinfectants on the fertility and vitality of the moth. The collected eggs are introduced for 9 d in a warm humid atmosphere, and the number of eggs hatched determined subsequently. Optimum conditions that can be replicated are provided for the rearing and max. longevity of adults. By using transparent waxed paper dead moths could be detected and removed daily.


The scanning electron microscope has been used to produce stereoscopic pictures of living T. tubifex at magnifications up to 1200 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 at only 5.005°C but the dose rate of ionizing radiation may reach 10$^6$ rad/sec. Observations times of 1 h were tolerated. 25 keV electrons and a beam current of $10^{-7}$ A were used.

1742 Kansa, S.K. DETECTION OF MECHANICAL DAMAGE AND INTERNAL INSECTS IN SEED BY X-RAY RADIOPHOTOG. Svensk biol. Tidskr. 61, 1 (1967) 43-46. Fourteen species of agricultural seed were used. The external mechanical damage to seed (e.g., cracks or holes in the testa, etc.) as well as the internal mechanical damage (to peas encased by the seed coat) could be seen on x-ray pictures. The radiographs revealed the occurrence of larvae (for adult insects) and/or holes bored by them in the seeds. Thus, larvae of Taphrophaga grandum K. in Triticeum aestivum were clearly seen in some cases. Sometimes only the
empty coat was left. Tunnels bored into seed (Lem esculenta) by larvae of Bruchus sp. are distinctly visible. A few adults have also been seen in some cases. In Phascolus minor, many 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 C. arietinum. Larvae of different sizes (Pachnoda sp.) were visible in Vicia faba, sometimes in the same seed. Many seeds of Phaseolus vulgaris were found to contain larvae of Stenopius graemianus. 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 (Crozet rays) were used: kV = 24, mA = 10. Source 25 cm, 0 sec-exposures, with x-ray industrial film type B (CEA var. Int, Stenograph, Sweden).

1743
Korcz, J. ETUDE RADIOPHUIQUE DU TRANSIT INTESTINAL CHEZ UN TRANCHEE SUPERIEUR. Expérience 10, 1967. 520-521. (With English summary)

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Pease, B.W., Bayer, INSECTS. Science, N.

1749
Pierce, F.P., Oster, M. STUDY OF THE EFFECTS (1960) 413.

1750
Robbins, J.D., Bailey, J. DETECTOR. J. Opt. CI

A method was developed allowing for the measurement of the energy of thermal neutrons using a detector. The method is particularly useful for studies involving the interaction of neutrons with matter.

* (1962)
by larvae of Brachitus sp. are
present. In Phelopsinus niger.
larvae of Brachitus sp. Various views
in the same mod.
illuminated. Illustrations
be reliably used for detecting
advantages of the method,
out. Soft X-rays (Gratz pop)
radiation. Film type L

The principle of the instrument consists of focusing an electron beam on the surface of a specimen, the diameter of the beam, after passing through several electron lenses, being ~100 A. 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 specimen, and practical limits of resolution (in practice ~200 A for average specimen) 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 coil within remains unbroken on being placed in a vacuum. Photos are shown of the coil at the vertex of a fly's head, the compound eye of Musca domestica, and a bristle of Perebrotia miliaris at 20000 X magnification. Under suitable conditions, a more readily inspected 3-dimensional image may be obtained than in the ordinary transmission electron microscope, while using a very much smaller mean current density.

A scanning electron microscope, in which the electron current is very much lighter 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 80 min in a chamber evacuated to a pressure of 10^{-4} mm. 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 x 10^{-11} to 2 x 10^{-6} amp, at an electron energy of 20 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.

1279 Person, F. P., Opper, M. APPLICATION OF AN AUTOGRAPHIC RECORDING METHOD TO THE STUDY OF THE EFFECTS OF IRRADIATION ON Calandra granaria LARVAE. Folia Ent. 7 (1965) 26.
G. Bannai, Director of the I.N.R.A. "Laboratoire de la Physiologie acroptique à Jouy-en-Josas" has constructed an apparatus for us that enables the mouse of Calandra larva 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 been performed. Over three consecutive weeks, we have recorded the activity of a larva 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 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 version)

* (1965)

1279 Robbins, J. D., Balle, J. E. A METHOD FOR COLLECTING 14CO_2 FROM A HYDROGEN FLAME DETECTOR. J. Gas Chem. 21 (1967) 568-569.
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 CO_2-labelled compounds, such as pesticides. Gases from an enclosed flame detector are passed through
A 15-m1 pipette was used with ethanolic amide to trap $^{14}CO_2$ from labelled herbicides. Recovery of $^{14}CO_2$ was 42-68% when treated with $^{14}C$-labelled propazine (C-Clomine-6,8-dihydropropylylamino)-N-triazine uniformly ring labelled and previously passed through a column composed of 5% Carbosorb 10X or Chromotone W at 51°C with N at 30 ml/min. (CA 68:1063, 1968)

* Applicable to other herbicides. (Comp.)


Six varieties of sorghum stored for periods of 6-18 yr. were infested with fixed numbers of the rice weevil Sitophilus oryzae. The oviposition rate was measured by berbrine staining and x-ray counts, and the number of emerging adults was noted. Relative grain hardness, net storage time, influenced the reproductive rate. (Absst.)


A simple apparatus and method is described for the combustion of biological samples containing 14 Cl- labelled compounds. The samples are combusted in a mixture of zinc and sulphuric acids and the liberated chloride trapped as silver chloride, which is dissolved and counted in a scintillation counting system. With these techniques it is possible to detect chlorine-labelled compounds with specific activity of 5.02 mC in concentrations of 0.02 to 0.05 ppb in tissue. (Auth. Summary)

Talas, L. Drábek, J. Získání vhodnosti použití mikrodávkovacích prostředků pro topáním aplikace insekticídů na brosky Mandelinký bramborové. (Determination of the suitability of a microdose for topical application of insecticides to the Colorado potato beetle.) Věd. Pr. výsk. Čes. res. Výzkum o plaga. Plod. Praha - Krup. 31 (1967) 281-286. (In Czech, with Russian, German and English summaries)

The apparatus was tested for accuracy and suitability at the Central Research Institute for Plant Production in Prague-Krpany. A radioactive method was used for determining the drop size of the deposit of tricline-14Cl oil solution amounting to 6.40 x 10^-6 ml. The mean square error amounted to 1.60 x 10^-5 ml. On the 2nd day after application of the tricline oil solution cleaning movements of the beetles had transferred 18.8% of the deposit to the hind pair of legs, 14.6% to the front and central pairs, and 1.4% to the antennae. At the original place of deposit only 55.9% of the substance remained.


During a field test of lin dane 0.001 ppm to control the California flatheaded borer, Metaporia californica Van Dyke, in Jeffrey pine, Plum Jefers, and Ball, x-rayography was used to check for unma larval winter hibernation in the bark after most of the insects had emerged. An attempt was also made to identify late larval-instar mortality. Back samples 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 A x-ray film in regular packs were used. Dead larvae and pupae were easily distinguished on radiographs, and the results confirmed by dissection.

See also:

94 Control of crop insects in the blower. (Gelletty, A., 1969)
576 Distribution measurements for testing new devices of insecticide and fungicide spreading. (Belyg, W. et al., 1967)
1525 Ecological methods with particular reference to the study of insect populations. (Southwold, T. R. E., 1968)
1703 Damage to biceps caused by Lasioderma serricorne (F.) (and data on its biology as shown by radiographs). (Caldwell, M. et al., 1960)
1704 Criteria for radiographic examination of internal insect infestations. (Freeman, C. C., 1960)

1705 Laboratory mycotoxins (Oliveira, S. F. L. et al., 1967)
1706 Radiographic x-ray kernels. (Mull, A. R., 1965)

3.2. VIETNAM

1708 Blomrell, M.-H. RADI (1964-1965), International Series No. 26. Fully annotated bibliography. (Bibliographical Series) References on radiogenic rocks are given, complete indexes are given. A map of the relevant radians devoted to table, consolidating references, (2) 43.

1756 Deleted,

1797 Deduk, W. RADIOACTIVITY in a pesticide chemistry. Continuation of the latter surveys and analytical of thiophosphates and diithiophosphates and thiophosphates, nematocides substances (insecticides)

1758 Franz, I. M., Simon, I. Synopose 12, 1 (1964) Continuation of bibliography with autocatalytic measures. References in any one or earlier listings, see III/3

1759 Ingram, M. BIOLOGIC TID-3007, Division of B The 12756 references; they were collected. T) each followed by one of

1760 International Atomic Energy Agency (1964-1965). The circuitry is aimed at its included in this circuit study, 17 on the effects of radiation sterilisati
3.2. BIBLIOGRAPHIES AND GENERAL SURVEYS


3.2.2. DECEK, W. RADIOACTIVE NUKLEIDE IN DER CHEMIE DER PESTICIDE (II. Radioactive nucleides in pesticide chemistry. II.) Anorganika 15.3 (1967) 116-120. (In German)


3.2.5. INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA (Austria). INFORMATION CIRCULAR ON RADIATION TECHNIQUES AND THEIR APPLICATION TO INSECT PESTS. No. 7. WP31/1, May 1966. 48p.

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 disinfection, 21 on rearing techniques, 8 on radiation sterilization theory and application, and 88 on chemosterilants.

469
3.2.2. Surveys


Brief survey of applications in pest control. 6

6 Original not available.


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


General review. Stabilizing and lethal effects of radiations are discussed, and the data collected in two tables.
1770 Castaño, D. **IONIZING RADIATION IN APPLIED ENTOMOLOGY.** Montes 22 (1965) 159-168. (In Spanish)

A review is given of the present state of experimentation and application of radioisotopes in entomology. Studies on genetics, sterilization, 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 inherited lethal genetic characteristics, irradiation of products attacked by insects, and irradiation of plants for the production of useful mutations. (NRA 22: 1966, 10083)


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


Survey article.


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 disinfection of grains and processing of other foods, sterilization of pharmaceutical and medical supplies, remote therapy of cancer, and insect control by the sterile-male-release technique. Tracer studies include those in hydrology, fertilizer utilization, and nutrition. (Auth.)


Review of control techniques: chemical, sterilization, biocidal, and integrated means.

1775 Jenkies, D. W. **RADIOISOTOPES IN ECOLOGICAL AND BIOLOGICAL STUDIES OF AGRICULTURAL INSECTS.** AD-636695, Army Biological Labs., Frederick, Md. 1960, 30 p.

For abstract, see 11/4.

1776 Kratz, W. **ÜBER DIE VERMÖGENSVOH RADIOAKTIVEN ISOTOPEN IN DER MODERNEN BIOLOGIE.** (On the application of radioactive isotopes in modern biology.) Progr. Biol. 6 (1957) 125-130.

The survey also considers the use of radioisotopes in entomology.

1777 Ladoray, J. R. **APLICACION DE LOS RADIOISOTOPES EN ENTOMOLOGIA.** (Application of radioisotopes in entomology.) Ingenieria agron. 21 (1963) 19-25. (In Spanish)


Applications of radioisotopes in agriculture and food research are described. In South Africa, the greatest interest was shown in the possibility of preserving meat by irradiation. For this purpose, a 500-Cl Co irradiation center was installed. With this high intensity radiation, male insects are sterilized so that insect pests can be eventually eradicated.

1779 Mia, M. M. **ATOMIC ENERGY FOR AGRICULTURE.** Nucleus, Lahore 2, 1 (1965) 20-34.

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-FAO coordinated programme is also briefly discussed. (NRA 19: 1966, 20728)
Montagné, P. G. de. LES RECHERCHES FRANÇAISES EN AGRONOMIE NUCLEaire.

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 13: 1964, 879a)


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 behavior, populations, and the relation between the effects of radiation and some abiotic 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 radioecology are treated in individual sections. Proposals are made for the use of ionizing radiations in pest control in Hungary. 122 references are cited.

Nagy, B. POSSIBILITIES OF USING IONIZING RADIATION IN THE CONTROL OF INSECTS IN HUNGARY. isotherm, Tech. 10 (1965) 1-6. (in Hungarian)

The uses of ionizing radiation and radioisotopes in entomology are reviewed. Radioisotope application in the study of food dispersion, libitation, and migration of insects is considered. Techniques for eradication of insects by irradiation are compared, and the application of small doses in the sterile male technique for control of May cockchafers in Hungary is discussed. (in Hungarian)


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 tobacco fly. Insect light traps were used to control the tobacco bollworm population. Grain beetles were killed by γ-rays, radio frequency electric fields or infrared radiation without damaging effects on the nutritional qualities of the grain. The possibility of using sound and ultrasound for insect control through influencing behavior is suggested.


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


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 3,000 mutants are on file. Flow charts are given, and the program phases are described in detail. The program are written in the COBOL language with some MAP routines for the IBM 7090/7094 and 1401 computers. (NSA 21: 1967, 53077)


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

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Control of insects in food processing. Radioisotopes application. Techniques for sublethal dose in sterile insect release. (K-math)


The studies made at the Bayr. Landesanstalt für Bodenkultur, Pflanzenbau, and Pflanzenzucht 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 diseases, 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 16: 1994, 33672)


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)


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.J. et al., 1963)
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)
1263 Institut National de Génétique du Japon. (Tokio, B.G., 1967)
1301 Research activities of the association EURATOM-ITAL. (Zeewe, D. de, 1966)
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 (G. S. Atkinson); fundamentals of radiobiology, and medical applications of isotopes and radiation (H. L. Compton); fly eradication projects (J. C. Keller); neutron activation analysis (G. G. Cockroft); 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. Ball); metabolism of chlorinated hydrocarbon insecticides by insects (A. S. Perry); use of irradiated water for continuous registration of insect movement; 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. Kahl); use of radioisotopes in dispersion studies: part A = flies, part B = mosquitoes and coldroaches (H. F. Schoof); sterilization of the screw-worm fly from Southern United States (A. H. Baumhovet); laboratory and field studies of ticks labelled with radioisotopes (M. L. Emmons); chemoentrants as a potential weapon for insect control (C. N. Smith); application of chemosterilants (G. C. Lalonde); 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 Culex pipiens fatigans. Wind tagged with 14C in the Kannelorskoye Area of Rasegoa, Eanna (from WHO/Vacket Control/297.602); sterile male release studies with Protophila malagasyet (J. C. Honaker); fundamental principles of radiation-induced insect sterilization (L. E. LaChance); the effects of gamma radiation on soil (C. F. Eno); projecting laboratory rearing of insects to mass-scale forestry-type project (G. H. Fussman). Laboratory exercises were divided into metabolism of 14C in mammals in the house fly (W. W. Flagg, Jr.); the use of radioisotopes for the study of systemic insecticides in plants (D. L. Ball); laboratory exercises for studying the metabolic fate of insecticides by use of isotope-labelled compounds (A. S. Perry); laboratory exercises on insect sterilization (Lalonde, G. C., Morgan, P. B., Glancy, B. M., Meisner, D. W.); tracer experiments on uptake and social distribution of food in ants; use of radioisotopes as tracers in biological half-life in cockroaches using 14C and 3H separately; tagging adult house flies for estimation of population density by "isotope dilution" method; topical application of 3H as phosphate in water solution on the pronum 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. Kahl).

The training course was held at the United Nations, Rome, Italy. The course ended on November 6th. The course was divided into lectures given in two parts: lectures on the principles of using radioisotopes and radiotracers in entomology and laboratory exercises on the properties of radioactive tracers, and an applied part consisting of detailed laboratory exercises in the use of isotopes and radiotracers in entomology. (From the foreword)
The training course was held at the University of Florida, Gainesville from Oct. 26 - Nov. 30, 1987. Similar training courses had been held at the University of Florida in 1983 and 1986. 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. There were primarily those in the IAEA "Laboratory Manual on The Use of Isotopes and Radiation in Entomology" (see 1980). 16 countries were represented.
4. TABLES

TABLE 1. SYSTEMATIC LISTING OF INSECTS AND RELATED ARTHROPODS
<table>
<thead>
<tr>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Systematic Code</th>
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* See *Tyrophagus dimidiatum* (Herman)
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*see Tyrophagus dimidiatus (Hiernann)
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Drywood termites

Termites

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- Eastern subterranean termite
- true bugs
- giant water bugs
- bat, bed, and bird bugs
- bed bug
- coccid bugs
- grass bug
- water boarmen
- water striders
- lygaeid bugs
- peanut litter bug
- milkweed bugs
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Common Name(s):
- ants, bees, sawflies, wasps, and hornets
- bumble, carpenter, honey and social bees
- honey bee
- honey bee
- bumble bee
- bumble bee
- argid sawfly
- braconids
- stem sawfly
- wheat stem sawfly
- chalkid
- conifer sawfly
- European spruce sawfly
- Virginia pine sawfly
- jack pine sawfly
- ants
- smaller yellow ant
- carpenter ant

512
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- **Common Name:**
  - carpenter ant
  - pyramid ant
  - chief ant
  - Ichneumons
  - velvet ants
  - wall-splashing sawflies
  - sawfly
  - hornet
  - wood wasp
  - cicada killer, mud dauber, African hornet, yellow jackets, and paper wasp
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Common Name(s):
- antomyiid flies
- onion maggot
- spinach leaf miner
- house flies, stable flies, and s.
- little house fly
- tsetse fly
- horn fly
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antomyiid fly
onion maggot
spinach leaf miner
diary fly, stable fly, and allies
little house fly

testee fly
horn fly
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Common Names:
- house fly
- cabbage fly
- stable fly
- fungus gnats
- bot and warble flies
- cattle grub
- Northern cattle grub; warble gnats
- humpbacked flies
- moth flies
- sandflies
- flesh flies
- flesh fly
- black flies
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<td>2, 3, 14, 27, 587, 606, 7119, 1229, 1230, 1325, 1327, 1332, 1334, 1358, 1468, 1474, 1564-9, 1565, 1566, 1569, 1569-6, 1584-6, 1590-9, 1593-5, 1599, 1610-7, 1647, 1650, 1702</td>
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<td>Xenopityla gebithi (Bothachida)</td>
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TABLE 2. RAJ

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</table>

2 Chemical names and "o" compiled following the general Insecticides" (1966) Review in 12: 2, 1966, 381-417, and in a ibid. 12,3 (1966) 566-7. 15: 4 (3
maintained, apart from slight n index, and (ii) Letter-and-Num
2 The chemical name use clature is generally marked with
### TABLE 2. RADIOTRACER STUDIES ON INSECTICIDES

Data have been assembled in the following categories:

- **A. ACTIVATORS OR SYNERGISTS**
- **B. BOTANICALS AND DERIVATIVES**
- **C. CHLORINATED ARYL HYDROCARBONS** (containing 6 or more chlorine)
- **D. EDT RELATIVES** (dihyphen aliphatics)
- **E. FUMIGANTS**
- **N. NICOTINE ALKALOIDS** (including ANABASINE and related compounds)
- **P. PHOSPHORUS-CONTAINING COMPOUNDS**
  - **A. ALIPHATIC DERIVATIVES**
  - **C. ARYL (PHERYL) DERIVATIVES**
  - **H. HETEROCYCLIC DERIVATIVES**
- **R. CHEMOSTERILANTS**
- **X. CARBAMATES**

---

1 Chemical names and "other designations" for compounds cited in the bibliography have been compiled following the general lines of E.T. Kenaga's "Commercial and Experimental Organic Insecticides" (1963 Revision) in Bull. ent. Soc. Am. 8: 2, 1963, 87-103 and (1966 Revision) in ibid. 13: 2, 1966, 183-217, and in announcements of the Insecticide Terminology Committee published ibid. 19: 3 (1970) 356-7; 14: 4 (1975) 202, and 14: 4 (1975) 202. The chemical categories have been maintained, apart from slight modifications. Two indexes (i) Common and Manufacturers' Names Index, and (ii) Letter-Names Index have been prepared.

1 The chemical name used in accordance with the principles of Chemical Abstracts nomenclature is generally marked with an asterisk.*
### ACTIVATORS OR SYNERGISTS FOR INSECTICIDES

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<tr>
<th>Index Code</th>
<th>Chemical name</th>
<th>Other designations for chemical and its composition</th>
<th>Synthesis(α)</th>
<th>Metabolism</th>
<th>Residues</th>
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<tbody>
<tr>
<td>A.1</td>
<td>2-(2-butoxyethoxy)ethoxy)-4,5-methylene dioxy-3-propyl tolune</td>
<td>piperonyl butoxide butoxide</td>
<td>14C [896]</td>
<td>Musca domestica</td>
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<tr>
<td></td>
<td>2-(2-butoxyethoxy)ethoxy-3-propyl-piperonyl ether</td>
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<td>A.2</td>
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<td>A.4</td>
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<td>sulfoxide sulfoxide-Cide</td>
<td>14C [886]</td>
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<td>2-ethyl sulfoxide of laurafine</td>
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**α:** If no other indication

### Additional Information

- A.5: dimethyl sulfoxide
- A.6: methylenedioxyphenyl compounds
- A.7 [899, 896]
| A.5  | dimethyl sulfide       |                          |                            |                            |
| A.6  | methylenedioxybenzyl compounds |                          |                          |                            |
| A.7  | 4-allyl-1,2-methylenedioxybenzene | safrrole                 | 4-allyl-1,2-methylenedioxybenzene | 4C [896]                   |
| A.8  | 4-propyl-1,2-methylenedioxybenzene | dihydroxafeol            | 4-propyl-1,2-methylenedioxybenzene | 4C [896]                   |
| A.9  | 8-allyl-1-methoxy-2,3-methylenedioxybenzene | myristicin               | 8-allyl-1-methoxy-2,3-methylenedioxybenzene | 4C [896]                   |
| A.10 | 2,3-methylenedioxy-2-phenanthrene |                          |                            |                            |

** if no other indication.

| Muco domestica | 4C [866, 899] | 14C [896] | 15N [896] |

<p>| Muco domestica | 4C [866, 899] | 14C [896] | 15N [896] |</p>
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<th>Index Code</th>
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<th>Other designations for chemical and its compositions</th>
<th>Synthesis</th>
<th>Metabolism</th>
<th>Residues</th>
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<tbody>
<tr>
<td>B.1</td>
<td>rotanone (from plant species Derris and Lecococcus)</td>
<td>rotanone, derris, derris powder and resin</td>
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<td>Musca domestica &lt;sup&gt;MC&lt;/sup&gt; [820] inhibition sites of amylase and polyphenol A &lt;sup&gt;14C&lt;/sup&gt; [871]</td>
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<td>reaction sites respiratory chain transferable EPNH-coenzyme Q reductase &lt;sup&gt;14C&lt;/sup&gt; [872]</td>
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<td>mouse &lt;sup&gt;14C&lt;/sup&gt; [875]</td>
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<td>B.2</td>
<td>pyrethrum (principally from plant species Chrysanthemum cinaerifolium)</td>
<td>pyrethrins I &lt;sup&gt;14C&lt;/sup&gt; (natural extract) &lt;sup&gt;[851]&lt;/sup&gt;</td>
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<td>Musca domestica &lt;sup&gt;MC&lt;/sup&gt; [860] absorption of synthetic pyrethrin I &lt;sup&gt;14C&lt;/sup&gt; [862]</td>
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<td>pyrethin (principally from plant species Chrysanthemum cinnamomeum)</td>
<td>pyrethin I</td>
<td>$^{14}$C (natural enzymes)</td>
<td>Musca domestica in vivo and in vitro $^{14}$C [852] portion of synthetic pyrethin I $^{14}$C [861]</td>
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| B.3 | 2,2-dimethyl-3-(5-methylbenzyl)cyclopropanecarboxylic acid ester with 2-allyl-4-hydroxy-3-methyl-2-cyclopentene-2-one  
+ dl-2-allyl-4-hydroxy-3-methyl-2-cyclopentene-2-one esters of cis and trans dl-chrysanthemum-monomocarboxylic acid  
+ 3-allyl-2-methyl-4-oxo-2-cyclopenten-1-yl chrysanthemumate  
+ 2-allyl-4-hydroxy-3-methyl-2-cyclopentene-2-one ester of 2,2-dimethyl-3-(5-methylbenzyl)cyclopropanecarboxylic acid | alliedrin allyl homologue of cinerin I  
+ synthetic pyrethrin | Entomol. 87010 | Musca domestica products $^{14}$C [862]  
+ general studies $^{14}$C [863]  
+ general studies $^{14}$C [969] | labelled in ketol aciddi portion $^{14}$C [851] | Musca domestica in vivo and in vitro $^{14}$C [852]  
+ Metabolism $^{14}$C [849] |

| B.4 | 2,4-dimethylbenzyl 2,2-dimethyl-3-(2-methylpropyl)cyclopropanecarboxylate  
+ 2,4-dimethylbenzyl chrysanthemumate  
+ 2,4-dimethylbenzyl ester of cis trans chrysanthemumic acid | dimethrin | Entomol. 83270 | Musca domestica in vivo and in vitro $^{14}$C [852] |
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<td>- 1,2,3,4,5,6-hexachlorocyclohexane, 99% or more gamma isomer</td>
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<td>DL-2-14C-nicotine</td>
<td>34Cl (804)</td>
<td>34Cl (633)</td>
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<td>ring-labelled 14C [659, 654]</td>
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<td>methyl-labelled 14C [660, 654]</td>
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<td>C.3</td>
<td>1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane</td>
<td>clorodane; Octa-Klor; Octachlor Velsicol 1098</td>
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<td>1,2,4,5,6,7,10,10-octachloro-4,7,8-tetrahydro-4,7-endomethanoindane</td>
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<td>heptachlor Velsicol 104 $^8$-3314</td>
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<td>Compound</td>
<td>Heptachlor</td>
<td>Anopheles aegypti</td>
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<tr>
<td>oxochlordane</td>
<td>*9 1,4,5,6,7,8,8'-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene</td>
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<td>*1(2a),4,5,6,7,8,8'-heptachloro-3a(1),4,7,7a-tetrahydro-4,7-methanoindene</td>
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<td>1,4,5,6,7,10,10'-heptachloro-4,7,8,9-tetrahydro-4,7-endogenethybenzidine</td>
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<td>4,5,6,7,8,9,10,10'-heptachloro-4,7,8,9-tetrahydro-4,7-endogenethybenzidine</td>
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</tbody>
</table>

**Notes:**
- *Heptachlor:* A synthetic insecticide.
- *Anopheles aegypti:* A species of mosquito.
- *Toxaphene:* A synthetic insecticide.
- *Chlorinated camphene:* A chemical compound.
- *C.4, C.5, C.6:* Sections of the text.
- *13C, 14C:* Stable isotopes of carbon.
- *Mice, rats, rabbits:* Test subjects.
- *Dieldrin:* A chlorinated hydrocarbon pesticide.
- *Dieldrin-13C:* A labeled form of dieldrin.
- *Andrographis paniculata:* A medicinal plant.
- *Chlorophyll a:* A pigment.
- *3H, 16H:* Stable isotopes of hydrogen.
- *Honey, rapeseed oil:* Commercial products.
- *Synthesis of 3H, 16H labeled heptachlor*
<table>
<thead>
<tr>
<th>Index Code</th>
<th>Chemical name</th>
<th>Other designations for chemical and its compositions</th>
<th>Synthesis</th>
<th>Metabolism</th>
<th>Residues</th>
</tr>
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<tbody>
<tr>
<td>C.7</td>
<td>dichloro</td>
<td>decomposition products (non-metabolite) radiolysis</td>
<td>δH/δC DBA†</td>
<td>Acides aspergil (4) δH [686]</td>
<td>reduced analysis γH/δH C DBA‡ [699]</td>
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<tr>
<td></td>
<td>Hexachloroperoxycyclohexane</td>
<td>double isotope derivative dilution analysis</td>
<td>[600, 1259]</td>
<td>dihydroton movement (CNS) δNa, δCa [688]</td>
<td>forensic correlates δH [688]</td>
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*DBA = δ-acetoxy-δ-bromo-6,7-dihydrodichloro
<table>
<thead>
<tr>
<th>Oecophagus fasciatus (t) uptake</th>
<th>$^{14}$C [610]</th>
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</thead>
<tbody>
<tr>
<td>Periplaneta americana diodrin ion movement (CNS)</td>
<td>$^{32}$P, $^{32}$Ca [628]</td>
</tr>
<tr>
<td>birds</td>
<td>diodrin: steroid metabolism $^{14}$C [669]</td>
</tr>
<tr>
<td>Hela S cells</td>
<td>DDT: NA synthesis, protein synthesis $^{14}$C [633]</td>
</tr>
<tr>
<td>mouse</td>
<td>$^{14}$C [645]</td>
</tr>
<tr>
<td>rabbit</td>
<td>transport in pregnancy $^{14}$C [658]</td>
</tr>
<tr>
<td>rat</td>
<td>$^{32}$Cl [689]</td>
</tr>
<tr>
<td>$^{14}$C [646, 647, 678] distribution and elimination $^{14}$C [647]</td>
<td></td>
</tr>
<tr>
<td>toxicity</td>
<td>$^{32}$Cl [629]</td>
</tr>
<tr>
<td>fish</td>
<td>uptake $^{14}$C [629]</td>
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</table>

$^{14}$DHA = $^{6}$-acetoxy-$^{6}$-bromo-$^{4}$-dehydrosaldrin
<table>
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<th>Residues</th>
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<td>C.9</td>
<td>6,7,8,9,10-hexachloro-1,2,3,6,7,8,9,10-octahydro-1,4-endo-endu-endu-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-endo-dimethanoaptenalenone</td>
<td>endosulfan</td>
<td>mouse $^{14}$C [644] &lt;br&gt; rat $^{14}$C [644, 646]</td>
<td>$^{14}$C [644] &lt;br&gt; fish [666]</td>
<td>&lt;br&gt; endosulfan © properties antioxidation</td>
</tr>
<tr>
<td>C.V</td>
<td>Compound</td>
<td>Species</td>
<td>Rat</td>
<td>Mouse</td>
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<td>-----</td>
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<tr>
<td><em>1, 2, 3, 4, 10, 10</em>-hexachloro-6, 7-epoxy-3, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo-endo-endo-endo-endo-endo-endo-endo-dimethanonaphthalene</td>
<td>endrin</td>
<td>compound 269</td>
<td>Aeotes aegypti (4)</td>
<td>*14C [546]</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>fungi (Aspergillus niger Penicillium notatum)</td>
<td>14C [645]</td>
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</table>

<table>
<thead>
<tr>
<th>C.9</th>
<th>Compound</th>
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<th>Rat</th>
<th>Mouse</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>1, 2, 3, 4, 10, 10</em>-hexachloro-1, 5, 5a, 6, 7, 8a-octahydro-6, 8-methano-2, 4, 2-benzoic-xanthene 3-oxide</td>
<td>endrin</td>
<td>Thiodan 5 Malin BIO [546] Hoe 2071 Niagara 6462</td>
<td>fish</td>
<td>*14C [575]</td>
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<td></td>
<td></td>
<td></td>
<td>mouse</td>
<td>*14C [648]</td>
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<td></td>
<td></td>
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<td>storage and excetration</td>
<td>*14C [648]</td>
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<tr>
<td><em>1, 2, 3, 4, 5, 6, 7, 8-octachloro-3a, 7, 7</em>-octahydro-6, 7-methanophthalan</td>
<td>Teledrin SD 4402 CP-14317</td>
<td>Aeotes aegypti</td>
<td>*14C [648]</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Aspergillus niger</td>
<td>*14C [648]</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Penicillium notatum</td>
<td>*14C [648]</td>
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<td></td>
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<td>mouse</td>
<td>*14C [648]</td>
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<td></td>
<td></td>
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<td>rat</td>
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**DDT RELATIVES**

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<thead>
<tr>
<th>D.1</th>
<th>Compound</th>
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<th>Mouse</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Buopilus microplus</td>
<td>*14C [675]</td>
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**Analysis**

<p>| 1H/14C [509] |
| Insects |
| Musca domestica |
| Anopheles |</p>
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<tr>
<th>Index Code</th>
<th>Chemical name</th>
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<td>Oncopeltus fasciatus resistance</td>
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<td></td>
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<td>(018)</td>
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<td>14C [690]</td>
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<td>double isotope analysis</td>
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<td>Periplaneta americana resistance</td>
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<td>14C [890]</td>
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<td>Blattella germanica (CNS): E and S</td>
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<td>14C [637]</td>
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<td>Periplaneta americana</td>
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<td>14C [690]</td>
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<td>14C [692, 693, 694, 693, 692]</td>
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<td>Heliothis virescens (L)</td>
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<td>Heteroptera lutea</td>
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<td>14C [693]</td>
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<td>14C [696]</td>
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<td>Muca domestica</td>
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<td>DDT-resistant and substituted derivatives, comparative toxicity</td>
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<td>Oncopelus fasciatus</td>
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<td>Stegobium paniceum</td>
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<td>DDT-reversed</td>
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<td>S. ocellatus</td>
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<td>Sciomyzus calcitrans</td>
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<td>DDT: glutathione turnover</td>
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<tr>
<td>Substance</td>
<td>Method</td>
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<tr>
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<td>Synthesis, protein synthesis</td>
<td>*C [413]</td>
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<tr>
<td>Monkey</td>
<td>DDT: plasmodium metabolism</td>
<td>*H [653]</td>
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<td>Rabbit</td>
<td>Resorption and excretion</td>
<td>*C [682]</td>
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<tr>
<td>Rat</td>
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<td>DDT: protein metabolism</td>
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<td>Uptake</td>
<td>*C [629]</td>
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<td>Elimination</td>
<td>*C [609]</td>
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<td>Animals (various)</td>
<td>Blood-sucking leeches (Haemadipsa maclennani)</td>
<td>Minue (inoffens)</td>
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<td>blood-sucking leeches, &lt;br&gt;absorption and &lt;br&gt;demythiolization &lt;br&gt;$^{32}C$ [483]</td>
<td>Miscellaneous: &lt;br&gt;bacteria &lt;br&gt;$^{14}C$ [477] &lt;br&gt;yeast &lt;br&gt;dechlorination by &lt;br&gt;$^{14}C$ [642] &lt;br&gt;soil &lt;br&gt;dilution in &lt;br&gt;$^{14}C$ [663] &lt;br&gt;anaerobic degradation &lt;br&gt;in &lt;br&gt;$^{14}C$ [600] &lt;br&gt;marsh ecosystem &lt;br&gt;cycling &lt;br&gt;$^{14}C$ [601, 862] &lt;br&gt;field tests &lt;br&gt;$^{60}C$ [580]</td>
<td>Miscellaneous: &lt;br&gt;food chains &lt;br&gt;$^{14}C$ [616] &lt;br&gt;mud &lt;br&gt;$^{14}C$ [616] &lt;br&gt;soil &lt;br&gt;$^{14}C$ [616, 646] &lt;br&gt;field tests &lt;br&gt;$^{60}C$ [580]</td>
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<td>Plants: &lt;br&gt;barley &lt;br&gt;$^{14}C$ [601] &lt;br&gt;carrots &lt;br&gt;$^{14}C$ [601, 671] &lt;br&gt;potatoes &lt;br&gt;$^{14}C$ [601] &lt;br&gt;weeds &lt;br&gt;$^{60}C$ [582]</td>
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<td>D, 2</td>
<td>*1,1-dichloro-2,2-bis(p-chlorophenyl)ethane</td>
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<td>soil microorganisms &amp; ( {\text{CH}}_4 )[684]</td>
<td>carrots &amp; ( {\text{CH}}_4 )[671]</td>
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<td>isoamyl 4,4'-dichlorobenzilate</td>
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<td>Chloropropylate &amp; ( {\text{C}_2} )[670]</td>
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**FUMIGANTS**

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<tr>
<th>F, 1</th>
<th>carbon tetrachloride</th>
<th>tetrachloroethane &amp; ( {\text{C}_2} )[695]</th>
<th>rats &amp; ( {\text{CH}}_4 )[695]</th>
<th>local ambuscades &amp; ( {\text{CH}}_4 )[684]</th>
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<td>CCl(_4)</td>
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<td>F.3</td>
<td>²⁴⁷ napthalene</td>
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<td>Muca domestica, R- and S-, detoxication, M²⁴⁷ C (1944)</td>
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<td>F.4</td>
<td>²⁴⁷ sulfonyl fluoride</td>
<td>Viloxin ²⁴⁷</td>
<td>M⁵ [601]</td>
<td>insect eggs, M²⁴⁷ S [501], Schistocerca gregaria uptake and metabolism (e)</td>
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**PHOSPHORUS CONTAINING COMPOUNDS**

**ALIPHATIC DERIVATIVES**

| PA.1       | ³¹⁷ dimethyl (2,2'-trichloro-1-hydroxyethyl)-phosphonate | trichlorfen, Dipuran ²⁴⁷, Dylox ²⁴⁷, Neogus ²⁴⁷, chlorophos, Trichlorphon, Tugun, Bayer 123/69, ENT 19763 | M³ [748]  | insects absorption and metabolism, M⁵ [702] chewing, M³ [738] sucking |
|           |                                                        |                                                     | M³ [748]  |                                                                         |
|           |                                                        |                                                     | via chloral |                                                                         |
|           |                                                        |                                                     | M⁵ [618]  |                                                                         |

**Castle**

M³ [798, 796]

reception (percutaneous)

M³ [715, 784]

oral

M³ [725, 797]

excretion

M³ [798]
<table>
<thead>
<tr>
<th>PA, 2</th>
<th>Synthetic-type of compound</th>
<th>tinox</th>
<th>protective materials permeability ( ^{3}P \ [701] )</th>
<th>cattle ( ^{3}P \ [708] )</th>
<th>resepsia (percutaneous) ( ^{3}P \ [715, 784] ) (ocular) ( ^{3}P \ [700, 787] ) excretion ( ^{3}P \ [709] ) metabolites in serum ( ^{3}P \ [713] ) milk ( ^{3}P \ [760] ) veterinary medicine applications in metabolic studies ( ^{14}C \ [702] ) fungus (Fusarium sp.) ( ^{14}C \ [702] ) entero plant ( ^{14}C \ [702] )</th>
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<tr>
<td>PA, 1</td>
<td># 2,2-dichlorovinyl dimethyl phosphate, O,2-dimethyl 2,2-dichlorovinyl phosphate</td>
<td>dichlorvos Vapona (^{6}) Herbol DDVP</td>
<td>protective materials permeability ( ^{3}P \ [707] )</td>
<td>Onecopetis facultatus uptake ( ^{6} ) ( ^{14}C \ [610] )</td>
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<td>PA.3 (calc.)</td>
<td></td>
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<td>cattle polymer/insecticide as food additive</td>
<td>$	ext{^{14}C}$ [762]</td>
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<td>chicken (traces)</td>
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<td>rat</td>
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<td>absorption after oral administration $^{32}$P [852]</td>
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<td>Pseudomonas methylothera (apola maggor symbiont)</td>
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<td>PA.4</td>
<td>$d$-dimethyl phosphate, ester with $cis-3$-hydroxy-$L$-methylcrotonamide</td>
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<td>Azodan® SD 9129</td>
<td>$^{32}$C [560]</td>
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<td>dimethyl phosphate of $3$-hydroxy-$L$-methyl-$cis$-crotonamide</td>
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<td>dimethyl $L$-methyl-2-(methylcarbamoyl) vinyl phosphate, OMI</td>
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<td>Anthonomus grandis (a)</td>
<td>$^{14}$C [706] $^{32}$P [706]</td>
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<td>Heliothis virescens (45)</td>
<td>$^{14}$C [760] $^{32}$P [706]</td>
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<td>Heliothis sea (45)</td>
<td>$^{14}$C [706] $^{32}$P [706]</td>
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<td>Musca domestica (a)</td>
<td>$^{14}$C [706] $^{32}$P [706]</td>
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<td>PA. 6</td>
<td>Bidrin®</td>
<td>methoxy-labelled $^{14}$C (988)</td>
<td>cotton plant $^{14}$P (701)</td>
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<td>dimethyl phosphate, ester with 2-chloro-N,N-diethyl-3-hydroxycrotonamide</td>
<td>phosphoramidate Dimetrid® ML-97 CB-1301</td>
<td>Anthomonas gracilis $^{14}$C (702) $^{14}$P (701) Helicotrichum virescens (5) $^{14}$C (702) $^{14}$P (701) Helicotrichum ses (1) $^{14}$C (702) $^{14}$P (701) Musca domestica (A) $^{14}$C (702) $^{14}$P (701)</td>
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<td>2-chloro-2-diehydrazamoyl-1-methylvinyl dimethyl phosphate</td>
<td>$^{14}$P (702) carbonyl-labelled $^{14}$C (702) methyl-vinyl-labelled $^{14}$C (702)</td>
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<td>(cont.)</td>
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<td>PA.7</td>
<td>*O,O-dimethyl S-(ethylthio)methyl phosphorodithioate</td>
<td>phonate</td>
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<td>*O,O-dimethyl S-ethylmercaptoethyl dithiophosphate</td>
<td>Thiram®</td>
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<td>AC 3811</td>
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<td>PA.8</td>
<td>*O,O-dimethyl S-(ethylthio)ethyl phosphorodithioate</td>
<td>disulfoton</td>
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<td>DI-Systox®</td>
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<td>dihydrodiammonium Thiodemeton</td>
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<td>Bayer 19850</td>
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<td>*Ethyl mercaptooxacinate, S-ether with O,O-dimethyl phosphorodithioate</td>
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- *P [741, 745]
- *S [745]
- Metab Comb Chem Acta 279:13-14
- Metabolism
- Residues
- Kyklos 26:199-210
- Metab Comb Chem Acta 279:13-14
- Metabolism
- Residues
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<td>cattle (heifer)</td>
<td>#P [704]</td>
<td>hen numerodes elimination</td>
<td>#P [744]</td>
<td>man (liver)</td>
<td>*C [832]</td>
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| PA.11      | 0, 0-dimethyl-1-butyloxy-2, 2, 2-trichloroethyl phosphonate | dimethyl (O, O, O-trichloro-1-hydroxyethyl)-phosphonate butyrate | Butanate ENT 30582 | productive materials permeability $^{20}P$ (1985) | blood (lactating cow) $^{30}P$ (1906)  

cattle $^{30}P$ (715, 716)  
resorption (sider) $^{30}P$ (1906)  
toxicity $^{30}P$ (715)  
apples $^{30}P$ (715)  
plums $^{30}P$ (715)  
wheat $^{30}P$ (715) | blood (lactating cow) $^{30}P$ (715, 716)  
milk (cow) $^{30}P$ (715, 716)  
apples $^{30}P$ (715)  
plums $^{30}P$ (715)  
wheat $^{30}P$ (715) |
| PA.12      | 0, 0-dimethyl 2-(methylcarbamoylmethyl) phosphorodithioate | dimethoate Cygon $^{8}$  
PERFECTION $^{8}$  
Roger $^{8}$  
Roxdon $^{8}$  
AC 12880  
ENT 34650  
NC-660 | insecticidal activity $^{30}P$ (1909)  
in vivo and in vitro $^{30}P$ (1903)  
Musca domestica $^{30}P$ (787)  
-c/EPN metabolism $^{30}P$ (787)  
Oesopagus fasciatus $^{30}P$ (787) | apples $^{30}P$ (808, 789)  
apricots $^{30}P$ (789)  
cacao beans $^{30}P$ (787)  
ceaberry $^{30}P$ (789)  
grapefruit $^{30}P$ (789) |
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<th>Residues</th>
</tr>
</thead>
</table>
| PA,13     | O-tetramethylphosphorodiamidic fluoride + bis(dimethylaminomethyl)phosphorodiamidite | dimethox 
Terra Zymar 
Hanane 
Feoxon 14 | ²⁸P [748] | hops | hops leaves | ²⁸P [748] |
|           |               |                                                   |            |            |         |

**PHOSPHORUS ARYL (PHENYL) DERIVATIVES**

| PC, 1     | O,O-Dimethyl O-p-nitrophenyl phosphorothionate 
O,O-Dimethyl O-p-nitrophenyl phosphorothionate | methyl parathion 
Menox 
methyl homologue of parathion 
Nitorox 
Bayon 8-602 | Bombyx mori (2) (silkworm) | ²⁸P [748] | ²⁸P [720] |
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chile suppressa (3)</td>
<td>²⁸P [724, 733]</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Mursta domestica</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC.1</td>
<td>1</td>
<td>D, D-dimethyl D-p-nitrophenyl phosphorochloridate</td>
<td>methyl parathion</td>
<td>Bornyson mori (L) (midgut)</td>
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<tr>
<td></td>
<td></td>
<td>O, D-dimethyl D-p-nitrophenyl phosphoric acid</td>
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<td>Chilo suppressalis (L)</td>
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<tr>
<td></td>
<td></td>
<td>D, D-dimethyl D-p-nitrophenyl thiophosphate</td>
<td></td>
<td>Musca domestica</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>dimethyl p-nitrophenyl chlorophosphate</td>
<td></td>
<td>Periplaneta americana (a)</td>
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PHOSPHORUS ARYL (PHENYL) DERIVATIVES

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<thead>
<tr>
<th></th>
<th></th>
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<th>methyl homologue of parathion</th>
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<tr>
<td></td>
<td></td>
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<td>Nitrox</td>
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<td>Bayer B-661</td>
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</tbody>
</table>

bou (748)

hop leaves (748)
<table>
<thead>
<tr>
<th>Code Index</th>
<th>Chemical name</th>
<th>Other designations for chemical and its compositions</th>
<th>Synthesis</th>
<th>Metabolism</th>
<th>Residues</th>
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Note: The table contains chemical names and their toxicological information, along with synthesis and metabolisms details.
<table>
<thead>
<tr>
<th>Animal</th>
<th>Treatment</th>
<th>Reference</th>
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<tbody>
<tr>
<td>rabbit</td>
<td>14C [764]</td>
<td>fish</td>
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<td>#5 [720]</td>
<td>fish</td>
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<td></td>
<td>#5 [763, 767, 768]</td>
<td>translocation in Pseudomonas melolontha (apple maggot symbiont)</td>
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<td>#5 [764]</td>
<td>bean plant uptake, translocation, accumulation</td>
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<td>#5 [760]</td>
<td>cauliflower production monitoring</td>
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<td>#5 [780]</td>
<td>mixture of paraquat and methyl paraquat metastasis production monitoring t.l. [1717]</td>
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**Note:** The table is incomplete and contains placeholders for certain entries. The reference numbers [720] and [1717] are indicated.
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<tr>
<th>Code Index</th>
<th>Chemical name</th>
<th>Other designations for chemical and its composition</th>
<th>Synthesis</th>
<th>Metabolism</th>
<th>Residues</th>
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<tr>
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<td>dimethyl p-nitrophenyl phosphate, O,O-dimethyl O-p-nitrophenyl phosphate</td>
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<td>Sp [7858]</td>
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<td>Spoplus americana (a)</td>
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<td>Sp [7858]</td>
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<td>rat (liver homogenates)</td>
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<td>Sp [7858]</td>
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<td>cauliflower Sp [7858]</td>
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<td>PC. 5</td>
<td>2-diethyl p-nitrophenyl phosphate, O,O-diethyl O-p-nitrophenyl phosphate</td>
<td>parathion oxygen analogue of parathion Bayer E-600</td>
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<td>ear Sp [723]</td>
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<td>man Sp [723]</td>
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<td>rabbit Sp [723]</td>
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<td>rat Sp [723]</td>
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<td>PC. 6</td>
<td>2-diethyl O-p-nitrophenyl phenylphosphonothioate, ethyl p-nitrophenyl benzene thiosulfonate, O-diethyl O-p-nitrophenyl benzene phosphonothioate</td>
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<td>effect on dimethoate</td>
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<td>metabolism</td>
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<td>C. fischeri (1)</td>
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<td>effect on dimethoate</td>
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<td>guinea pig</td>
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<td>Mouse</td>
<td>Guinea Pig</td>
<td>Reference</td>
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<tr>
<td>PC. 6: + O-ethyl O-p-nitrophenyl phenylphosphonothioate</td>
<td>SPN</td>
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<td>+ p-nitrophenyl benzene thio phosphonate</td>
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<tr>
<td>+ O-ethyl O-p-nitrophenyl benzene thio phosphonate</td>
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<td>Musca domestica effect on dimethoate metabolism</td>
<td>±H [797]</td>
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<tr>
<td>Concopelar fasciatus effect on dimethoate metabolism</td>
<td>±H [797]</td>
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<td>guinea pig effect on dimethoate metabolism and toxicity</td>
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<tr>
<td>mouse effect on dimethoate metabolism and toxicity</td>
<td>±H [797]</td>
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<td>PC. 7: + O,O-dimethyl O-(4-nitro-2-tolyl) phosphorothioate</td>
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<td>+ O,O-dimethyl O-(2-methyl-6-nitrophenyl) phosphorothioate</td>
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<td>Sumitomo S-1192A</td>
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<td>Tribolium confusum (F)</td>
<td>±p [788]</td>
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<td>Blattella germanica (F)</td>
<td>±p [788]</td>
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<tr>
<td>Musca domestica</td>
<td>±p [765]</td>
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<tr>
<td>Focidion®: americana (B)</td>
<td>±p [788]</td>
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<tr>
<td>Xylobiops elaterothora (B)</td>
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<tr>
<td>mouse</td>
<td>±p [788]</td>
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<tr>
<td>rat</td>
<td>±p [788]</td>
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<tr>
<td>liver</td>
<td>±p [788]</td>
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<tr>
<td>liver homogenates</td>
<td>±p [788]</td>
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<tr>
<td>Index Code</td>
<td>Chemical name</td>
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<td>Synthesis</td>
<td>Metabolism</td>
<td>Residues</td>
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<tr>
<td>PC. 7 (cred.)</td>
<td></td>
<td></td>
<td></td>
<td>carniflour</td>
<td></td>
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<tr>
<td>PC. 8</td>
<td>( \text{O,O-dimethyl O-2,4,5-trichlorophenyl} ) phosphorothioate</td>
<td>rated ( \text{Bionex} ) ( \text{Pennclor} ) ( \text{Kwitrin} ) ( \text{Nanocit} ) ( \text{Ronadex} ) ( \text{Toludex} ) ( \text{Veocote} ) Dow ET-14 Dow ET-57</td>
<td>( \text{H}^\text{P} ) [746]</td>
<td></td>
<td>( \text{cattle (fattening cow)} ) ( \text{H}^\text{P} ) [746] ( \text{meat} ) ( \text{H}^\text{P} ) [758] ( \text{milk} ) ( \text{H}^\text{P} ) [746, 758]</td>
</tr>
<tr>
<td>PC. 9</td>
<td>( \text{O,O-dichloro-2,5 dichlorophenyl} ) ( \text{O,O-dimethyl} ) phosphorothioate ( \text{O,O-dimethyl-O-2,5-dichloro-4-bromophenyl} ) chlorophosphate ( \text{O,O-dimethyl-O-2,5-dichloro-4-bromophenyl} ) phosphorothioate</td>
<td>bromophos ( \text{ Nexon} ) S-1942 Cela S-2228</td>
<td></td>
<td>( \text{H}^\text{P} ) [706]</td>
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</tr>
<tr>
<td>PC. 10</td>
<td>( \text{O,O-4-nitro-butyly-2-chlorophenyl O-methyl} ) methylphosphoramide</td>
<td>Dowex 132 Icaral ( \text{H}^\text{P} )</td>
<td></td>
<td>( \text{meat} ) ( \text{H}^\text{P} ) [758] ( \text{milk} ) ( \text{H}^\text{P} ) [758]</td>
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</tr>
<tr>
<td>PC. 11</td>
<td>( \text{O,O-dimethyl O-[4-(methylthio)-m-tolyl]} ) phosphorothioate ( \text{O,O-dimethyl ( \text{O-[3-methyl-4-methylmercapto-phenyl]} ) phosphorothioate ( \text{O,O-dimethyl 4-(methylmercapto)-3-methylphenyl thiophosphate} )</td>
<td>Fasation BAYTEX ENTEX Lebassyid TIGUVON Bayer 96482 ENT 25540 S 1702</td>
<td></td>
<td>Climek Lociotus ( \text{H}^\text{S} ) [801] absorption ( \text{H}^\text{S} ) [801] Coleus falcatiss (f) absorption ( \text{H}^\text{S} ) [795] resistance</td>
<td></td>
</tr>
</tbody>
</table>
| PC. 10 | *O*-4-tert-buty1-2-chlorophenyl O-methyl methylphosphonamidate | Downy* 132 | Resistance* | Most milk
| PC. 11 | *O,O*-dimethyl O-[3-(methylthio)-m-coty1] phosphorothioate + O,O*-dimethyl O-(5-methyl-4-methylmercapto-phenoxy) phosphorothioate + O,O*-dimethyl O-(4-methylmercapto-5-methyl)phenyl phosphorothioate | foundation | RATTEX® ENTEX Lebaculid TIQUANON Bayer 29693 ENT 25540 S 2753 | Cimex lectularius
| PC. 12 | *O,O*-diethyl O-[m-(methylsulfony1)phenyl phosphorothioate | Dately | TERRACID®-9® fensulfothion Bayer 25141 ENT 24945 | cotton plant
<p>| PC. 13 | <em>O,O</em>-diethyl O-[2-(methylsulfony1)phenyl O,O*-dimethyl phosphorothioate | fampburs WARDEX® Fampheos CL 38923 | Oncopeltus fasciatus uptake (c) 1h [615] cattle (olf) 1h [727] polymer/insecticide as feed additive 4h [783] |</p>
<table>
<thead>
<tr>
<th>Index Code</th>
<th>Chemical name</th>
<th>Other designations for chemical and its composition</th>
<th>Synthesis</th>
<th>Metabolism</th>
<th>Residues</th>
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<tr>
<td>PC, 12</td>
<td>ethyl mercaptophenylacetate, O,O-dimethyl phosphorodithioate</td>
<td></td>
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<td>sheep</td>
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<td>ethyl ester of O,O-dimethylthiophosphoryl o-phenyl acetic acid</td>
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<td>PC, 14</td>
<td>α-ethyl mercaptophenylacetate, O,O-dimethyl phosphorodithioate</td>
<td>PAPTHERON®, Cidar®, Phenthoate BAY 5021 EMT 27268 L 56X</td>
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<td>apples</td>
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<td>ethyl ester of O,O-dimethylthiophosphoryl o-phenyl acetic acid</td>
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<td>olive oil</td>
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<td>PC, 15</td>
<td>α-methylbenzyl 3-hydroxyacetone, dimethyl phosphate</td>
<td>Criorin®, SD-3894</td>
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<td>meat</td>
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<td>dimethyl phosphate of α-methylbenzyl 3-hydroxyacetone</td>
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<td>α-methylbenzyl 3-hydroxyacetone, dimethyl phosphate</td>
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<td>PC, 16</td>
<td>2-chloro-2-(2,4-dichlorophenyl)vinyl diethyl phosphate</td>
<td>compound 472 SD-7859</td>
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<td>Musca domestica</td>
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<td>14C [898]</td>
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<td>Musca domestica</td>
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<td>after spraying</td>
<td>14C [898]</td>
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<td>dog</td>
<td>14C [727]</td>
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<td>rat 14C [727]</td>
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<tr>
<td>PC, 17</td>
<td>2-chloro-1-(2,3,5-trichlorophenyl)vinyl dimethyl phosphate</td>
<td>SD 9447</td>
<td>8-tracer of</td>
<td>Musca domestica</td>
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<td></td>
<td></td>
<td></td>
<td>14C-SD 9447 [898]</td>
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<td>Musca domestica</td>
<td>14C [798]</td>
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<td>Compound</td>
<td>Description</td>
<td>Isotopes of 1,2-13C-SD 8447</td>
<td>Heliotris zea toxicity</td>
<td>Macrothylax pli toxicity</td>
<td>Musca domestica toxicity</td>
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<td>PC.17</td>
<td>2-chloro-1-(2,3,5-trichlorophenyl)vinyl dimethyl phosphate</td>
<td>13C [737]</td>
<td>2-13C-SD 8447 [509]</td>
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<tr>
<td>PC.19</td>
<td>2-chloro-1(2',4'-dichlorophenyl)vinyl diethyl phosphate</td>
<td>13C [697]</td>
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<td>Metabolism</td>
<td>Residues</td>
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<td>O-methyl O-p-methylthiophenyl methyl-phosphonothioate</td>
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<td>cotton plant</td>
<td>soil [697]</td>
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<td>[705, 774]</td>
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**PHOSPHORUS HETEROCYCLIC DERIVATIVES**

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<th>Other designations for chemical and its compositions</th>
<th>Synthesis</th>
<th>Metabolism</th>
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<td>9-O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-y) O-Q-diethyl phosphonothioate</td>
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<td>[744]</td>
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| pH |          | arsinophenyl |          |
|    |          | Guatillon® |          |
|    |          | Cohon® |          |
|    |          | AZINPh®(methyl) |          |
|    |          | Bayer 900® |          |
|    |          | Bayer 1714® |          |
|    |          | 17/147 |          |
|    |          |          |          |

<p>|          |          | cattle |          |
|          |          | tissue |          |
|          |          | from treated forage |          |
|          |          | $^{32}$P | [721] |
|          |          | milk |          |
|          |          | $^{32}$P | [723] |</p>
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<td>5-(4,6-diamino-5-triazino-2-ydimethyl) dimethyl phosphorothioate</td>
<td>mazon&lt;br&gt;Saphir®&lt;br&gt;Saphiron&lt;br&gt;PP 178</td>
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<td>rat&lt;br&gt;$^{14}$C [703, 728]&lt;br&gt;$^{32}$P [703]&lt;br&gt;toxicity&lt;br&gt;$^{14}$C [792]&lt;br&gt;$^{32}$P [793]&lt;br&gt;plants&lt;br&gt;$^{14}$C [793]&lt;br&gt;$^{32}$P [793]</td>
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<td>R. 1</td>
<td>$^{32}$-2,2,4,4,6,6-hexakis (2-aminodihydropyrimidin-4-yl) phosphonic acid</td>
<td>apholite&lt;br&gt;ENT 20316&lt;br&gt;CM 3174&lt;br&gt;SQ 9889</td>
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<td>Musca domestica&lt;br&gt;effect on NA metabolism (8)&lt;br&gt;$^{14}$C [897]&lt;br&gt;chromosome&lt;br&gt;aberrations (species not specified)&lt;br&gt;$^{14}$C [883]&lt;br&gt;$^{32}$P [882]</td>
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<td>hexakis (2-aminodihydropyrimidin-4-yl)phosphonitrile</td>
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<td>R. 2</td>
<td>$^{32}$-(3-aminodihydropyrimidin-4-yl)phosphonic acid</td>
<td>tepa&lt;br&gt;apholoxide&lt;br&gt;AFO&lt;br&gt;ENT 24015</td>
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<td>Antabonwestern gravidia&lt;br&gt;absorption and translocation&lt;br&gt;$^{14}$C [881]&lt;br&gt;turnover&lt;br&gt;$^{14}$C [882]</td>
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<td>1,2-aziridinyl)phosphine oxide</td>
<td>tepa auroxide</td>
<td>APO</td>
<td>ENT 24935</td>
<td>Anomalous grandis absorption and translocation ¹⁴C [881] turnover ¹⁴C [882]</td>
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<td>R.3</td>
<td>2,3-aziridinyl)phosphine oxide</td>
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<td>Musca domestica effect on NA metabolism (v) ¹⁴C, ²²P [887] rat leukemia, concentration in tissue ¹⁴C [886] chromosome aberrations (species not specified) ¹⁴C [880] ²²P [883]</td>
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<td>R.4</td>
<td>hexamethylphosphoric triamide</td>
<td>hemipa</td>
<td>analysis, purification $^{14}$C [690]</td>
<td>Trichophtha ni (69) $^{14}$C [886]</td>
<td>Musca domestica $^{14}$C [874, 877] sterilization $^{14}$C [874, 877]</td>
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<td>R.6</td>
<td>triphenyltin</td>
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<td>rat $^{113}$Sn [659]</td>
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<td>Musca domestica biochemical effects (various) $^{14}$C [691]</td>
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<td>R.7</td>
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### Carbamates

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<td>X.1</td>
<td>6-Isopropoxyphenyl-methylcarbamate</td>
<td>Baygon®</td>
<td>$^{14}$C [627] carbonyl-labelled $^{14}$C [857]</td>
<td>Musca domestica $^{14}$C [871]</td>
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<td>7-Isopropoxyphenyl-methylcarbamate</td>
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| X.2 (cont.) | *4-dimethylamino-*m-tyli methylcarbamate | MATACH® aminocarb arvocarb Bayer 44946 ENT2-5704 | | NADPH₂ system
^{14}C [944, 944]
arat
^{14}C [927, 829]
| bean plant
^{14}C [829, 829]
persistent glucoside metabolites
^{14}C [829]
foliage
^{14}C [844] | rat persistence in
^{14}C [827] |
| X.2 (cont.) | *4-dimethylamino-*m-tyli methylcarbamate | MATACH® aminocarb arvocarb Bayer 44946 ENT2-5704 | | Culex pipiens quinquefasciatus resistance
^{14}C [829]
Musca domestica
^{14}C [837]
abletted taxate of oxidative metabolism
^{14}C [844]
NADPH₂ system
^{14}C [844, 944]
arat
^{14}C [927, 829, 839] | rat persistence in
^{14}C [827] |
| X.3 (cont.) | | bean plant  
\( ^{14}C \) [805, 823]  
persistent glucoside  
metabolites  
\( ^{14}C \) [830]  
foliage  
\( ^{14}C \) [804, 805]  |
|---|---|---|
| X.4 | 4-dimethylamino-5,5-xylyl methylcarbamate  
Zectran<sup>®</sup>  
Dowco 159<sup>®</sup>  
ENT 25968  
carbonyl-labelled  
\( ^{14}C \) [827, 830]  
methyl-labelled  
\( ^{14}C \) [827]  |  
Moxa domestica  
NADPH<sub>4</sub> system  
\( ^{14}C \) [845]  
rat  
\( ^{14}C \) [823, 828]  
liver microsomes  
\( ^{14}C \) [839]  
bean plant  
\( ^{14}C \) [805, 829]  
persistent glucoside  
metabolites  
\( ^{14}C \) [835]  
foliage  
\( ^{14}C \) [804, 805]  |
| X.5 | 4-1-naphthyl methylcarbamate  
1-naphthyl 2-methylcarbamate  
\( \alpha \)-napthyl 2-methylcarbamate  
carbaryl  
Sevin<sup>®</sup>  
7744  
carbonyl-labelled  
\( ^{14}C \) [827]  
methyl-labelled  
\( ^{14}C \) [827]  |  
aethylchloristerone  
inhibition  
\( ^{14}C \) [840]  
Anthosoma granatii  
\( ^{14}C \) [807, 815]  
absorption  
\( ^{14}C \) [815]  
Helobdella cer (F, A)  
\( ^{14}C \) [807]  |
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X. 6 1-dimethylcarbamoyl-3-methyl-9-pyrazolyl dimethylcarbamate
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<th>Metabolism</th>
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<td>2-dimethylcarbamoyl-9-methylpyrazolyl-(6)-dimethylcarbamate</td>
<td>Dimethiline G6-10202</td>
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<td>Mutra domestica 14C (945) Augmenta americana 14C (946)</td>
<td>cattle polyure/pesticide as feed additive 14C (955) rat 14C (927, 938) liver microsomes 14C (939) bean plant 14C (929), persistent glucoside metabolites 14C (939)</td>
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<td>X, 7</td>
<td>2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate</td>
<td>ENT 20164 NIA 10242</td>
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<td>cattle (lactating cow) 14C (941)</td>
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| X, 8       | 2-methyl-2-(methylthio) propionic acid  
2-(methylcarbamoyl) oxime  | Tomil® ENT 20000 IUC 21149                             | 2-methyl-labelled 14C (812) 3-methyl-labelled 14C (828) | Anthocarpus spinosus 14C (809, 813, 814) | Holothrix vittata (f) 14C (814) 21S (814) 31S (814) |
<p>|            |                                                   |                                                     | lact-labelled 14C (812)  | Musa domestica 14C (759, 806, 814) | Mutra domestica 14C (857) 806, 814, 857 |
|            |                                                   |                                                     | stable mix 14C (814) | cattle (lactating cow) 14C (814) | milk |</p>
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<th>2-methyl-2-(methylthio) propionaldehyde</th>
<th>Tomlin®&lt;br&gt;EC 1.1.4</th>
<th>3-methyl-labelled&lt;br&gt;(^{13}\text{C}) [912]</th>
<th>Anticodon genetic&lt;br&gt;(^{13}\text{C}) [886, 823, 814]&lt;br&gt;(^{35}\text{S}) [886, 823, 814]&lt;br&gt;Heliothis virescens (F)&lt;br&gt;(^{13}\text{C}) [914]&lt;br&gt;(^{35}\text{S}) [814]</th>
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| X: 9 | 3-(1-isopropyl-3-methyl-5-pyrazolyl)<br>dimethylcarbamate<br>3-(1-isopropyl-3-methylpyrazolyl)-<br>carbamate | IslaM®<br>EC 2.2.11 | acetylsulphate-labelled<br>\(^{13}\text{C}\) [909] | Mascota domesticus<br>NADPH<sub>4</sub> system<br>\(^{13}\text{C}\) [943]<br>rat<br>\(^{13}\text{C}\) [827, 825]<br>liver mitochondria<br>\(^{13}\text{C}\) [829]<br>bean plant<br>\(^{13}\text{C}\) [829]<br>peripheral glucoside<br>\(^{13}\text{C}\) [909] |

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<td>Banul®</td>
<td>carbonyl-labelled $^{13}$C [800, 805]</td>
<td><em>Malus domestica</em></td>
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<td>6-chloro-4,6-xylyl methylcarbamate (2)</td>
<td>Sek</td>
<td>$^{13}$C [802]</td>
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<td>2-chloro-4,6-xylyl methylcarbamate (3)</td>
<td>Upjohn U-13927</td>
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<td><em>Malus domestica</em></td>
<td>Carcass, edible portion, non-leaf</td>
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<td>benzal [b] thio-4-yl methylcarbamate</td>
<td>MCA-100</td>
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<td>Moban®</td>
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<td><em>Malus domestica</em></td>
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5.1.1. Cor
## 5. INDEXES

### 5.1. INSECTICIDE INDEXES

#### 5.1.1. Common and Manufacturers' Names Index

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