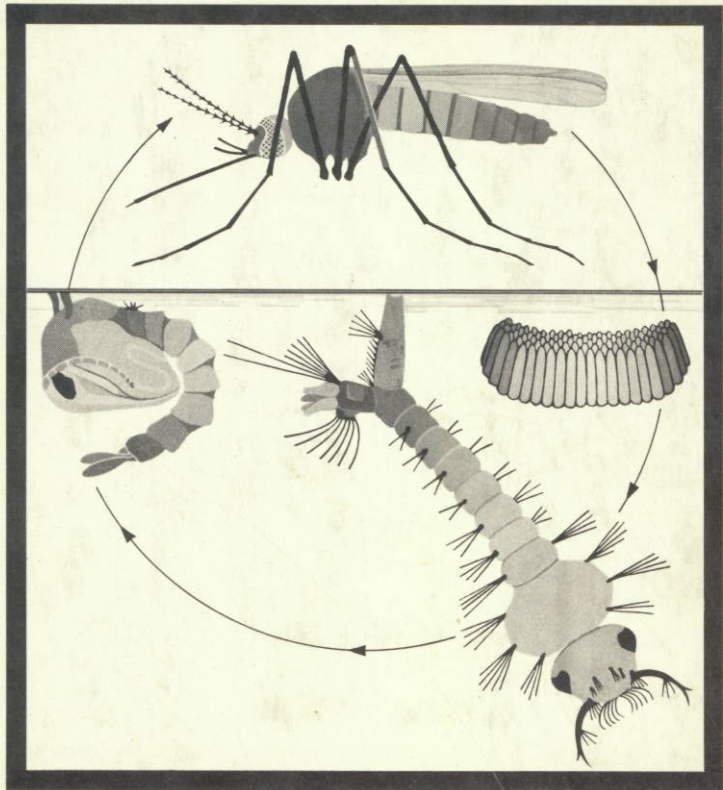


Bibliographical Series No.9



**Radioisotopes
and Ionizing Radiations
in Entomology**
Vol. I (1950-1960)



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1963

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BIBLIOGRAPHICAL SERIES

No. 9

RADIOISOTOPES
AND IONIZING RADIATIONS
IN ENTOMOLOGY

INTERNATIONAL ATOMIC ENERGY AGENCY

VIENNA 1963

BIBLIOGRAPHICAL SERIES, No. 9: RADIOISOTOPES AND IONIZING
RADIATIONS IN ENTOMOLOGY, IAEA, VIENNA, 1963
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FOREWORD
AVANT-PROPOS
ПРЕДИСЛОВИЕ
PREFACIO

This bibliography on Radioisotopes and Ionizing Radiations in Entomology is the ninth in the "Bibliographical Series" published by the International Atomic Energy Agency. Source material was obtained from the open world literature for the years 1950 to 1960, inclusive. The aim, scope and details of coverage are discussed more fully in the Introduction. No claim to completeness is made although every effort has been made to include all pertinent references that could be traced. The bibliography reflects the enormous impetus given to research into various aspects of entomology by the availability of radioisotopes and ionizing radiations. It should be of interest to the specialist in need of a survey of relevant publications in related disciplines, and to workers requiring collected references covering particular aspects of the field. The Agency intends to continue bibliographical work in entomology.

A special effort has been made to present the references in such a way that they will be of the fullest use to readers in developing countries where certain publications may not be easily available. References have therefore been supplied with abstracts. To increase the usefulness of this bibliography a detailed subject index is included, in addition to the usual author index.

The bibliography was compiled by Mrs. M. Binggeli of the Agency's Division of Scientific and Technical Information.

Readers are invited to address their suggestions and other correspondence regarding the "Bibliographical Series" to: The Director, Division of Scientific and Technical Information, International Atomic Energy Agency, Vienna I., Kärntnerring 11, Austria.

La présente bibliographie, consacrée aux radioisotopes et aux rayonnements ionisants en entomologie, est la neuvième de la collection "Bibliographies" publiée par l'Agence internationale de l'énergie atomique. Les ouvrages cités ont été choisis dans la documentation publiée dans le monde entier entre 1950 et 1960. Le but, la portée et le détail de cette bibliographie sont indiqués d'une manière plus complète dans l'introduction. Sans prétendre à une étude exhaustive, on n'a ménagé aucun effort pour citer tous les ouvrages pertinents qu'on a pu retrouver. Cette bibliographie reflète l'essor considérable de la recherche dans divers domaines de l'entomologie depuis qu'on utilise les radioisotopes et les rayonnements ionisants. Elle devrait intéresser les spécialistes qui désirent posséder une liste de publications en la matière et les chercheurs qui ont besoin de rassembler des références sur certains aspects particuliers de la recherche entomologique. L'Agence a l'intention de continuer ce travail bibliographique en entomologie.

On s'est efforcé surtout de présenter les listes d'ouvrages de telle manière que les lecteurs des pays en voie de développement, qui peuvent avoir des difficultés à se procurer certaines publications, puissent en tirer le meilleur profit. On a donc fait suivre chaque titre d'un bref résumé. Pour qu'il soit encore plus facile de consulter cette bibliographie, on a complété l'index par auteur habituel par un index détaillé par sujet.

Cette bibliographie a été établie par Mme M. Binggeli, de la Division de la documentation scientifique et technique de l'Agence.

Les lecteurs sont priés d'adresser leurs suggestions et toute la correspondance concernant la collection "Bibliographies" au Directeur de la Division de la documentation scientifique et technique, Agence internationale de l'énergie atomique, Vienna I, Kärntnerring 11, Autriche.

Библиография по вопросам использования радиоактивных изотопов и ионизирующих излучений в энтомологии является девятой в "Библиографической серии", издаваемой Международным агентством по атомной энергии. Материал, вошедший в нее, был взят из открытой литературы, опубликованной в разных странах за период с 1950 - 1960 гг. Предмет, объем и характерные особенности библиографии подробно изложены во Введении. Библиография не претендует на полноту охвата, хотя было сделано все возможное, чтобы отыскать и включить в нее все относящиеся к данной теме материалы. В библиографии отражены огромные успехи в исследовании различных областей энтомологии, стимулированном использованием радиоактивных изотопов и ионизирующих излучений. Библиография представит интерес как для специалистов, работающих в смежных с данной областью, так и для ученых, нуждающихся в подборке работ, посвященных специфическим проблемам, охватываемым настоящей библиографией. Агентство намерено продолжать библиографическую работу по энтомологии.

Особое внимание было уделено форме представления библиографических данных, с тем чтобы ученые развивающихся стран, где некоторые издания могут оказаться труднодоступными, могли извлечь наибольшую пользу из каждой приведенной ссылки. Поэтому всюду, где было возможно, библиографические данные сопровождаются аннотациями. Для увеличения ценности данной библиографии, кроме обычного авторского указателя, в нее включен также подробный предметный указатель.

Библиография составлена сотрудницей Отдела научно-технической информации Агентства г-жой М. Бинггели.

Читателей просят направлять предложения и замечания, относящиеся к "Библиографической серии", по адресу: Австрия, Вена I, Кэрнтнерринг 11, Директору Отдела научно-технической информации Международного агентства по атомной энергии.

Esta bibliografía sobre el empleo de radioisótopos y radiaciones ionizantes en entomología es la novena que edita el Organismo Internacional de Energía Atómica en su "Colección de Bibliografías". En ella se recopilan las obras de carácter no confidencial publicadas entre 1950 y 1960 inclusive. En la Introducción se describen detenidamente los fines, el alcance y los detalles de las obras recopiladas. Claro está que la bibliografía no resulta completa, aunque se ha hecho todo lo posible por recoger todas las referencias que se han podido encontrar. Pese a ello, queda perfectamente reflejado el enorme impulso adquirido por las investigaciones sobre diversos aspectos de la entomología gracias al empleo de radioisótopos y de radiaciones ionizantes. La recopilación será de interés para los especialistas que necesiten un análisis de las publicaciones importantes sobre disciplinas afines a las suyas, y para los investigadores que precisan disponer de datos bibliográficos acerca de un aspecto particular de esta esfera. El Organismo tiene la intención de continuar sus trabajos bibliográficos sobre entomología.

Se ha tratado especialmente de confeccionar y presentar la bibliografía de forma que resulte del máximo provecho para los lectores de los países en vías de desarrollo, que quizá tropiecen con dificultades para procurarse ciertas publicaciones. Por eso, con cada obra citada se da un breve resumen de su contenido. Para facilitar el empleo de esta recopilación, además del índice de autores hay un índice detallado de materias.

La bibliografía ha sido preparada por la Sra. M. Binggeli, de la División de Información Científica y Técnica del Organismo.

Se ruega a los lectores que envíen sus observaciones y toda la correspondencia relativa a la "Colección de Bibliografías" al Director de la División de Información Científica y Técnica, Organismo Internacional de Energía Atómica, Kärntnerring 11, Viena I (Austria).

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INTRODUCTION

GENERAL

A bibliographical survey on radioisotopes and radiation in entomology was initially undertaken to provide documentation for an internal study in the Division of Isotopes of the International Atomic Energy Agency. The decision to publish a fully annotated bibliography was taken subsequently, when it became clear that it would meet a real need. The present volume represents a reference work covering the 11-year period from 1950-1960. Relatively little was published before 1950 and this can easily be traced by following the references to earlier work given in some of the review articles cited. The exciting possibilities opened up by the general availability of radioisotopes for research in the field of entomology are reflected in the ever-increasing number of research reports and publications. The present bibliography will be followed up by further surveys, each dealing with a more specialized aspect, to bring the information up to date. It is intended to aid those who are interested in documentation, not only in their own particular and rapidly developing fields, but also in those border-line areas where it is often difficult to get an overall picture of research trends and achievements. Yet such an orientation may have important bearings on the specialist's own problem.

SOURCES

The bibliography was compiled from the open literature. A routine documentation search was conducted by scanning the following secondary sources:

- (a) Abstracting journals, including
 - Biological Abstracts (BA),
 - Chemical Abstracts (CA),
 - Bullétin Signalétique (BS),
 - Review of Applied Entomology, series A and B (RAE-A, -B),
 - Berichte der gesamten Biologie, Teil A (BgB-A),
 - Nuclear Science Abstracts (NSA),
 - Excerpta Medica (EM),
 - Referativnyj Zhurnal (in as far as subject indexes were available); and
- (b) Reference listings such as those in
 - Bibliography of Agriculture (B. Ag.), and
 - Agricultural Index (A. I.),which were followed up.

Among the many surveys, books and reports consulted are:

- "Annual Review of Entomology". (Steinhaus, E.A., Smith, R.F., eds.)
1-6 Palo Alto, Calif., Annual Reviews, Inc. (1956/61);
- "Advances in Pest Control Research", (Metcalf, R.L., ed.) 1-3, New York, (1957/59);
- Radiation Biology 1-3;

- Bibliography of Scientific Publications of South and Southeast Asia, UNESCO Science Cooperation Offices for S & S.E. Asia, INSDOC, N. P. L., New Delhi (1959) (1960) (1961);
- Annual Report of the Research Committee on the Applications of Artificial Radioisotopes in Japan, 1-3, Jap. Soc. for the Promotion of Science (1951/53);
- Selected abstracts of Atomic Energy Project Unclassified Report Literature in the Field of Radiation Chemistry and Bibliography of Published Literature, AERE C/R 1575 (1-6), (1958);
- Bibliographies of papers published by United Kingdom Sources on Radiobiological and Allied Subjects;
- Archiv für Geflügelzucht und Kleintierkunde: "Titel der im landwirtschaftlichen Zentralblatt 1960 referierten Arbeiten auf dem Gebiet der Kleintierzucht" (with reference to work on bees and silkworms);
- Congress and Conference Proceedings (see source references in bibliography) (including the Proc. UN Int. Conf. PUAE, 1955/58).
- Books and bibliographies (as listed in the bibliography)

Nevertheless, an essential part of the work consisted in consulting and, where necessary, abstracting original papers, reviews and reports and in following up the references cited there.

ORGANIZATION

The references within any one section have been arranged alphabetically by first author.

Whenever abstracts have not been compiled directly their source has been indicated. The length of an abstract is not a criterion for the importance of the article concerned; thus, a good review article may be dealt with very briefly. A comparative inaccessibility of the source may justify a more detailed abstract.

Some papers which, as far as could be ascertained, have only appeared as abstracts without subsequent publication in full have nevertheless been when their contents would appear of sufficient cited partially or *in toto* interest.

Some research reports of special interest have been cited and abstracted individually; when publications under the same or similar titles have appeared, reference to corresponding preceding research reports has been limited to a brief comment at the end of the particular abstract.

The bibliography has been broadly divided into two main parts: I dealing with radioisotopes, as applied in research on insects and insecticides, and II dealing with ionizing radiations in research and their possible applications. Occasionally the assigning of categories proved difficult because of a certain overlap; therefore, cross-references are freely cited throughout.

A section (III) on techniques has been included in part I on radioisotopes. Sample papers have been chosen to represent work on autoradiography, dosimetry, isotope dilution techniques, the labelled-pool technique, paper chromatography and others.

For orientation purposes, an attempt was made to head sub-sections by some introductory or survey article(s). General bibliographies and reviews are grouped together in Section IV.

Some difficulties arose in separating research on ionizing radiation effects from applications since present-day research is frequently at a pre-application stage; it may then be taken to mean here "research with a definite application

in view". This is true of the "sterile-male" technique applied to insects other than the screwworm fly as much as of radiation measures envisaged for controlling stored-products infestation.

Particular difficulties were experienced in selecting papers from the vast amount of fundamental work which has appeared on radiation effects in the field of Drosophila genetics (see I. H. Herskowitz "Bibliography on the Genetics of Drosophila", Bloomington, Indiana Univ. Press (1958) 296p.). It would have been neither possible nor justifiable to include more than a slight sampling; however, it would have been equally untenable to ignore this field. Bushland (see author index) stressed that "...anyone planning work on insect sterilization should read the publications by

Catcheside, D. G., *Advances in Genetics* 2: 271 (1958),

Lea, D., *Actions of radiations on living cells*. (Macmillan, New York, 1957),

Muller, H. J., *Cold Spring Harbor Symposia Quant. Biol.* 9: 290 (1941),

Hollaender, A., *Radiation Biology*, Vol. 1, Part 2 "High Energy Radiation" (McGraw-Hill, New York, 1955)

Bacq, Z. M. and Alexander, P., *Radiobiol. Symp.*, Liège 1954 (Butterworths Scientific Publ., London, 1955) "...".

A number of papers on genetics (Drosophila, Habrobracon, Mormoniella, mosquito and silkworm) have therefore been included. The importance of genetics research emerges clearly in connection with the sterile-male technique, and the significance of, for example, developing strains allowing sex differentiation according to egg colour for the silkworm industry, and strains with modified feeding behaviour.

Special attention needs to be paid to genetic and developmental effects incurred through radioisotope labelling, and a separate section (I:D) has been devoted to this aspect in the present bibliography.

Addendum - A special section on nematodes of agricultural interest has been included.

Appendix - An appendix has been included, consisting of tabulated summarizing data with supporting references, taken from recent review articles.

Author index - The usual alphabetical author index has been included. Authors' institutions may easily be traced by referring to the article in question, or to the abstracting journal were indicated.

Subject index - A comprehensive subject index was compiled. Alongside each entry the radioisotope or radiation used is indicated, when feasible.

ACKNOWLEDGEMENTS

Additional very useful references were also obtained through direct correspondence with scientists, among them

Professor Astaurov, Severtzov Institute of Animal
Morphology, Academy of Sciences of the USSR,
Bol'shaja Kalougeskaja

Dr. M. Legay, Maitre de Conferences, Faculté des
sciences de Lyon, Laboratoire de zoologie ex-
périmentale, 16, Quai, Claude-Bernard;

Dr. Shigematsu, The Sericultural Experiment Station,
Ministry of Agriculture and Forestry, Sugunami-ku,
Tokyo, Japan;

} on silkworm

Professor Tazima, National Institute of Genetics, Siznikaken - Mishima, Japan;	}	on silkworm
Dr. C.C. Hassett, United States Army Chemical Research and Development Labs.;		on dispersal and radiation studies of insects
Dr. D.F. Heath, Medical Research Council, Toxi- cology Research Unit, MRC Laboratories, Woodmansterne Road, Carshalton, Surrey, United Kingdom;	}	on insecticides
Dr. T. L. Hopkings, Assistant Professor of Entomology, Kansas, USA		
Professor Dr. K. Gösswald and Privatdozent Dr. W. Kloft, Institut für angewandte Zoologie der Universität Würzburg, Würzburg, Röntgenring 10. Federal Republic of Germany	}	on social insects

The compiler of this bibliography is greatly indebted to Mr. Claude H. Schmidt of the Division of Research and Isotopes for active collaboration and advice.

Very useful references and reprints have also been received from a variety of other sources, too numerous to acknowledge individually. These have all been greatly appreciated and of considerable assistance.

PART I
RADIOISOTOPES

I INSECTS

I-A Ecology

I-A-1 SURVEY ARTICLES

- 1 Ankersmit, G.W. HET MERKEN VAN INSEKTEN MET RADIOACTIEVE ISOTOPEN EN ENKELE TOEPASSINGSMOGELIJKHEDEN (Labelling of insects by radioisotopes and its possible applications). Landbouwk. Tijdschr., Groningen 70, extra no. (1958) 350-6, disc. 356-7. (In Dutch).
- A review article (20 references), Methods for labelling insects, and the doses to be applied are discussed. Dispersal and behaviour of insects, population density, and plant-insect and insect-insect relations are amongst the problems which may be studied by these techniques.
- * Asperen 1958 - [804]
- 2 Auerbach, S.I. THE SOIL ECOSYSTEM AND RADIOACTIVE WASTE DISPOSAL TO THE GROUND. Ecology 39 (1958) 522-9.
- Weighted samples of tree hole substrate containing dense and complex arthropod populations were exposed to various doses of γ -radiation from a Co^{60} source. Irradiated samples were then maintained in the laboratory at 30-d intervals up to 90 d; a series of these samples was processed through Berlese funnels to obtain the surviving arthropods. It appears from the data on Collembola and Acarina that related species can differ in their sensitivity to radiation. Evidence of predator-prey differential radiosensitivity was also obtained for 2 mite species, *Rhizoglyphus* sp. (a herbivorous, saprophagous mite) and a predator (Neoparasitidae). It was noticed as an increase in number amongst individuals of the irradiated population above control levels at around 300 r.
- * Dahm 1953 - [805]
- * Dahm 1957 - [806]
- 3 Day, M.F. APPLICATION OF ISOTOPIC TRACERS IN ENTOMOLOGICAL RESEARCH. A REVIEW. p.145-60 in "Proceedings of the Conference on Applications of Isotopes in Scientific Research, University of Melbourne August 1950". 1951.
- The author comments on the (then!) less than 30 papers which had appeared in the field during the 20-year period of 1930 to 1950. They deal with problems in pharmacology, biosynthesis, genetics, biochemistry, physiology and ecology. The isotopes mentioned are C^{14} , Na^{24} , P^{32} , S^{35} , Mn^{56} , Co^{60} , As^{74} and As^{76} , Br^{82} , Sr^{90} , Zr^{95} , I^{131} , and Ba^{140} .
- 4 Dick, W.E. RADIOACTIVE MATERIALS IN THE FIGHT AGAINST PESTS. p.74-100 in "Atomic Energy in Agriculture", Chapter 4. London, Butterworths Scientific Publications, 1957.
- Radioisotope tagging and its use in insect studies (habits, physiology, insecticide action and resistance phenomena), and applications of radiation for killing or the production of sterile males are reviewed. (Work is cited by author and year but no bibliography is included).
- 5 Dugal, L.-P. L'EMPLOI DES ISOTOPES EN BIOLOGIE. Ann. Soc. Ent. Quebec 2 (1956) 21-31.
- Après avoir touché aux principes nécessaires pour l'application des radioisotopes, l'auteur donne plusieurs exemples où les radioisotopes ont été employés avec succès: le marquage d'insectes pour étudier leurs zones de dispersion, le marquage de pucerons et d'autres insectes vecteurs de maladie des plantes par transmission de virus, bactéries, etc.

- * Haller 1956 - [410]
- 6 Hinton, H.E. RADIOACTIVE TRACERS IN ENTOMOLOGICAL RESEARCH. Sci. Progr. 42 (1954) 292-305.
A very useful review, dealing with insect physiology, insecticide metabolism and distribution, and insect tagging in dispersal and field studies. More than 100 relevant references are cited.
- 7 Jenkins, D.W. RADIOISOTOPES IN ENTOMOLOGY. p.195-229 in "Atomic Energy and Agriculture", Publication No.49. Cornar, C.L., ed. Washington, D.C., American Association for the Advancement of Science, 1957.
Review. The use of radioisotopes is discussed in studies of insect dispersal, abundance and size of insect populations, the transmission of disease, insect physiology, and the mode of action of insecticides. The biosynthesis by insects of complex radioactive chemicals from simpler tagged compounds, and the dispersal by aeroplanes of labelled insecticides are also covered. The absorption and transmission through plants of radioactive systemic insecticides, and the synthesis by plants grown in an atmosphere of $C^{14}O_2$ of various botanical insecticides, e.g. pyrethrum and nicotine, are discussed. The section on radiation effects on insects considers mutations, growth, physiology, metamorphosis, reproduction, longevity, behaviour, etc. Five tables are included. The comprehensive bibliography contains 178 references.
- 8 Lindquist, A.W. RADIOACTIVE MATERIALS IN ENTOMOLOGICAL RESEARCH. J. econ. Ent. 45 (1952) 264-70.
The possible applications of radioisotopes are reviewed, together with the nature of the problems involved, the results obtained in connection with recent research, and suggestions on how to initiate studies on the biology and control of insect pests. The need for close collaboration with other disciplines is stressed.
- 9 Lindquist, A.W. STUDIES OF INSECTS AND INSECTICIDES WITH RADIOACTIVE MATERIALS. p. 527-35 in "Proceedings of the Inter-American Symposium on the Peaceful Application of Nuclear Energy. Brookhaven National Lab., 13-17 May 1957". TID-7554, Department of Agriculture, Beltsville, Md. 1957.
Review article. Entomology is among the scientific disciplines employing radioactive materials in studies on the biology, physiology, toxicology, biosynthesis, disease transmission, and effects of radiation on reproduction, habits, longevity, and control of insects. Flight habits, dispersal distances, migrations, longevity, and population numbers have been studied with specimens tagged with radioactive materials. Results are reviewed from studies on the effects of radiation on insects and studies with radioactive insecticides. Applications in the control of insect pests are discussed. (NSA 13: 8537, 1959)
- 10 Lindquist, A.W. ENTOMOLOGICAL USES OF RADIOISOTOPES. p. 688-710 in "Radiation Biology and Medicine". Claus, W.D., ed. Reading, Mass., Addison-Wesley Publishing Co. 1958, 944p.
Review article. Application of radioisotopes to studying the biology (dispersal, flight range, etc.) of a particular pest is described, with citations from the literature. The use of radiation effects (lethal) to various insects and the practical feasibility of such measures are discussed. Further possible applications of the sterile-male technique are considered. Tracers may be used to evaluate the effectiveness of control measures, and in insect-physiology studies, in which a labelled chemical is traced during its absorption, metabolism, and excretion. A similar technique is used for tracing the course of a systemic insecticide in animal and plant tissues. Insecticide residue hazards may also be evaluated. (57 references)
- 11 Russel, S.R., Middleton, L.J. USE OF RADIOACTIVE ISOTOPES IN THE STUDY OF CERTAIN AGRICULTURAL PROBLEMS. p.75-86 in "Progress in Nuclear Energy. Series 6: Biological Sciences". Bugher, J.C., Coursaget, J., Loutit, J.F., eds. London, Pergamon Press, Ltd. 1956, 205p.
Various types of applications are reviewed such as in insect migration studies. The investigations described range from studies on the dispersal of populations of mosquitoes, locusts, blackflies, grasshoppers and pine weevils to that of the movement of individual cutworms and wireworms in the soil. Automatic recording equipment has been designed for the latter purpose. The dispersal of pollen, also by insects, is discussed. Eradication of insect pests by sterilization with γ -radiation is described.

- 12 Spinks, J.W.T. STUDIES OF SPECIAL PROBLEMS IN AGRICULTURE AND SILVICULTURE BY THE USE OF RADIOISOTOPES. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.8/P/10. 12 (1956) 75-86.

In tracer studies of insect dispersal and behaviour, insects were tagged with a suitable radioactive tracer, released, and followed by means of a suitable radiation detector. The tracer needs to be easily applicable, have a minimal effect on the insect, be easily recognized, persistent, possess a suitable half-life and be readily available. Experiments on mosquitoes, blackflies, grasshoppers, wireworms and cutworms are described, together with appropriate references. A method for the automatic plotting of the position of a tagged insect is discussed, including a block diagram, and a schematic diagram for interaction of a sensing-element carriage unit of the automatic following device. Work on the white-pine weevil is mentioned.

- 13 Шура-Бура, Б.Л. ПРИМЕНЕНИЕ МЕЧЕННЫХ АТОМОВ В ЭНТОМОЛОГИИ. Усп. совр. Биол. 44, 1 (1957) 103-20.

Обзор экспериментальных данных, охватывающих применение меченых атомов в экологии, при изучении переноса возбудителей инфекции, в физиологических исследованиях, в токсикологических исследованиях инсектицидов; затрагиваются также вопросы влияния радиации на насекомых и применения ионизирующих излучений для борьбы с насекомыми. Обзор содержит значительную библиографию, 32 ссылки которой относятся к Советским работам за период с 1950 до 1960 гг.

Shura-Bura, B.L. THE APPLICATION OF TRACER ELEMENTS IN ENTOMOLOGY. Adv. mod. Biol. 44, 1 (1957) 103-20 (In Russian).

A review of experimental data covering the application of tracer methodology to basic and practical aspects of entomology (ecology, disease vectors, physiology, toxicology of insecticides, radiation effects on insects, and applications of ionizing radiations in insect control). The review contains a comprehensive bibliography, including 32 references to Soviet sources relevant to the present bibliography.

- 14 Spinks, J.W.T. NUCLEAR ENERGY IN AGRICULTURE AND BIOLOGY. "38th Annual Meeting and Convention of the Agricultural Institute of Canada, Acadia University, Wolfville, N.S. 24 June 1958".

Some reference works are cited, followed by a survey of relevant work in progress in the various laboratories of the Department of Agriculture, and of a number of universities. Work on bees, insect nutrition, the amino acid metabolism of the blowfly and others, P^{32} in predator studies, and others using radiotracers are cited; also some Canadian publications that have appeared so far.

- 15 Hassett, C.C. ARMY ENTOMOLOGISTS FIND NEW USES FOR RADIOACTIVE ISOTOPES. Armed Forces Chem. J. 10, 1 (1956) 12.

The use of C^{14} - and P^{32} -labelled compounds is described briefly.

- 16 Huque, H. INSECTS TAGGING WITH RADIOISOTOPES. Pakistan J. Sci. 12, 3 (1960) 135-6.

- 17 Kips, R.H., Brande, J. van den RADIOACTIVE RAYS AND RADIOACTIVE ISOTOPES IN APPLIED ENTOMOLOGY AND PHYTOPHARMACY. Land- en Tuinbouw Jaarb. 13 (1958/59) 143-8. (In Flemish)
Review article.

- 18 Nichev, L. INSECT MARKING WITH RADIO ISOTOPES. Priroda (Sofia) 5, 4 (1956) 61-2. (In Bulgarian)

- 19 Pendleton, R.C. USES OF MARKING ANIMALS IN ECOLOGICAL STUDIES: LABELING ANIMALS WITH RADIOISOTOPES. Ecology 37 (1956) 686-9.

Applications of radioisotope labelling are reviewed, including their usefulness, hazards, cost, and the choice of isotope to be made for a particular study. One section is devoted to work on insects. The author warns against indiscriminate use of radiotracers. Literature references cite work after 1945.

I-A-2 BEHAVIOUR

1-A-2-a FEEDING

- 20 Plichet, A. LE MARQUAGE DES INSECTES À L'AIDE DES RADIO-ISOTOPES. *Pr. méd.* 64 (1958) 824.
Une indication très brève du genre de recherches entreprises et des possibilités diverses pour l'avenir.

* Jenkins and Hassett 1950 - [808]

Aphids

- 21 Banks, C.J., Nixon, H.L. EFFECTS OF THE ANT, *LASIUS NIGER* L., ON THE FEEDING AND EXCRETION OF THE BEAN APHID, *APHIS FABAE* SCOP. *J. expt. Biol.* 35,4 (1958) 703-11.

Bean plants (*Vicia faba*) on which groups of *A. fabae* nymphs were feeding, were made radioactive by growing them in water culture with P^{32} added, so that the aphids took up the isotope and excreted it in their honeydew. The radioactivity of the honeydew taken from them by attendant *Lasius niger* was then compared with that of the honeydew excreted concurrently by unattended control aphids on separate plants. By increasing their uptake of plant sap the ant-attended aphids produced twice as much radioactivity in their excreta as did the ant-free aphids. The aphids directly control their rates of excretion and feeding, which are not determined solely by forces within the plant. The aphid apparently controls its feeding by the "sucking pump" in its head. It is suggested that the pump is normally closed but that periodically it opens to admit sap into its lumen and then closes ventrally to force the ingested sap into the stomach. During normal feeding the pump probably opens and closes at regular intervals; but when the aphid is ant-attended it could operate more frequently so as to force sap into the stomach more often. The uptake of sap by normally feeding aphids is apparently not continuous. (from auth. summary)

- 22 Banks, C.J., Nixon, H.L. THE FEEDING AND EXCRETION RATES OF *APHIS FABAE* SCOP. ON *VICIA FABAE* L. *Ent. exp. et appl.* 2 (1958) 77-81.

The feeding and excretion rates of nymphs of *A. fabae*, feeding on young leaves of *Vicia faba*, were studied, using host plants grown in water culture and made radioactive with P^{32} . The amounts of sap ingested at first were small but the rate of ingestion increased rapidly between 12 and 16 h. The maximum rate of feeding was estimated at 0.2 mg sap/h, an uptake of 53% of the mean body weight of the insects per hour. The results are discussed in relation to other recent work on aphid feeding and excretion. (auth.)

- 23 Day, M.F., Irzykiewicz, H. FEEDING BEHAVIOUR OF THE APHIDS *MYZUS PERSICAE* AND *BREVICORYNE BRASSICAE*, STUDIED WITH RADIOPHOSPHORUS. *Aust. J. biol. Sci.* 6, 1 (1953) 98-108.

The volume of material ingested and excreted by *Myzus persicae* (Sulz.) and *Brevicoryne brassicae* (L.) was measured by feeding apterae on sucrose solutions containing P^{32} as disodium hydrogen phosphate or sodium dihydrogen phosphate through a plastic membrane or on isolated leaves of *Brassica chinensis* standing in a solution containing it. *Myzus* ingested approximately 0.07 mg plant material in one hour, and *Brevicoryne* less than one-twentieth of that amount. The results are discussed with reference to those obtained by other workers with *M. persicae* and *Orosius argentatus* (Evans) and to the mechanism by which aphids transmit plant viruses. Non-persistent viruses can be transmitted within a feeding period of 2 min, but in the present work no ingestion occurred so soon after insertion of the stylets. Short periods of starvation increase the amount ingested by *Orosius*, but not by *Myzus*. The long feeding period required for the latter to ingest enough material for accurate measurement may vitiate the effects of starvation, but it seems likely that the effect of starvation on the ability of aphids to transmit non-persistent viruses may be due to factors other than the amount subsequently ingested. This summary is largely based on that of the authors.

- 24 Henning, E. UNTERSUCHUNGEN AM SAUGAKT VON *APHIS FABAE* SCOP. MIT P^{32} (P^{32} Studies on the suction process in *Aphis fabae* Scop.). *Naturwissenschaften* 46,12 (1959) 410-1. (In German)

Young test plants of *Vicia faba* L. were made radioactive by placing them in a neutral P^{32} -solution (specific activity 16 mc/ml). Wingless virgins of *A. fabae* Scop. were placed on the plants and tested for individual radioactivity after various "sucking" periods and penetrations. It would appear that the phloem is the only source of nourishment. The duration of a feeding puncture is no evidence of whether suction has actually taken place or, if so, for how long it had continued. Radioactivity could usually only be detected once the *Aphis* had definitely settled down in one spot. The insects became radioactive on an average 25-60 min after the puncture.

- 25 Kloft, W. UNTERSUCHUNGEN ÜBER PFLANZENSUGENDE INSEKTEN UND REAKTIONEN DES WIRTS-PFLANZENGEWEBES (Studies on plant-sucking insects and the reactions of the plant host-tissue). Ber. phys.-med. Ges. Würzburg 68 (1956-57) 64-72. (In German)
- A preliminary note reports on results obtained with radioactively labelled aphids on the mechanism of secretion and the distribution of saliva. Results are presented in more detail in Z. angew. Entomol. 45 (1960) 337-81 and ibid. 46 (1960) 42-70.
- 26 Kloft, W., Ehrhardt, P. UNTERSUCHUNGEN ÜBER SAUGTÄTIGKEIT UND SCHADWIRKUNG DER SITKAFICHTENLAUS LIOSOMAPHIS ABIETINA (WALK.) (NEOMYZAPHIS ABIETINA WALK.) (Studies on the sucking activity and damaging effects of the Sitka spruce louse *Liosomaphis abietina* (Walk.) (*Neomyzaphis abietina* Walk.)) Phytopathologische Z. 35 (1959) 401-10. (In German)
- After dealing with the laboratory rearing of *L. abietina*, sucking behaviour and sucking effects on larch tissue, the authors describe work on the secretion and composition of the saliva. *L. abietina* was labelled with P^{32} by placing them on larch branches stood in a $Na_2P^{32}O_4$ solution (specific activity 1 mc/ml). Maximum activity was reached after 24 h and radioactivity could subsequently be transferred by lice allowed to suck non-radioactive needles. Measurements indicated that the mechanism of saliva excretion is similar to that observed for *Myzus ascalonicus*, i.e., a phloem-sucker. In order to investigate the influence of sucking on the metabolism and physiology of the needles, variously damaged needles were placed in a P^{32} -labelled solution. Autoradiography showed that much less P^{32} was deposited in regions of chlorotic spots than in undamaged portions.
- 27 Kloft, W. WECHSELWIRKUNGEN ZWISCHEN PFLANZENSUGENDEN INSEKTEN UND DEN VON IHNEN BESOGENEN PFLANZENGEWEBEN. TEIL I & II (Exchange reactions between plant-sucking insects and host-tissues of the plant. Part I and Part II). Z. angew. Ent. 45 (1960) 337-81 Part I and Z. angew. Ent. 46 (1960) 42-70 Part II. (Habilitationsschrift, Würzburg). (In German)
- An investigation by means of plant physiological methods was made into the reaction of plant tissue to the penetration by and feeding of plant lice. Results showed that spontaneous primary reactions and long term secondary reactions must be distinguished. Data on the mechanism of saliva secretion was found by the use of a tracer, P^{32} . In phloem-feeding aphids (*Myzus ascalonicus* Donc.), saliva is secreted only with insertion (6-8 min) and retraction of the styles, and not in the intervening time no matter how long the insect may feed. In contrast to this, parenchyma-feeders secrete more or less continuously and the fundamental differences between the two types of feeding are discussed fully. The mutual effects on plant and aphid, with a parenchyma-feeding species, are illustrated by histochemical and physiological methods. The spread of saliva in the plant is described in detail, using autoradiographic and x-ray techniques. Distribution occurs preferentially along veins of the leaf. On heavy infestation the saliva is distributed uniformly over the entire leaf surface.
- 28 Kloft, W., Kunkel, H. EINBLICKE IN DIE SPEICHEL AUSSCHÜTTUNG BEI MYZUS ASCALONICUS DONC. MIT HILFE DER TRACER-METHODIK (Aspects of saliva release by *Myzus ascalonicus* Donc., elucidated by means of the tracer technique). p. 746-9 (disc. p. 749) In "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol. 1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Söhne. 1962. (In German)
- The course of saliva injection was followed by means of P^{32} -labelled aphids (see Kloft, earlier work, publ. 1960). The increase in radioactivity of aphids on radioactive *Allium schoenoprasum* L. was measured in terms of the time elapsed from the penetration of the mandibles into the plant. Within 10 min, 5-10% of the aphids already showed appreciable activity. Several hours are required, however, before all pricking aphids show increased radioactivity, thus indicating that they have reached the phloem, and that food uptake has actually started. The interval was measured between tracer uptake via food taken from the plant, and its elimination after resorption by the intestines or by resecretion from the salivary gland. Results are discussed in their bearings on the transmission of plant diseases (virus) by sucking insects.
- 29 Lawson, F.R., Lucas, G.B., Hall, N.S. TRANSLOCATION OF RADIOACTIVE PHOSPHORUS INJECTED BY THE GREEN PEACH APHID INTO TOBACCO PLANTS. J. econ. Ent. 47, 5 (1954) 749-52.
- Myzus persicae* (Sulz.) has recently become an important pest of tobacco in the United States, not only excreting honeydew on which sooty moulds develop but also causing yellowing and stunting of the leaves on which it feeds. In experiments carried out in N. Carolina in 1951, P^{32} was used to determine whether

the substances injected by this aphid into living plants are translocated. Aphids that fed on tobacco plants growing in soil treated with an aqueous solution of radioactive phosphoric acid became radioactive, and the tracer was found in their honeydew. It was also found in leaves on which the aphids had fed, into which it was probably injected with the salivary secretions. The P^{32} introduced into the leaf by the aphid was translocated to other parts of the plant, and part of the injury to tobacco caused by *M. persicae* may thus be due to translocation of injected salivary secretions. (RAE-A 43: 308, 1955)

- 30 Pendleton, R. C., Grundmann, A. W. USE OF P^{32} IN TRACING SOME INSECT-PLANT RELATIONSHIPS OF THE THISTLE, *CIRSium UNDULATUM*. *Ecology* 35 (1954) 187-91.

The thistle plant was labelled by placing a solution containing P^{32} in a hollow cut into the pith of the main stem. The amount of uptake of P^{32} from the plant by aphids, *Anuraphis* sp., ants, and other insects was measured. The series of transfers of P, and the level of labelling of various insects was noted. The accumulation of radioactivity in predators in units roughly equivalent to the average radioactive level of the prey was observed and termed "unit predation concentration". The status of several insects was determined by using unit predation concentration to identify their activities. (BA 30: 7027, 1956)

- 31 Watson, M. A., Nixon, H. L. STUDIES ON THE FEEDING OF *MYZUS PERSICAE* (SULZ.) ON RADIO-ACTIVE PLANTS. *Ann. appl. Biol.* 40, 3 (1953) 537-45.

Adult aptera of *M. persicae* were fed on leaves containing P^{32} after fasting. The weight of sap imbibed by the aphids after varying feeding times was estimated, assuming that P^{32} is uniformly distributed in the leaf tissues. The results are used in a discussion of the mechanism of aphid transmission of plant viruses. (auth. summary.)

Jassid

- 32 Day, M. F., McKinnon, A. A STUDY OF SOME ASPECTS OF THE FEEDING OF THE JASSID *OROSIUS*. *Aust. J. sci. Res.*, B 4, 2 (1951) 125-35.

In experiments on the transmission of the witches'broom disease of lucerne by *Orosius argentatus* (Evans) in Australia, transmission was somewhat irregular, and since a similar irregularity had been reported in work with other Jassids, tests were made to determine whether variations in feeding might be the cause and whether feeding was modified by routine procedures in handling. The method adopted was to confine the Jassids in cages on the leaves of young beet plants that had been left for 24 h with their roots in a culture solution containing tracer doses of sodium dihydrogen phosphate prepared with P^{32} and to transfer them to a normal culture solution prior to infestation, or to feed them on a solution of sugars incorporating the radioactive material. *O. argentatus* ingested P^{32} incorporated into the plant, and excreted approximately 65% of the amount ingested within 30 minutes after feeding had begun. The total amount ingested increased directly with the feeding period during an experiment lasting 3 days. There was considerable variation in uptake between individual Jassids, but the differences were usually insufficient to account for the observed differences in ability to transmit the virus. No evidence of transmission of P^{32} to another plant was obtained. Anaesthesia by CO_2 had little or no effect on subsequent feeding. Starvation for about 30 minutes before feeding slightly increased the amount ingested in a 30-minute period. The pH and the sugar concentration of the artificial diet did not significantly alter the amount ingested. (from RAE-A 41: 404, 1953)

Lygus

- 33 Flemion, F., Weed, R. M., Miller, L. P. DEPOSITION OF P^{32} INTO HOST TISSUE THROUGH THE ORAL SECRETIONS OF *LYGUS OBLINEATUS*. *Contr. Boyce Thompson Inst.* 16, 9 (1952) 285-94.

Lygus oblineatus were made highly radioactive by feeding them with sucrose solution to which radioactive phosphate had been added. Techniques and precautions to avoid contamination are described. On subsequent feeding on bean (*Phaseolus vulgaris* L.) pods the insects transmit their radioactivity at the feeding site as shown by counting and by radioautographs. The results offer strong evidence that on feeding oral secretions are injected into the host tissue.

- 34 Flemion, F., Miller, L. P., Weed, R. M. AN ESTIMATE OF THE QUANTITY OF ORAL SECRETION DEPOSITED BY *LYGUS* WHEN FEEDING ON BEAN TISSUE. *Contr. Boyce Thompson Inst.* 16, 9 (1952) 429-33.

The quantity of saliva injected by *Lygus oblineatus* (Say) into bean tissue during feeding was determined by the use of P^{32} . Adults were fed on sucrose solutions containing large amounts of P^{32} until they had taken up

amounts equivalent to about 500 000 cpm, and after a precautionary period, transferred to bean tissue prepared as previously described. Saliva was collected from them with a micropipette under the microscope as soon as possible after feeding. From the radioactivity per unit volume of the saliva and the radioactivity of the bean tissue it was calculated that volumes of 0.038-0.251 μ l saliva were injected in feeding periods of about 20-108 min, but the amount of activity imparted was not directly associated with the length of the feeding period. The insects are apparently not necessarily feeding during the whole time that the proboscis is inserted into plant tissue.

- 35 Nourteva, P., Reinius, L. INCORPORATION AND SPREAD OF C^{14} -LABELED ORAL SECRETIONS OF WHEAT BUGS IN WHEAT KERNELS. Ann. ent. fenn. 19, 3 (1953) 95-104.

In the course of investigations in Finland on the way in which cereal bugs injure wheat grains and reduce the baking quality of the flour, specimens of Dolycoris baccarum (L.) and Lygus rugulipennis Popp. (pubescens Reut.) were allowed to feed 1-4 days on leaves of Canna indica rendered radioactive by exposure to light in a chamber containing $C^{14}O_2$, prepared from a compound of C^{14} , and then enclosed in bags with wheat ears at various stages of ripeness. Most injured kernels were obtained from the bags containing L. rugulipennis. Positive radioautographs were obtained from 16 of these, 10 of which had been injured at the milky stage and 6 at the yellow stage of ripeness. In all of them, radioactivity was distributed over the whole kernel, indicating distribution of oral secretions, and in two it was relatively greater at the feeding point. Of the few kernels injured by D. baccarum, seven gave positive radioautographs. Radioactivity was strong at the feeding points, but evidence of spread of oral secretions was found only in two grains injured at a very early stage of ripeness. The great dilution in radioactivity during transfer from the leaves into the wheat kernels rendered measurements in the kernels difficult, and a G-M counter gave unsatisfactory results. The counts for all wheat samples, including the controls, differed significantly from the background, and this is attributed to the presence of the natural potassium isotope K^{40} . On the assumption that C^{14} was present in the carbon of the saliva in the same ratio as in the body, it is calculated that the maximum concentration of possible proteolytic enzymes (containing about 50% carbon) in the saliva of D. baccarum was 1:40 000. (RAE-A 42: 376, 1954)

- 36 Miller, L.P., McCallan, S.E.A. SOME EXAMPLES OF THE USE OF RADIOISOTOPES IN STUDIES OF PESTICIDE ACTION. p.546-55 in "Proceedings of the 14th International Horticultural Congress, The Hague-Scheveningen", Vol.I, 1955.

The interaction between fungus spores and certain labelled toxicants was studied. Isotopes were also used to study the feeding habits of Lygus oblineatus which does severe damage to crops. Deposition of toxic salivary secretions was suspected and investigated by labelling the insect with P^{32} (feeding treated sugar solutions), 0.05 - 0.25 μ l of saliva were found to be deposited at each feeding whilst 0.2 - 2.0 μ l of cell sap were sucked up. The quantity of fluid ingested by the insects on feeding was determined using Ag^{110} and Ce^{144} .

Mealybug

- 37 West African Cacao Research Institute. ANNUAL REPORT OF THE WEST AFRICAN CACAO RESEARCH INSTITUTE, APRIL 1952 - MARCH 1953. 1953, 39p.

Work described by R.M. Lister in this report included the development of a method for determining, by means of radioactive phosphorus as orthophosphoric acid, whether Pseudococcus njalensis used in experimental transmission has fed on the source plant; in tests, some of the mealybugs that had apparently settled on the plants did not pick up P^{32} and so may not have fed. (see RAE-A 43: 79-82, 1955)

- 38 West African Cacao Research Institute. ANNUAL REPORT OF THE WEST AFRICAN CACAO RESEARCH INSTITUTE, 1955-56. 90, 1957, 20p.

The report contains numerous studies on mealybugs. Observations on their movements showed that first-instar nymphs and adults comprise over 90 and less than 2%, respectively, of the mobile population of Pseudococcus njalensis on cacao trees. Mobile individuals occurred at all levels, but 85% of both moving and static populations were found in the canopy. Over a period of four months, significant positive correlations were found between numbers of mobile mealybugs and temperature and, to a lesser extent, hours of sunlight, but not with changes in the evaporation capacity of the air. Sunlight begins to penetrate the canopy at about noon, and movement continues from then, probably in response to increased temperature in the carton tents built by ants over the colonies, until about 6 p.m., with a maximum at about 3 p.m.

It was confirmed by the use of mealybugs rendered radioactive with P^{32} that movement occurs from tree to tree through the canopy where the branches interlock.

Mites

* Rodriguez 1954 - [301]

* Lieserling 1960 - [408]

Mosquitoes

* Jenkins and Knight 1950 - [61]

* Jenkins and Hassett 1951 - [110]

39 Jenkins, D.W., West, A.S. PLANT FEEDING HABITS OF NORTHERN MOSQUITOES STUDIED WITH RADIOISOTOPES. Mosquito News 11, 4 (1951) 217-9.

In studies at Churchill, Manitoba, various spp. of northern flowering plants took up and retained P^{32} when their stems are put in a P^{32} solution. Aedes communis males and females visited flowers and ingested plant juices and nectars as shown by their accumulation of P^{32} from the activated flowering plants. This fact lends indirect support to the hypothesis that some arctic mosquitoes, observed to visit and probe flowers, may be able to produce viable eggs without a blood meal. (auth. -A.S.W.)

40 West, A.S., Jenkins, D.W. PLANT FEEDING HABITS OF NORTHERN MOSQUITOES STUDIED WITH RADIOISOTOPES. Mosquito News 11 (1951) 217-9.

Under laboratory conditions Aedes communis males and females visit P^{32} -labelled northern flowers and ingest plant juices and nectars as shown by their accumulation of P^{32} from the activated flowering plants. Northern mosquitoes have frequently been observed to visit and probe several species of arctic and subarctic flowers. Proof in the present studies that the mosquitoes ingest plant juices lends indirect support to the hypothesis that some arctic mosquitoes may be able to produce viable eggs without a blood meal from a mammalian or avian host. (from auth. summary)

Thrips

41 Kloft, W., Ehrhardt, P. ZUR FRAGE DER SPEICHELINJEKTION BEIM SAUGAKT VON THRIPS TABACI LIND. (THYSANOPTERA, TEREBRANTIA) (The problem of saliva injection during the suction process of Thrips tabaci Lind. (Thysanoptera, Terebrantia)). Naturwissenschaften 46 (1959) 586-7. (In German)

By means of radioactive labelling a glandular secretion was shown to be not merely a lubricant for the mouth parts but to be released into the plant during sucking. Adults of Thrips tabaci Lind. were left for about 24 h on cut chives (Allium schoenoprasum L.), placed in a radioactive phosphate solution. A measurable quantity was taken up by the thrips which were then transferred to moistened filter paper to get rid of external radioactive contamination. They were then caged in single-layered allium epidermis skins by means of glass rings. The thrips then punctured some cells. After various intervals, the allium epidermis was carefully cleaned to remove any radioactive faeces. Subsequent autoradiography showed clearly that radioactive saliva had been injected into the tissue. Individual points and also their distribution were recognizable. A contact-autoradiography is shown of an allium epidermis which had been sucked by Thrips tabaci Lind.

* Day and Irzykiewicz 1954 - [320]

Various

42 Ball, R.C., Hooper, F.F. PRELIMINARY REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. TID-12432, Technical Information Service, AEC, Progress Report 14 June 1958 - March 1959 on "A Study of Productivity in a Stream Ecosystem".

P^{32} was added to the river in order to follow its translocation. One section of the report deals with the uptake of P^{32} by 7 invertebrates, amongst them the black fly Simulium, the stone fly Pteronarcys, the caddis fly Brachycentrus, the burrowing may fly Hexagenia and tabanids. Differences and fluctuations in the rate of uptake are described. Corrected counts per min per g are tabulated and discussed.

- 43 Ball, R.C., Hooper, F.F. A SECOND REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. TID-12433, Michigan State Univ., East Lansing and Michigan. Inst. for Fisheries Research, Ann Arbor. 1959, 33p.
- Phosphorus-32 was released in the West Branch of the Sturgeon River, Michigan, on July 8, 1959, at a theoretical maximum concentration of 1.22×10^{-3} mc/ml. Studies were made on the movement of radio-phosphorus through the food chain during a two-month period. Data are also presented on the activity of insects. Results are compared with results from a similar study done in 1958.
- 44 Ball, R.C., Hooper, F.F. A THIRD REPORT ON TRANSLOCATION OF RADIOACTIVE PHOSPHORUS (P^{32}) IN A MICHIGAN TROUT STREAM. TID-12309, Michigan State Univ., East Lansing and Michigan. Inst. for Fisheries Research, Ann Arbor. 1960, 20p.
- Results are compared with results from similar studies during 1958 and 1959. An attempt was made to relate uptake to the amount of P present. The influence of chelating agents on the distribution of activity was also studied. The work on insects is somewhat incidental.
- 45 Сорокин, Ю.И., Мешков, А.Н. ПРИМЕНЕНИЕ РАДИОАКТИВНОГО УГЛЕРОДА (C^{14}) ДЛЯ ОПРЕДЕЛЕНИЯ УСВОЯЕМОСТИ ПРОТОКОККОВЫХ ВОДОРОСЛЕЙ МОТЫЛЕЙ. Доклады Акад. Наук СССР 118, 1 (1958) 205.
- Взвеси протоккокковых водорослей *Scenedesmus* метились C^{14} через фотосинтез с помощью $Na_2C^{14}O_3$. Меченые водоросли затем отнимались от радиоактивного карбоната и подсаживались мотылькам *Tendipes plumosus*. Их активность варьировала от $1,10^4$ до $10,10^4$ ипм/мг. Они очень быстро выводились из организма, лишь незначительное количество усваивалось мотыльками. Было найдено, что после кипячения водоросли и их гидролизаты усваиваются в значительно большей степени.
- Sorokin, Yu.I., Meshkov, A.N. THE USE OF RADIOACTIVE CARBON (C^{14}) FOR DETERMINING THE ABSORPTION OF PROTOCOCCI ALGAE BY THE MOTH *TENDIPES PLUMOSUS*. Dokl. Akad. Nauk. SSSR 118, 1 (1958) 205.
- A suspension of *Scenedesmus* was labelled with C^{14} via $Na_2C^{14}O_3$. The algae were then washed free of contaminating matter, and fed to *Tendipes plumosus*. Their activity ranged from 1.10^4 - 10.10^4 cpm/mg. They were excreted rapidly, very little being assimilated by the moth. On boiling the algae, the hydrolyzed material was found to be absorbed to a much greater extent.

I - A - 2 - b TRANSMISSION OF FOOD

Bee

- 46 Nixon, H.L., Ribbands, C.R. FOOD TRANSMISSION WITHIN THE HONEYBEE COMMUNITY. Proc. roy. Soc., Ser. B 140, 898 (1952) 43-50.
- Six bees were trained to a dish, from which they collected 20 ml of sugar-syrup containing P^{32} . The distribution of radioactivity among the bees and larvae of their colony of 24 500 bees was then studied. 82% of the foragers and 16 to 21% of all the bees in the hive were radioactive within 4 h; 76% of the foragers and 43 to 60% of all the bees were radioactive within 27 h. The nurse bees were significantly less radioactive than the house bees and the foragers significantly more so. Within 48 h all the large larvae in unsealed cells were radioactive. These results are attributed to widespread food transmission. Food transmission is suggested as the foundation of the division of labour within the honeybee community and of the similar odour produced by the members of each colony, which serves for mutual recognition. Food transmission would enable slow-acting insecticides contained in their food to be widely distributed among the members of a honeybee colony. (auth.)
- 47 Oertle, E., Emerson, R.B., Wheeler, H.E. TRANSFER OF RADIOACTIVITY FROM WORKER TO DRONE HONEY BEES AFTER INGESTION OF RADIOACTIVE SUCROSE. Ann. ent. Soc. Amer. 46, 4 (1953) 596-8.
- Caged drone honey bees, with access to sucrose sirup, received radioactive material through a dividing screen from worker bees that had access to radioactive sucrose sirup. After correction for time and background the net radioactivity counts per minute were 456 for drones and 9430 for workers of equal sample weight. It can be inferred that the drones had become at least partly dependent upon workers for food, or perhaps for an essential growth factor, or that they preferred regurgitated food to sucrose sirup. (auth. E.O.)

(A report was also published as AECU-2630, Bureau of Entomology and Plant Quarantine, Dept. of Agriculture, 1953, 7p.)

Ant

- 48 Eisner, T., Wilson, E.O. RADIOACTIVE TRACER STUDIES OF FOOD TRANSMISSION IN ANTS. p.509-13 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug.1956", Vol.2, Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

In a series of experiments, honey mixed with a radioactive isotope of iodine (NaI^{131}) was fed to colonies of several species of ants and the rate of intranidal transmission of this substance studied. Striking inter-specific differences were noted, from very limited, almost negligible exchange in the myrmicine *Pogonomyrmex badius* (Latr.), to rapid transmission leading to near or complete colony saturation in the myrmicine *Crematogaster lineolata* (Say) and species of the formicine genus *Formica*. An unexpected additional discovery was that the nest queens and larvae were often the last individuals to receive honey and, as a rule, received less than the individual workers. (auth.)

- 49 Gösswald, K., Kloft, W. UNTERSUCHUNGEN ÜBER DIE VERTEILUNG VON RADIOAKTIV MARKIERTEM FUTTER IM VOLK DER KLEINEN ROTEN WALDAMEISE (*FORMICA RUFOPRATENSIS MINOR*) (Studies on the distribution of radioactively labelled food amongst ants of a colony of *Formica rufopratensis minor*) *Waldhygiene* 1 (1956) 200-2. (In German)

Honey water was labelled with P^{32} , at a dosage which gave measurable activity even on very wide distribution of the labelled food. Measuring techniques are described. One individual passes food to 8-10 fellow ants, 1/3 of the food being given away within 15 seconds. Group experiments gave varying results, not only depending on the size of the group but of the ants to be fed, the allocation of food being proportional to ant size. In *Camponotus ligniperda* Latr. distribution of essentially rather liquid food was found to be much more rapid which was also the case in *Formica pratensis* Retz.

- 50 Gösswald, K., Kloft, W. NEUE UNTERSUCHUNGEN ÜBER DIE SOZIALEN WECHSELBEZIEHUNGEN IM AMEISENVOLK, DURCHGEFÜHRT MIT RADIOISOTOPEN (New studies by means of radioisotopes on the social interrelations in the ant). p.543 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol.2, Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958. (Details of this and further studies were presented at the 3rd International Congress of the International Union for the Study of Social Insects, Paris 9-13 July 1957) (In German)

P^{32} was given in food or by injection into the hemolymph. The distribution of food was investigated, particularly in a group of *Formica rufa*. A worker ant can directly share food from the crop with 8 others, the contents of one crop being ultimately distributed between 80-100 animals. Winged and unwinged females, and males participate in distribution. Further problems studied were the speed of distribution, the effect of animal size on allocation, trophallaxis and general behaviour. Relations between social parasitic ants and their hosts and also myrmecophiles were also investigated.

- 51 Gösswald, K., Kloft, W. RADIOBIOLOGISCHE UNTERSUCHUNGEN AN STAATENBILDENDEN INSEKTEN (Radiobiological investigations on colony-forming insects). *Umschau* 58 (1958) 743-5. (In German)

Metabolic processes of inhibition were investigated by which animals in a particular insect colony are maintained as worker or soldier members instead of becoming sexually potent. P^{32} -labelled worker ants of known activity were placed with 1-100 unfed fellow ants. The radioactivity of every insect was measured individually at various intervals. The level of measurable activity made it possible to gauge, both qualitatively and quantitatively, the extremely wide distribution of regurgitated radioactive food available from one insect. Extent (primary, secondary, etc.) and speed of distribution were a function of temperature. Both imaginal males and workers in developmental stages receive merely regurgitated food whereas queen larvae are fed with superior gland extract. Winged males also work actively in food distribution. An interchange between nursing ants and larvae (trophallaxis) was confirmed. Queens also release food to workers. Individual food requirements are much greater for bees than for ants; food is quickly resorbed and distributed throughout the entire organism. Drones also actively participate in passing on food to worker bees. The termite, *Calotermes flavicollis*, does not show a genuine caste system. The allocation of work in supplying food is described at the different developmental and social levels. Distribution of food brought in by a few individuals was relatively rapid, though much slower than among bees or even ants.

- 52 Gössewald, K. EINBLICKE IN DAS STAATENLEBEN DER INSEKTEN AUF GRUND VON RADIOBIOLOGISCHEN STUDIEN (New data on colony life amongst insects on the basis of radiobiological studies). Natur u. Volk 89 (1959) 209-13, 249-59. (In German)
- The paper is a summary of results obtained by means of radioisotopes, and published by the author and his collaborators in a series of papers. They concern the exchange of substances between different castes and individuals as well as developmental stages in social insects. An analysis is also made of the interchange relations existing in the case of different types of hosts as well as for social parasites and ants.
- 53 Gössewald, K. DER AMEISENSTAAT (The ant colony). Math. Naturwiss. Unterricht 12 (1959) 208-23. (In German)
- The paper is a review of the interchange of substances which takes place in labelled ants between different castes, and different developmental stages, and also between the ant population and its hosts and social parasites. Results obtained by means of the radio-tracer technique allow further insight into the sociological structure within an ant colony.
- 54 Gössewald, K., Kloft, W. NEUERE UNTERSUCHUNGEN ÜBER DIE SOZIALEN WECHSELBEZIEHUNGEN IM AMEISENVOLK. DURCHGEFÜHRT MIT RADIOISOTOPEN (Recent studies by means of radioisotopes on the social interrelations amongst ants). Zool. Beitr., Berl. 5 (1960) 519-66. (In German)
- (Paper presented at the 3rd International Congress of the International Union for the Study of Social Insects, Paris 9-13 July 1957)
- After discussing techniques (radiation sources, application of radioisotopes, measurements and methods of calculation) the data thus obtained on the distribution of food among ants is described. A number of sub-families were used in the study. The distribution of labelled food in the individual ant (here, Formica polyctena Foerst.) is described. Resorption only takes place in the mid gut, whilst regurgitated food is concentrated in the crop. Contact-autoradiography was used for following distribution with time; a very high activity was found in the labial gland. Food transmission within a group of workers (speed and extent) depends on several factors including temperature (opt. 22°C) and the size of the group; uniform distribution will ultimately be reached. The polymorphism within the worker caste has a direct influence on the quantity of food received: the larger ones appear better fed both quantitatively and qualitatively. Regurgitated food is accepted by queens although they normally receive gland-secreted food. The males participate actively in food transmission. Some problems of trophallaxis are discussed; uptake of larval material by nursing ants and vice versa is confirmed. Special characteristics of different types of ants are also studied (independent and social parasitic types).
- 55 Gössewald, K., Kloft, W. UNTERSUCHUNGEN MIT RADIOAKTIVEN ISOTOPEN AN WALDAMEISEN (Radioisotope studies on forest ants). Entomophaga 5,1 (1960) 39-41. (In German)
- The distribution of P^{32} -labelled food (honey water) among workers of the red forest ant was studied. The transmission process of the crop contents is a function of time and temperature. At optimal temperature (24-26°C) the contents of one single crop may be distributed amongst 80 workers, with a direct primary transmission to 6-8 workers, at most. Distribution is Gaussian. Winged and dewinged queens, and male ants also participate. Given a sufficiently large number of workers, the queens are fed with high-quality gland extracts. Similarly, larvae destined for a sexually active life are also given preferential treatment. Distribution amongst members of different species of Formica was also studied.
- 56 Wilson, E.O., Eisner, T. QUANTITATIVE STUDIES OF LIQUID FOOD TRANSMISSION IN ANTS. Insectes Sociaux 4 (1957) 157-66.
- Transmission of honey in several species of ants was studied using ^{131}I as tracer. Great variation in transmission rates between species was noted, ranging from negligible transmission over a 10-day period (in Pogonomyrmex badius) to complete colony saturation within 30 h (in Formica spp.). The honey was passed mostly among workers, very little being given to the queens or larvae. Indirect evidence is cited which suggests the occurrence of chain transmission beyond the primary donations given by the original foragers. (auth. summary)

Termite

- 57 Alibert, J. LES ÉCHANGES TROPHALLACTIQUES CHEZ LE TERMITE À COU JAUNE (CALOTERMES FLAVICOLLIS FABR.) ÉTUDIÉS À L'AIDE DU PHOSPHORE RADIOACTIF (Trophallactic exchanges in the yellow-necked termite Calotermes flavicollis Fabr., studied by means of radioactive phosphorus). C.R. Acad. Sci., Paris 248 (1959) 1040-2.

By means of feeding filter paper soaked in P^{32} to homogeneous groups of termites, all larvae and nymphs from the third stadium onwards could be shown to feed independently. First stage larvae and soldier termites absorb no food, and second stage larvae only very small quantities. Three-year old, sexually potent adults are able to feed independently, but only after having been separated from the larvae for 65-75 h. Trophallactic exchange takes place surprisingly slowly. When radioactive termites in the ratio of 1:10 are added to normal colonies then the level of radioactivity found in the insects is 40% after 12 h, 20% after 70 h and only reaches 100% after about 35 h. The older larvae and younger nymphs play the most important part in trophallaxis, in the sense of "chewing the cud".

- 58 Banks, C.J. THE SEARCHING BEHAVIOUR OF COCCINELLID LARVAE. Brit. J. anim. Behav. 2 (1954) 37-8.

Laboratory and field experiments are briefly recorded in which radioactive labels in the form of radium sulphate were attached to late stage larvae, thus permitting their detection at a distance of about 2 feet. Positions of larvae were recorded at intervals of several days. They are able to travel as much as 21 feet in 2 days. It is tentatively concluded from these preliminary experiments that ladybird larvae, while capable of making a thorough search of their surroundings, may be inefficient in finding their prey, which may be an important contributory cause of the high mortality suffered by the early-stage larvae.

- 59 Banks, C.J. THE USE OF RADIOACTIVE TANTALUM IN STUDIES OF THE BEHAVIOUR OF SMALL CRAWLING INSECTS ON PLANTS. Brit. J. anim. Behav. 3,4 (1955) 158-9.

For studies on the behaviour of unfed newly-hatched Coccinellidae on plants, the radioactive material has to be suitable for external application as small labels, yet have a sufficiently high specific activity for easy detection with a G-M counter from about 1 ft. away. Radium labels are too large to use on first instar coccinellid larvae, and tantalum (Ta^{182}) was used instead, which has a half-life of 120 d, and emits a high-energy γ -radiation. The method and apparatus used for attaching labels to larvae are described, and experimental details (dimensions, etc.) given. Labels of two levels of radioactivity were used on 1st instar larvae of Coccinella septempunctata L. (250 μ C/mg and 42 μ C/mg). In the first case, the larvae became less and less active, ceased feeding and after 2-3 d died without ecdysis. The lower activity caused no noticeable effect on growth and behaviour, nor did the approximately 24% increase in weight due to the Ta -strip.

- 60 Banks, C.J. THE BEHAVIOUR OF INDIVIDUAL COCCINELLID LARVAE ON PLANTS. Brit. J. anim. Behav. 5,1 (1957) 12-24.

As the survival of a larva depends primarily on the ability of its 1st instar to find aphids, observations were made on larvae recently dispersed from their egg shells. The species studied, Adalia bipunctata (L.), Coccinella septempunctata L. and Propylea quatuordecimpunctata (L.), are common predators of Aphis fabae and others. Larvae were either labelled with metal foil disks containing radium sulphate or with strips of radioactive tantalum (Ta^{182}). The behaviour of the larvae appeared to be rather random in their search for food, and it is considered likely that in areas of low prey density many larvae, especially newly hatched ones, die of starvation because they do not find food. Larvae which encountered aphid colonies tended to stay near them, because after feeding they made small turning movements from side to side, which increased the chance of meeting another aphid of a colony. This behaviour differed from that before feeding. Larvae, especially the 1st and 2nd instar, took a comparatively long time to consume aphids and, in the field, one of them was prevented from feeding on an aphid colony by the attacks of their attending ants.

- * Fuller et al. 1951 - [358]

- 61 Jenkins, D.W., Knight, K.L. ECOLOGICAL SURVEY OF THE MOSQUITOES OF GREAT WHALE RIVER, QUEBEC. Proc. ent. Soc. Washington 52, 5 (1950) 203-23.
- Fifteen species of culicids were collected from tundra, alpine, and northern conifer forest habitats. The breeding habitats, dates, adult activity and biting habits are presented for each species. The most important pest species were Aedes communis, A. pullatus, and A. excrucians. Radioactive (P^{32}) test pools were used and acquired radioactivity measured in the mosquitoes. Odonata nymphs and some corixid adults were observed eating larvae of A. pullatus in the field. Dytiscid and gyrinid larvae were observed pursuing larvae of A. pullatus and A. excrucians in the field, and eating them in the laboratory. Large dytiscid larvae showed a radioactivity of 8.5 m/h in a radioactive pool which indicated that they had fed on radioactive A. pullatus and A. excrucians larvae.
- 62 Kannowski, P.B. THE USE OF RADIOACTIVE PHOSPHORUS IN THE STUDY OF COLONY DISTRIBUTION OF THE ANT Lasius minutus. Ecology 40, 1 (1959) 182-5.
- Five widely-separated groups of mounds of this hypogaeic ant were studied in a swamp in South East Michigan. Honey mixed with P^{32} was placed in a mound of each group to determine whether or not each mound represented a separate colony. The honey was quickly fed upon by workers of these mounds and passed to other members of each colony. Within 6-8 h food had spread throughout each colony. Sampling of adjacent mounds showed the presence of radioactive ants in some of them. Occurrence of radioactive ants in nearby mounds indicated that some mounds are interconnected by tunnels. Thus, a colony may occupy one or more mounds. (auth.)
- 63 Long, W.H., Lilly, J.H. WIREWORM BEHAVIOR IN RESPONSE TO CHEMICAL SEED TREATMENTS. J. econ. Ent. 51, 3 (1958) 291-5.
- Orientation reactions of the wireworm, Melanotus communis Gyll., to various insecticide seed treatments were studied by following the movements of individual larvae tagged with Co^{60} in the soil. It was found that the repellency of certain insecticide seed treatments to wireworms apparently has two components: (1) inhibition of the feeding reaction, and (2) orientation of the insects away from treated seeds. For convenience these are referred to as type one and type two repellency, respectively. Type two repellency does not preclude contact with treated seeds, and varies in degree depending on the insecticide used. Aldrin, Dieldrin, Eudrin, heptachlor and Lindane seed treatments all appeared to possess considerable type one repellency. Type two repellency was most pronounced with Lindane-treated seeds, and with Aldrin-treated seeds where this insecticide was not used in excess of 1 oz of actual toxicant per bushel of seed. Dieldrin, Eudrin and heptachlor seed treatments showed a degree of type two repellency intermediate between Lindane and Aldrin on the one hand and untreated control seed on the other. (auth.)
- * (An abstract of earlier work appeared in Bull. ent. Soc. Amer. 2, 3 (1956) 27, abstr. 18 under "Effects of insecticide seed treatments on wireworm activities")
- 64 Nagel, R.H., Davis, J.M. RESULTS FROM STUDIES ON THE ENGELMANN SPRUCE BEETLE (DENDROCTOMUS ENGELMANNI) IN 1955. Ent. Soc. Amer. North Central States Br. Proc. 11 (1956) 20-1.
- The device described here was used in the treatment of about 19 000 beetles with I^{131} in Colorado. The beetles were treated in batches of about 1000 each, and the entire lot treated and released in about 2 hours' time. Mortality, as indicated by those remaining in the trays the following day, was about 15%. This loss was not considered excessive as many were in poor health when treated. The treated beetles were fairly easily located beneath the bark of trees, by use of portable scintillation counters, for a period of about 2 weeks following the treatment. At this time the radioactivity of the isotope was only about one fourth of its original value. About 830 beetles (ca. 5%) were later relocated by their radioactive tag. A few tagged beetles were examined by peeling the bark from over them. They appeared to be making typical galleries and laying eggs in typical numbers, indicating that little adverse effect had resulted from their treatment.
- 65 Rings, R.W. FRUIT INSECT BEHAVIOUR STUDIES AIDED BY RADIOISOTOPES. Bull. Ohio agric. Exp. Sta. 725 (1953) 59-60.
- A solution of at least 50 μ C/ml of P^{32} was required for labelling peach terminals. Plum curculios (Conotrachelus nenuphar) then reached an activity of 5 m/h within 3-4 d, P^{32} being present nearly throughout the body. No mass movement of the curculios into the centre of the orchard from the outside rows bordering woodlands was indicated. The greatest proportion of hibernating curculios can be found in the orchard rather than in the adjoining woodland.

* Rings and Layne 1953 - [370]

- 66 Schmidt, C.H., LaBrecque, G.C. ACCEPTABILITY AND TOXICITY OF POISONED BAITS TO HOUSE FLIES RESISTANT TO ORGANOPHOSPHORUS INSECTICIDES. J. econ. Ent. 52 (1959) 345-6.

Laboratory-reared Malathion-resistant flies (Grothe) were tested for any behavioural resistance in terms of an avoidance reaction to Malathion and Dipterex baits. The baits, which contained 1% toxicant, and the plain sugar standards were mixed with P³²-phosphoric acid. Mortality was determined after 24 h. The Malathion bait killed 40% of the Grothe females, 85% of the Grothe males, and 100% of the normal flies. All the flies of both colonies were killed by the Dipterex bait. No mortality was observed with the sugar controls. Both physiological and behavioural resistances to Malathion were involved in the survival of the Grothe females. The results of the test with Dipterex bait run on female flies only, showed no such evidence. The laboratory experiments are not strictly comparable with field conditions.

1-A-3 POPULATION DYNAMICS (DISPERSAL, FLIGHT RANGE, ETC.)

Conotrachelus

- 67 Layne, G.W. STUDIES OF THE MOVEMENTS OF THE PLUM CURCULIO, CONOTRACHELUS NENUPHAR HERBST., IN A PEACH ORCHARD WITH RADIOPHOSPHORUS (P³²) AS A TRACER. M.S. Thesis. Ohio State Univ., Columbus. 1951.

* Rings 1954 - [369]

Cockroach

- 68 Jackson, W.B., Maier, P.P. DISPERSION OF MARKED AMERICAN COCKROACHES FROM SEWER MANHOLES IN PHOENIX, ARIZONA. Amer. J. trop. Med. Hyg. 4, 1 (1955) 141-6.

Studies of this type have assumed increasing importance since the cockroach has been proved to be a potential vector of several filth diseases (amongst them poliomyelitis). Its capacity for transmission needs evaluation under varied field conditions. Movements of Periplaneta americana from sewer manholes were studied by a trap, mark, release, and recapture technique using paint or P³² (about 100 cc of a 5% aqueous casein solution containing 10 µc of P³²/cc per group of roaches treated). In 2 experiments where only the resident manhole populations were marked, very limited emigration was observed, only 4 of 800 marked cockroaches being recovered by intensive trapping in yards, homes and neighbouring manholes. However, when 1200 marked roaches were super-imposed on a resident manhole population of 300, 71 tagged individuals were recovered within 15 d: 1 in a home, 5 in yards, and 65 still in the sewer system at distances up to 350 ft. from the release point. This suggests that a sudden increase in population over that of the carrying capacity of the environment may incite emigration from the centre of pressure.

- 69 Schoof, H.F., Siverly, R.E. THE OCCURRENCE AND MOVEMENT OF PERIPLANETA AMERICANA (L.) WITHIN AN URBAN SEWERAGE SYSTEM. Amer. J. trop. Med. Hyg. 3, 2 (1954) 387-71.

Cockroaches are known to be able to harbour Salmonella for several days, the collection of Periplaneta americana (L.) contaminated with 3 species of Salmonella from sewer manholes in Texas was reported by R.S. Bitter and O.B. Williams (1949), and J.T. Syvertson and others (1952) recorded the isolation of 4 strains of poliomyelitis virus from P. americana, Blattella germanica (L.) and Supella sepeletillum (Serv.) caught on the premises of patients ill with paralytic poliomyelitis. The movements of P. americana in and from city sewerage systems, which might affect its importance as a transmitter of disease, was studied at Phoenix, Arizona, in Oct. 1952. Surveys at 22 manholes for 7 weeks had shown a weekly average of 92-143 cockroaches, all of this species, whereas the predominant cockroaches in dwellings were S. sepeletillum and B. germanica. Some 6500 individuals of P. americana were trapped in sewer manholes, marked with radioactive phosphorus by spraying with a solution containing 5% casein and 10 mc P³²/ml, and released in 4 manholes. During the next 8½ weeks, traps at 3 of the release sites yielded 929 cockroaches, of which 906 were radioactive; 34 traps in other manholes of which most were less than half a mile and the others up to one mile from the release sites yielded 16021 cockroaches, of which none was radioactive, and 10 traps on premises in blocks adjacent to the release sites yielded only one cockroach which was radioactive and was caught 60 ft from the nearest release site. The lack of evidence of movement was surprising in view of an observed tendency of the species to disperse and the likelihood of induced population pressure at the points at which the cockroaches were released. (RAE-B 43: 150, 1955)

Dendroctonus

- 70 Nagel, R.H. INFLUENCE OF NEMATODES AND A TAGGING SOLUTION ON THE FLIGHT PERFORMANCE OF THE ENGELMANN SPRUCE BEETLE. Bull. ent. Soc. Amer. 5,3 (1959) 131, abstr.185.

By means of flight mills, flight performances with captive beetles were recorded and compared for (1) possible adverse effects of tagging solutions used earlier in dispersal studies; and (2) the influence of nematodes on flight in the case of infested specimens. (See Davis and Nagel, 1956)

Flea

- 71 Hartwell, W.V., Quan, S.F., Scott, K.G., Kartman, L. OBSERVATIONS ON FLEA TRANSFER BETWEEN HOSTS; A MECHANISM IN THE SPREAD OF SUBONIC PLAGUE. Science 127 (1958) 814.

There is circumstantial evidence that fleas of ground-squirrels can transmit plague bacilli from wild rodents to rats in rural areas of the western United States, and the development of a method for tagging fleas with radioactive cerium (Ce^{144}) made possible the direct investigation of the transfer of fleas from host to host. One male and two female voles (*Microtus californicus*), marked by clipping their toes, were placed in each of a number of experimental plots simulating field conditions, in which they could establish nests; 10-40 radioactive fleas (*Xenopsylla conformis* (Roths.)) were put on certain of them. The animals caught in traps set each day were lightly anaesthetized and any fleas were removed, examined for radioactivity and returned to the hosts. Fleas were found to have transferred from one vole to another in all of five trials and were found in nests in the three trials in which nests were established. In a second type of experiment, none of 30 tagged fleas on three voles transferred to three rats (*Rattus norvegicus*), kept in an adjacent enclosure, while the voles were alive. After the latter had been killed, seven fleas moved to rats that were allowed to enter the area with the dead voles, but no transfers were noted on three new voles put in the enclosure after the rats had again been removed to the adjacent one. Of 30 tagged fleas put on the new voles, 12 moved to rats in the same area. None of the 60 fleas was found in the nests of the voles, but 27 were recovered from those of the rats. Radioactivity was twice detected in the *Microtus* faeces and once in rat faeces. (RAE-B 48: 32, 1960)

- 72 Hanec, W. A STUDY OF THE ENVIRONMENTAL FACTOR AFFECTING THE DISPERSION OF HOUSE FLIES (*MUSCA DOMESTICA* L.) IN A DAIRY COMMUNITY NEAR FORT WHYTE, MANITOBA. Canad. Ent. 88, 6 (1956) 270-2.

The following is based on the author's summary and conclusions. Two releases of radioactive houseflies (*Musca domestica* L.) were made in a dairy community near Fort Whyte, Manitoba, during the summer of 1954 to investigate the effect of wind direction and wind-borne odours on dispersion and to determine whether houseflies dispersed from one farm unit to another within the experimental area. The flies were tagged by feeding on P^{32} in aqueous solution sweetened with sucrose. The recaptures from the two releases indicated that houseflies orientate themselves to wind-borne odours from farmyards, and migrate from one farmstead to another in appreciable numbers even in weather that is not optimal for flight. This suggests the need for community rather than individual attempts at control.

- 73 Jenkins, D.W. A QUELLE DISTANCE UNE MOUCHE PEUT-ELLE VOLER? Naturaliste Canadien 83, 5 (1956) 95-102.

Although some results are presented on the dispersion of flies and mosquitoes marked with radioactive isotopes, the article is mainly a summary of the use of these isotopes in marking insecticides, insects and protozoa in research on disease vectors and disease organisms. (BA 33: 7816, 1959)

- 74 Lindquist, A.W., Yates, W.W., Hoffman, R.A., Burns, J.S. STUDIES OF THE FLIGHT HABITS OF THREE SPECIES OF FLIES TAGGED WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44, 3 (1951) 397-400.

Three specimens of flies were tagged by feeding them solutions of P^{32} -labelled phosphoric acid and then released. A total of approximately 36 000 *Musca domestica* (L.), 15 000 *Phaenicia sericata* (Meig.), and 1 200 *Phormia regina* (Meig.) flies were released, of which the following ratios of tagged to untagged flies were caught in the traps: - 1:11 for *Musca domestica*, 1:70 for *Phaenicia* spp., and 1:758 for *P. regina*. *P. regina* comprised approximately 50%, *Phaenicia* spp. 15, and *M. domestica* 7% of the total number of flies caught. Most of the tagged flies were caught the first day in the traps 0.5 mile from the release point. Tagged flies had moved outward 4 miles in each cardinal direction the first 24 h after release. Traps set in barnyards caught several times as many houseflies and *Phaenicia* as those set in open fields. The use of radioactive P^{32} as a means of tagging flies has proved satisfactory and reduced the

amount of work in examining large catches of flies over that necessary when pigmented dusts are used to colour insects. (from auth. summary)

- 75 Long, D.B. FIELD OBSERVATIONS ON ADULTS OF THE WHEAT BULB FLY (LEPTOHYLEMYIA COARCTATA (FALL.)). Bull. ent. Res. 49, 1 (1955) 77-84.

In a field study of adult populations (Rothamsted) it was found that the males emerge slightly before the females and that the emergence period may cover at least 3 weeks in late June and early July. Although the number of males may exceed the number of females at first, the females predominate later in the season due to the shorter life span of the males. The numbers of flies on the wheat fluctuate appreciably throughout the day. During the 1st week of the emergence period the number of flies taken increased steadily throughout the day. After the date of population peak, however, the max. numbers occurred in the crop in the very early morning and the late evening, which suggested a daily flight dispersion followed by a general or localized return of the flies to the crop. Further study of the data showed that the daily temperature rhythm was only partly responsible for this daily flight dispersion, and that there appeared to be an active return flight to the crop in the evening. Generally the males were more active than the females and did not settle so deeply in the crop. Recaptures of P^{32} -labelled flies indicated that the extent of the sometimes rapid dispersions was not very great. The females dispersed more than the males, and were somewhat influenced by the occurrence of wheat in flower. Frequently flies were found to have congregated on the lee edge of the crop, but other preferred regions have been observed which could not be attributed to wind influence. (from auth. summary)

- 76 MacLeod, J., Donnelly, J. METHODS FOR THE STUDY OF BLOWFLY POPULATIONS. II. THE USE OF LABORATORY-BRED MATERIAL. Ann. appl. Biol. 44, 4 (1956) 643-8.

The use of laboratory-bred blowflies for experiments on release and capture of marked flies is briefly discussed. In an experiment to test the possibility of a rhythmic protein-hunger cycle complicating the results when flies with a uniform history of protein hunger are used, no difference was observed in the response to carrion-baited traps of groups of flies from whom protein had been withheld for 3, 2, 1 and 0 days. In release experiments the ratio of marked to unmarked flies in trapped samples differed irregularly between laboratory-bred and wild flies, apparently depending on whether the climatic conditions at release were markedly or only slightly different from those of the insectary. (auth.)

- * Kartmann et al. 1958 - [406]

Flies

- * Freeden et al. 1953 - [334]

- 77 MacLeod, J., Donnelly, J. INDIVIDUAL AND GROUP MARKING METHODS FOR FLY-POPULATION STUDIES. Bull. ent. Res. 48, 3 (1957) 585-592.

Four different methods of marking insects are described in detail. Although they have been applied by the present authors only to the British Calliphorinae, they should be of value in ecological studies of mobile arthropods in general. These methods are: individual marking with paints, mass powdering with dyes, radioactive labelling with P^{32} , and a combination of the last two. A fifth method in which the emerging fly labels itself with fluorescent dust, is briefly described. The circumstances affecting the choice of method are outlined. Technical details are given concerning the supply and dilution of P^{32} , given in a sucrose solution. Alternatively, it was added to the drinking water instead. Experiments were made using the following flies: C. erythrocephala, C. vomitoris (L.), Lucilia spp.

- 78 Quarterman, K.D., Mathis, W., Kilpatrick, J.W. URBAN FLY DISPERSAL IN THE AREA OF SAVANNAH, GEORGIA. J. econ. Ent. 47, 3 (1954) 405-12.

Employing as marking agents a combination of radioactive chemicals (P^{32} , Ca^{45} , and I^{131}) incorporated in their food and a variety of dyes dusted on them before release, dispersal habits of the common species of flies in urban areas were studied. Ca^{45} , used as calcium chloride, proved unsuitable since causing considerable mortality among flies marked with it. It was also rapidly excreted, and no dispersal data was obtained for flies marked with it. The iodine caused considerable mortality among male flies. Flies marked

with phosphorus and iodine were separated by the differences in types of emissions. Dispersal was rapid, continuous and independent of direction. Large numbers of Callitroga macellaria (F.) and some of all species were recovered in vacant areas considerably removed from major fly-breeding foci. Sources of heavy breeding near the city were found to contribute substantially to the city's fly population. Flies from dairies, an abattoir and a garbage dump situated outside the city moved into all parts of the city and right across it. From the relation between the release and trapping points for Musca domestica L., blowflies of the genus Lucilia (Phaenicia), C. macellaria, L. cuprina cuprina (Wied.) (pallidescens Shann.), L. sericata (Mg.) Fannia pusio (Wied.) and Sarcophaga sueta Wulp. It was concluded that municipal fly control should be city-wide and should in some instances include the most important of the immediately outlying foci of production. (from auth. summary)

79

Quarterman, K. D., Kilpatrick, J. W., Mathis, W. FLY DISPERSAL IN A RURAL AREA NEAR SAVANNAH, GEORGIA. J. econ. Ent. 47, 3 (1954) 413-9.

Dispersal tests were conducted with natural populations of wild house flies and Callitroga macellaria, obtained by trapping adult flies on the rural premises used as the release points. They were marked by feeding them with P^{32} -labelled milk. The marked flies were released where they had originally been caught. To minimize the effects of temporary caging, the releases of the marked flies were made at dusk after it had become too dark for them to migrate. In a test in early May, only one release point was used. In another test in late June, five release points were used simultaneously. Dyes were used in combination with P^{32} to mark the test flies. Houseflies were recovered up to 5 miles from the release points in less than 24 hours after release, with a range and pattern of flight apparently quite similar to those of Callitroga macellaria. The higher percentages of C. macellaria taken in the recovery traps tends to substantiate the general belief that it is the more migratory of the two species. In both tests the flies apparently dispersed at random over an area 8 to 10 miles in diameter, with a few individuals being trapped up to 10 miles from the release point. Within the general dispersal area, the flies tended to congregate more at premises where food and breeding material were favourable. The availability of these materials, however, did not prevent great numbers of flies from leaving any given location, indicating that movement over this relatively large area is a normal pattern of fly activity. (from auth. summary)

80

Schoof, H. F., Siverly, R. E., Jensen, J. A. HOUSE FLY DISPERSION STUDIES IN METROPOLITAN AREAS. J. econ. Ent. 45, 4 (1952) 675-83.

In studies of the dispersal range of flies, principally Musca domestica L., made at Phoenix, Arizona, in 1951, 31 000 flies marked with P^{32} were released in June and 56 000 in September. Catches made subsequent from baited traps distributed over the metropolitan area in concentric rings or segments included 227 and 284 marked flies, of which 88 and 81% respectively were found within a mile of the place of release. The proportion of radioactive flies in the catches varied inversely with the distance from the place of release, except that more were taken at one mile than 0.5 mile in June and about equal numbers in September. Some flies travelled a mile within 24 h, three miles within 48 h and four miles within 72 h. The numbers of marked flies collected three, four and five miles from the release points were small, but the fact that 10.1% of the marked flies recovered in June-July and 13% of those recovered in September-October were taken two miles from the release point indicates that movement to this distance may be of practical importance. The importance to a community of an area of high fly production situated a mile or more away from it depends on the sources of attraction in the intervening zone. In view of the influence of attractants on the infiltration of Musca domestica into an area, removal of these substances is as important a part of a community fly control programme as the elimination of breeding media. (from RAE-B 41: 42, 1953)

81

Schoof, H. F., Matl, G. A. DISPERSAL HABITS OF PHORMIA REGINA IN CHARLESTON, WEST VIRGINIA. J. econ. Ent. 46, 2 (1953) 258-62.

Release of about 8000 marked adults of Phormia regina (Mg.) from each of two sites in Charleston, West Virginia, during 1951 and 1952, and subsequent trapping revealed dispersal for distances up to nearly 10 miles in 3 d and just over 10 miles on the 4th d, though most of the marked flies recaptured were taken within 5 miles of the site of release. It was shown that flies moved from a zone with a low standard of sanitation to all parts of the city, and that their migration was not prevented by the presence of wooded ridges 400-500 ft high or by watercourses. The findings supported the recommendation that to effect the maximum reduction of P. regina within a community, control operations should be extended to sites of prolific breeding 3-4 miles beyond the boundaries of the urban area. The method adopted to mark the flies was to feed them on radioactive milk (containing 1 mc/l P^{32} as phosphoric acid) and then to

dust them with a red or green dye. They were detected in the trap catches by their radioactivity and then treated with acetone to expose the dye characteristic of the point of release. (RAE-B 41: 172, 1953)

- 82 Schoof, H.F., Siverly, R.E. MULTIPLE RELEASE STUDIES ON THE DISPERSION OF MUSCA DOMESTICA AT PHOENIX, ARIZONA. J. econ. Ent. 47, 5 (1954) 830-8.

The relative importance of five major sources of houseflies (Musca domestica L.) near Phoenix, Arizona, on the control programme in operation in the town was studied in 1952. Flies marked with P³² and a dye characteristic of the site were released simultaneously from the 5 sites, and catching stations were operated at the release sites themselves, 0.5 and 1 mile from each site in all directions and 2, 3 and 4 miles from each site in the direction of the centre of town. The recaptures are discussed in some detail. The following is based on the authors' summary of the findings. Flies from three sites, two on the periphery of the town and one 0.5 mile away, readily infiltrated into the town itself, but comparatively few flies from sites 1.8 and 2 miles away did so. From 59 to 81% of the marked flies recovered were taken within 1 mile of the release points and from 86 to 94% within 2.3 miles. Maximum recovery of marked flies occurred at release sites on the first day after release and at other sites on the fourth day. Available evidence indicates that although house-flies can travel 5-20 miles, the dispersion capacity of the mass population is expended within 0.5-2 miles because of the randomized, reciprocal type of meandering that characterizes housefly movement. One mile is the distance to which it is recommended that fly control operations should be extended outside most communities. (RAE-B 43: 156, 1955)

- 83 Schoof, H.F., Siverly, R.E. URBAN FLY DISPERSAL STUDIES WITH SPECIAL REFERENCE TO MOVEMENT PATTERN OF MUSCA DOMESTICA L. Amer. J. trop. Med. Hyg. 3, 3 (1954) 539-547.

In continuation of investigations carried out in the summer of 1952, about 147 000 radioactive houseflies (Musca domestica L.) were liberated at a primary release site at Phoenix, Arizona, on 30th Oct. For the next two days, 15 fly traps were operated at three secondary sites half a mile from the primary release point. The flies collected at each secondary site were then dusted with a characteristic dye and liberated. Catches at 48 collection stations within a mile of the primary release point indicated that, although fly dispersion from that site followed a general random design, radioactive flies were recaptured at a higher rate in one sector of the recovery zone than in the other two. In all, 104 dyed radioactive houseflies were caught. Movement from each of the secondary release sites was random; some individuals reversed their initial path of migration and returned in the general direction of the primary release site. The findings indicate that M. domestica is essentially a species of migrating habits. The flies apparently spend most of their lives moving from site to site not only in search of suitable places in which to feed and breed but also from an inherent instinct to wander. (from auth.)

- 84 Schoof, H.F. HOW FAR DO FLIES FLY? AND WHAT EFFECT DOES FLIGHT PATTERN HAVE ON THEIR CONTROL? Pest Control 27, 4 (1959) 16-24.

The report covers a number of fly dispersal studies conducted by investigators in Arizona, Oregon, West Virginia and Georgia. Flies were tagged by feeding on P³²-labelled milk-honey or sugar solutions (1 mc/1 of milk) for a 24-h period. Dispersal from each site proved random in pattern. Specimens congregate in areas or sites having suitable feeding or breeding sites. In some studies, flies liberated from several sites were dusted with different dyes. It was concluded that flies can move rapidly from site to site; overall movement of the population is from 1-2 miles for Musca domestica. Maximum dispersal distance for this species is 20 miles. Blow flies generally migrate farther and more rapidly than houseflies. Maximum dispersal distance for Phormia regina is 28 miles. Other species investigated were Callitroga macellaria, Ophyra leucostoma, O. aeneus, Phaenicia cuprina, P. sericata, P. caenolevis, Fannia pusio, Sarcophaga sueta, S. bullata, Muscina stabulans. In some instances abatement measures 0.5 to 1 mile around the periphery of a municipality will suffice for housefly control. With blow flies, control treatments 3 to 4 miles beyond the city may be necessary.

- 85 Shura-Bura, B.L., Ivanova, E.V., Omuchin, A.N., Glazunova, A. Ya., Shaikov, A.D. WAYS OF FLY DISPERSION FROM PLACES OF MASS BREEDING IN LENINGRAD. Rev. Ent. URSS 35, 2 (1956) 334-6. (Ent. Obozrenie). (In Russian)

The range of dispersal of flies from a garbage dump situated about half a mile from densely inhabited districts of Leningrad was studied between 22nd June and 25th July 1954. Identification of 2000 adults taken on the dump in June showed that Phormia (Protophormia) terraenovae R.-D., constitutes 82.5, 12.8, 2.0 and 0.5% of the population. Dishes of a bait consisting of a liquid mixture of sugar, yeast, flour and water,

with the addition of 10% meat paste and enough P^{32} as sodium phosphate to give a radioactivity of 1.8 mc/lb were exposed for 4 d on the dump, and it was found that about 8% of the first two species were rendered radioactive. Traps were subsequently operated at various distances from the dump, and radioactive examples of *P. terraenovae*, *Musca domestica*, *Muscina stabulans* and *L. caesar* were taken at distances ranging up to 2.86, 2.4, 1.3 and 2.86 miles, respectively. Dispersion occurred in all directions, but inhabited districts were the most attractive. It was mainly due to active flight, though many flies were carried for up to about five miles on vehicles. (RAE-B 45: 210, 1957)

- 86 Shura-Bura, B.L. EMPLOI DES ISOTOPES RADIOACTIFS DANS L'ÉTUDE DU RÔLE ÉPIDÉMIOLOGIQUE DES MOUCHES. *J. Hyg. Epidem. Microbiol. Immunol. (Prague)* 1 (1957) 249-55. (In French)
Cess pools in a town were labelled with P^{32} in $Na_2HP^{32}O_4$ solution. 0.8% of flies captured subsequently was found to be radioactive. Privy pits located not far from the town were marked similarly. Flies (*Musca domestica*) were found to move as far as 5 km from the pits towards the town. Maximal flight ranges were studied in another experiment. *M. domestica* covered as much as 3.84 km and, in a trial run in a sparsely populated area, up to 10.7 km. Other species of synanthropic flies behaved similarly. Sanitary measures (protection belts around towns), as at present, evidently need revision. On feeding flies a labelled culture of dysentery type Flexner 1/3 to 2/3 of the radioisotope was found in the intestinal content whilst the remainder had already been incorporated in the fly tissues. It is inferred that the insect digests the agent of dysentery and resorbs the radioactive phosphorus.
- 87 Shura-Bura, B.L., Shaikov, A.D., Ivanova, E.U., Glazunova, A. Ya., Mitryukova, M.S., Fedorova, K.G. SUR LE CARACTÈRE DE LA DISPERSION DE CERTAINES MOUCHES SYNANTHROPES À PARTIR DU LIEU DE LEUR MISE EN LIBERTÉ. *Rev. Ent. URSS* 37, 2 (1958) 336-346 (Ent. Obozrenie). (In Russian)
87 000 exemplaires de mouches (dont 50 000 exemplaires de *Musca domestica* L.) marquées avec du phosphate de Na radioactif, administré dans la nourriture, furent mises en liberté dans une localité peu peuplée des environs de Leningrad. Il a été capturé pendant les 2-12 jours suivants dans des localités voisines 281 exemplaires de ces mouches radioactives, soit environ 0,3% du total. La principale direction de leur migration a été vers Leningrad, la distance maximum parcourue de 15 km et la volée moyenne de migration de 1 km par h. (BS 20: 229962, 1959)
- 88 Smith, A.H., Bohart, R.M. EVALUATING FLY NUISANCE SOURCE. *Calif. Agric.* 10, 7 (1956) 11-12.
The results were obtained for a natural population. The test consisted of labelling flies with P^{32} by suspending 10 treated strings 3 ft long which had previously been soaked in a 5% sugar solution containing 3 mc P^{32} and then dried under a heat lamp. The strings were placed in a steer shed and left for 24 h. Fly populations from 4 nearby barns were sampled by using insecticide-treated strings. Seven percent of the flies in the steer shed were radioactive on the following day while only 1% and 0.5% were radioactive in the horse and the artificial insemination barn. No radioactive flies were found in the swine barn 1400 ft away, indicating very little dispersion under prevailing conditions.
- 89 Waldrop, R.H., Peel, R., Schoof, H.F. FLY MOVEMENT STUDY SHOWS BENEFITS OF CONTROL PROGRAM. *Mod. Sanit. Build. Maint.* 10, 9 (1958) 19, 43-5.
 P^{32} -labelled flies were released in 2 adjoining communities. The release sites could be distinguished by additional marking with dyes. Attached-bait-pan type traps were used. The resultant captures reflect the levels of sanitation existing in the particular area. Maximum benefits in fly control are only achieved if both communities undertake control programs.
- 90 Yates, W.W., Lindquist, A.W., Butts, J.S. FURTHER STUDIES OF DISPERSION OF FLIES TAGGED WITH RADIOACTIVE PHOSPHORIC ACID. *J. econ. Ent.* 45 (1952) 547-8.
This further study into flight habits was made on laboratory-reared flies which were fed radioactive phosphoric acid. Details are given. The investigation was made on *Phormia regina* (Meig.), *Musca domestica* (L.) and *Phaenicia* sp., their activity ranging from 200 to 8000 cpm/insect. A standard laboratory monitor equipped with a thin-walled Geiger-Müller tube was used for testing. Details of the type and spacing of traps are given, and the results of the various collections. Both sexes of *Phormia* were shown to have the capacity for long flight: a maximum of 8 miles was observed. The remarkable flight range of 20 miles was noted for *Musca domestica*.

Fruit flies

- 91 Barnes, M.M. RADIOTRACER LABELLING OF A NATURAL TEPHRITID POPULATION AND FLIGHT RANGE OF THE WALNUT HUSK FLY. Ann. ent. Soc. Amer. 52,1 (1959) 90-2.
About 15% of a naturally occurring population of *Rhagoletis suavis completa* Cress. in a 5-acre walnut grove in California were labelled within 26 h by spraying small areas of foliage on 15 trees with a water solution including 5% of a liquid maize protein hydrolysate, a powerful attractant, containing 0.05 mc P^{32} /ml. The recovery of radioactive flies in traps at various distances from the baited trees showed that populations redistributed themselves fairly rapidly through the grove and that the comparatively mature population there contributed about 7% of the individuals in the surrounding area, to a distance of 0.125 mile, and about the same proportion in an orchard 0.3 mile away. As labelled flies were caught almost a mile away in the third week after baiting, it is concluded that the species may easily spread a few miles in a season under reasonably favourable conditions. In the treated orchard, 56% of the females contained eggs, and radioactive eggs were readily collected from the walnuts. (RAE-A 48: 513, 1960)
- 92 Christenson, L.D., Foote, R.H. BIOLOGY OF FRUIT FLIES. Annu. Rev. Ent. 5 (1960) 171-92.
General review article covering representative fruit flies. Mention is made of a radioisotope study on the migration of *Ceratitis capitata*. A naturally emerging male tagged with P^{32} was recovered more than 20 miles away, with the distance traversed including at least 9 miles or more of open sea.
- 93 Jones, S.C., Wallace, L. CHERRY FRUIT FLY DISPERSION STUDIES. J. econ. Ent. 48,5 (1955) 616-7.
Investigations in Oregon in 1950 showed that P^{32} -labelled phosphoric acid could be combined with sucrose as a food for adults of *Rhagoletis cingulata* (Lw.) without shortening their life. The flies ingested the food readily, and those with an initial radioactivity of 6000 cpm could be detected for 6 weeks with a portable survey meter. There were considerable variations in the amount of radioactivity retained by individual flies, but 80 selected at random after feeding on radioactive sucrose for 2-4 days showed an average of 8893 cpm. Females that received heavy dosages of radioactive phosphoric acid failed to oviposit in cherries, and their excreta and the juice and pulp of the cherries caged with them became radioactive. On 16th July 1951, 2010 radioactive adults were released in a cherry orchard, and captures in traps containing ammonium carbonate, with an insect net or under trees sprayed with nicotine sulphate were made until 9th August. In all, 39 radioactive individuals were recovered, including 14 from the point of release, seven 205 ft away and one each 555 and 942 ft away; one was taken in another cherry orchard on the far side of a beet field, 560 ft from the release point.
- 94 Pimentel, D., Fay, R.W. DISPERSION OF RADIOACTIVELY TAGGED *DROSOPHILA* FROM PRIVY PRIVES. J. econ. Ent. 48,1 (1955) 19-22.
Three tests were carried out at Edcouch and Pharr, Texas, in 1951 to determine the extent to which *Drosophila* migrated from privy pits into houses, using flies marked with P^{32} . In the first test, treated baits were placed in the pits of 10 privies and marked flies were subsequently recovered in 8 of the 10 adjacent houses. In the second test, flies were trapped, marked, and released in a privy pit; during the following 4 nights marked specimens were recovered in houses and privy pits as far as 500 ft from the release point. In the third test approximately 1000 marked *D. melanogaster* were released in one privy pit, and 3000 marked *D. repleta* were released in another privy pit 100 ft away. Subsequent trapping indicated that both species dispersed rapidly from the release privies to other privies and houses in a nearby area. *Drosophila melanogaster* were recaptured as far as 500 ft from the release point and *D. repleta* almost 1000 ft from the release point. The three tests demonstrated there was extensive migration of *Drosophila* from privy pits to houses in the area studied. The indications were that a major portion of the *Drosophila* which were found in the houses had, at one time or another, frequented privies. (auth. summary)
- 95 Roan, C.C. TAGGING ORIENTAL FRUIT FLIES WITH RADIOACTIVE PHOSPHORUS FOR FIELD-MOVEMENT STUDIES. J. econ. Ent. 45, 5 (1952) 826-8.
Various methods of marking Diptera with radioactive phosphorus for field-movement studies were tested for use on *Dacus ferrugineus dorsalis* Hendel. In the first test, potassium dihydrogen phosphate containing P^{32} was added to the carrot medium used for routine rearing of the larvae at the rate of 0.1 or 0.34 μ C P^{32} /ml, and 500 eggs were placed on 200 ml of the mixture. Differences due to the two concentrations of P^{32} were not adequate to distinguish between individuals from different samples. However, the fruitflies were sufficiently radioactive to permit their identification in releases made at time intervals of the half-life of

P^{32} (14.3 d) by taking advantage of radioactivity decay and excretion losses. In the second test, 600 adults were kept without food or water for 24 h, allowed to feed for 24 or 48 h on a sugar solution containing $3.9 \mu\text{C } P^{32} / \text{ml}$, and then restored to the normal diet. Assays showed that the differences in radioactivity between the two groups were inadequate for positive identification of all adults according to the period of feeding. Assay of individuals at different intervals after marking showed that the rate of loss of radioactivity differed with the method of marking, probably owing to differences in the biochemical distribution and rate of turnover of the P^{32} . Females reared from marked larvae lost P^{32} more rapidly than the males, and 80 mg eggs collected from them 15 d after emergence gave a reading of 1000 cpm. Neither treated adults nor adults from treated larvae showed adverse effects from exposure to the different levels of radiation. Those from treated larvae resembled the normal laboratory strain in percentage emergence from pupae, fecundity, fertility, viability of larval progeny and length of life under laboratory conditions, and the use of P^{32} did not complicate normal rearing unduly.

* Rings 1953 - [65]

- 96 Steiner, L.F., Mitchell, W.C., Holloway, J.R., Nakagawa, S. LURE EFFICIENCY AND MOVEMENT STUDIES WITH TAGGED FRUIT FLIES. Bull. ent. Soc. Amer. 5, 3 (1959) 117, abstr. 66.

P^{32} was used for labelling several hundred thousand flies of all 3 species (Dacus orientalis Hendel, the Mediterranean fruit fly Ceratitidis capitata Wied., and the melon fly D. cucurbitae Coq.). Recoveries revealed flights up to 26 miles over 12 miles of ocean. Up to 55% recovery of released oriental fruit fly males occurred with methyl eugenol. One release of this species spread over an area of 100 sq. miles. Females spread as far as males with heaviest recaptures made downwind.

(Work to be published in near future, according to personal communication from the author, dated Aug. 7, 1962)

- 97 Warner, R.M. RADIOACTIVE TAGGING FOR TRACING MOVEMENTS OF DROSOPHILA. Calif. Fig. Inst. Proc. Annu. Res. Conf. 13 (1959) 35-7.

Forest insects

- 98 Beal, J.A. STATUS AND TRENDS IN FOREST INSECT RESEARCH IN THE UNITED STATES. p. 323-30 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 4. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Review article. Brief mention is made of radioisotope applications to forest insects. Tagged Dendroctonus engelmanni have been located underneath log bark up to 3 miles from the release point.

- 99 Godwin, P.A., Jaynes, H.A., Davis, J.M. THE DISPERSION OF RADIOACTIVELY TAGGED WHITE-PINE WEEVILS IN SMALL PLANTATIONS. J. econ. Ent. 50, 3 (1957) 264-6.

The overwintering females of Pissodes strobi (Peck) which infest white pine, Pinus strobus, disperse from their hibernation quarters and oviposit from mid-April to mid-June. Reports as to their capability of flight are conflicting, and as it affects the degree of control afforded by the sprays normally applied at their first appearance, 1600 adults were tagged with radioactive scandium (Sc^{46}), applied as the chloride in solution, and liberated under pine trees in a plantation 900 ft x 600 ft in area. The distribution pattern suggested the occurrence of direct uninterrupted flight of 300-400 ft, the distance from the release trees to the edge of the plantation, and total movement covering at least 724 ft. It is concluded that experimental plots should be separated from infested areas by at least 800 ft., and that the practice of spraying a few trees round the infested ones to remove the residual population is of doubtful value. A hardwood over-story appears to act as a mechanical barrier to penetration by the weevil.

- 100 Jaynes, H.A. SOME RECENT DEVELOPMENTS IN WHITE-PINE WEEVIL RESEARCH IN THE NORTHEAST. Bull. ent. Soc. Amer. 3, 3 (1957) 40, abstr. 19.

Spring emergence of white-pine weevil, Pissodes strobi (Peck), the most serious insect pest of eastern white pine, can now be predicted by using cumulative degree hours above 40°F. Dispersion of weevils in a small plantation has been recorded by tagging with a radioisotope. (from abstr.)

* Nagel and Davis 1956 - [64]

* Speers 1956 - [371]

- 101 Sullivan, C.R. USE OF RADIOACTIVE COBALT IN TRACING THE MOVEMENTS OF THE WHITE-PINE WEEVIL, *Plissodes strobi* PECK. (COLEOPTERA: CURCULIONIDAE). Canad. Ent. 85, 8 (1953) 273-6.

Since radioactive cobalt (Co^{60}) has a long half-life and emits gamma rays, a method was devised for tagging adults of *Plissodes strobi* (Peck) with it so as to facilitate studies of their behaviour during periods of their life when ordinary observation is difficult. The amount of Co^{60} applied per insect was found to be about 200 μ c for 47 of them, and about 500 for the rest. A plantation of white pine (*Pinus strobus*), 190 ft x 170 ft, in Ontario was divided into 9 ft squares, since it was calculated that the amount of Co^{60} applied would be sufficient for detection at a distance of 9 ft, and the 56 weevils were liberated on the evenings of 31st August and 1st September 1951. Two were removed after a week because of peeling of the cobalt, and on 1st November, 21 of the remainder were alive and had entered hibernation quarters; among the rest, 46% had died from unknown causes, as compared with 43.5% mortality among the controls. In spring, only 19% of the adults that entered hibernation were still alive, though the survival percentages among untreated adults caged in the open and in a closed group of white pines were 68 and 56, respectively; it is therefore concluded that the amount of Co^{60} used was excessive. The cellulose cement adhered well until spring, when peeling increased. In subsequent tests, cellulose acetate was combined with or replaced by Glyptal, with satisfactory results. (RAE-A 43: 70, 1955)

Grasshopper

- 102 Baldwin, W.F., Riordan, D.F., Smith, R.W. NOTE ON DISPERSAL OF RADIOACTIVE GRASSHOPPERS. Canad. Ent. 90, 6 (1958) 374-6.

A method is described for tagging grasshoppers with P^{32} in the form of $H_3P^{32}O_4$. Nymphs and adults of *Camnula pellucida* (Scudd.) had previously been found to disperse for up to 240 yd in 6 d when released on bare, cultivated fields but to be unable to orientate themselves towards a food supply. In 1953, tagged *Melanoplus bilatatus* (Wlk.) (mexicanus, auct.) were released at the centre of a 10-acre field, 8000 in the 3rd and 4th instars, and later 7500 adults. Adequate food was available. The range of movement under those conditions was found scarcely to exceed 30 yd in 3 weeks. The findings are discussed with respect to earlier experiments.

- 103 Riegert, P.W., Fuller, R.A., Putnam, L.G. STUDIES ON DISPERSAL OF GRASSHOPPERS (ACRIDIDAE). TAGGED WITH PHOSPHORUS-32. Can. Ent. 86, 5 (1954) 223-232.

P^{32} was shown to be a useful tag for field studies of grasshopper movement and dispersal over a relatively short period. About 15 000 - 20 000 individuals were conveniently tagged at a time by feeding on wheat seedlings, growing on an area of 4 ft² that had been sprayed with 50 cm³ solution containing 0.5 mc P^{32} . About 14% of the applied radioactivity was taken up and retained by the grasshopper. (RAE-A 44: 110, 1956)

Mealybug

- 104 Cornwell, P.B. SOME ASPECTS OF MEALYBUG BEHAVIOUR IN RELATION TO THE EFFICIENCY OF MEASURES FOR THE CONTROL OF VIRUS DISEASES OF CACAO IN THE GOLD COAST. Bull. ent. Res. 47, 1 (1956) 137-66.

The mealybug migration from infected slash is discussed, as are the results from tests on P^{32} -labelled mealybugs at various ages.

- 105 Cornwell, P.B. MOVEMENT OF THE VECTORS OF VIRUS DISEASES OF CACAO IN GHANA. I. CANOPY MOVEMENT IN AND BETWEEN TREES. Bull. ent. Res. 49, 3 (1958) 613-30.

An examination was made of the movements of *Pseudococcus njalensis* Laing, the dominant vector of swollen-shoot disease, on cacao in Ghana. The mobile population is composed almost entirely of first-instar nymphs (92%). Movement is initiated at about 23.5°C and activity becomes more pronounced at higher temperatures. Movement is maximal during mid-afternoon when many hundreds of insects become mobile on heavily infested trees. The density of mobile mealybugs increases from the base of the trunk and reaches a maximum at a few feet below the top of the canopy. Under experimental conditions, nymphs walked at least 28 ft in search of favourable feeding sites and their dispersion increased proportionately with the number of canopy bridges. On cacao, adults are occasionally carried by the ant, *Crematogaster striatula* Emery. Using insects labelled with P^{32} the assumption was confirmed that *P. njalensis* is capable of walking from tree to tree via the canopies of farmers' cacao. In a plantation of 8-year-old Amelonado cacao, 40%

of the branches were in contact at 4-ft spacing and about 20% at spacings between 5 and 7½ ft. No branches were in contact, where the trees were spaced more than 12 ft apart. At the closest spacing, the ratio between the number of mobile mealybugs that reached adjacent contact trees and those that did not was about 9:100, this ratio being reduced to 1 or 2:100 amongst trees growing 5 to 7½ ft. apart. The significance of the movement of mealybugs in the canopy in relation to virus spread is emphasized. Methods of preventing vector dispersal by pruning, wide spacing and interplanting with a secondary tree crop are discussed. The importance of a closed canopy in preventing attack on the trees by *Miridae* is stressed. (auth. summary)

- 106 Ward, A. A. OUTLINE OF THE USE OF RADIO-ISOTOPES AT THE WEST AFRICAN COCOA RESEARCH INSTITUTE. p.89-91 in "Radioisotopes". CSA publ. no. 28, Scientific Council for Africa South of the Sahara, Pretoria. 1957.

Article includes a brief review of the uses to which radioisotopes have been put in studies of the mealybugs (*Pseudococcus nyalensis*) that transmit the swollen-shoot virus disease of cacao in Ghana. In 1952, the mealybugs were placed on agar containing P^{32} , to estimate the interval before feeding began. The results indicated that the preliminary resting period was long and variable, which possibly explains the low and unequal percentages of transmission obtained when viruliferous mealybugs were artificially transferred in experiments. The results were confirmed in 1953, when mealybugs were allowed to feed on cacao seedlings with their roots in radioactive solution. The isotopes used in this were first Sr^{90} and then P^{32} . The latter was used in 1953-54 to assist in discovering the distances traversed by mealybugs dispersing from piles of slash from felled diseased cacao trees; the distance proved to be short. The uptake and translocation of P^{32} in cacao trees was also investigated, in connection with attempts to label mealybugs in their natural habitat in the tree-canopy. Application to the soil resulted in the most even distribution of radioactivity. (RAE-A 47: 511, 1959)

Mosquitoes

- 107 Aragão, M.B. UTILIZAÇÃO DO MOSQUITOS RADIOATIVOS NA AVALIAÇÃO DO RAIO DE VÔO. (Use of radioactive mosquitoes to determine flight-range). Rev. bras. Malariol. 5, 2 (1953) 137-43. (In Portug.)

Larvae were raised in a 1:10 000 solution of thorium nitrate. The abdomens of captured mosquitoes were burned and the ashes tested with G5 (Bford) nuclear track plates. Radioactive specimens were captured in all catching stations. The longest flight recorded was 800 m. (BA 28: 14876, 1954)

- 108 Bidlingmayer, W.L., Schoof, H.F. THE DISPERSAL CHARACTERISTICS OF THE SALT-MARCH MOSQUITO, *Aedes taeniorhynchus* (WIEDEMANN), NEAR SAVANNAH, GEORGIA. Mosquito News 17, 3 (1957) 202-12.

Mosquitoes were produced by collecting mosquito-egg - infested sod samples or by inducing captive ♀♀ to oviposit on soil media. Radioactive marking was done at the 3rd instar by $H_2^{32}O_4$. From a release of approx. 2 million radioactive *A. taeniorhynchus* near Savannah, Georgia, 428 marked specimens, of which 13% were ♂♂, were recovered. Recapture of tagged ♀♀ was made at the maximum distances of trap locations (18-21 miles). However, most of the radioactive ♀♀ (90%) were collected within 4 miles of the release point, the number of recoveries decreasing as the distance increased. Females were observed to bite readily prior to their departure from the release site. Radioactive ♂♂ *A. taeniorhynchus* were recovered at maximum distances of 12 miles and for periods of 12 to 20 days after release. The majority of the ♂♂ recaptures occurred near the release point, but recoveries were made at 2, 4, 8, 10 and 12 miles. Some results are also given for *A. sollicitans*.

- 109 Bruce-Chwatt, L.J. RADIOISOTOPES FOR RESEARCH ON AND CONTROL OF MOSQUITOES. Bull. World Health Org. 15, 3-5 (1956) 491-511.

Review article. The application of radioisotopes to studies concerned with Anopheline control is discussed, particularly in connection with ecological problems which cannot be solved by other means. Larvae of *Aedes aegypti* (L.) were labelled by immersion. Both P^{32} and Sr^{90} were readily absorbed; in view of their half-lives of 04, 3 and 64 days, Sr^{90} is preferable because of its slower rate of decay. The flight ranges of various mosquitoes have been determined by means of radiotracers (references included). Methods of labelling with radioisotopes are described, and observations on physiological and biological effects of radiation mentioned. The use of radiotracers in the study of insecticides is discussed, with numerous examples. A promising use of tracers would appear to lie in the determination of the area of dispersal aerosols dispensed from aircraft by means of isotopes with strong radiation incorporated into the insecticides.

- 110 Jenkins, D.W., Hassett, C.C. DISPERSAL AND FLIGHT RANGE OF SUBARCTIC MOSQUITOES MARKED WITH RADIOPHOSPHORUS. Canad. J. Res. D-Canad. J. Zool. 29, 3 (1951) 178-87.
- The dispersal and flight range of *Aedes communis* (Deg.), a mosquito characteristic of the northern coniferous forest, were studied at the timberline at Churchill, Manitoba, during the summer of 1950. Four million larvae were collected and reared in four shallow wooden tanks containing a total of 1200 l water, and P^{32} in the form of a solution of $KH_2P^{32}O_4$ was added at a total rate of 206.3 mc P^{32} (0.05 μ c/larva) as soon as the larvae reached the late 4th instar. About 3 million adults with an average radioactivity of 775 cpm emerged and dispersed in the Warkworth area. Of the 141 radioactive mosquitoes recovered in the course of 6 weeks, 63 had dispersed 150 - 5000 ft, the average dispersal being 500 ft. A possible variable results from the presumed occurrence of two races of *A. communis* in the Churchill area; the larger adults dispersed further than the more numerous smaller ones. The effective dispersal (dispersal in numbers sufficient to constitute a pest) was determined to be about a quarter of a mile. This study indicates that *A. communis* is a relatively sedentary mosquito and has a limited flight range in the northern coniferous forest in comparison with arctic tundra species. It rests in vegetation and does not attack man during the daytime. Additional data are given on the habits of this and other northern species of mosquitoes. (RAE-B 40: 134-135, 1952)
- 111 Provost, M.W. THE DISPERSAL OF *AEDES TAENIORHYNCHUS*. I. PRELIMINARY STUDIES. Mosquito News 12 (1952) 174-90.
- Radioactive *A. taeniorhynchus* adults were produced by exposing the larvae to P^{32} . The subsequent dispersion from Sanibel Island, Florida, was studied from the time and space distribution of marked recapture. Other collecting methods were used but only light traps yielded significant numbers of recoveries. Migration, as a special non-purposive flight, occurs from 1-4 d after emergence. This initial exodus carried females to the limits of the collecting area, 20 miles, and probably beyond. The males probably did not migrate beyond 2 miles. This main flight was deflected to the northwestward, possibly by prevailing southeasterly winds and by the NW-SE alignment of the coastline and topography. Light traps collected females on a 5-d cycle of numbers; the last one was caught 19 d after emergence. Males entered light traps the first 3 d only after emergence. There is some indication that females may migrate early in each 5-d progenitive period. Dispersion of female *A. taeniorhynchus* appears to be random, omnidirectional, and appetential, periodically repeated from foci established by a previous migratory channeled, non-appetential dispersal. Males accompany the females on the initial exodus but probably drop out of the migration within a mile or two and thereafter settle down to a sedentary life characterized by swarming during twilight periods for 2-3 weeks. (from auth. summary)
- 112 Provost, M.W. THE DISPERSAL OF *AEDES TAENIORHYNCHUS*. II. THE SECOND EXPERIMENT. Mosquito News 17 (1957) 233-47.
- A technique was developed for producing large numbers of *A. taeniorhynchus* in the field under controlled conditions. The *Phloxenus* sod in egg-laden swale was cut out and transported to a "nursery" pool when water was immediately pumped in and the sods flooded. A yield of 2 1/4 million mosquitoes were obtained. Larvae were then transferred from "nursery" to wooden vats for P^{32} -introduction. 1 1/2 million radioactive mosquitoes were then allowed to disperse freely from the middle of Sanibel Island. Females were recovered up to 25 miles away and until the 24th night after emergence. Only a few males were recovered, all within 3 mi. The dispersal was generally downwind. It was considered that migration occurs the night of departure only, the twilight departures resulting in longer migrations than middle-of-the night departures. Appetential flights expand the range of occupation by a brood much beyond what is established by the migration.
- 113 Provost, M.W. THE DISPERSAL OF *AEDES TAENIORHYNCHUS*. III. STUDY METHODS FOR MIGRATORY STUDIES. Mosquito News 20, 2 (1960) 148-61.
- Two field studies of the migratory exodus in the salt-marsh mosquito, *A. taeniorhynchus*, in Florida are described. Techniques described from the Ft. Pierce 1952 study are: (1) inducing mosquitoes in nature to lay their eggs where they can be gathered, in this case 3 million eggs were laid on 1280 ft² of sod; (2) production of larvae by flooding egg-laden sods placed on the bottom of specially dug pools; (3) marking the larvae, and resultant adults, with radioactive phosphorus, emphasizing the inter-relationship of larval feeding and P^{32} dosage in affecting degree of marking; and (4) recovering of departing mosquitoes in directional, stationary nets to learn direction and angle of migratory exodus. The Vero Beach 1958 study involved the following described techniques: (1) sampling the resting population at the emergence site for determination of age, sexual state, feeding state; (2) sampling the departing mosquitoes by sticky nets and kyttoon net. In the Vero Beach experiment emphasis is placed on the coordination of field observational techniques, field collecting techniques, and laboratory examination techniques. (auth.)

- 114 Quarterman, K.D., Jensen, J.A., Mathis, W., Smith, W. FLIGHT DISPERSAL OF RICE FIELD MOSQUITOES IN ARKANSAS. J. econ. Ent. 48, 1 (1955) 30-2.
- Using field-collected mosquitoes which were tagged with P^{32} in the larval and adult stages, preliminary studies were made on the flight habits of rice field mosquitoes, *Psorophora* spp., in the Grand Prairie section of Arkansas. Efforts at mass-rearing of field-collected early 4th instar *Psorophora* larvae for tagging with P^{32} were only partially successful. Marked rice field mosquitoes dispersed in many directions from the release point, but tended to move mostly with the wind. *Psorophora confinnis* travelled at least 6 miles and traversed heavily wooded areas over 1 mile in width. *P. discolor* was recovered up to 1.5 miles from the release site, but the number of specimens of this species, tagged and recovered, was too low to provide significant information on its flight habits. (auth. summary)
- 115 Shemanchuk, J.A., Fredeen, F.J.H., Kristjanson, A.M. STUDIES ON FLIGHT RANGE AND DISPERSAL HABITS OF *Aedes flavescens* (MÜLLER) (DIPTERA: CULICIDAE) TAGGED WITH RADIO-PHOSPHORUS. Canad. Ent. 87, 9 (1955) 376-9.
- About 415 000 larvae of *Aedes flavescens* (Müll.) were collected from sloughs at Indi (Saskatchewan) in May 1952, kept in tubs in water containing $0.1 \mu\text{C } P^{32}/\text{ml}$ for periods (19-45 h) long enough for the average radioactivity of sample larvae to exceed 3000 cpm, and then returned to one of their natural habitats. The batches of tagged larvae were released daily from May 10-15, and about 1 500 000 adults collected with hand nets between May 17 and June 20 at up to 14 miles from the release site. These included 82 tagged mosquitoes (0.02% of the tagged larvae), all of which were obtained between May 21 and June 6, and at distances from the release site ranging up to 6.6 miles for females and 1400 yd for males. The average radioactivity of the tagged larvae and adults were 8130 and 640 disintegrations per minute, respectively, indicating a loss of 93% of the original radioactivity, of which about 58% could be accounted for by decay of the P^{32} . It was observed in this experiment that the larvae needed the longer periods of treatment to acquire adequate radioactivity when the weather was cool, and the effect of temperature was confirmed by a laboratory test in which disintegration per minute for larvae kept for 15, 40 and 60 h in pond water containing $0.1 \mu\text{C } P^{32}/\text{ml}$ at 34 and (in brackets) 76°F were 1250 (33 000), 2860 (82 200) and 3320 (121 000). Of larvae kept for 24 h in water containing 1 and $0.1 \mu\text{C } P^{32}/\text{ml}$, 100 and 41% died in 4 d, while control mortality was 36.5%. Treatment at $0.1 \mu\text{C}$ retarded the emergence of adults by about 3 d, but did not appreciably affect their life-span. (from RAE-B 45: 95, 1957)
- 116 Shura-Bura, B.L. AN ATTEMPT TO STUDY THE MIGRATION OF HOUSE FLIES BY USING RADIOACTIVE TRACERS. Zool. Zh. 31, 3 (1952) 410-2. (In Russian).
- 117 Шура-Бура, Б.Л. ОПЫТ ИЗУЧЕНИЯ МИГРАЦИИ МУХ СО СВАЛКИ МЕТОДОМ МЕЧЕННЫХ АТОМОВ. Гигиена и Санитария 9 (1955) 12-5.
- В статье освещаются вопросы о правильной организации мероприятий по борьбе с комнатной мухой и, в основном, вопрос о естественных миграциях мух. При помощи метода радиоактивных индикаторов получены доказательства миграции мух со свалки в жилые кварталы города и в расположенные на его окраине посёлки. Миграция мух со свалки происходит как путем активного полета, так и пассивно с транспортом, вывозившим отбросы. Предельная дальность миграции прослежена на расстояниях до 5 км.
- Shura-Bura, B.L. STUDYING FLY MIGRATION FROM A GARBAGE DISPOSAL DUMP BY THE TRACER TECHNIQUE. Hyg. & Sanit. Moscow 9 (1955) 12-5.
- Possible effective measures against *Musca domestica* are discussed and the problem of its natural migration. Data are given on migration from the dump to the living-quarters and outskirts of cities. The migration habits were studied by means of tracer techniques. Migration is effected both actively, by their flight, and through transporting the garbage. The maximum distance of fly migration was 5 km.
- 118 Thurman, D.C., Husbands, R.C. PRELIMINARY REPORT ON MOSQUITO FLIGHT DISPERSAL STUDIES WITH RADIOISOTOPES IN CALIFORNIA, 1950. US Pub. Health Serv. CDC Bull. 10, 4 (1951) 1-9.
- Large scale tagging of mosquitoes with P^{32} was effected near Turlock, California. Of the approximately 400 000 mosquitoes about 90% were *Aedes nigromaculis* (Lud.) The mosquitoes in the release area were recovered by means of light traps, and an aspirator technique collected them off people. A total of 475 tagged mosquitoes were recovered; 17 were taken between 0.75-1 mile from the release point, and 10 between 1 and 2 miles.

- 119 Washburn, G.E. PROGRESS REPORT ON MOSQUITO STUDIES IN CALIFORNIA. Mosquito News 12, 4 (1952) 235-8.

Various studies on problems of mosquito control by different workers are reported. Flight studies were carried out on Aedes nigromaculis in which the dye Rhodamine "B" and P^{32} were used.

- 120 Welch, H.E. TWO APPLICATIONS OF A METHOD OF DETERMINING THE ERROR OF POPULATION ESTIMATES OF MOSQUITO LARVAE BY MARK AND RECAPTURE TECHNIQUE. Ecology 41 (1960) 228-9.

A method for determining the error of population estimates is outlined, and used to test the decrease in density of prey described by Baldwin, James and Welch (1955), and to compare larval densities in permanent and temporary pools. The earlier work had used radioactive larvae, labelled by means of $H_2P^{32}O_4$. The technique and analysis are easy to use in the field. It is important that a) a large number of larvae be tagged; b) the experiment be of short duration; and c) as many samples as possible be taken. The technique is in general more satisfactory in permanent or discrete pools.

Various

- * Arason, Fuller and Spinks 1950 - [350]
- 121 Cherepanov, A.I., Volgina, K.P. DETERMINING THE MOVEMENT OF WIREWORMS IN THE SOIL BY THE METHOD OF TAGGED ATOMS. Dokl. Akad. Nauk SSSR, 98 (1954) 301-2. (In Russian).

Agriotes obscurus was used in this study.

- * Courtois and Lecomte 1958 - [353]
- 122 Dow, R.P. DISPERSAL OF ADULT HIPPELATES PUSIO, THE EYE GNAT. Ann. ent. Soc. Amer. 52 (1959) 372-81.

Female eye gnats maintained on honey in the laboratory retained more than half their original radioactivity 5 days after being tagged with P^{32} . When tagged gnats were released at the center of three concentric circles of traps on a windy day, some moved 25 ft directly upwind but an equally large number was caught 75 ft downwind in traps on the outermost circle, on both sides of the mean downwind direction. Releases of tagged gnats $\frac{1}{2}$ and 1 mile from a rural population center in southwestern Georgia resulted in almost complete penetration of the small town on the day of release. In one test, traps more than a mile from the release box caught 15 gnats in less than $3\frac{1}{2}$ h after it was opened. Chi-square analysis was used to test the hypothesis that tagged gnats are distributed like the wild ones. Local departures from an overall equilibrium between tagged and untagged gnats could be recognized, and progress of the dispersal could be followed by comparing successive collections. (auth.)

- * Foott 1954 - [333]
- * Fuller et al. 1951 - [358]
- 123 Green, G.W., Baldwin, W.F., Sullivan, C.R. THE USE OF RADIOACTIVE COBALT IN STUDIES OF THE DISPERSAL OF ADULT FEMALES OF THE EUROPEAN PINE SHOOT MOTH, RHYACIONIA BUOLIANA (SCHIFF.). Canad. Ent. 89, 8 (1957) 379-83.

A solution containing Co^{60} as nitrate was applied to the first 7 abdominal segments of the pine shoot moth which had been anesthetized with CO_2 . The majority of insects carried 25-50 μc of Co^{60} . Tagging appeared to have no effect on behaviour, life expectancy or reproduction. Recoveries indicated that the insects tended to remain in the stand of pine in which they were released. Radioactivity was subsequently detected in bird droppings, pine needles, and preying insects. Dispersal of the moths was never beyond 50 m from the point of release, in spite of strong counter winds.

- * Kannoowski 1959 - [62]
- * Kartman et al. 1958 - [406]
- 124 Kettlewell, H.B.D. USE OF RADIOACTIVE TRACER IN THE STUDY OF INSECT POPULATIONS (LEPIDOPTERA). Nature 170 (1952) 584-5.

The species studied were Panaxia dominula and Arctia caja. The food plants selected for them were dead nettle (Lamium spp.) and dock (Rumex spp.) respectively, and these were treated with S^{32} . The radioactive imagines hatched gave counts far in excess of those observed from the larvae and pupae, probably due to a much greater surface. Methods are discussed possibly useful for ascertaining mortality, total populations, larval death-rates, dispersal activity, and other aspects of population dynamics as well as pigment chemistry in many orders of insects.

- 125 Lebedev, D.V. STUDY ON THE MIGRATION OF TAGGED WIREWORMS IN SOIL. Priroda 12 (1950) 56-7. (In Russian)
- 126 Mulla, M.S., March, R.B. FLIGHT RANGE, DISPERSAL PATTERNS AND POPULATION DENSITY OF THE EYE GNAT, HIPPELATES COLLUSOR. Ann. ent. Soc. Amer. 52 (1959) 641-6.
- Gnats tagged with P^{32} , released in the Palm Desert and Indio areas of the Coachella Valley in southern California, generally dispersed into agricultural areas and adjacent residential sections where favourable conditions existed for their feeding and breeding activities. They avoided virgin desert and barren hills, but were found to half a mile of desert to suitable habitats on the far side. Dispersal occurred both upwind and downwind, but the greatest distance travelled in both experiments (4.1 and 4.3 miles, respectively) was with the wind. In one experiment, the population density was estimated at 3-5 000 gnats/acre. Gnats were found resting at night on dry or damp ground, on soil clods, on dried rootlets protruding above ground, and on foliage of low-growing plants. (auth.)
- 127 Stern, V.M., Schlinger, E.I. A STUDY OF THE DISPERSAL HABITS OF TRICHOGRAMMA FASCIATUM PERKINS USING RADIO-ACTIVE P^{32} . Bull. ent. Soc. Amer. 6,3 (1960) 153, abstr. 80.
- Trichogramma fasciatum is a key parasite of certain field crop pests in California. Its dispersal habits were studied by feeding individuals P^{32} mixed in honey. In one test two million individuals were released and in a second test ten million individuals.
- 128 Walker, D., Harwood, R., Groves, K. DETERMINING INSECT POPULATIONS IN EMPTY GRAIN BINS BY THE USE OF P^{32} . Bull. ent. Soc. Amer. 2,3 (1956) 25, abstr. 5.
- Lots of 1000 red flour beetles, Tribolium confusum, each tagged with P^{32} -labelled phosphate were released in empty grain bins which were subsequently sprayed with DDT as a residual spray. Tagged insects were recovered from 17 of the 30 bins so treated in 1955 and from 9 of the 34 bins in 1956. The actual numbers of insects originally in the bin were calculated on the basis of the ratio of the number of radioactive insects recovered to the total number of insects recovered. Considerable variation was found in the numbers of insects and the various species in different bins.

- * Banks 1957 - [60]
- * Banks and Nixon 1958 - [21]

I-A-4 PARASITES AND PREDATORS

- * Ahmed et al. 1954 - [732]
- * Auerbach 1958 - [2]
- 129 Baldwin, W.F., James, H.G., Welch, H.E. STUDY OF PREDATORS OF MOSQUITO LARVAE AND PUPAE WITH A RADIOACTIVE TRACER. Canad. Ent. 87 (1955) 350-5.
- The prey-predator relationship of Aedes stimulans (Wlk.) and A. trichurus (Dyar) at Chatterton, Ontario, were investigated by P^{32} . Larvae and pupae were made radioactive by placing them in $H_2P^{32}O_4$ at 0.05 μ C/ml, the larval density in the trays being ca. 200 larvae/litre. The larvae were left for 2 more days in fresh pond water to rid themselves of radioactive excreta, then examined or returned to the ponds. Several species of pond animals were found to be predators of larvae and pupae. The importance of these predators in control was evident from the numbers that become radioactive, and also from the high radioactivity of certain species, dytiscids and limnephilids being the most important. Three new records of mosquito predators were obtained, Limnephilus indidivus Wlk. amongst them. As the generations of pond animals developed, more predators fed on the mosquitoes. The resulting decrease in the population density of the mosquitoes coincided with the increase in the density of the predators.

- 130 Cunliffe, F. BIOLOGY OF THE COCKROACH PARASITE PIMELIAPHILUS PODAPOLIPHAGUS TRAGARDH, WITH A DISCUSSION OF THE GENERA PIMELIAPHILUS AND HIRSTIELLA (ACARINA, PTERYGOSOMIDAE). Proc. ent. Soc. Washington 54, 4 (1952) 153-69.
- A species of mite, P. podapoliphagus, was found to be parasitic rather than commensal in habit when the mites became radioactive after feeding on roaches which had been fed on radioactive salt. The use of radioactive salts in studying its host-parasite relationship is described. Its relationship to the lizard mite is discussed. P. triatoma, from Triatoma infestans, Chile, is new; brief diagnoses are given of P. podapoliphagus and P. isometri. The relationship of Hirstiella to Pimeliaphilus is discussed. H. bakeri from Iguana, Calif. California, and H. boneti from Ctenosaura multispinis, Nebraska, are new; brief diagnoses are given for H. insignis, H. trombidiformis, H. pelaezi, and H. tenuipes. Keys to the spp. in both genera are given.
- 131 George, K.S. PRELIMINARY INVESTIGATION ON THE BIOLOGY AND ECOLOGY OF THE PARASITES AND PREDATORS OF BREVICORYNE BRASSICAE (L.). Bull. ent. Res. 48, 3 (1957) 619-29.
- P^{32} was applied to turnip seedlings. Brevicoryne brassicae feeding on them became radioactive. Parasites bred through the aphids also became radioactive. On subsequent breeding in other aphids no counts were obtained. The experiment was designed to test the specificity of aphid parasites. It was concluded that at the existing level of contamination by radio-phosphorus insufficient deposits are made in the eggs for detection.
- (The tracer experiment forms only a small part of the whole paper)
- * Güsswald 1959 - [52]
- * Ibid 1959 - [53]
- 132 Grosch, D.S., Sullivan, R.L. SEQUELAE OF REARING HABROBRACON ON RADIOACTIVE HOST LARVAE, Growth 18 (1954) 191-205.
- P^{32} at 48 dilutions was injected by capillary needle into paralyzed Ephestia larvae. Habrobracon eggs were then transferred to these hosts as well as to controls, both injected and non-injected. Radioactive food did not affect hatchability significantly although deleterious effects appeared at later developmental crises. Most noticeable was the failure of treated braconids to accomplish metamorphosis. The degree of lethality was related to the level of treatment. At higher dosages a developmental delay appears for the survivors along with increased frequency of developmental abnormality of treated males. Females, the diploid type, were more radioresistant (metamorphosis and structural abnormalities). The life span of males achieving adulthood was not affected nor was there any apparent influence on F_1 egg production although embryo survival appeared slightly decreased. The discussion points out similarities between internal irradiation and irradiation from external sources. The question of different periods of sensitivity for developing structures as well as the variability due to leakage from an injection site are discussed. (from auth.)
- * Jenkins and Hassett 1950 - [808]
- * Jenkins and Knight 1950 - [61]
- * Kartman et al. 1958 - [406]
- * Kuper and Peic 1952 - [405]
- * Nagel 1959 - [70]
- 133 Narayanan, E.S. THE PHENOMENA OF INSECT PARASITISM AND THEIR PRACTICAL UTILISATION IN THE BIOLOGICAL CONTROL OF INSECT PESTS. Proc. Indian Soc. Congr. 44, 2 (1957) 167-89.
- The usefulness is stressed of morphological, biological and ecological studies of the insects in question. Cases of multi- and super-parasitism, and genetic factors are considered, and the use of radioisotope labelling. Examples of biological control are given. 106 references altogether.
- 134 Narayanan, E.S., Ratan Lal, Rahalkar, G.W., Serhi, G.R., Saxena, P.N. LABELLING OF ADULTS OF AN INSECT PARASITE BRACON GELECHIAE ASHMEAD WITH RADIOACTIVE PHOSPHORUS (P^{32}). Proc. Indian Acad. Sci., Sec. B: 49, 3 (1959) 149-55.

Labelling of the adults of Bracon gelechia by allowing them to feed on 10% glucose solution containing phosphoric acid (H_3PO_4) with P^{32} is not practicable as the adult parasites are unable to pick up enough radioactivity. On the other hand, labelling of the adults by rearing them on host caterpillars of Coreyra cephalonica, the latter being fed on crushed maize mixed with radioactive phosphoric acid, is quite a convenient and satisfactory method for the purpose of mass release of the parasite under natural conditions. Such individuals show a tolerably high degree of radioactivity and are therefore easy to detect. Moreover, the developmental period of the parasite by rearing it on radioactive host caterpillars is not adversely affected and the adults remain alive for a considerable period. (auth. summary)

* Pendleton and Grundmann 1954 - [30]

- 135 Quednau, W. RADIOAKTIVE MARKIERUNG VON SCHLUPFWESPEN (Radioactive labelling of certain hymenoptera). Atompraxis 6, 10/11 (1960) 427-31. (In German)

The uptake of P^{32} is possible during the parasite's (Hymenoptera) development in the radioactive host. The contamination by 1.6 mc per 3 l of nutrient solution was as follows: leaf sample 89 000 cpm, aphids of first generation 29 000 cpm, aphids of second generation 15 000 cpm, parasites 3 600 cpm (at the saturation point). The transmission of 150 cpm into the host eggs parasitized by labelled Trichogramma proved to be adequate for a distinction from hosts which could be naturally infested. (auth.)

* Spinks 1958 - [14]

* Stern and Schlinger 1960 - [400]

I-B Insect Physiology and Metabolism

I-B-1 CARBOHYDRATES

- 136 Avi-Dor, Y., Gonda, O. STUDIES ON THE ADENOSINETRIPHOSPHATE - PHOSPHATE EXCHANGE AND THE HYDROLYSIS OF ADENOSINETRIPHOSPHATE CATALYZED BY A PARTICULATE FRACTION FROM THE MOSQUITO. Biochem. J. 72 (1959) 8-14.

ATP and the enzyme system catalyzing the incorporation of P^{32} into ATP have been studied in respiratory particles prepared from the mosquito Aedes aegypti L. Addition of ethylenediaminetetra-acetic acid to the isolation medium and of ethylenediaminetetra-acetic acid and albumin either to the washing liquid or to the assay medium have been found obligatory for the exchange reaction. The effect of nucleotides, respiratory inhibitors and inhibitors of oxidative phosphorylation on the exchange reaction and the ATP activity has been investigated. Quantitative differences exist between the response of insect and mammalian respiratory particles to 1,1,1-trichloro-2,2-di-(p-chlorophenyl)-ethane (DDT). 0.1 mM DDT inhibits the exchange reaction by more than 50% in insect sarcosomes whereas the inhibition in mammalian liver mitochondria is less than 10%. (auth. summary)

- 137 Candy, D.J., Kilby, B.A. SITE AND MODE OF TREHALOSE BIOSYNTHESIS IN THE LOCUST. Nature 183 (1959) 1594-5.

A short note reports results of a study on trehalose biosynthesis. The authors have shown the locust fat body to be an important site. Generally labelled D-glucose- C^{14} was incubated with fat-body tissue from Schistocerca (5th instar) and the products examined by paper chromatography. Hemolymph, leg muscle, fore, mid and hind gut tissues were also tested but found to be largely inactive in converting glucose into trehalose. The probable mode of biosynthesis is discussed.

- 138 Gonda, O., Kaluszyn, A., Avi-Dor, Y. EFFECT OF 1 : 1 : 1-TRICHLORO-2 : 2-DI-(p-CHLOROPHENYL) ETHANE (DDT) AND RELATED COMPOUNDS ON THE ADENOSINE TRIPHOSPHATE - PHOSPHATE EXCHANGE CATALYSED BY A PARTICULATE FRACTION FROM THE MOSQUITO. Biochem. J. 73, 4 (1959) 583-7.

The effect of the above compound and its analogues on the ATP- P^{32} exchange reaction in mosquito [Aedes aegypti (L.)] sarcosomes has been compared. All analogues of DDT tested inhibited the exchange reaction to nearly the same extent when the concentration in the particles reached the same level. No correlation was found between the toxicity for mosquito larvae of the compounds tested and their effect in vitro on

the exchange reaction. The analogue tested included: 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane, 1,1,1-trichloro-2,2-bis(p-methoxyphenyl)ethane, 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene, bis(p-chlorophenyl)acetic acid, 1,1,1,2-tetrachloro-2,2-bis(p-chlorophenyl)ethane, 1,1-bis(p-chlorophenyl)ethanol, 1,1,1-trichloro-2,2-diphenylethane, 1,1-bis(p-chlorophenyl)-2,2,2-trifluoroethanol, and 1,1-bis(p-chlorophenyl)-2,2,2-trichloroethyl acetate.

- 139 Gray, R.A. COMPOSITION OF HONEYDEW EXCRETED BY PINEAPPLE MEALYBUGS. Science **115** (1952) 129-33.

The general view that plant-sucking insects which excrete copious quantities of excess carbohydrates in their honeydew must take in large amounts of plant juice in order to get sufficient amounts of amino acids and proteins, was not found to be the case with pine apple mealybugs. Relatively large amounts of as many as 19 different amino acids have been found in the honeydew excreted by pineapple mealybugs (*Pseudococcus brevipes*, Kell.) by the method of paper chromatography. The number of amino acids excreted was shown to increase with the period of feeding. Sixteen amino components of the honey dew have been identified from their R_f values. Three ninhydrin spots have not been identified. At least 5 amino acids were found in the honeydew which were not found in the food source. The carbohydrate components identified by different sprays and radiograms of radioactive honeydew were fructose, glucose, sucrose, glucose-1-phosphate, and possibly maltose. Malic acid, citric acid, and salts of citric acid were also found.

- 140 Hassett, C.C. TRANSFORMATION OF HEXOSEPHOSPHATES BY THE COCKROACH. Fed. Proc. **10**, 1 (1951) 61.

Fructose diphosphate, glucose-1-phosphate, glucose-6-phosphate, and fructose-6-phosphate passed from the intestine to the muscle in rates which decreased in the above order. P^{32} -labelled compounds were used. (BA 25: 26759, 1951).

- 141 Hassett, C.C., Summerson, W.H., Solomon, F. A BIOSYNTHESIS OF C^{14} -LABELLED GLYCOGEN. Nucleonics **12**, 4 (1954) 59-60.

Newly emerged adults of *Drosophila melanogaster* are known to be low in glycogen. When ample food is available the glycogen content increases rapidly in the first few days. Unfed adults less than 24 h old were exposed to an atmosphere containing $C^{14}O_2$. Experimental details are given, and of the steps taken to identify the radioactive carbohydrate obtained as glycogen. The mechanism of labelling and the positions occupied by the C^{14} (presumably random) were not investigated.

- * Nourteva and Reinius 1953 - [35]

- 142 Novotný, I. THE EFFECT OF UNCOUPLING AGENTS ON THE METABOLISM OF INSECT MUSCLE, p.660-3 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960". Vol.1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Sohne, 1962.

The study was aimed at finding the conditions under which the uncoupling agents provoke increased metabolic rates and at determining the resultant changes in carbohydrate and phosphate metabolism. *Periplaneta americana* was used. Stimulation of glycolysis was observed, and two independent regulatory reactions appear to take place resulting from dinitrophenol. Attention is focused on phosphate metabolism. A special technique is cited for studying it in intact muscle preparations. The animals were injected with P^{32} -labelled Ringer solution and left for 4 or more days to ensure equal labelling in all P compounds. Subsequent steps consisted of freezing and pulverizing in liquid air, separation of individual P compounds by paper ionophoresis and estimating the activity preferably after elution from individual parts of the paper after autoradiography. The changes in phosphate compounds after application of 2,4-dinitrophenol are very profound. Within 20 min of injecting 10^{-3} M dinitrophenol there is a pronounced decrease in high energy phosphate compounds, accompanied by an increase in anorganic phosphate. The change in ADP is small. The ATP:ADP ratio shifts in favour of ADP, with a simultaneous increase in α -glycerophosphate. Tentative explanations of the mechanism of dinitrophenol action on muscle are offered.

- 143 Treheme, J.E. GLUCOSE ABSORPTION IN THE COCKROACH. J. exp. Biol. **34** (1957) 478-485.

The absorption of glucose from the gut of the cockroach, *Periplaneta americana*, was studied by feeding starved insects with C^{14} -labelled glucose together with a dye, Amaranth. This dye is not absorbed from the lumen of the intestine, and the net percentage glucose absorption was calculated from the glucose/dye

ratio in various parts of the intestine. Glucose absorption is largely confined to the mid-gut ceca. The rate of crop emptying, which is an exponential function of time, is related to glucose concentration, so that the amount of fluid leaving the crop decreases with increasing concentration. This effect is determined by the osmotic pressure of the ingested fluid. Total glucose absorption shows a linear relation with crop emptying, suggesting that crop emptying is the limiting process in glucose absorption. (from CA 52: 4040e, 1958)

- 144 Treherne, J.E. FACILITATED DIFFUSION AND EXCHANGE IN THE ABSORPTION OF GLUCOSE BY THE LOCUST, SCHISTOCERCA GREGARIA (FORSK.). Nature 181 (1958) 1280-1.

Preliminary account of investigation into the movement of glucose between the gut and the hemolymph at low concentrations. The uptake of C^{14} -labelled glucose was studied under conditions in which the specific activity of labelled glucose in the hemolymph, where it is in equilibrium with trehalose approximated to that in the gut lumen. The results were compared with those for the uptake of labelled glucose by insects initially containing no radioactive material in the hemolymph.

- 145 Treherne, J.E. THE ABSORPTION OF GLUCOSE FROM THE ALIMENTARY CANAL OF THE LOCUST SCHISTOCERCA GREGARIA. J. exp. Biol. 35 (1958) 297-306.

The absorption of glucose was studied by filling the gut with a saline solution containing C^{14} -labelled glucose together with a dye, Amaranth, which was used as a marker. The net percentage absorption was calculated from the glucose/dye ratio in various parts of the alimentary canal. Most of the glucose was absorbed from the mid-gut ceca, lesser amounts by the ventriculus. The percentage absorption was similar at concentrations of 0.002 and 0.02 M, but was significantly less at 0.20 M. The absorbed glucose was rapidly converted to trehalose in the hemolymph. At the high concentration this mechanism became saturated and the excess glucose accumulated in the hemolymph. The absorption *in vitro* from a gut suspended in saline containing KCN and iodoacetic acid was similar to that in the intact insect. Glucose is apparently absorbed by diffusion across the gut wall and this process is facilitated by rapid conversion to trehalose in the hemolymph, which tends to maintain a steep concentration gradient across the gut wall. (CA 52: 20705c, 1958)

- 146 Treherne, J.E. THE ABSORPTION AND METABOLISM OF SOME SUGARS IN THE LOCUST, SCHISTOCERCA GREGARIA (FORSK.). J. exp. Biol. 35, 3 (1958) 611-25.

The uptake of C^{14} -labelled glucose, mannose, and fructose was confined to the mid-gut, the proportion absorbed by the ceca depending on the type of sugar and its concentration in the gut lumen. The absorbed sugars were converted, in varying degrees, to trehalose which accumulated in the hemolymph. The extent of this conversion paralleled the rate of absorption of these sugars. It is suggested that the sugars are absorbed by diffusion across the gut wall, this process being facilitated by the rapid conversion to trehalose. At very low concentrations in the gut lumen much of the uptake of labelled glucose occurred as a result of exchange with the small amount of glucose in equilibrium with the trehalose in the hemolymph. (auth.)

- 147 Treherne, J.E. THE DIGESTION AND ABSORPTION OF TRIPALMITIN IN THE COCKROACH, PERIPLANETA AMERICANA L. J. exp. Biol. 35, 4 (1958) 882-70.

A partial hydrolysis of C^{14} -labelled tripalmitin was demonstrated in the crop of this insect. No significant absorption could be demonstrated in the crop, whether the tripalmitin was suspended in an experimental fluid or dissolved in emulsified oleic acid. Absorption occurred in the mid-gut and was largely confined to the caeca and the anterior part of the ventriculus. Total absorption of tripalmitin showed a linear relation with crop emptying. Apparently the rate at which the material left the crop, rather than the uptake in the mid-gut, was the limiting factor in absorption. (auth.)

- 148 Treherne, J.E. THE NUTRITION OF THE CENTRAL NERVOUS SYSTEM IN THE COCKROACH, PERIPLANETA AMERICANA L. THE EXCHANGE AND METABOLISM OF SUGARS. J. exp. Biol. 37 (1960) 513-33.

A rapid influx from the hemolymph of C^{14} -labelled trehalose and glucose has been demonstrated in the intact abdominal nerve cord. Approximately half of the absorbed C^{14} was incorporated as glutamic acid and glutam in the nervous tissue. Smaller amounts of glycogen, trehalose, glucose, aspartic acid and occasional traces of alanine were also found. These results demonstrate a linkage of carbohydrate and amino acid metabolism and represent circumstantial evidence for the presence of the tricarboxylic acid cycle enzymes in the central nervous system of this insect. (BA 36: 7813, 1960).

- 149 Treherne, J. E. THE EXCHANGE AND METABOLISM OF SUGARS IN THE CENTRAL NERVOUS SYSTEM OF *PERIPLANETA AMERICANA*. p. 632-5 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol. 1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna). Vienna, Christoph Reisser's Sohn. 1962.

An adequate exchange of nutritive materials between the hemolymph and the central nervous system across the perilemma must take place. In order to study this function the exchange and metabolism of some C^{14} -labelled sugars in the abdominal nerve cord (n.c.) of *P. americana*, C^{14} -labelled glucose solution was injected into the hemolymph. Graphs illustrate the rate of conversion to trehalose as it accumulated in the hemolymph, compared with the entry of radioactivity into the n.c. expressed as the ratio: activity in n.c./activity in hemolymph. Approximately 7 molecules of trehalose may be estimated to pass into the n.c. for every molecule of glucose. Since the trehalose molecules are, however, 17 times more concentrated than those of glucose, individual glucose molecules were therefore passing into the n.c. at approximately 2.5 times the rate of the disaccharide molecules. The metabolism of the sugars within the CNS was followed by separating the extracts of radioactive n.c. on paper chromatograms. At least 7 peaks of radioactivity were found (trehalose, glucose, glycogen, aspartic acid, glutamic acid, glutamine and alanine). Their proportions are tabulated, and the significance of the findings discussed.

- 150 Shigematsu, H. UTILIZATION OF GLUCOSE BY FAT BODY OF THE SILKWORM IN VITRO. *J. sericul. Sci.*, Tokyo 29 (1960) 22-7. (In Japanese)

- 151 Silva, G.M., Doyle, W.P., Wang, C.H. GLUCOSE CATABOLISM IN THE AMERICAN COCKROACH. *Nature* 182 (1958) 102-4.

Time-course studies on the utilization by intact cockroaches (*Periplaneta americana*) of glucose- C^{14} were carried out. Radioactive assay of the respiratory CO_2 samples provided confirmatory evidence for the operation of glycolysis and a direct oxidative pathway for the primary breakdown of glucose in this species. It was found that in intact male adult cockroaches, glucose is catabolized by way of the direct oxidative pathway to an extent of only 4-5%, and the bulk of glucose is catabolized via the Embden-Meyerhof-Parnas glycolytic pathway. The latter, in conjunction with tricarboxylic acid cyclic processes, is probably responsible for the respiratory activity and biosynthetic functions in this insect. It is possible that the observed small amount of activity of the direct oxidative pathway is primarily for the purpose of pentose production. (CA 52: 20697c, 1958)

- 152 Vyskrebentseva, E.I. CARBOHYDRATE TRANSFORMATION IN THE COELOMIC FLUID OF THE SILKWORM *BOMBYX MORI* DURING METAMORPHOSIS. *Biochimica* 22 (1957) 657-66, (English translation) *Biochemistry Leningr.*, Moscow 22 (1957) 613-25.

Uniformly labelled C^{14} sucrose, radioactive carbon dioxide ($C^{14}O_2$) and also various glycolysis inhibitors (NaF and CH_2ICOOH) were employed in order to investigate the transformation of carbohydrates in the cavity fluid of the silkworm during metamorphosis. Oxidation of sugar in the cavity fluid could be shown to produce phosphoric esters and organic acids. The presence of radioactivity in malic, fumaric and succinic acids when labelled sugar is administered in the cavity fluid shows that conversion of pyruvic acid is essentially linked with its role in dicarboxylic acid synthesis by means of carboxylation. Synthesis of tricarboxylic acids, and in particular citric acid, is insignificant. The latter is formed chiefly, not from carbohydrates, but as a result of carboxylation of organic acids, probably decomposition products of fats. This fact strongly suggests that in the cavity fluid anaerobic oxidation of carbohydrates is the predominant process. Sucrose introduced in the cavity fluid may be subjected not only to oxidative transformations, but may be used in the synthesis of a complex, unidentified high-molecular weight phosphorus compound. On suppression of glycolysis this method of transformation predominates. Study of carbohydrate transformation during metamorphosis showed that lysis substantially reduces the capacity of the cavity fluid to synthesize phosphoric esters and organic acids from the introduced sugar, while, in the course of histogenesis and differentiation, this capacity is restored.

The abstract is essentially that of the paper given at the "All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science" (Session: Biology, Medicine and Agriculture), Moscow, 2-5 April 1957. Engl. trans. p.152, Consultants Bureau, Inc.

(For a more detailed abstract of the paper see CA 52: 4873 b, c. 1958).

- 153 Vyskrebentseva, E.I. CARBOHYDRATE TRANSFORMATION PATHWAYS IN THE CAVITY FLUID OF THE SILKWORM BOMBYX MORI IN THE METAMORPHOSIS PERIOD. p.137-42 In "Application of Radioactive Isotopes in the Food and Fishing Industries and in Agriculture. A portion of the Proceedings of the All-Union Scientific and Technical Conference on the Application of Radioactive Isotopes. Moscow 1957". New York, Consultants Bureau, Inc. 1959 (English transl.)
- [For detailed abstr. see "Nature of carbohydrate conversion in the cavity fluid of mulberry silkworm (*Bombyx mori*) in the metamorphosis period". p.152 in Abstracts of papers given at the "All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science. (Session: Biology, Medicine and Agriculture), Moscow 2-5 Apr. 1957". AEC-tr-2925(III). New York, Consultants Bureau, Inc. 1957 (English translation)]
- 154 Vyskrebentseva, E.I. MEANS FOR THE CONVERSION OF CARBOHYDRATES OF THE CAVITY FLUIDS OF BOMBYX MORI DURING ITS PERIOD OF METAMORPHOSIS. *Izucheniye Zhivom. Organizma* (Moscow; Akad. Nauk SSSR) Sbornik 1959: 145-51; Referat. Zhur. Khim., Biol. Khim. 1959, abstr. no. 5521)
- Results of experiments with C^{14} -labelled sucrose showed that the carbohydrates in the body cavity fluids of *Bombyx mori* underwent a continuous change during the period of metamorphosis with an accompanying formation of phosphate esters and organic acids. The rate of such conversion of carbohydrates abated during the period of histolysis and rose again during the period of histogenesis and differentiation. The injection into the body cavity of glycolytic poisons hampered the process of phosphate ester synthesis and the formation of organic substances from the carbohydrates. About 1 h after the injection into the body cavity of the labelled sugar, the specific activity became concentrated in malic, fumaric, and succinic acids. Within the body cavity of *B. mori* anaerobic oxidation of carbohydrates and their conversion predominated which resulted in the production of pyruvic acid; such processes seem to be associated with the synthesis of dicarboxylic acids by way of decarboxylation; in the case of tricarboxylic acid synthesis, and particularly in citric acid formation, the process is considerably depressed.
- (CA 53: 20588i, 1959)
- * Winteringham et al. 1955 - [311]
- * Winteringham 1956 - [156]
- 155 Winteringham, F.P.W. COMPARATIVE ASPECTS OF INSECT BIOCHEMISTRY WITH PARTICULAR REFERENCE TO INSECTICIDAL ACTION. p.201-10 (dis. p.211-5) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbock, L., ed. London, Pergamon Press. 1959.
- Possible differences in basal metabolism between insects and vertebrates have been critically examined in the light of recent work. There is evidence that trehalose plays the part of mammalian glucose in insect tissues and that trehalose is broken down glycolytically as far as pyruvate and then to acetate as in vertebrate tissues. Data on the metabolism of uniformly labelled (C^{14}) glucose by the adult housefly, *Musca domestica*, *in vivo* are tabulated, showing the distribution of total soluble C^{14} recovered from thoracic tissues (flight muscle) after different treatments. There is evidence that lactic acid does not accumulate significantly in insect flight muscle even under anaerobic conditions. The reported accumulation of α -glycerophosphate and the failure to find significant lactic acid formation under conditions of anoxia are discussed. Experiments on the fate of [2- C^{14}]acetate injected intrathoracically into adult *M. domestica* showed that there was a rapid incorporation of C^{14} into the free amino acids. This and other results suggest that the significance of the high concentrations of free glutamate (and free amino acids) in insect tissues may lie in their providing a soluble and readily available substrate reserve for the Krebs tricarboxylic acid cycle, liberated ammonia being trapped as glutamine.
- 156 Winteringham, F.P.W. PRESENCE AND SIGNIFICANCE OF α -GLYCEROPHOSPHATE IN INSECT TISSUE. *Biochem. J.* 71 (1959) 21 P.
- The labelled pool technique has been used to determine the relative concentrations of the principal soluble phosphorus compounds in the adult housefly. One fraction, which was resistant to acid hydrolysis and which represented some 20% of the total acid-soluble phosphorus of the thoracic tissues, was tentatively identified as phosphoglyceric acid by paper cochromatography with the 'authentic' compound but there was an element of doubt because the latter was not chromatographically pure (Winteringham, Bridges and Heliyer, 1955). The possible importance of α -glycerophosphate in insect metabolism prompted a re-examination of the compound recovered from the housefly. The insect compound which had been labelled with P^{32} *in vivo*

was separated from all the known compounds except α -glycerophosphate on paper chromatograms. Added α -glycerophosphate co-chromatographed exactly with the insect compound in all the systems tried. The implications of these results are discussed briefly.

I-B-2 PROTEINS AND AMINO ACIDS

- 157 Bheemeswar, B. SOME ASPECTS OF AMINO ACID METABOLISM IN INSECTS. p.78-87, disc. 87-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956". Vol. 2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Available information on general biochemical reactions undergone by amino acids is divided into data on deamination, transamination, decarboxylation, and peptide and protein synthesis. Radioisotopes have been used in work on transaminases in connection with the silkworm, *Bombyx mori* (references cited). The author describes work on inorganic nitrogen metabolism where pyruvic oxime-2- C^{14} and pyruvate-2- C^{14} were either injected or fed, in order to study (1) C^{14} -activity in the blood following injection of either; (2) C^{14} -incorporation into gut and "body" proteins after injection; (3) respired $C^{14}O_2$ after injection; (4) C^{14} -activity of faecal pellets excreted after feeding either substance; (5) identification by chromatography of the excreted end products following such radioactive feeding. The results revealed that pyruvic oxime-2- C^{14} is removed from the blood at a faster rate than pyruvate-2- C^{14} . Contrary to the first, the latter is incorporated into the "body" and gut proteins. It further appears to enter the tricarboxylic acid cycle and is rapidly metabolized to $C^{14}O_2$, whereas the labelled oxime is not metabolized in such a way but rapidly excreted in the pellets as oxime-2- C^{14} . It is suggested that the conversion of oximes into amino compounds is of little, if any, importance in the silkworm. Radiotracers are cited in work on peptide and protein synthesis.

- 158 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. UTILIZATION OF THE CARBOXYL CARBON OF L-PHENYLALANINE FOR THE SYNTHESIS OF THE AMINO-ACIDS OF SILK BY *BOMBYX MORI*. *Nature* 177 (1956) 1237-8.

C^{14} -labelled phenylalanine was used to demonstrate that carboxyl phenylalanine was not utilized for the synthesis of alanine. The technique used for labelling the compound is indicated; the silkworms were injected when they had already stopped eating and their silk glands were swollen prior to spinning their cocoons. Fibroin was isolated from the cocoons, and the tyrosine, glycine and alanine isolated. Only the purified tyrosine was found to be radioactive (not due to contamination by the labelled phenylalanine). Results indicate that phenylalanine is converted to tyrosine by the silkworm by a fairly direct process, since radioactivity was exclusively localized in the carboxyl group of the injected phenylalanine and the isolated tyrosine. About 15% of the injected phenylalanine radioactivity was found in the tyrosine of the silk fibroin. On the other hand, the carboxyl carbon of phenylalanine is not utilized for the synthesis of alanine or glycine of the silk of *B. mori*. *

- 159 Bricteux-Grégoire, S., Duchateau, G., Florkin, M., Jemiaux, C. SUR LE MÉTABOLISME DE LA GLYCINE PLASMATIQUE CHEZ LE VER À SOIE. *Arch. int. Physiol. et Biochim.* 66,1 (1958) 111-2.

Pour déterminer le sort de la glycine prélevée par la glande pour la synthèse de la soie, les auteurs ont injecté de la glycine-1- C^{14} , dans l'hémolymphe de vers à soie au début du filage ("montée"). Un quart de l'activité totale injectée a été retrouvée dans la fibroïne du cocon. Cette activité se répartit, dans l'ordre des activités spécifiques décroissantes, entre la glycine, la sérine et l'alanine. La tyrosine n'a incorporé aucune activité.

- 160 Bricteux-Grégoire, S., Verly, W.G., Florkin, M. UTILIZATION OF THE CARBOXYL GROUP OF GLYCINE FOR THE SYNTHESIS OF THE AMINO ACIDS OF SILK BY *BOMBYX MORI*. *Nature* 182 (1958) 1515.

When fasting and ready to spin their cocoons, the silk worms were each injected with 112 μ g (2.1 μ Ci) of glycine-1- C^{14} . One quarter of the total activity injected appeared in silk fibroin. The injected glycine was found diluted about 1000-fold, which was most probably not uniformly labelled. Direct conversion of glycine to serine keeping the label in the C-1 position occurs in the silkworm. Glycine is also converted to alanine, possibly through serine and pyruvic acid, but in any case introducing the C-1 of glycine exclusively into the carboxyl group of alanine. Tyrosine did not incorporate any radioactivity from glycine- C^{14} ; the phenylalanine-tyrosine pair would appear to be essential to the silkworm.

* But cf. Fukuda, *Nature* 177 (1956) 429.

- 161 Brictoux-Grégoire, S., Verly, W.G. UTILIZATION OF FORMATE FOR THE BIOSYNTHESIS OF GLYCINE CARBON-1 AND -2 IN *BOMBYX MORI*. Nature 182 (1958) 1515-6.
- Just prior to spinning their cocoons, each of 20 silkworms was injected with 1.7 mg (25 μ C) of C^{14} -labelled formate. The isolated glycine was decarboxylated; C-1 was isolated as barium carbonate and C-2 as formaldehyde. Their specific activities are tabulated. The degradation procedure was checked on synthetic glycine-1- C^{14} and glycine-2- C^{14} . Formate carbon may be concluded to be utilized for the synthesis of glycine C-1 and C-2 in *B. mori*. 1.5% of the injected radioactivity appeared in the fibroin glycine, while 2% was found in fibroin serine which had a specific activity 6 times greater than glycine. Various possible biochemical pathways are postulated.
- 162 Brictoux-Grégoire, S., Verly, W.G., Florkin, M. BIOSYNTHESE DE LA GLYCINE À PARTIR DU FORMIATE CHEZ LE VER À SOIE. Arch. int. Physiol. et Biochim. 67, 3 (1959) 503-4.
- Du C^{14} -formate a été injecté à des larves de *Bombyx mori* au 5e âge, juste avant le début du filage. La fibroïne de la soie a été hydrolysée et la glycine a été isolée et purifiée. La glycine a ensuite été dégradée par la ninhydrine, le C-1 isolé sous forme de carbonate de baryum et le C-2 sous forme de formaldéhyde. La formaldéhyde et la glycine ont été brûlées et transformées en carbonate de baryum avant les mesures de radioactivité. Les procédés de dégradation ont été vérifiés au moyen de glycine-1- C^{14} et de glycine-2- C^{14} . L'activité spécifique de la glycine isolée était répartie pour les 2/3 dans le C-1 et pour 1/3 dans le C-2. (Note entière)
- 163 Brictoux-Grégoire, S., Fukuda, T., Dewandre, A., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VIII. CONVERSION OF PYRUVATE INTO ALANINE, GLYCINE, AND SERINE OF SILK FIBROIN. Arch. int. Physiol. et Biochim. 67 (1959) 545-52.
- Five-tenths μ C of Na pyruvate-1- C^{14} (I), Na pyruvate-2- C^{14} (II), or Na pyruvate-3- C^{14} (III) were given per os to 3 groups of about 20 silkworms in the stage of development in which fibroin synthesis begins in the silk gland. The fibroin isolated from the cocoons of each group was hydrolyzed with HCl, the acid was removed by evaporation and the amino acids were adsorbed on Dowex 50. The adsorbate was eluted with 3N NH_4OH , the eluate was evaporated, and the tyrosine ppt. removed. Glycine, alanine, and serine were isolated as salts of nitronaphthalenesulfonic acid, azobenzene-p-sulfonic acid, and 4'-hydroxyazobenzene-4-sulfonic acid, resp. The sulfonates were then placed on a column of Dowex 50 and the amino acids eluted with 3N NH_4OH . When the silkworms had been fed with I, the radioactivity was found exclusively in the C_1 of these amino acids. When II had been fed, the radioactivity was equally distributed in C_1 and C_2 of glycine and in C_1 , C_2 , and C_3 of serine; alanine was mostly labelled in C_2 . If III had been given, the activity was highest in C_2 of glycine and in C_3 of serine and alanine. Of the ingested pyruvate 7-10% was converted into the alanine of the silk fibroin and smaller amounts into glycine and serine. (CA 54: 14482d, 1960)
- 164 Brictoux-Grégoire, S., Verly, W.G., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. IX. UTILIZATION OF THE CARBOXYL-C OF PHENYLALANINE FOR THE SYNTHESIS OF THE AMINO ACIDS OF SILK FIBROIN. Arch. int. Physiol. et Biochim. 67 (1959) 563-6.
- L-Phenylalanine (I) labelled with C^{14} in the carboxyl group was prepared from glycine-1- C^{14} by a modification of the method of Bergmann et al. (CA 21: 61). Ten silkworms in the stage in which the silk production begins were anesthetized with Et_2O and injected with 0.2 mg (= 0.078 μ C) of I. From the cocoons produced, silk fibroin was prepared 6 days later. The glycine, alanine, and serine isolated from the fibroin hydrolyzate did not contain C^{14} ; the tyrosine contained C^{14} exclusively in the carboxyl group. About 17% of the injected I was transformed into silk tyrosine. (CA 54: 14482g, 1960)
- 165 Brictoux-Grégoire, S., Dewandre, A., Florkin, M., Verly, W.G. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XII. UTILISATION DES DEUX CARBONES DE LA GLYCINE POUR LA BIOSYNTHESE DES ACIDES AMINÉS DE LA FIBROÏNE DE LA SOIE. Arch. int. Physiol. et Biochim. 67, 4 (1959) 693-8.
- Une fraction très importante de l'activité injectée à des vers à soie (des larves de *Bombyx mori* au 5e âge, juste avant le début du filage) sous forme de C^{14} -glycine a été retrouvée dans la glycine, la sérine et l'alanine de la fibroïne de la soie. Après injection de glycine-1- C^{14} , le radioisotope apparaît uniquement dans la le carboxyle de la glycine, de l'alanine et de la sérine de la fibroïne. Après injection de glycine-2- C^{14} , le radioisotope apparaît principalement dans le C-3 de ces acides aminés, mais aussi dans tous leurs autres carbones. Les voies métaboliques unissant la glycine, la sérine et l'alanine chez *B. mori* sont discutées à la lumière de ces observations.

- 166 Corrigan, J.J. METABOLISM OF SOME FREE AMINO ACIDS IN DDT-POISONED PERIPLANETA AMERICANA L. Ph.D. Dissertation, Illinois, Univ., Urbana, 1959.
- During DDT prostration, the free proline in the blood and central nervous cord is selectively depleted to about 1/4 the normal level. By using C^{14} -labelled proline it was found that as proline was depleted, there was a corresponding rise in C^{14} -labelled glutamine. If the temperature was raised so that the roach recovered, the proline and glutamine contents were restored to a normal level.
- 167 Cotty, V.F., Henry, S.M. GLUTATHIONE METABOLISM IN DDT RESISTANT AND SUSCEPTIBLE HOUSE FLIES. Contr. Boyce Thompson Inst. 19, 5 (1958) 393-401.
- Glutathione concentration was measured in prepupae, pupae and newly emerged susceptible and DDT-resistant houseflies through its adduct with C^{14} -labelled N-ethylmaleimide. Free glutathione in both strains followed the same general pattern, no over-all difference being noted. During the pupal period the glutathione concentration decreased during the first two days, showed a relative increase on the 3rd, and fell to a low level on the 4th day. The newly emerged adult had a higher level of glutathione than any other stage studied. Measured amounts of S^{35} labelled cysteine were injected into DDT-resistant and susceptible flies. At timed intervals the flies were killed and the glutathione was coupled with N-ethylmaleimide and isolated chromatographically for radioassay of S^{35} . Susceptible flies appeared to incorporate injected cysteine into glutathione and to metabolize the newly synthesized glutathione more rapidly than did resistant flies. (auth.)
- 168 Demyanovsky, S. Ya., Vasileva, N.V., Konikova, A.S. INVESTIGATION OF THE PROTEIN METABOLISM IN THE OAK SILKWORM (ANTHRAEA PERNYI) WITH THE HELP OF RADIOACTIVE METHIONINE. Biokhimiia 17 (1952) 529-34.
- Methionine- S^{35} (I) was injected into the hemolymph on the basis of 10 000 cpm/g. After a definite time the proteins were separated from the hemolymph, fatty material, muscle, intestinal lining, and other organs, and the amount of S^{35} detected. In the larvae an increase in the intensity of protein metabolism was observed up to the middle of the 5th larval stage. The maximum incorporation of S^{35} occurred on the 11th-12th day; a decrease was noticed on the 19th-20th day. As to the individual tissues, the largest amount of S^{35} was incorporated in the hemolymph during the second half. At the end of the larval stage the intestinal walls possessed the least intensity of protein metabolism. A high metabolic rate from the very beginning of the 5th stage was noted in the walls of the silk-forming gland. In spinning of the cocoon, the incorporation of S^{35} was on a low level and the synthesis of protein in the organism of the silkworm almost stopped, when silk appeared. After the end of silk formation, an increase in protein metabolism was noted. A gradual increase in the S^{35} incorporation occurred during the 1st-3rd day of development of the summer pupal stage with a maximum after 48 h. The most intense protein metabolism during the pupal stage occurred in the fatty material, and then in the hemolymph. Protein metabolism, especially in the muscles, varied with sex. No I was incorporated into the proteins of dead cocoons. Hence, the radioactivity of the proteins separated from live organisms was not the result of adsorption of I, but was caused by the incorporation of I into the protein molecules. (CA 47: 4000c, 1953)
- 169 Faulkner, P., Bheemeswar, B. METABOLISM OF OXIMES IN THE SILKWORM BOMBYX MORI L. II. METABOLISM OF PYRUVIC OXIME-2- C^{14} . J. Insect Physiol. 4, 1 (1960) 14-9.
- Pyruvic oxime-2- C^{14} and pyruvate-2- C^{14} were injected into larvae. The label in pyruvate-2- C^{14} is incorporated into the gut and body proteins, but the small amount of activity found in protein following injection of pyruvic oxime-2- C^{14} is of a much lower order. The amount of $C^{14}O_2$ expired is also negligible. Chromatographic analysis of aqueous extracts of fecal pellets following injection or feeding indicates that pyruvic oxime-2- C^{14} is rapidly excreted unchanged and is not converted to pyruvate-2- C^{14} . The results suggest that transoximase and oximase, if they are present, are of little importance in the protein and carbohydrate metabolism of the silkworm.
- 170 Faulkner, P., Bheemeswar, B. STUDIES ON THE BIOSYNTHESIS OF PROTEINS IN THE SILKWORM, BOMBYX MORI (L.). Biochem. J. 76, 1 (1960) 71-8.
- The incorporation of C^{14} -labelled glycine into tissue proteins of injected silkworm larvae was studied, and depends on the stage of development of the larvae. The rate is low during the 4th molt and increases progressively during the 5th larval instar. Just before spinning the rate of incorporation is again low. Incorporation *in vitro* into silk-gland minces is an aerobic process depending upon the presence of bivalent ions. It is enhanced by the addition of intermediates of the tricarboxylic acid cycle, particularly by malate, citrate, succinate, fumarate and α -glycerophosphate. A pH 5 extract was prepared by precipitating at pH 5.1 an

ultracentrifugate of brei obtained from the posterior portion of the silk gland and subsequently dissolving the precipitate at pH 7.8. Incorporation of C^{14} -labelled glycine into this extract is rapid, and is stimulated by Mg ions and either adenosine or guanosine triphosphate. In addition to C^{14} -labelled glycine, labelled phenylalanine and glutamate are incorporated into the pH 5 extract but at a slower rate; in mixture, the 3 amino acids are incorporated additively. The $[1-C^{14}]$ glycine-pH 5 extract complex is decomposed by heating at pH 7.8 by treatment with hot trichloroacetic acid, and by the action of ribonuclease. A glycine-activating enzyme has been purified 20-fold by ammonium sulfate precipitation of the pH 5 extract. The purified preparation no longer incorporates C^{14} -labelled glycine, which indicates that separate enzymes are involved in activation and incorporation. (auth.)

- 171 Florkin, M. THE FREE AMINO ACIDS OF INSECT HEMOLYMPH. p.63-73 (disc. p.73-5) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbock, L., ed. London, Pergamon Press. 1959.

A section is devoted to the aminoacidemia of Bombyx mori. The author discusses aminoacidemia and amino acid components of tissues, and the free amino acids taken up by the silk-gland from the hemolymph, where extensive use has already been made of C^{14} -labelling (cf. Fukuda 1955, 1956, 1959). The fate of the amino acid taken up by the gland from the hemolymph has also been traced. Radioactive serine is found in the silk after injection of glycine-1- C^{14} (Fukuda 1956); the activity of glycine-1- C^{14} injected into the hemolymph has been found (Bricteux-Grégoire 1957) in decreasing order of specific activities in the glycine, serine and alanine of the silk. Changes in the pattern of aminoacidemia during the development of Bombyx mori are discussed.

- 172 Fukuda, T. A STUDY OF SILK PROTEIN SYNTHESIS BY MEANS OF C^{14} . p.528-31 in "Proceedings of the 1st Japan Conference on Radioisotopes, 1956". Tokyo, Japan Atomic Industrial Forum, Inc. 1956. (In Japanese)

The biosynthesis of C^{14} -labelled phenyl-alanine into tyrosine in the silkworm was confirmed by means of paper chromatography and autoradiography. C^{14} -labelled glycine was shown to be converted into serine. The degree to which 4 radioactively labelled amino acids (glycine-2- C^{14} , DL-alanine-1- C^{14} , L-phenyl alanine-2- C^{14} and glutamic acid-1- C^{14}) were incorporated into silk protein was shown. The significance of the findings is discussed.

- 173 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. III. THE CONVERSION OF C^{14} -LABELED PHENYLALANINE TO TYROSINE IN THE SILKWORM LARVA (BOMBYX MORI). J. Biochem Tokyo 43,2 (1956) 137-42.

After the injection of phenylalanine-2- C^{14} to silk worm (Sl 122 X Nichi 122) on the 4th day at 5th instar in an amount of 0.5 μ Ci/larva, the specific radioactivities of sericin and fibroin separated from cocoon fibers were 1407 and 4531 cpm/100 mg, respectively. Among amino acids composing fibroin, tyrosine possessed exclusively high activity (41 147 cpm/ μ mole). This was also proved by paper chromatography with a phenol-0.1% NH_3 mixture (85:15), which was followed by radioautogram as well as by radioactivity estimation with a SC-16 gas flow windowless counter. (BA 31: 3767, 1957)

- 174 Fukuda, T. CONVERSION OF PHENYLALANINE INTO TYROSINE IN THE SILKWORM LARVA (BOMBYX MORI). Nature 177 (1956) 429-30.

C^{14} -labelled phenylalanine was used in a study to determine whether phenylalanine is a precursor of tyrosine. 0.5 μ Ci of radioactive phenylalanine per worm was injected into the body cavity of the silkworms, on the 4th day of the 5th instar. The techniques are described. On examining the radioactivities of the amino acids isolated from fibroin almost all the activity was found to be located in tyrosine. Analysis of isolated tyrosine by paper chromatography and radioautography gave results which suggest that the tyrosine is labelled with C^{14} . The synthesis of tyrosine from phenylalanine in vivo was confirmed, as was its subsequent utilization for biosynthesis of the silk proteins.

- 175 Fukuda, T. CONVERSION OF PYRUVIC ACID TO ALANINE IN THE SILKWORM LARVA. Nature 180 (1957; 245.

A solution prepared from silkworm larvae by homogenization and freezing of the silk-glands, the alimentary canals, and fat tissues, was used as an enzyme preparation. To 1 ml of the enzyme solution was added 0.5

of 0.1 M L-glutamic acid, 0.5 ml of 1 M Na pyruvate, and 0.1 ml of M/15 phosphate buffer, pH 7.4, containing 0.1 μ C of Na pyruvate-2- C^{14} , and the mixture was incubated for 60 min at 38°C. Analysis by paper chromatography resulted in 2 spots, one of which was alanine (R_f 0.42) in which most of the radioactivity was concentrated, and another spot for the remaining glutamic acid. This indicated the conversion of pyruvate to alanine, an important constituent of the silk protein. (CA 51: 16936g, 1957)

- 176 Fukuda, T. THE FORMATION OF SILK PROTEIN. IV. THE CONVERSION OF PYRUVIC ACID TO ALANINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 44 (1957) 505-10.

After the peroral administration of 17.5 γ of Na pyruvate-2- C^{14} (500 mc) per silkworm (*Bombyx mori* Nichi 122xSi 115 strain) per day for 3 days from the 4th day of the 5th instar, the C^{14} -incorporation into cocoon fibre (I) amounts to 3443 counts/min/100 mg of specific activity. The C^{14} -distribution in alanine (II) molecule isolated from I is determined as follows: COOH-C 5, α -C 80, β -C 2 counts/min/mg. With the enzyme solution prepared by homogenizing the tissues with M/15 phosphate buffer of pH 7.4, freezing-thawing, and centrifuging off the insoluble protein, successively, the production of C^{14} -II occurs by posterior division of silk gland, alimentary canal, muscle plus fat tissue preparations in the presence of L-glutamic (III) or L-aspartic acid (IV). The transaminase activity of silk gland to convert pyruvic acid to II is markedly high when III, or to a less extent, IV is used as NH_2 -donator. (CA 51: 16971b, 1957)

- 177 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. V. TIME OF BIOSYNTHESIS OF FIBROIN AND ITS LOCATION IN THE SILK OF *BOMBYX MORI*. Arch. int. Physiol. et Biochim. 67 (1959) 185-9.

Silkworms of the European race of *B. mori* were given 0.5 μ C of L-alanine- C^{14} from the 1st to the 12th day of the 5th stage. Alanine is a major constituent of the fibroin of silk and presumably is transferred from the hemolymph to the silk gland while fibroin synthesis is in progress. Thread from the cocoons was unwound, degummed by boiling in a 0.02 M solution of Na_2CO_3 , washed with EtOH, Et_2O , dried, and laid out in horizontal segments. Autoradiographs of the thread segments showed that a relation existed between C^{14} in the hemolymph and the different segments of the silk thread spun by the animals. (from CA 54: 14482a, 1960)

- 178 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VI. TIME OF BIOSYNTHESIS OF FIBROINOGEN AND ITS LOCATION IN THE RESERVOIR OF THE SILK GLAND AT THE END OF THE FIFTH STAGE. Arch. int. Physiol. et Biochim. 67 (1959) 190-4.

B. mori was fed 1 μ C of glycine-2- C^{14} . Radioautographs of degummed and dried slices of isolated frozen silk glands showed that high radioactivity appeared in a definite section of the fibroinogen stored in the reservoir of the middle portion of the gland. The macromolecules of fibroinogen synthesized in the posterior division of the silk gland were stored in order of their synthesis. (CA 54: 14482b, 1960)

- 179 Fukuda, T., Florkin, M. BIOCHEMISTRY OF THE SILK WORM. VII. ORDERED PROGRESSION OF FIBROINOGEN IN THE RESERVOIR OF THE SILK GLAND DURING THE 5TH INSTAR. Arch. int. Physiol. et Biochim. 67 (1959) 214-21.

To further test the hypothesis that macromolecules of fibroinogen move in an ordered fashion in the reservoir of the silk glands of *B. mori*, 1 μ C of glycine-2- C^{14} was fed to silkworms of the European race on the 6th day of the 5th instar. Radioautographs were taken of sliced silk glands and the results showed that the fibroinogen synthesized at different periods was deposited in the reservoir in order of succession and appeared in the fibroin of the silk thread in this order. (CA 54: 14482c, 1960)

- 180 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. VI. CONVERSION OF SERINE TO GLYCINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 47 (1960) 581-3.

Oral administration of uniformly C^{14} -labelled serine to *Bombyx mori* at the 5th instar resulted in glycine- C^{14} -rich cocoon (silk fibroin) in the posterior silk gland. Alanine in the isolated cocoon was slightly labelled by C^{14} . Glycine had approximately equal C^{14} at C-1 and C-2. (CA 54: 230781, 1960)

- 181 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. VII. THE CONVERSION OF GLYCINE TO SERINE IN THE SILKWORM LARVA. J. Biochem., Tokyo 47 (1960) 720-5.

Following oral administration of glycine-1- C^{14} and -2- C^{14} to silkworm the serine residue of fibroin and sericin was labelled in the carboxyl (C-1) and side chain (C-2 and C-3), respectively. At the same time glyoxylic acid in body fluid was highly labelled. The following reactions are suggested for *in vivo* synthesis of serine: glycine \rightleftharpoons glyoxylate \rightarrow HCHO + CO_2 ; glycine + HCHO \rightarrow serine. (CA 54: 230781, 1960)

- 182 Fukuda, T., Hayashi, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. VIII. THE SYNTHESIS OF α -KETOGLOUTARIC ACID, OXALACETIC ACID AND GLYOXYLIC ACID FROM GLUCOSE IN THE SILKWORM. J. Biochem., Tokyo 48 (1960) 9-12.
After oral administration of glucose- C^{14} to the silkworm, keto acids were separated as the dinitrophenyl compounds by paper chromatography, and analysed for radioactivity. α -Ketoglutaric acid was most highly enriched with C^{14} . Oxalacetic acid was labelled considerably, but glyoxylic acid was almost free of C^{14} incorporation. (CA 55: 4799e, 1960)
- 183 Fukuda, T. BIOCHEMICAL STUDIES ON THE FORMATION OF SILK PROTEIN. IX. THE DIRECT AND INDIRECT FORMATION OF SILK PROTEIN DURING THE GROWTH OF THE SILKWORM LARVA. Bull. agric. chem. Soc. Japan 24 (1960) 396-401.
The distribution of C^{14} was studied in the silk produced by the silkworms fed 1 cm² of radioactive mulberry leaf or some radioactive amino acids on the different days of the 5th instar. The 1st 100, 200-400, and 700-1000 m of silk unwound from a cocoon was made mainly from the amino acids taken on the 4th, 6th, and 8th day, respectively. The radioactivity taken on the 1st through 3rd day appeared at the very beginning and at the last part (700-1200 m) of the silk. (CA 55: 824c, 1961)
- 184 Fukuda, T., Suto, M., Nakagawa, Y. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. X. ORDERED PROGRESSION OF FIBROIN IN THE INSIDE OF THE SILK GLAND DURING THE FIFTH INSTAR. (CONTINUATION). Bull. agric. chem. Soc. Japan 24 (1960) 501-5.
The movement of fibroin in the silk gland of the 5th instar silkworm was studied by using glycine- C^{14} as the tracer. Fibroin was synthesized in the posterior division of the gland, and moved toward the middle and anterior divisions. (CA 55: 3859e, 1961)
- 185 Fukuda, T., Kameyama, T. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. XI. THE KINDS OF FREE AMINO ACIDS CONCERNED IN THE BIOSYNTHESIS OF THE SILK PROTEIN. (CONTINUATION). J. sericult. Sci., Tokyo 29 (1960) 120-4. (In Japanese)
- 186 Fukuda, T., Matsuda, M. BIOCHEMICAL STUDIES ON THE FORMATION OF THE SILK PROTEIN. XII. THE FUNCTIONAL LOCALIZATION OF THE SILK GLAND ON THE AMINO ACID ABSORPTION. J. Sericult. Sci., Tokyo 29 (1960) 415-9. (In Japanese)
- 187 Fukuda, T. THE CORRELATION BETWEEN THE MULBERRY LEAVES TAKEN BY THE SILKWORM, THE SILK PROTEIN IN THE SILK GLAND AND THE SILK FILAMENT. Bull. seric. Exp. Sta., Japan 15 (1960) 595-610. (In Japanese, summary in English)
- 188 Fukuda, T., Sudo, M., Matsuda, M., Hayashi, T., Kurose, T., Horuchi, Y., Florin, M. FORMATION OF THE SILK PROTEINS DURING THE GROWTH OF THE SILKWORM LARVA (*BOMBYX MORI*). p. 90-8 (disc. p. 98-9) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol. 12. Levenbock, L., ed. London, Pergamon Press. 1959.
1 cm² of mulberry leaves labelled with C^{14} or 0.5 μ c of C^{14} -labelled amino acid was fed to single silkworm larva at different stages of development from the beginning of the 3rd to the end of the 5th instar. The larvae were then reared on normal mulberry leaves until they produced cocoons. The silk filament was unwound and the radioactivity located by a radioautograph. There were two pathways for the formation of silk proteins during growth of the silkworm larva. About 70% of the silk proteins produced by one silkworm was derived directly from the proteins of the mulberry leaves, but approx. 30% came from the tissue and blood proteins. Direct formation of silk protein occurred during the period from the 3rd day of the 5th instar to maturity, while the indirect formation occurred from the 7th day of the 5th instar to just before termination of the spinning after reaching maturity. Fibroin (I), from the anterior portion of the middle division of a mature larva silk gland, was derived from mulberry leaves eaten at the beginning of the 5th stage and was used for the formation of the first part of the silk filament unwound from the cocoon. I from the rear portion of the middle division was from leaves eaten during the middle of the 5th instar and was used for the formation of the middle part of the filament, while I from the posterior division was from leaves eaten on the 8th day of the 5th stage and formed the next segment of filament. The last part of the thread was derived from tissue proteins synthesized from leaves eaten at the beginning of the 4th and 5th stages. (CA 54: 15724f, 1960)

- 189 Fuzeau-Braesch, S. UTILISATION D'ACIDES AMINÉS MARQUÉS DANS L'ÉTUDE DES PIGMENTS TÉGUMENTAIRES DES INSECTES. C.R. Soc. Biol., Paris 152, 5 (1958) 715-8.
- L'utilisation de tyrosine et de tryptophane marqué de ^{14}C a permis l'étude des pigments de la cuticule et de l'hypoderme de *Gryllus bimaculatus*; les granules hypodermiques ont pu être identifiés aux "ommochromes" dérivés du tryptophane. (BS 20-230478, 1959)
- 190 Hyland, K.E., Hammar, J.L. TRANSOVARIAL PASSAGE OF RADIOACTIVITY IN TICKS LABELED WITH C^{14} GLYCINE. (abstr.) J. Parasit. 45 (4, sect. 2, suppl.) (1959) 24-5.
- Preliminary to field studies of *Dermacentor variabilis* a consideration of various techniques was undertaken for the internal labelling of adult female ticks, the goal being to pass to the offspring a degree of radioactivity. Female ticks were administered the tracer through a glass capillary tube which was fitted over the hypostome and chelicerae (after the techniques of Chabaud and of Bergdorfer). The tube was calibrated to accept 0.01 ml of glycine, which contained $0.5 \mu\text{C}$ of C^{14} . Each tick after imbibing the radioactive glycine was allowed to finish engorging on laboratory rabbits. Eggs and resulting larvae were found to be radioactive although there was a decrease of approximately 55% in the activity between egg and larvae. Preliminary results indicate that there is no reduction in the egg laying capacity of the females, nor is there a decrease in the hatchability of the radioactive eggs. The effects of C^{14} on the remainder of the life cycle have not been investigated.
- 191 Ishi, S., Hirano, C. BIOSYNTHESIS OF TYROSINE FROM C^{14} -PHENYLALANINE IN THE LARVA OF THE RICE STEM BORER, *CHILO SUPPRESSALIS* WALKER. p.295-8 in "Proceedings of the 10th International Congress on Entomology, Montreal, 17-25 Aug. 1956", Vol. 2, Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.
- The nutritional requirement of the larva of the rice stem borer, *Chilo suppressalis* Walker, was studied by synthetic media under aseptic conditions. Amino acids and vitamins required by the larva have been reported in the previous papers. Tyrosine, one of the non-essential amino acids, is derived from other compounds in the larval body, but the course of metabolism is still unknown. In the present experiment, biosynthesis of tyrosine was studied by using α -labelled- C^{14} -L-phenylalanine. The radioactive tyrosine was detected by radiometric analysis in the larvae which were reared with a tyrosine free synthetic diet containing the labelled phenylalanine. Phenylalanine is converted to tyrosine, and not to alanine during the course of metabolism. (auth.)
- 192 Ito, H. ON THE BIOSYNTHESIS OF FIBROIN IN THE POSTERIOR SILKGANDS OF SILKWORM. Bull. Soc. Franco-Jap. Biol. 14, 5 (1960) 13-20. (In Japanese)
- 193 Kasting, R., McGinnis, A.J. USE OF GLUCOSE LABELLED WITH CARBON-14 TO DETERMINE THE AMINO ACIDS ESSENTIAL FOR AN INSECT. Nature 182, 4646 (1958) 1380-1.
- Third-instar larvae of the blowfly *Phormia regina* Meig. were injected with 3-8 μl of a solution of uniformly labelled glucose- C^{14} containing 5000 cpm/ μl . After 24 h the CO_2 was found to be radioactive, indicating that glucose- C^{14} when injected into the larvae, was metabolized during this stage of development. A table gives the specific activities of carbon from amino-acids isolated from the blowfly after injection, and the amino-acid requirements as determined by the deletion procedure. The presence of intermediate quantities of radioactivity in proline and alanine indicates that both were synthesized from glucose. The radioactivity method described gave results for the blowfly that were sufficiently comparable to those of the classical deletion procedure to warrant application to insects that cannot yet be reared on chemically defined diets.
- 194 Kasting, R., McGinnis, A.J. USE OF GLUTAMIC ACID- $\text{U}-\text{C}^{14}$ TO DETERMINE NUTRITIONALLY ESSENTIAL AMINO ACIDS FOR LARVAE OF THE BLOW FLY, *PHORMIA REGINA*. Canad. J. Biochem. Physiol. 38, 11 (1960) 1229-34.
- The production of C^{14}O_2 by third-instar larvae of the blow fly, *Phormia regina* Meig., after it was injected with glutamic acid- $\text{U}-\text{C}^{14}$, indicates that this substrate was metabolized under these conditions. However, the nutritionally essential amino acids lysine, phenylalanine, valine, isoleucine, leucine, and threonine, isolated from the injected larvae, contained little radioactivity. A low level of radioactivity in arginine, histidine, and methionine suggests that they were slowly synthesized. The nutritionally non-essential amino acids alanine, serine, aspartic acid, and proline contained large quantities of radioactivity; tyrosine and glycine were exceptions. These results, in agreement with earlier work that used glucose- $\text{U}-\text{C}^{14}$, show that radioactivity data are useful for determining certain of the nutritionally essential amino acids. (auth.)

- 195 Levy, M., Slobodian, E. SEQUENCES OF AMINO ACID RESIDUES IN SILK FIBROIN. J. biol. Chem. **199** (1952) 563-72.
- Partial hydrolysates of silk fibroin (Bombyx mori) have been analysed by the isotope derivative technique, for glycine, alanine, glycyllalanine, alanylglycine, and glycyglycine. (In order to obtain distribution data in several immiscible solvent systems, following purification, minute amounts of each derivative were also prepared from radioactive (^{131}I) pipsyl chloride). Complete hydrolysates have been analysed for certain amino acids. The results showed little glycyglycine in partial hydrolysates, while the amounts of alanylglycine are so large as to eliminate the possibility of a random amino acid arrangement in fibroin. All of the analytical data, from studies of complete and partial hydrolysates, can be accounted for by the sequence -X-Ala-Gly-Ala-Gly-X-Gly-, which is proposed as a minimum repeating unit for fibroin.
- 196 Mfura, Y., Ito, H., Tanaka, S., Momose, K., Moriyama, A. TRANSFER OF RADIOACTIVITY FROM THE PRELABELED CELL DEBRIS TO THE MICROSOMAL PROTEIN. Biochim. biophys. Acta **43** (1960) 362-4.
- The transfer of radioactivity from C^{14} -labelled cell debris of silk glands to microsomal protein was measured in the presence of various subcellular fractions. Considerable radioactivity was transferred to the protein under appropriate conditions. When glycine- C^{14} was used as the source of radioactivity instead of labelled cell debris, the relative sp. activity of the microsomal protein was less than 0.0001%, compared to around 20% in the case of the cell debris. (CA 55: 10536a, 1961)
- 197 Oratz, M. STUDIES ON THE AMINO ACID SEQUENCE OF SILK FIBROIN. Diss. Abstr. **21** (1960) 41-3.
- Silk fibroin was reacted with S^{35} -labelled pipsyl chloride (p-iodophenyl-sulfonyl chloride) in 50% aqueous acetone containing an excess of NaHCO_3 . Hydrolysis and paper chromatography yielded 3 peaks which were identified as (Glycine) $_2$ (Alanine) $_2$ O-pipsyl Tyrosine, O-pipsyl tyrosylalanylglycine and glycyl O-pipsyl tyrosine. These 3 peptides isolated accounted for at least 35% of the total tyrosine in the sample of fibroin taken. The yields of these peptides exceed the statistically indicated yields based on a random distribution of amino acids in fibroin. The amino acid sequences found are compatible with the proposed repeating sequence of fibroin.
- 198 Passonneau, J.V., Williams, C.M. THE MOLTING FLUID OF THE CECROPIA SILKWORM. J. exp. Biol. **30** (1953) 545-60.
- During the first 2/3 of adult development the molting fluid is a dilute aqueous proteinaceous gel resembling egg albumen; at this time it is without effect on the pupal cuticle. On approximately the 14th day the gel is converted into a sol and shows considerable increase in chitinase activity and the first demonstrable proteolytic activity. The active molting fluid then begins to hydrolyze the protein and chitin in the overlying pupal endocuticle. Finally, the molting fluid is completely resorbed into the underlying insect. The molting fluid shows numerous quantitative and qualitative differences from the blood. A dynamic state exists between the molting fluid and the underlying insect. Radioactive glycine, injected into the molting fluid, was promptly resorbed and incorporated into the protein of the adult moth. (CA 48: 8969a, 1954)
- 199 Rabinovitch, M., Vugman, I. AUTORADIOGRAPHIC OBSERVATIONS ON THE SILK GLANDS OF BOMBYX MORI. J. biophys. biochem. Cytol. **6** (1959) 293-4.
- Glycine- ^{14}C was administered to B. mori larvae and its incorporation in the silk glands followed autoradiographically. After 15 and 30 min the autoradiographs showed strong and diffuse activity in the cell cytoplasm. At 1 h it was mainly found over the cell apex and newly formed secreted material. At 12 and 24 h the activity was localized mainly in the material secreted into the lumen. (auth.)
- 200 Shigematsu, A. INCORPORATION OF C^{14} -AMINO ACIDS INTO PROTEINS AND LIPID FRACTIONS OF SILKWORMS. J. Biochem., Tokyo **32** (1960) 519-24. (In Japanese)
- 201 Shigematsu, H. SYNTHESIS OF BLOOD PROTEIN BY THE FAT BODY IN THE SILKWORM, BOMBYX MORI L. Nature **182**, 4639 (1958) 880-2.

It is not yet clear which organ is concerned in the synthesis of blood protein in the larval stage. The protein content in the fat body of an individual has been shown to remain almost constant after the middle period of the last larval instar, whereas protein synthesizing activity of the tissue during the same period was rather high. In the first experiment described here, net synthesis and secretion of protein by the fat body was demonstrated. In the second experiment, the incorporation of amino acids labelled with C^{14} into protein

was investigated to confirm the synthesis and the secretion of protein by the tissue. (The labelled amino-acid mixture was isolated from *Euglena* cultured in a $C^{14}O_2$ atmosphere). In the third experiment, the nature of the protein secreted by the fat body was investigated by paper electrophoresis. The author proposes that the fat body of the silkworm synthesizes globulins and secretes them into the blood circulation during the larval stage, at least in the 5th larval instar.

- 202 Shigematsu, H. PROTEIN METABOLISM IN THE FAT BODY OF THE SILKWORM, *BOMBYX MORI* L. Bull. seric. Exp. Sta., Japan 18 (1960) 141-70. (In Japanese, with summary in English)

- 203 Shimura, K., Fukai, H., Sato, J., Saeki, R. NONUNIFORM LABELING OF THE SILK FIBROIN SYNTHESIZED *IN VIVO*. J. Biochem., Tokyo 43 (1956) 101-2.

After the administration of $CH_3NH_2C^{14}O_2H$ (5 mg, 1.2×10^4 cpm) to each silk worm larva on the 3rd-4th day of the 5th instar, silk fibroin was isolated from the posterior gland by washings with 0.14 M and M NaCl, distilled water, EtOH, and ether, in that order, and the radioactivity of the fibroin was then determined. The labelled glycine was shown to be incorporated non-uniformly but to be present predominantly in N-terminal amino acids of the fibroin molecule.

- 204 Shimura, K., Fukai, H., Suto, S., Hoshi, R. BIOSYNTHESIS OF SILK FIBROIN. I. INCORPORATION OF GLYCINE-1- C^{14} INTO FIBROIN *IN VIVO*. J. Biochem., Tokyo 45 (1958) 481-8.

After the injection of glycine-1- C^{14} (I) (1.4×10^5 counts/min/worm) to *Bombyx mori* on the 3rd-5th day of the 5th instar, I is incorporated promptly into posterior silk gland (II), the CCl_3CO_2H (III)-precipitated protein of which shows the maximum radioactivity at the 4th h. Radioactivity of III-precipitated protein of middle silk gland rises slowly in initial 4-6 h and then increases rapidly up to the 10th h, while that of the 70% alcohol-precipitated protein of blood is far lower up to 24 h. Of protein fractions of posterior II prepared by the Griffin's method (cf. CA 43: 2314a) fibroin (IV) is predominantly radioactive, but this Griffin IV fraction is impure in comparison with IV prepared by precipitating off other proteins by III. Of intracellular fractions of Schneider *et al.* (cf. CA 45: 8110e) of posterior II large granules (V) strongly incorporate I and small granules (VI) also do to a lesser extent. V and VI have 9.8 and 5.3 for total N/ribonucleic acid P ratio, and 462 and 73 for succinic oxidase activity (as Q_m /mg N). The I incorporation into IV (the III-method) of posterior II shows a lag phase of 30 min, which is not the case with Griffin's IV fraction. Column (Dowex 50) chromatography of the hydrolyzate of IV (the III method) of posterior II gives the following pattern of radioactive amino acid distribution: I 95, serine 3, alanine 1, and threonine 0.5-1%. The incorporation pathway of I is presented: free I in blood \rightarrow synthesis to IV in posterior II \rightarrow IV in middle silk gland by simple transport. (CA 52: 18918d, 1958)

- 205 Shimura, K., Kobayashi, H., Hoshi, R., Sato, J. BIOSYNTHESIS OF SILK FIBROIN. II. NONUNIFORM LABELING OF SILK FIBROIN SYNTHESIZED *IN VIVO*. J. Biochem., Tokyo 46 (1959) 849-55.

After injecting glycine-1- C^{14} or alanine-1- C^{14} in *Bombyx mori* (strain Si 122 x Nichi 122) at the 3rd-5th day of the 5th instar, the incorporation of C^{14} in N-terminal amino acids of silk fibroin of the posterior silk gland was 2-5 times that in nonterminal amino acids of silk fibroin. The radioactivity of the N-terminal amino acids decreased at a rate higher than that of nonterminal groups. Similar tendencies were demonstrated with tissue protein, fraction IV (Coleman and Howitt, CA 42: 4216e), of the silk gland. A stepwise synthesis of silk fibroin is suggested. (CA 53: 22103c, 1959)

- 206 Sisakyan, N.M., Kuvaeva, E.B. EFFECT OF ENERGY DONORS AND INHIBITORS ON INCLUSION OF C^{14} -GLYCINE INTO PROTEINS OF CAVITY FLUID OF *BOMBYX MORI*. Dokl. Akad. nauk. SSSR 113 (1957) 873-6. (In Russian)

The ability of the pupal cavity fluid to incorporate C^{14} -labelled glycine varies with time of metamorphosis, being low at 25-30% pupal age and intense at 65% pupal age. Addition of sucrose increases the incorporation at histolysis stage by some 47%, while at histogenesis stage the addition causes a 3-fold increase of incorporation. Adenosinetriphosphate (ATP) greatly increases the rate of incorporation at the histolysis stage, and almost stops it at histogenesis stage. The results were similar with pupae of *Antheraea pernyi* (*). At histolysis stage NaF inhibits the incorporation and either has no effect or a slight stimulating effect during histogenesis stage. (CA 51: 13243b, 1957)

* The Chinese oak silkworm

- 207 Slobodian, E., Levy, M. THE SEQUENCE GLYCYLALANYLGLYCINE IN SILK FIBROIN. J. Biol. Chem. 201 (1953) 371-5.

In the silk fibroin of Bombyx mori the major portion of the nitrogen is accounted for by the amino acids glycine and alanine. The amino acid sequence in the protein may be studied through the identification and estimation of the peptides obtained on partial hydrolysis of the protein. The tripeptide glycylalanylglycine was identified in partial hydrolysates by a technique using H^{15} -labelled pepsyl chloride. Analysis by the isotope derivative technique indicated amounts of this peptide well in excess of the maximum value to be expected from a random arrangement of amino acid residues in silk. Evidence is thus provided for the view of a non-random, ordered amino acid arrangement in silk fibroin, with the sequence glycylalanylglycine as an important structural element.

* Spinks 1958 - [14]

- 208 Suzuka, I., Shimura, K. BIOSYNTHESIS OF SILK FIBROIN. I. INCORPORATION OF GLYCINE- C^{14} INTO PARTICLES OF POSTERIOR SILK GLAND IN VITRO. J. Biochem., Tokyo 47 (1960) 551-4.

The large particulate fraction (I) capable of incorporating glycine, was purified as follows: the posterior silk glands of Bombyx mori were homogenized in 0.4 M sucrose-0.0025 M KCl-0.005 M $MgCl_2$ (pH 8.0), centrifuged and the debris (700 g) removed. I was precipitated at 14 000 g. The supernatant was then adjusted to pH 6.1, centrifuged, the precipitants removed, the supernatant acidified to pH 4.9 and the glycine-incorporation stimulating factor (II) brought down by precipitation. The glycine- C^{14} incorporation into protein of I catalyzed by I cannot be stimulated by II or any other intra-cellular fractions. Deoxycholate (2%) treated I (III) in 0.4 M sucrose at pH 8.0 is not active and required II for glycine incorporation which is markedly stimulated by the addition of 2×10^{-4} M guanosine triphosphate. II cannot be replaced by ribonucleic acid or other intra-cellular fractions. II does not catalyze the formation of glycine hydroxamate or the exchange reaction between adenosine triphosphate and phosphate or P^{32} -labelled pyrophosphate.

- 209 Suzuka, I., Shimura, K. BIOSYNTHESIS OF SILK FIBROIN. II. INCORPORATION OF SPECIFIC C^{14} -LABELLED AMINO ACIDS INTO PROTEINS OF POSTERIOR SILK GLAND IN VITRO. J. Biochem., Tokyo 47 (1960) 555-7.

The relative rate of incorporation of glycine-, alanine-, and leucine- C^{14} by I was determined as 5:2.5:1 for Bombyx mori whereas the fraction for Artacus ricini, whose fibroin is rich in alanine, incorporated alanine at the highest rate. The amino acid incorporation took place by combining either rat-liver microsomes (IV) or III preparation of B. mori or A. ricini with rat liver pH 5 enzyme or II preparation of B. mori or A. ricini. The bulk of the incorporated amino acids was determined as leucine, glycine, and alanine with the use of III of B. mori and A. ricini, respectively, regardless of the sort of activating or stimulating factor supplemented.

(For key to notation used, see abstract for part I of the study)

- 210 Suzuka, I., Tanaka, S., Shimura, K. AMINO ACID INCORPORATION ENZYME IN POSTERIOR SILK GLAND. J. Biochem., Tokyo 48 (1960) 774-6.

- 211 Teifer, W.H., Williams, C.M. INCORPORATION OF RADIOACTIVE GLYCINE INTO THE BLOOD PROTEINS OF THE CECROPIA SILKWORM. Anat. Record 122 (1955) 441-2.

Injection of radioactive glycine (C^{14} carboxyl-labelled) intrahemally into the Cecropia silkworm leads to the appearance of radioactivity in the proteins of both blood and tissues. Ninhydrin tests revealed that the radioactivity of the blood proteins occurred in carboxyl groups associated with peptide bonds. Pupae in the overwintering state of diapause readily incorporated C^{14} into their blood proteins, although this occurred at a slow rate. The termination of diapause, which is marked by the initiation of adult development, was accompanied by a four-fold increase in the rate of incorporation of C^{14} into the blood proteins. Diapausing pupae in which the end of the abdomen had been replaced by a plastic coverslip incorporated C^{14} into blood proteins at a rate characteristic of developing adults. The capacity of diapausing pupae to respond to injury in this manner indicates that their inability to grow and differentiate is not due to an inability to synthesize proteins. The effects of injury, carbon monoxide and stage of metamorphosis on the rate of incorporation of C^{14} into blood proteins parallel the effects of these same factors on the rate of oxygen consumption (Schneiderman and Williams, Biol. Bull. 105: 320-34).

(Abstract of paper presented before the 52nd Ann. Meeting of the American Society of Zoologists, 6-8 Sept. 1955)

- 212 Telfer, W.H., Williams, C.M. THE EFFECTS OF DIAPAUSE, DEVELOPMENT, AND INJURY ON THE INCORPORATION OF RADIOACTIVE GLYCINE INTO THE BLOOD PROTEINS OF THE CECROPIA SILKWORM (HYALOPHORA CECROPIA). J. Insect Physiol. 5,1 (1960) 61-72.

Radioactive glycine, injected into the haemocoel of diapausing pupae and developing adults, is incorporated into the proteins of the blood. The rate of incorporation parallels previously described rates of O consumption under a variety of conditions. The incorporation of amino acids can be added to the list of metabolic processes which proceed at depressed rates during diapause, but which accelerate temporarily in response to injury. (CA 55: 4802a, 1961)

- 213 Treherne, J.E. AMINO ACID ABSORPTION IN THE LOCUST (SCHISTOCERCA GREGARIA FORSK.) J. exp. Biol. 36 (1959) 533-45.

Chromatographic analysis of the hemolymph revealed the presence of 10 amino acids of which glycine and serine occurred in the relatively high concentrations of 33.2 and 34.6 millimoles/l, respectively. After injection of C^{14} -labelled glycine and serine into the gut lumen, uptake was shown to occur rapidly in the mid-gut region and especially from the lumen of the caeca. The concentrations of glycine and serine, and also of glutamine in the caecal fluid, were found to increase significantly above the concentrations in the hemolymph, an effect which was paralleled by a relatively rapid decrease in fluid volume. During this time rapid exchange of C^{14} -labelled glycine and serine between the hemolymph and the gut lumen was demonstrated. Absorption of these amino acids depends, in part at least, upon the diffusion gradient created by the relatively rapid movements of water into the hemolymph. (CA 54: 16673g, 1960)

- * Winteringham and Harrison 1956 - [782]

I-B-3 NUCLEIC ACIDS

- 214 Bishop, G.H., Friedkin, M. UTILIZATION OF THYMIDINE- C^{14} BY QUEEN BEE LARVAE. J. exp. Zool. 141 (1959) 245-56.

Tissues of queen bee larvae were incubated with thymidine- C^{14} at various stages of larval and pupal development. The radioactivity/mg/h of incubation of the acid-insoluble fraction and per mg wet weight of tissue decreased sharply with the age of the larva. The activity per unit larva, however, increased with age, but less steeply. The implications of these findings are discussed. Despite the massive breakdown of the fat body cells prior to transformation of the larva, the biochemical and histological data suggest that DNA synthesized during early larval stages, or at least its nucleotides, may be utilized intact during later periods of cellular differentiation in the queen bee. Larvae fed thymidine- C^{14} in royal jelly apparently digested it, since the greatest activity was then found in the silk cocoons spun at maturity. The C^{14} was not in the protein of the cocoon since only an insignificant amount of activity appeared in the acid-insoluble fraction of the silk after alkaline treatment. Injection of thymidine into the blood space of the pupa lead to some utilization, activity being still present after emergence of the mature queen, mating and beginning of egg-laying. (auth. summary)

- 215 Ficq, A., Pavan, C. AUTORADIOGRAPHY OF POLYTENE CHROMOSOMES OF RHYNCHOSCIARA ANGELAE AT DIFFERENT STAGES OF LARVAL DEVELOPMENT. Nature 180 (1957) 983-4.

Tritiated thymidine (0.01-0.1 μ C) was injected into larvae of Rhynchosciara angelae. The sites of greatest incorporation of thymidine into the chromosome vary with the age of the larvae, but are constant at the same stage of larval development, and much more evident in certain loci of the chromosomes than in others. The authors conclude that the intense incorporation of thymidine in "puff" loci of the polytene chromosomes show that DNA plays a very active part in the puffing. "Puffs" which are characteristic for the larval stages are interpreted as indicating special gene activity which is localized and confined to certain periods. The gene metabolism in R. angelae appears to be linked with DNA synthesis.

- 216 Ficq, A., Pavan, C. AUTORADIOGRAPHIC STUDY OF ISOLATED CHROMOSOMES. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/114. 25 (1958) 211-3.

The metabolism of the chromosomes of the salivary glands of Rhynchosciara angelae were studied by means of the specific radioactive precursors of the nucleic acids (thymidine- H^3 and adenine- C^{14}) and proteins. Doses of the order of 0.01 to 0.1 μ C of thymidine- H^3 , adenine-8- C^{14} , or phenylalanine-2- C^{14} were administered to the larvae by microinjection. The larvae were then sacrificed, usually after 24 h, and after appropriate treatment the chromosomes were autoradiographed. The "puffs" show a higher incorporation of

the two precursors, indicating a concomitant synthesis of DNA and of proteins at this level. This confirmed earlier results.

- 217 Gauden, M.E. DNA SYNTHESIS AND X-RAY EFFECTS AT DIFFERENT MITOTIC STAGES IN GRASSHOPPER NEUROBLASTS. Genetics 41 (1956) 645.

A study has been initiated to determine at what stage or stages of mitosis synthesis of deoxyribonucleic acid (DNA) occurs in the grasshopper neuroblast, to determine the effects of irradiation on this synthesis, and to determine whether radiation-induced mitotic inhibition can be correlated with an inhibition of DNA synthesis. - Grasshopper embryos were observed in living culture preparations. When a neuroblast entered a given stage of mitosis, C^{14} -labelled thymidine was added to the culture medium. When the cell reached the end of the given mitotic stage, the embryo was fixed immediately and washed with water to remove unincorporated thymidine. It was subsequently sectioned, stained with Feulgen reagent, and covered with stripping film. The cell originally observed in living condition was then examined for presence of grains in film above it. (Since fractionation of embryos revealed that the C^{14} was in the DNA fraction, it is assumed that uptake of thymidine indicates synthesis of DNA.) - Uptake of thymidine in neuroblasts begins in the middle telophase and continues into very early prophase. Maximum uptake occurs during late telophase and interphase, rate of uptake being approximately the same in both stages. Thus the stages of mitosis most sensitive to x-rays, namely middle and late prophase, are not involved in synthesis of DNA. Data accumulated thus far indicate that interference with uptake of thymidine occurs only in cells that have received a dose of x-rays much higher than that sufficient for blocking mitosis.

(Abstract of paper presented at the 1956 meetings of the Genetics Society of America, Storrs, Connecticut 27-29 Aug. 1956)

- 218 Gross, J.D. INCORPORATION OF PHOSPHORUS-32 INTO SALIVARY-TYPE CHROMOSOMES WHICH EXHIBIT "PUFFS". Nature 180 (1957) 440.

A preliminary study was made into the rate of incorporation of P^{32} into the chromosomes and associated structures in the salivary gland of the Chironomid, Metriocnemus hygropliticus. Larvae were grown on medium containing P^{32} (as phosphate) for 2-24 h, and the incorporation studied in autoradiographs of squashes and sections, which were stained with methyl-green-pyronin and in some cases extracted with ribonuclease or hydrochloric acid. Incorporation of tracer was adequate after feeding the larvae on labelled medium for 4-8 h. The puffs appear to concentrate the P^{32} much more actively than the remainder of the chromosome which show an incorporation little above the background. Staining reactions indicate that ribonucleic acid is much more highly concentrated in the puffs than in the remainder of the chromosome.

- * Horikawa and Sugahara 1960 - [914]

- 219 Ito, T., Horie, Y., Tanaka, M. PHOSPHORUS COMPOUNDS OF THE MIDGUT IN THE SILKWORM. p.283-9 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

During the 4th and 5th larval instars of the silkworm, Bombyx mori, nucleic acid P occupies one-third of total P of the midgut. Just before cocoon-spinning, nucleic acid P and lipid P decrease gradually, while acid-soluble P increases rapidly. This is caused by the increase in inorganic P, suggesting the excretion of P as a form of inorganic P into the midgut cells from other parts of the body at this period. There is almost no change in protein P throughout larval stage. As the result of using P^{32} , it was shown that the part absorbing P actively is the posterior midgut. The total P^{32} of the midgut reaches the maximum 2 h after feeding P^{32} , then decreases gradually. The same is true for the acid-soluble fraction, which, however, decreases more rapidly with time than the total P^{32} . Lipid P^{32} reaches the highest level 14 h after feeding. The changes relating to the turnover in the midgut were also observed in various P fractions of the blood. There are some differences in paperchromatograms and radioautograms between the midgut and the blood. (auth.)

- 220 Kaplan, W.D., Siskin, J.E. GENETIC AND AUTORADIOGRAPHIC STUDIES OF TRITIATED THYMIDINE IN TESTES OF DROSOPHILA MELANOGASTER. Experientia 16 (1960) 67-9.

Autoradiographic studies were made of D. melanogaster larvae at various intervals after removal from a thymidine-containing diet up to 56 h. The preliminary data show that spermatocytes reduplicate their chromosomes very early and move posteriorly as additional cells are proliferated from the apical spermatogonia. The mutagenic effect of tritiated thymidine was studied genetically. Unquestionably the thymidine produces a mutagenic effect. (auth.)

- 221 Karnkowska-Gonka, Z. INCORPORATION OF TRITIUM-LABELLED THYMIDINE INTO THE SPINNING GLANDS OF THE SILK WORM BOMBYX MORI L. Bull. Acad. Polon. Sci., Sér. Sci. Biol. 8,8 (1960) 353-6. (In Polish)
- 222 King, R.C., Falk, G.J. IN VITRO INCORPORATION OF URIDINE- H^3 INTO DEVELOPING FRUIT FLY (DROSOPHILA MELANOGASTER) OOCYTES. J. biophys. biochem. Cytol. 8,2 (1960) 550-3.
- The excised ovaries of 3-day-old female D. melanogaster were immersed in a solution containing TC 199 and uridine- H^3 . The H^3 was incorporated into ribonucleic acid within 4 min and localized in the dense ribbon-like chain of plasmasomes found in the nuclei of nurse cells associated with the oocyte. (CA 55: 12674 e, 1961)
- * Kogure and Nakajima 1958 - [1148]
- 223 McMaster-Kaye, R., Taylor, J.H. EVIDENCE FOR TWO METABOLICALLY DISTINCT TYPES OF RIBONUCLEIC ACID IN CHROMATIN AND NUCLEOLI. J. biophys. biochem. Cytol. 4,1 (1958) 5-11.
- Patterns of radioisotope incorporation are useful characteristics in describing cellular RNA fractions, and have indicated a distinctive "nuclear" RNA. In order to characterize the RNA fractions of the two nuclear components, nucleoli and chromatin, and to determine thereby the precise localization of the RNA typical of isolated nuclei, time-courses of P^{32} incorporation into nucleolar, chromosomal, and cytoplasmic RNA of Drosophila salivary glands have been determined from autoradiograms. Two experiments are reported which cover 12 and 18 h periods including an initial 2 h feeding on P^{32} . Concentrations of RNA- P^{32} (identified by ribonuclease digestion) were determined by grain counts. After 1 h only the nucleolar RNA is labelled. Activity is detectable in chromosomal and cytoplasmic RNA after the 2nd h. The nucleolar fraction reaches its maximum activity shortly after transfer of the larvae to non-radioactive food, the other fractions several hours later. Maximum activities persist in the chromosomal and cytoplasmic fractions; nucleolar activity decreases after the 9th h. The observed differences in times at which incorporation begins and maximum activities are reached, and in maintenance of maximum activities indicate that chromosomal and nucleolar RNA are distinct fractions. The metabolic characteristics which have been ascribed to "nuclear" RNA apply only to the nucleolar fraction. (auth.)
- 224 Miura, Y., Ito, H., Shigematsu, A. MICROAUTORADIOGRAPHIC STUDIES ON THE METABOLISM OF PROTEIN AND RIBONUCLEIC ACID IN POSTERIOR SILKGLANDS. Jap. J. appl. Ent. & Zool. 4,2 (1960) 123-6. (Nihon Ōyō Dobutsu Konchū Gakkai-shi) (In Japanese, with English summary)
- Data was obtained for Bombyx mori.
- * Pavan 1960 - [375]
- 225 Pelc, S.R., Howard, A. METABOLIC ACTIVITY OF SALIVARY GLAND CHROMOSOMES IN DIPTERA. Exp. Cell Res. 10 (1956) 549-52.
- Larvae of Drosophila melanogaster were given S^{35} -DL-methionine (I), 8- C^{14} -adenine (II), or $Na^{35}SO_4$ (III) with their food. The salivary glands were removed 24 h later and autoradiographs prepared. The autoradiographs with I were not sufficiently strong to decide the relative concentration in small portions. With II, good autoradiographs were obtained in the chromosome bands. After treatment with ribonuclease, the preparations showed no autoradiographs, suggesting the incorporation of II into ribonucleic acid. No autoradiograph of the chromosomes or cytoplasm was obtained with III. (CA 51: 21861, 1957)
- 226 Pelling, G. CHROMOSOMAL SYNTHESIS OF RIBONUCLEIC ACID AS SHOWN BY INCORPORATION OF URIDINE LABELLED WITH TRITIUM. Nature 184 (1959) 655-6.
- The investigation was made on the gland chromosomes of Chironomus tentans. Special staining techniques for showing up RNA within the chromosomes were used. Sites of RNA were determined by autoradiography; 0.25 - 1.25 μ c of tritium-labelled uridine was injected into larvae, with special precautions to avoid loss of haemolymph. The uptake of uridine was allowed to continue for 15 min to 24 h. Nucleolar RNA was found to be synthesized at the nucleolar organizer only. Synthesis is continuous. Many other sites of the chromosomes are also involved in RNA synthesis, but the bulk is produced by a few very active loci. This confirms earlier interpretations of the phenomenon of differential puffing in dipteran giant chromosomes. RNA synthesizing structures show no activity after short application (up to 2 h) of radioactive amino-acids (glycine- C^{14} , tryptophan- H^3 , methionin- S^{35}). Protein synthesis seems not to be correlated with RNA synthesis.

- 227 Rudkin, G.T., Woods, P.S. INCORPORATION OF H^3 CYTIDINE AND H^3 THYMIDINE INTO GIANT CHROMOSOMES OF *DROSOPHILA* DURING PUFF FORMATION. Proc. nat. Acad. Sci., Washington 45,7 (1959) 997-1003.
- The morphological change involving a local increase in diameter of the chromosome, frequently called "puff", was examined in terms of its chemistry, particularly a comparison of the metabolic activities of puff and non-puff regions with respect to both DNA and RNA. Methods are described for the incorporation of tritium-labelled thymidine and cytidine into puff regions. Results with H^3 -thymidine indicated that DNA synthesis is not a necessary concomitant of puff formation and disproportionate synthesis does not occur during puff formation. H^3 -cytidine incorporation was interpreted to indicate the presence of RNA, and was found to label cytoplasm, chromosomes and nucleoli of all cells; puff regions were more heavily labelled than on administration of thymidine.
- 228 Shigematsu, A., Miura, Y., Ito, H. ETUDES AUTORADIOGRAPHIQUES SUR LA RELATION ENTRE LES BIOSYNTHESES DE L'ACIDE RIBONUCLÉIQUE ET CELLES DE LA PROTÉINE DANS LES GLANDES SÉRICIGÈNE CHEZ *BOMBYX MORI* L. C.R. Soc. Biol., Paris 154, 4 (1960) 892-5.
- Les auteurs ont mis en évidence que la synthèse de l'acide ribonucléique précède celle des protéines dans les glandes séricigènes, ainsi confirmant leurs conclusions basées sur l'expérimentation *in vivo*. Les auteurs ont utilisé *Bombyx mori* L., ayant atteint le 5e âge et une heure après injections de la solution de ^{32}P ou glycine-1- ^{14}C (1 μ g) la partie sécrétrice des glandes séricigènes a été fixée à la solution de Carnoy. Le résultat de l'autoradiographie a été résumé dans un tableau.
- 229 Takeyama, S., Ito, H., Miura, Y. FIBROIN SYNTHESIS AND RIBONUCLEIC ACID (RNA) METABOLISM IN THE SILK GLAND. Biochim. biophys. Acta 30 (1958) 233-43.
- The posterior silk glands of the 5th instar larvae of silkworms were incubated with RNA and protein precursor. Glycine- C^{14} was actively incorporated into the protein fraction and orotic acid- C^{14} into the RNA fraction. The greater part of the radioactivity incorporated into protein represented fibroin synthesis. Orotic acid was incorporated into RNA uracil. Impairment of orotic acid incorporation by inhibitors of RNA metabolism (6-uracilmethyl sulfone) was not accompanied by impairment of the incorporation of glycine into protein. Apparently, the simultaneous renewal of RNA was not necessarily required for the synthesis of fibroin. Ribonuclease (200 γ /ml) almost completely inhibited fibroin synthesis. Neither the metabolic renewal of RNA nor the RNA remaining after enzyme treatment was able to restore this synthesis, nor was it restored by the addition of RNA obtained from the same tissue. Thus, fibroin synthesis was dependent on the existence of intact RNA. (CA 53: 3518g, 1959)
- 230 Taylor, J.H., McMaster, R.D., Caluya, M.F. AUTORADIOGRAPHIC STUDY OF INCORPORATION OF PHOSPHORUS-32 INTO RIBONUCLEIC ACID AT THE INTRACELLULAR LEVEL. Exp. Cell Research 9 (1955) 460-73.
- Larvae of *Drosophila repleta* were given food containing P^{32} -labelled phosphate for 1 to 2 h and then transferred to non-labelled food. The larvae were fixed at intervals of $\frac{1}{2}$ or 1 h and the incorporation of P^{32} into ribonucleic acid (RNA) determined in the cytoplasm, chromosomes, and nucleoli of the salivary glands. Incorporation was high in all cells during the first half of the third instar but then decreased so that no radioactive RNA could be detected in the last third of the instar. Labelled RNA was detected after 1 h in sectors of chromosomes lying near the nucleolus and in the nucleolus itself. Within 3 h the activity in the nucleolus increased so that RNA appears in cytoplasm about this time and in 5-6 h is as high as in the nucleolus. From activity-time relation study, the cytoplasmic RNA could originate from nucleolar RNA or both could have a common precursor. (CA 50: 9830b, 1956)
- 231 Weygand, F., Waldschmidt, M. ÜBER DIE BIOSYNTHESE DES LEUCOPTERINS, UNTERSUCHT MIT ^{14}C -MARKIERTEN VERBINDUNGEN AM KOHLWEISLING (On the biosynthesis of leucopterin, studied in the cabbage moth by means of C^{14} -labelled compounds). Angew. Chem. 67,12 (1955) 328. (In German)
- In a preliminary experiment, larvae of *Gonepteryx rhamni* and *Pieris brassicae*, *napi* and *rapae* were allowed to feed on C^{14} -labelled folic acid-[2- C^{14}], guanine-[2- C^{14}], guanine-[8- C^{14}], hypoxanthine-[2- C^{14}], 2,4,5-triamino-6-oxy-pyrimidine-[2- C^{14}]-hydrochloride, glycine-[1- C^{14}] and sodium formate-[C^{14}]. The uptake of radioactivity from the various compounds was tested, and considerable variation found. Glycine-[1- C^{14}] (37 γ /larva) and sodium formate (100 γ /larva) were injected into the legs. By separating the leucopterin in both cases, and from analysis of the degradation products (degradation taking place in two ways) it was possible to show that pterine synthesis in the cabbage moth follows an analogous pattern to that of the purines and lactoflavins.

- 232 Agarwal, H.C., Kapadia, G.G., Casida, J.E., Beck, S.D. PRELIMINARY STUDIES ON INSECT STEROLS AND THEIR METABOLISM. Bull. ent. Soc. Amer. 5, 3 (1959) 138, abstr. 241.

The metabolism of C^{14} -labelled cholesterol and cholesterol acetate was studied in the adult cockroach and housefly, and larvae of confused flour beetle. Sterols from the housefly were isolated and at least three compounds separated chromatographically. An attempt was made to characterize these sterols.

- 233 Bloch, K., Langdon, R.G., Clark, A.J., Fraenkel, G. IMPAIRED STEROID BIOGENESIS IN INSECT LARVAE. Biochim. biophys. Acta 21 (1956) 176.

Cholesterol (I) synthesis in Dermestes vulpinus larvae was studied with the aid of the tracer technique. Acetate- $I-C^{14}$ was utilized for the synthesis of both fatty acids and unsaponifiable material during larval growth. However, synthesis of I from the acetate did not occur. Dermestes larvae were unable to use squalene in lieu of I for growth and development. Since acetate- C^{14} is incorporated into squalene, but was not incorporated into either I or lanosterol the sterol requirement of Dermestes may be attributed to an interruption of I biogenesis at the squalene stage. (CA 50: 15975 e, 1956)

- 234 Casida, J.E., Beck, S.D., Cole, M.J. STEROL METABOLISM IN THE AMERICAN COCKROACH. J. biol. Chem. 224 (1957) 365-71.

Certain aspects of insect sterol metabolism were investigated with Periplaneta americana. The normal distribution of free and esterified sterols among the organ systems was determined and compared with the distribution of cholesterol-4- C^{14} 16 h after injection. The rate of colour formation with the Schoenheimer-Sperry reagent from the sterols in the various organs differed greatly. Injection of acetate- $I-C^{14}$ into cockroaches and mice resulted in almost the same percentage recovery of labelled digitonides. Cockroach cholesterol esterase was investigated in relation to distribution among the organs and substrate specificity. (CA 51: 8311d, 1957)

- 235 Clark, A.J., Bloch, K. THE ABSENCE OF STEROL SYNTHESIS IN INSECTS. J. biol. Chem. 234 (1959) 2578-84.

Larvae of the beetle Dermestes vulpinus reared on diets containing $I-C^{14}$ -acetate or randomly labelled C^{14} -fructose failed to form radioactive squalene or sterols. The nonsaponifiable matter isolated from these insects contained two radioactive fractions. One of them is shown to be a saturated aliphatic hydrocarbon, or mixture of hydrocarbons, with an average molecular weight of 346 and an unbranched carbon chain. The second fraction has been characterized as a primary aliphatic alcohol with an average molecular weight of 395 ± 17 . The cholesterol necessary for the growth of Dermestes larvae cannot be replaced or spared by mevalonic acid, squalene, lanosterol, or Δ^8 -4,4-dimethylcholesterol. It is suggested that the pathways of cholesterol biogenesis are multiply blocked in this organism. 24-Dehydrocholesterol can substitute for cholesterol in supporting the growth of Dermestes larvae. (auth. summary)

- 236 Clark, A.J., Bloch, K. CONVERSION OF ERGOSTEROL TO 22-DEHYDROCHOLESTEROL IN BLATTELLA GERMANICA. J. biol. Chem. 234 (1959) 2589-94.

The utilization of dietary ergosterol by nymphs of the German cockroach, Blattella germanica, was investigated. The insects were given ergosterol which had been uniformly labelled with C^{14} . The formation of a new radioactive sterol was observed. This conversion product could not be demonstrated with ergosterol labelled at C-28 only, which showed that it no longer contains the C-28 methyl substituent of ergosterol. By isotopic techniques the demethylation product of ergosterol was shown to be 22-dehydrocholesterol. A small amount of crystalline sterol was isolated from a large number of ergosterol-fed nymphs and shown to be identical with authentic 22-dehydrocholesterol. The significance of this conversion is discussed. (from auth. summary)

- 237 Clements, A.N. STUDIES ON THE METABOLISM OF LOCUST FAT BODY. J. exp. Biol. 36 (1959) 665-75.

The incorporation of glycine- C^{14} , leucine- C^{14} , NaOAc-2- C^{14} , and glucose- C^{14} into Schistocerca fat body was studied under in vitro conditions, and the distribution of radioactivity in the various fat body fractions and the labelling of compounds in the fractions are described. There was high incorporation into fat and protein and very low incorporation into glycogen. Incubation with glycine- C^{14} led to the appearance of

radioactivity in the glycine and serine of the protein and of the amino acid pool. Incubation with labelled acetate led to radioactivity in glutamic acid, proline, aspartic acid, and alanine, showing that the intermediates of the tricarboxylic acid cycle provided the C skeletons of the amino acids. Glucose was largely converted to trehalose. Succinic dehydrogenase and the condensing enzyme system were shown to be present in the fat body, contrary to previous reports. The succinic acid oxidase system was highly labile on homogenizing the tissue. Fat body, unlike flight muscle, used glycine and leucine as respiratory substrates. It is suggested that fat body acts like the vertebrate liver by transaminating amino acids and making them available for further metabolism by other tissues. (CA 54: 16674f, 1960)

- 238 Kaplanis, J.N., Monroe, R.E., Robbins, W.E., Loulides, S.J. THE FATE OF DIETARY H^3 - β -SITOSTEROL IN THE ADULT HOUSE FLY. Bull. ent. Soc. Amer. 6,3 (1960) 151, abstr. 38.

When houseflies were fed a diet containing H^3 - β -sitosterol the sterol was found to be efficiently absorbed and utilized in egg production. Analysis of the H^3 -compounds from the adults and eggs indicated the presence of several metabolites.

- 239 Kaplanis, J.N., Robbins, W.E., Tabor, L.A. THE UTILIZATION AND METABOLISM OF 4-C¹⁴-CHOLESTEROL BY THE ADULT HOUSEFLY. Ann. ent. Soc. Amer. 53,2 (1960) 260-4.

The metabolism and excretion of ingested 4-C¹⁴-cholesterol was studied in the housefly (*Musca domestica*). Only low levels of excretion (2.0% - 2.5%) were found 3 days after treatment and about 10% of this behaved as acidic material. When female flies were treated and the eggs collected, 78% of the radioactivity was recovered 3 weeks after treatment. The high recovery and low excretion rate indicate a strict sterol economy in the housefly. The administered cholesterol was efficiently utilized in egg production. Some of the radioactive sterols were found to be esterified in both egg and adult. Analysis by column chromatography and reverse isotope dilution demonstrated the presence of 2 major compounds - unchanged cholesterol and 7-dehydrocholesterol - and a lesser fraction consisting of unidentified polar steroids. (auth.)

- 240 Kodicek, E., Levinson, Z.H. METABOLISM OF β -SITOSTEROL AND OTHER LIPIDS IN THE PRESENCE OF ACETATE-2-¹⁴C BY BLOWFLY LARVAE. Nature 188, 4755 (1960) 1023-5.

Larvae of *Calliphora erythrocephala* were fed some sodium acetate-2-C¹⁴ in their diet. Details of the technique are given. The distributions of radioactivity in the total lipid content, unsaponifiable matter, digitonin-precipitable sterols, digitonin-non-precipitable, fatty acids, lipid-free residue and total CO₂ expired by the larva were tabulated. Results show that *Calliphora* larvae are unable to synthesize sterols from C¹⁴-labelled acetate, but indicate also that the cholesterol side-chain is not formed by re-synthesis from acetate, but rather by de-ethylation of the β -sitosterol side-chain at position C₂₄. Acetate would appear to be utilized at least as efficiently for biosynthesis of fatty acids as for biosynthesis of unsaponifiable matter, other than sterols. Significant amounts of C¹⁴ were incorporated into unsaponifiable lipids other than sterols; they were investigated by reversed-phase paper chromatography and radioautography. From the still significant radioactivity remaining in the larvae after removal of lipids it may be assumed that acetate was also used for the synthesis of non-lipid constituents of the body.

- 241 Loulides, S.J., Kaplanis, J.N., Robbins, W.E., Monroe, R.E. LIPOGENESIS FROM C¹⁴-ACETATE IN THE AMERICAN COCKROACH. Bull. ent. Soc. Amer. 5,3 (1959) 138, abstr. 245.

The incorporation of radioactivity into the saponifiable and unsaponifiable fractions of male and female American cockroaches was determined following injection of 1-C¹⁴-acetate. The unsaponifiable material was fractionated by chromatography and digitonin precipitation and the methyl esters of the fatty acids were analysed by gas chromatography.

- * (Published more fully in Ann. ent. Soc. Amer. 54,1 (1961) 99-103, not included in this bibliography)

- 242 Robbins, W.E., Kaplanis, J.N., Monroe, R.E., Tabor, L.A. METABOLISM OF C¹⁴-CHOLESTEROL BY NYMPHAL GERMAN COCKROACHES. Bull. ent. Soc. Amer. 5,3 (1959) 137, abstr. 229.

Only low levels of C¹⁴ compounds were excreted following injection of 4-C¹⁴-cholesterol to female flies. Most of the administered material was utilized in egg production. The C¹⁴ compounds present in the adults and eggs were characterized by column chromatography and reverse isotope dilution.

- 243 Robbins, W.E., Dutky, R.C., Monroe, R.E., Kaplanis, J.N. THE METABOLISM OF H^3 - β -SITOSTEROL BY NYMPHAL GERMAN COCKROACHES. Bull. ent. Soc. Amer. 6,3 (1960) 151, abstr. 39.

When houseflies were fed a diet containing H^3 - β -sitosterol the sterol was found to be efficiently absorbed and utilized in egg production. Analysis of the H^3 -compounds from the adults and eggs indicated the presence of several metabolites. Nymphal German cockroaches were reared on a synthetic diet containing H^3 - β -sitosterol. The isolated H^3 -compounds were fractionated by chromatography and further analysed to determine the nature of the metabolites.

- 244 Robbins, W.E., Kaplanis, J.N., Loulondes, S.J., Monroe, R.E. UTILIZATION OF 1- C^{14} -ACETATE IN LIPID SYNTHESIS BY ADULT HOUSE FLIES. Ann. ent. Soc. Amer. 53 (1960) 128-9.

Houseflies (*Musca domestica* L.) were injected with an aqueous solution of 1- C^{14} -sodium acetate and held for 18 h. On analysis, the rate of fatty acid synthesis from C^{14} acetate was found to be 3.7 to 8 times greater in female than in male flies. The males and females incorporated about the same percentage of radioactivity into the unsaponifiable fraction (1.3 to 2%). Further fractionation by column chromatography demonstrated that 80 to 88% of this radioactivity behaved as hydrocarbon (s) and less than 2% as sterols. When the sterol fraction was analysed by digitonin precipitation, no radioactivity was detected in the precipitate representing cholesterol and companions. (auth.)

- 245 Robbins, W.E., Kaplanis, J.N., Monroe, R.E., Tabor, L.A. THE UTILIZATION AND METABOLISM OF 4- C^{14} -CHOLESTEROL BY THE ADULT FLY. Ann. ent. Soc. Amer. 53,2 (1960) 260-4.

The metabolism and excretion of ingested 4- C^{14} -cholesterol was studied in the housefly (*Musca domestica*). Only low levels of excretion (2.0%-2.5%) were found 3 d after treatment, and about 10% of this behaved as acidic material. When female flies were treated and the eggs collected, 78% of the radioactivity was recovered 3 weeks after treatment. The high recovery and low excretion rate indicate a strict sterol economy in the housefly. The administered cholesterol was efficiently utilized in egg production. Some of the radioactive sterols were found to be esterified in both the egg and adult. Analysis by column chromatography and reverse isotope dilution demonstrated the presence of 2 major compounds - unchanged cholesterol and 7-dehydrocholesterol - and a lesser fraction consisting of unidentified polar steroids. (auth.)

(An earlier report appeared as an abstract in Bull. ent. Soc. Amer. 5,3 (1959) 137, abstr.233).

I-B-5 ELEMENTS

- 246 Babers, F.H., Mitlin, N., Shortino, T.J. THE FATE OF RADIOPHOSPHORUS INGESTED BY HOUSE FLIES AND GERMAN COCKROACHES. J. econ. Ent. 49,6 (1956) 820-2.

Houseflies (*Musca domestica* L.) and German cockroaches (*Blattella germanica* L.) were fed P^{32} to study its effect on their fertility. In houseflies the biological half-life of the ingested P^{32} was about 0.8 d, whereas in female cockroaches the radioactivity did not fall to 50% in the 14-day observation period. In male cockroaches this point was reached about the 9th day. Houseflies fed P^{32} -labelled food continuously for 6 days did not oviposit, but 2 days after they had been returned to a normal diet a few eggs of low viability were deposited. Flies kept on the P^{32} for shorter periods showed inhibited oviposition and fertility. Their ovaries were immature, but they recovered partially after a normal diet was given. Larvae reared on P^{32} medium (15.3 μ c/g) developed into normal adults. Some German cockroaches fed P^{32} developed oöthecae, but they were flaccid and contained no eggs.

- 247 Block, R.J. INORGANIC SULFUR IN THE SYNTHESIS OF PROTEIN IN THE RUMEN FROM NON-PROTEIN SOURCES WITH A NOTE ON THE SYNTHESIS OF CYSTINE AND METHIONINE IN *BLATTELLA GERMANICA*. TID-5115, Oak Ridge National Lab., Tenn. 1953, 492p.

Some experiments on the synthesis of protein-bound sulfur from inorganic sulfate were carried out on the German cockroach, *Blattella germanica* (L.). $H_2S^{35}O_4$ was added to the drinking water under controlled conditions (sterile, to eliminate possible bacterial contamination). Results indicate that cystine and methionine may have separate as well as combined synthetic pathways in *Blattella*.

- 248 Bowen, V.T. MANGANESE METABOLISM OF SOCIAL VESPIDAE. J. exp. Zool. 115 (1950) 175-205.

Wasps accumulate Mn during larval life, lose much of it at pupation, and accumulate it again as adults. Accumulation takes place rapidly in the cells of the mid-gut epithelium. Male wasps never build up Mn stores in their bodies; queen wasps only after leaving the nest; but workers store Mn almost immediately after emerging from the pupa. Manganese isotopes Mn^{55} , Mn^{54} and Mn^{56} were used. No evidence of a nutritional basis for wasp sex development was furnished by these studies. The distribution of Mn throughout each intestinal cell (radiotracer technique) is not rapid and transfer to the hemolymph may be discontinuous.

The cells of the wasp mid-gut offer a mineral-holding protein shelter of high stability. Larval and worker homets store Mn in excess of any known metabolic use, probably due to inefficient Mn excretion coupled with lack of control over absorption. 49 references. (from auth.)

(See earlier report AECU-825, Technical Information Service, AEC. 43p)

- 249 Bowen, V.T. THE UPTAKE AND DISTRIBUTION OF BARIUM¹⁴⁰ AND LANTHANUM¹⁴⁰ IN LARVAE OF DROSOPHILA REPLETA. J. exp. Zool. 118, 3 (1951) 509-29.

The barium metabolism of D. repleta larvae, studied by use of radioactive Ba¹⁴⁰, is described as involving uptake from the anterior part of the mid-gut, and to a less extent from the bases of the caecae. The absorbed material is rapidly transferred to the lumen of the ascending portions of the anterior malpighian tubules, where it is stored in a somewhat soluble form, until after pupation. Smaller amounts of the element appear in scattered patches of cells of the posterior mid-gut, and some is excreted from the anterior malpighian tubules. Lanthanum-140 is not found to be absorbed by D. repleta larvae, nor does it appear to be excreted when formed in the body by decay of Ba¹⁴⁰. The observation is made that material may be held for 10 to 20 h in the space between the peritrophic membrane and the anterior mid-gut epithelium. Partition of foodstuff between this slow-moving stream and the rapidly moving contents of the peritrophic membrane is seen to be of great importance in determining efficiency of absorption by the larvae. It is concluded that the location of Ba uptake indicates a functional localization of treatment of dissolved as opposed to particulate food, and not a localization of uptake of a particular ion or ions. (auth.)

(See earlier report BNL-1018, Brookhaven National Lab., Upton, N.Y. 26p.)

- 250 Bruce-Chwatt, L.J., Hayward, J. UPTAKE OF RADIOACTIVE PHOSPHORUS BY LARVAE AND ADULTS OF MOSQUITOES. Nature 177 (1956) 661-2.

Larvae of Aedes aegypti were immersed in mixtures of Na₂HP³²O₄, water, and rolled oats; the concentration of the radioisotope ranged from 17 to 4480 mμc/ml. The higher the concentration, the greater was the delay in pupation of the larvae, although at the end of two weeks, all larvae had pupated except those in the 4480-mμc/ml bath. At 2240 mμc/ml, the larvae remained normal for more than 3 weeks, but produced dead pupae. Apparently, a concentration of radioactivity greater than 100 mμc/ml decreased the number of emerged adults. Females were (average) 1.6 times heavier than the males, but were 2.5 times more radioactive. (CA 50: 10289g, 1956)

- 251 Cotty, V.F., Henry, S.M., Hickey, J.D. THE SULFUR METABOLISM OF INSECTS. III. THE METABOLISM OF CYSTINE, METHIONINE, TAURINE, AND SULFATE BY THE HOUSE FLY, MUSCA DOMESTICA L. Contr. Boyce Thompson Inst. 19 (1958) 379-92.

Houseflies were either fed or injected with S³⁵-labelled cystine, cysteine, methionine, taurine or sulfate. Extracts, hydrolyzates, and feces were then analysed by chromatography and autoradiography for radioactive metabolites. Cysteine-sulfinic acid, a key intermediate in sulfate formation, appeared on chromatograms of flies injected with cysteine-S³⁵. There appeared to be two pathways for the synthesis of taurine. Taurine seemed to arise from cystine via hypotaurine. When methionine was the precursor, hypotaurine was not found in detectable quantities but there was an increase in cysteic acid, a recognized intermediate in taurine synthesis. In the latter case relatively more taurine-S³⁵ was formed than when cystine-S³⁵ was administered. Sulfate-S³⁵ was not incorporated into soluble organic compounds. Taurine-S³⁵ gave rise to three unidentified metabolites, one of which may be isethionic acid. The results indicate that houseflies possess an active transulfuration system. (auth.)

- 252 Crossley, D.A., Jr., Pryor, M.E. THE UPTAKE AND ELIMINATION OF CESIUM-137 BY A GRASSHOPPER ROMALEA MICROPTERA. Health Phys. 4 (1960) 16-20.

Adults of Romalea microptera, the eastern lubber grasshopper, were fed cesium-137 in bean plants to investigate uptake and elimination of this isotope. A biological half-life of 4 to 5 d was obtained. In experiments where grasshoppers were allowed to feed repeatedly on cesium-contaminated food, the biological half-life was used to predict the equilibrium values. Most of the ingested Cs¹³⁷ was concentrated on muscular tissue, but some was also found in the digestive tract and reproductive organs. Only trace amounts were found in the exoskeleton. (auth.)

- 253 Darwish, R.O., Abdel Salam, F.A., Mahmoud, K.A. SOME SOMATIC CHANGES OBSERVED IN *CULEX MOLESTUS* FORSKAL 1775. A/AC.82/Gr. 193 Report presented by the Egyptian Delegation to the UN Scientific Committee on the Effects of Atomic Radiation, March 1958.
- A study on *Culex molestus* which, in the larval or pupal stage, had been placed in solutions containing $\text{NaH}_2\text{P}_2\text{O}_4$ with an activity of $0.106 \mu\text{Ci/ml}$ showed the radiation to be detrimental to the lifespan, sex organs, and reproduction rate of the mosquitoes. The general average activity of adult females appears to be 2.3 times higher than of males. Pupal activity was found to be proportional to the initial uptake of the larvae. Larval saturation occurred on the 4th and 5th day ($32,000 \text{ cpm}$).
- 254 Demyanovsky, S. Ya., Rusakova, N.S. THE PHOSPHORUS METABOLISM IN THE ORGANISM OF THE OAK SILK WORM *ANTHRAEA PERNYL*. *Biokhimiya* 20,4 (1955) 466-9. (Translation)
- P^{32} was used in chemical and isotopic studies to trace the changes in the metabolism of phosphorus compounds in the tissues of the larvae and pupae of the oak silk worm. Intensity of the phosphorus metabolism at the beginning of the 5th larval stage of the caterpillar decreased, increased towards the middle and dropped again towards the end of that stage. The intensity of phosphorus metabolism reached its minimum on the 8th day of development of the non-diapause pupa. The intensity of phosphorus metabolism in the diapausing pupa reached its maximum on the 8th day.
- (For abstract see Referat. Zhur. Biol. No.4722, 1956)
- 255 Demyanovsky, S. Ya., Rusakova, N.S. DIAPAUSE OF OAKTREE SILKWORM. *Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im. V.I. Lenina (Kafedra), Org. i. Biol. Khim.* 98 (1957) 49-58.
- Fats do not affect the start of diapause in the oaktree silkworm. During the diapause only the metabolism of low molecular weight P compounds is observed. Intensity of glycine metabolism in the tissues of summer and hibernating larvae differ from the 1st days of larval existence. (CA 52: 6651, 1958)
- 256 Demyanovsky, S. Ya., Rusakova, N.S. PHOSPHORUS METABOLISM IN THE ORGANISM OF THE OAKTREE SILKWORM. *Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im. V.I. Lenina (Kafedra), Org. i. Biol. Khim.* 98 (1957) 61-4.
- (See abstract for Demyanovsky and Rusakova 1956).
- In the summer larvae the P metabolism decreases up to the 8th day of life when it increases again. In winter larvae only the low molecular weight P compounds participate in metabolism and the intensity of P metabolism in all tissues except muscle tissues increases toward the 8th day of life and decreases towards the end of larval development.
- 257 Demyanovsky, S. Ya., Vasileva, N.V. THE RATE OF METABOLISM IN DIAPAUSING OAK SILKWORM PUPAE. *Uchenye Zapiski Moskov. Gosudarst. Pedagog. Inst. im. V.I. Lenina (Kafedra), Org. i. Biol. Khim.* 98 (1957) 65-70.
- It was shown with labelled methionine that the protein metabolism in the diapausing pupae of the oak silkworm was on a high level in all tissues and especially in the muscles. The addition of vitamin B_1 had no noteworthy effect on the metabolic rate of the proteins; there was a slight augmentation in the rate of fat metabolism. (CA 52: 2286 f, 1958)
- 258 Dissanaik, A.S., Dissanaik, F.A., Niles, W.J., Surendranathan, R. FURTHER STUDIES ON RADIO-ACTIVE MOSQUITOES AND FILARIAL LARVAE USING AUTORADIOGRAPHIC TECHNIQUES. *Expt. Parasitol.* 6,3 (1957) 261-70.
- Third-stage larvae of *Wuchereria bancrofti* and *Setaria digitata* were obtained with a radioactivity that would enable them to be traced in the definitive host. This was $174 \beta\text{-counts/min}$ in the case of the *S. digitata* larvae. The larvae had been produced in the respective vectors, *Culex pipiens fatigans* Wied. and *Armigeres obturans* Wlk., which had been kept for one to several days during the second to third larval stages in baths of P^{32} (orthophosphate) of activity $1 \mu\text{Ci/ml}$. *C. p. fatigans* females were allowed to feed on human volunteers infected with *W. bancrofti*, and *A. obturans* on cows infected with *S. digitata*. In spite of the large dose of radiation to which the filarial larvae were exposed in the mosquito their development was not seriously affected. The distribution of P^{32} in mosquitoes, pupae and infective filarial larvae were studied by means of autoradiographs. The highest amounts were found in the thoracic region of the male and in the ovarian region of the female mosquito. (from Helminth. Abstr. 26,2: 95 c, for 1957)

- 259 Donnelly, J. METHODS FOR THE STUDY OF BLOWFLY POPULATIONS. III. THE FATE AND DISTRIBUTION OF P^{32} IN BLOWFLIES LABELLED IN THE LARVAL STAGE. Ann. appl. Biol. 46 (1958) 243-53.

A simple method of radioactive labelling of *Lucilia sericata* larvae is described. More uniform count levels are obtained in individuals which have fed entirely on radioactive foods than in those which first feed on nonactive food. The radioactive count rates of the larvae are correlated with larval live weight and the counting rates of resulting imagines correlated both with corresponding larval counting rates and with imaginal live weight. The loss of P^{32} in the larvae due to causes other than decay of the isotope is traced from the prepupal stage to 3 weeks after emergence. The first and major loss occurs at emergence, when about 10% of the original P^{32} is shed as empty puparium and meconium. Adults lose about 1.5% per day. The distribution of P^{32} in the adult body of *L. sericata* labelled in the larval stage has been determined. The abdominal tissues have a lower activity than the rest of the body. (abstr. 147 in TID-3078, Technical Information Service, AEC)

- 260 Fang, S.C., Allen, D. DISTRIBUTION AND INCORPORATION OF RADIOACTIVE PHOSPHORUS IN THE DOUGLAS-FIR BEETLE. J. econ. Ent. 48, 1 (1955) 79-82.

The distribution of P^{32} in different parts of the body of *Dendroctonus pseudotsugae* Hopk. and its incorporation into phosphorylated intermediates was studied. Adult bark beetles were allowed to feed on 2.5% glucose solution containing 2.5 μ C/ml P^{32} -labelled phosphoric acid for 2 days. Only 2% of the total radioactivity was removed by washing. Dissection showed that about 16.6, 14 and 53% of the remainder were in the head, thorax, and abdomen, and 6.8 and 9.3% in the legs and wings respectively. In the alcohol extract, about 93% of the P^{32} was in phosphorylated intermediates, and in the water extract more than half was in the inorganic form. The glycolytic cycle is considered to be present in the beetle, since most of the phosphate esters that are known to be intermediates of glycolysis were found.

- 261 Fuller, R.A., Riegert, P.W., Spinks, J.W.T. PERSISTENCE OF RADIO-ACTIVITY IN GRASSHOPPERS (ACRIDIDAE) TAGGED WITH PHOSPHORUS-32. Canad. Ent. 86, 5 (1954) 201-3.

Nymphs of *Camnula pellucida* (Scudd.), allowed to feed in the first instar for 24 h on wheat seedlings sprayed with an aqueous solution containing P^{32} in the form of phosphate ion, retained sufficient radioactivity for it to be readily detected with a portable Geiger counter throughout their development. Loss of radioactivity through excretion was very great at first, but decreased steadily and almost ceased 14 d after treatment. Loss of radioactivity through moulting was negligible. The survival of treated grasshoppers was as high as that of untreated ones.

- 262 Gamô, T., Nishiyama, H., Tsukada, M., Yanagizawa, T. SOME OBSERVATIONS OF BIOLOGICAL INFLUENCES OF RADIOACTIVE ISOTOPES UPON PHYSIOLOGICAL FUNCTIONS OF SILKWORMS. II. ON INFLUENCE OF RADIOACTIVE PHOSPHORUS P^{32} UPON DEVELOPMENT AND NUMBER OF LEUCOCYTES OF SILKWORMS. p. 524-7 in "Proceedings of the 1st Japan Conference on Radioisotopes, 1956". Tokyo, Japan Atomic Industrial Forum, Inc. 1956. (In Japanese)

Mulberry leaves were labelled with P^{32} by spraying with $H_2P^{32}O_4$, and silkworm were allowed to feed on them. A series of experiments were carried out in which groups of 100 worms were tested. Varying levels of radioactivity were fed, the feeding of radioactive material starting at different larval stages. Controls were fed on leaves sprayed only with unlabelled phosphoric acid. The cocoons were weighed in each case. The ingested radioactivity caused reduction in silk production. The results are tabulated. The hemolymph was also tested and variations in the radiosensitivity of different cell types observed. Experiments were carried out in the spring and autumn.

- 263 Gamô, T., Nishiyama, H. SOME OBSERVATIONS OF BIOLOGICAL INFLUENCES OF RADIO-ACTIVE ISOTOPES UPON THE PHYSIOLOGICAL FUNCTIONS OF THE SILKWORM. (1) ON THE ABSORPTION OF Ca^{45} ADMINISTERED THROUGH THE MOUTH INTO SEVERAL TISSUES OF THE SILKWORM AND ITS INJURIOUS EFFECTS UPON THE RESPIRATORY FUNCTION. Shinshu Daigaku Sen Igakubu Kenkyû Hôkoku (Research Reports of the Faculty of Textile and Sericulture, Shinshu University) 6 (1958) 37-41. (In Japanese summary in English)

$Ca^{45}Cl_2$ was administered orally either (1) in the course of feeding mulberry leaves, (2) in the surfeit or (3) in the hungry state. The maximum quantity of absorbed Ca^{45} was found in the blood in (2). In the hungry state Ca^{45} was more quickly absorbed into blood than in the other two cases. Uptakes of Ca^{45} by the nervous system, sexual organs, fatty tissue, muscle, and the silk gland were measured 20, 30, and

60 min after administration of $\text{Ca}^{45}\text{Cl}_2$. The nervous system generally took up the largest amount of Ca^{45} , and the sexual organs, muscles, and fatty tissue followed successively in this order. The injurious effects of Ca^{45} were assayed by measuring the O_2 consumption per unit weight of the silkworm larva, pupa and imago.

- 264 Gamô, T., Nishiyama, H., Midorigawa, S. EFFECT OF CALCIUM-45 ON THE BLOOD CELLS OF SILK-WORM. Dai-2-kai Genshiryoku Shtmpojitumu Hôbunshû 4 (1958) 206-12. (In Japanese)

$\text{Ca}^{45}\text{Cl}_2$ solution was administered orally to silkworms at various growing stages, and variations in the blood picture were studied. Proleucocyte number was most extensively influenced by this administration and decreased to an average of 12% of the original value. The decrease in phagocytes was 68%, globule cells 67%, and oenocytoids 57%. The effects of radioactivity were greater in male than in female silkworms.

- 265 Gamô, T., Nishiyama, H., Midorigawa, S. STUDIES ON THE INFLUENCE OF RADIOACTIVE-RAYS UPON THE HEMOCYTES OF THE SILKWORM BOMBYX MORI, L. (IV) ON THE SEXUAL DIFFERENCES BETWEEN THE EFFECTS OF THE INGESTED RADIOISOTOPES ON THE NUMBER OF HEMOCYTES OF THE SILKWORM. Radioisotopes, Tokyo 1, 9 (1960) 17-21. (In Japanese)

Attempts were made to show some sexual differences in the destructive influences of radiation upon the numbers of hemocytes of the silkworm. Just moulted silkworm larva of the fifth stage were administered 0.1 cc of 0.5% solution $\text{Ca}^{45}\text{Cl}_2$ or 0.3% solution of $\text{H}_3\text{P}^{32}\text{O}_4$ through the mouth. It was concluded from the results that the largest damage of Ca^{45} and P^{32} was inflicted on the proleucocyte, especially in the male silkworm. (NSA 15: 22142, 1961)

- 266 Getsova, A.B. ON THE ELIMINATION OF RADIOACTIVE ISOTOPES (DESORPTION) IN SOME AQUATIC INVERTEBRATES. p. 744-6 in "Proceedings of the 11th International Congress on Entomology, Vienna 17-25 Aug. 1960", Vol. 1. Strouhal, H., Beier, M., eds. (Naturhistorisches Museum, Vienna), Vienna, Christoph Reisser's Söhne. 1962.

The practical importance of such data for pollution problems is stressed. The elimination of radioactive substances (here, Sr^{90} , Ru^{106} , Cs^{137} , Ce^{144}) from aquatic insects (Culex pipiens pipiens L. and Halesus interpunctatus Zett.) was, like accumulation, found to proceed in different ways, and to depend on the chemical element and the species. Mosquitoes eliminated Sr^{90} most slowly, caddis-flies Cs^{137} . The accelerating effect on desorption of the addition of EDTA (the sodium salt of ethylene diamine tetra-acetic acid) was studied and confirmed except for Sr^{90} . Two tables list concentration and desorption in larvae, in clear water and EDTA.

- 267 Getsova, A.B. ON THE DESORPTION OF RADIOACTIVE ISOTOPES OF CERTAIN REPRESENTATIVES OF AQUATIC INVERTEBRATES. Dokl. Akad. Nauk. SSSR 133 (1960) 459-61. (In Russian)

The desorption of radioactive isotopes from mosquitoes (Culex pipiens pipiens L.), caddis flies (Halesus interpunctatus Zett.), and mollusks (Aplexa hypnorum L.) was studied in order to determine the retaining time in live organisms after they are transferred from contaminated media to clean water, and also to find the effect of water-soluble complex ethylene diamine tetra-acetate (EDTA) on incorporated radioisotopes. The tests were made in lakewater-filled aquariums contaminated with Sr^{90} , Ru^{106} , Cs^{137} , and Ce^{144} . The results show that EDTA aids the adsorption process except for Sr^{90} . The uptake and desorption of Sr^{90} is slowest in mosquitoes; Cs^{137} is the slowest in caddis flies; and Ce^{144} is the slowest in mollusks. An intensive adsorption of Sr^{90} and Ce^{144} was observed during the first 2-4 d, after which it was stabilized; desorption of Cs^{137} was much slower. In spite of a high percentage of desorption, the organisms carry a considerable amount of the radioactive substance into the clean water. (NSA 14: 23893, 1960)

- 268 Гецова, А.Б., Тимофеева-Ресовская, Е.А., Тимофеев-Ресовский, Н.В. О ВЛИЯНИИ ЭТИЛЕН-ДИАМИНТЕТРААЦЕТАТА НА НАКОПЛЕНИЕ РАЗЛИЧНЫХ РАДИОИЗОТОПОВ ИЗ ВОДНОГО РАСТВОРА ПИЯВКАМИ И КОМАРАМИ. Доклады Акад. Наук СССР 160, 2 (1960) 440-2.

В сообщении приводятся данные по влиянию комплексона этилендиаминтетраацетата /ЭДТА/ на коэффициенты накопления 11-ти радиоактивных изотопов (Sr^{90} , Fe^{59} , Co^{60} , Zn^{65} , Sr^{90} , Y^{91} , Zr^{95} , Nb^{95} , Ru^{106} , Cs^{137} , Ce^{144}) малой ложнохохотской пиявкой из рода Heptobdella и 4-х элементов (Sr^{90} , Ru^{106} , Cs^{137} , Ce^{144}) разными стадиями комара Culex pipiens pipiens. Эффект ЭДТА основан на общих физико-химических закономерностях действия воднорастворимых комплексонатов на минеральный обмен пресноводных организмов.

Getsova, A.B., Timofeeva-Resovskaya, E.A., Timofeev-Resovsky, N.V. THE EFFECT OF ETHYLENE-DIAMINETETRAACETATE ON THE ACCUMULATION OF DIFFERENT ISOTOPES FROM AQUEOUS SOLUTIONS BY LEECHES AND MOSQUITOES. Dokl. Akad. Nauk. SSSR 160, 2 (1960) 440-2.

Results are discussed on the effect of the EDTA complex on the accumulation of 11 radioisotopes by a type of small horse leech of the *Herpobella* kind and of Sr^{90} , Ru^{106} , Cs^{137} and Ce^{144} by various developmental stages of the mosquito *Culex pipiens pipiens*. The EDTA effect is based on the general physico-chemical laws of the action of water-soluble complexes on the mineral metabolism in fresh-water organisms.

- 269 Grosch, D.S., Sullivan, R.L. THE FATE OF RADIOPHOSPHORUS INGESTED BY *HABROBRACON* FEMALES. Biol. Bull. 105 (1953) 296-307.

The distribution of radiophosphorus was studied in female wasps, *Habrobracon juglandis*, after a single feeding of P^{32} in honey. The biological half-life of P^{32} in egg-laying females is 4-5 d. 60% of the P^{32} lost appeared in the deposited eggs. The radioactivity of eggs rises to a peak the second day after feeding and drops sharply to a relatively low plateau. Radioactivity measurements were also made on excreta and various parts of the wasp. (CA 48: 6033 g, 1954)

- 270 Haines, T.H., Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. V. THE ABILITY OF INSECTS TO USE SULFATE IN THE SYNTHESIS OF METHIONINE. Contr. Boyce Thompson Inst. 20, 6 (1960) 363-4.

$\text{Na}_2\text{S}^{35}\text{O}_4$ was administered to 13 species of insects. The Japanese beetle, *Popillia japonica* New., was able to utilize the sulfur of $\text{Na}_2\text{S}^{35}\text{O}_4$ for the synthesis of methionine and other divalent sulfur-containing compounds. Of the remaining insects only the cockroaches, known to contain intracellular symbionts, were able to effect this reduction.

- 271 Hassett, C.C. RADIOPHOSPHORUS IN MOSQUITOES (*Aedes Aegypti*) (abstr.) Fed. Proc. 9, 1 pt. 1 (1950) 58.

Data are presented showing paths of absorption of P^{32} and its distribution in the tissues of *Aedes aegypti*, as studied by radioautographs and by Geiger-tube counting techniques. (B. Ag. 14: 55450, 1950).

- 272 Hassett, C.C., Jenkins, D.W. THE UPTAKE AND EFFECT OF RADIOPHOSPHORUS IN MOSQUITOES. Physiol. Zool. 24 (1951) 257-66.

Throughout most of the laboratory experiments the yellow-fever mosquito, *Aedes aegypti*, was used, but additional tests were made on the *A. atropalpus*, *Culex pipiens*, and the malaria mosquito, *A. quadrimaculatus*. All species became radioactive under treatment. The degree of radioactivity of the adults depended on the age of the larvae at the time of treatment, the concentration of radiophosphorus and of the larvae, and the sex of the resulting adults. The most satisfactory method of producing radioactive adults for large-scale uses was treatment of late third- and fourth-instar larvae with about 0.1 μC of P^{32} per larva in 1 ml of water. Both higher and lower concentrations of P resulted in adults with lower radioactivity. Females contained about three times as much phosphorus as males. The larvae are able to concentrate P^{32} at least 75 times its concentration in the medium. P enters the mosquito larvae through the gut, from ingested food, through the anal gills, and perhaps through the integument. Removal of the anal gills retards the uptake of phosphate but does not affect the final level. The distribution of the entering P^{32} is general throughout the organism, with somewhat heavier concentrations in the Malpighian tubes and in parts where rapid metabolic processes are occurring. Radiation effects were noticed at relatively low concentrations of P^{32} in the rearing medium (0.05 $\mu\text{C}/\text{ml}$) in the earlier instars. Resistance increased with age, but at concentrations above 5.0 $\mu\text{C}/\text{ml}$ practically no adults emerged. Radiation effects, such as retardation or inhibition of growth, and death occurred at high concentrations. Mating and egg-laying occurred normally in adults reared from larvae in P^{32} solutions of 1.0 or less $\mu\text{C}/\text{ml}$. Adult mosquitoes were also made radioactive by feeding them on P^{32} -labelled substances, such as animal blood, raisins, flowers, and sugar solutions. (from auth. summary)

- 273 Hassett, C.C. UPTAKE OF P^{32} BY *PERIPLANETA AMERICANA*; PASSAGE THROUGH THE FORE-, MID-, AND HINDGUT. Fed. Proc. 13, 1 (1954) 68.

Investigations on P^{32} -labelled phosphates introduced into the intestine of the cockroach show that the midgut is the chief site of absorption. Other factors affecting movement of phosphate ions through the intestine have been examined, KCN, for example, has no inhibitory effect; low temperatures decrease rate of passage.

(Abstract of paper presented before the American Physiological Society, 72nd Meeting, Atlantic City, N.J. 12-14 Apr. 1954)

- 274 Heller, J., Chojnacki, T. PYROPHOSPHATES IN THE HAWK-MOTH, CELERIO EUPHORBIAE. III. TRACER STUDIES WITH P^{32} . Bull. Acad. polon. Sci., Ser. Sci. biol. 5, 9 (1957) 277-9.
A study is reported on the incorporation of P^{32} -labelled orthophosphate in the pyrophosphates of the ejaculatory duct of the adult male. Data is presented which proves the enzyme found by Heppel and Hilmoe in bovine sperm to be present in the genital passage of C. euphorbiae.
- 275 Heller, J., Plechowska, M.J., Chojnacki, T. INORGANIC POLYPHOSPHATES IN THE HAWK-MOTH (CELERIO EUPHORBIAE L.). Acta biochim. polon. 5, 4 (1958) 343-54.
The genital pouch and the spermiduct of the male moth are rich in pyrophosphate which originates from nucleotide phosphorus. When P^{32} is injected into the abdomen of males immediately on hatching or 3 d prior to or little after metamorphosis it is found in the same location. After mating, the polyphosphate is not rediscovered in the egg.
- 276 Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. IV, THE CONVERSION OF INORGANIC SULFATE TO ORGANIC SULFUR COMPOUNDS IN COCKROACHES. THE ROLE OF INTRACELLULAR SYMBIOTANTS. Contr. Boyce Thompson Inst. 20, 5 (1960) 317-29.
The intermediary metabolism of inorganic sulfur into organic compounds in cockroaches was investigated by either feeding or injecting $Na_2S^{35}O_4$ into Blattella germanica (L.) and Periplaneta americana (L.). The possible role of the gut microorganisms and the intracellular symbionts of B. germanica on the metabolic pathways was studied by determining the S^{35} -labelled compounds developed in normal insects and aseptically reared insects containing the symbionts and in cockroaches freed of symbionts. In both normal and aseptically reared insects the S^{35} was found primarily in glutathione, cysteine, methionine, and methionine sulfoxide and only in limited quantities in taurine, sulfite, and several unidentified compounds. In symbiont-free B. germanica the S^{35} was detected only in sulfite and two unidentified compounds. (auth.)
(See earlier report in Bull. ent. Soc. Amer. 5, 3 (1959) 141, abstr. 271 under "Sulfate utilization and the role of intracellular symbionts in cockroaches (Orthoptera: Blattellidae)")
- 277 Heslop, J.P., Ray, J.W. PHOSPHORUS COMPOUNDS OF COCKROACH NERVE AND THE EFFECT OF DDT. Biochem. J. 70, (1958) 16 P (Proc. Biochem. Soc.)
The labelled-pool technique of Winteringham (1956) was applied to the study of P^{32} -labelled compounds in Periplaneta americana nerve extracts. Seven days after injection of 400 μ c of carrier-free $P^{32}O_4^{3-}$, the abdomen of each cockroach was opened and part of the ventral nerve cord dissected free from all other tissues. Only actively conducting cords, as indicated by electrical monitoring, were used. The cord was raised clear of the animal on hooks, the whole preparation flooded with liquid nitrogen and a cord sample rapidly transferred to a glass homogenizer immersed in liquid nitrogen. Six to ten samples were extracted three times with N-formic acid in 50% aqueous ethanol and the combined extracts analysed and resolved into five fractions (I-V) by ascending paper chromatography at 5°C in the acetone/formic acid/water solvent of Burrows, Grylls & Harrison (1952). Some constituents have been tentatively identified by co-chromatography. The amounts of P^{32} in fractions II, III and IV, measured by radiometric scanning (Winteringham, Harrison & Bridges, 1952), have been expressed as percentages of the total P^{32} in the three fractions. Where DDT was used 100 μ g was applied topically in 5 μ l of acetone 24 or 48 h before dissection. Animals showing early (Tremulous) and later (Prostrate) signs of DDT poisoning were used. Results and identifications are discussed.
- 278 Hilchey, J.D., Block, R.J., Miller, L.P., Weed, R.M. THE SULFUR METABOLISM OF INSECTS. I. THE UTILIZATION OF SULFATE FOR THE FORMATION OF CYSTINE AND METHIONINE BY THE GERMAN COCKROACH, BLATTELLA GERMANICA (L.). Contr. Boyce Thompson Inst. 18, 2 (1955) 109-23.
Adult male and immature B. germanica (L.) can utilize inorganic sulfate for the production of both cystine and methionine. The sulfate ion was provided in the form of trace amounts of $H_2S^{35}O_4$ which was offered ad libitum at 0.0136 mc/ml. The procedures followed for chromatography and radioassay are described. The two amino acids appear to be synthesized by independent routes. The degree of utilization depends on the developmental stage of the test animals; growing nymphs use sulfate at a more rapid rate than do adult males. The rate of utilization also depends on whether or not the insects are reared aseptically. The in-

corporation of inorganic sulfur into methionine and cystine can be carried on to a moderate degree under asptic conditions and at a high rate under nonaseptic conditions.

- 279 Hillehey, J.D., Cotty, V.F., Henry, S.M. THE SULFUR METABOLISM OF INSECTS. II. THE METABOLISM OF CYSTINE- S^{35} BY HOUSE FLY, MUSCA DOMESTICA L. Contr. Boyce Thompson Inst. 19,2 (1957) 189-200.
- S^{35} -labelled cystine fed to adult male or female houseflies was converted into taurine and sulfate. The hydrolysates and extracts as well as excreta from the flies were examined by paper chromatography. The peaks of radioactivity after hydrolysis and extraction occur in cystine and taurine. Taurine was partly retained in the body and partly excreted, while virtually all of the sulfate was excreted within 24 to 48 h after it was formed. Flies are unable to synthesize methionine from cystine.
- 280 Huot, L., Verly, W.G. DOSAGE DU ^{32}P TOTAL D'UNE LARVE VIVANTE DE TENEbrio MOLITOR L. (COLÉOPTÈRE: TENEBRIONIDAE). J. Insect Physiol. 4,3 (1960) 202-8.
- Les résultats démontrent qu'il est possible de mesurer le ^{32}P total d'une larve vivante de T. molitor avec une erreur de $\pm 5\%$ qui dépend essentiellement de l'erreur sur le facteur de correction appliqué. La très faible variation de ce facteur de correction en fonction du poids de la larve a été interprétée.
- 281 Huque, H., Myser, W.C. FATE OF RADIOSTRONTIUM IN THE MADEIRA COCKROACH (LEUCOPHAEA MADERAE) (abstr.). Ent. Soc. Amer. Proc. North Central States Br. Proc. 14 (1959) 33-4.
- 282 Irwin, R.L.B., Spinks, J.W.T., Amason, T.J. DEPOSITION OF P^{32} IN DEVELOPING DROSOPHILA. Canad. J. Res., D-Canad. J. Zool. 28 (1950) 247-42.
- Eggs of Canton Special stock of Drosophila were hatched and larvae reared on medium containing P^{32} . Alternate radioautographed and stained sections were made of larvae, pupae, and adults. Depositions of P^{32} were heavy in fat bodies, nervous structures, and in organs of digestion and excretion. Very high concentrations of P^{32} occurred in imaginal disks. Discharged materials and nuclei from fat bodies had much P^{32} in early pupal stages, the activity becoming concentrated at sites of organ differentiation in later pupae. In the adults, the gonads, the nervous system, and the digestive tract contained much P^{32} . (auth.)
- 283 Iyengar, R., Panigel, M. SUR L'EXCRÉTION DE ^{32}P CHEZ DROSOPHILA MELANOGASTER ET GRYLLUS DOMESTICUS. C.R. Acad. Sci., Paris 241 (1955) 823-4.
- Plusieurs générations de Drosophiles sont élevées sur un milieu contenant du N_2HPO_4 à P radioactif. La plus grande partie du phosphate radioactif ingéré par la Drosophile pendant la vie larvaire est éliminée lors des cinq premiers jours de vie de l'imago. La perte en radioactivité se fait ensuite beaucoup plus lente. Les auteurs ont pensé que les tubes de Malpighi pouvaient être l'organe responsable de cette élimination rapide des phosphates. On effectue chez des Grillons adultes surtout des injections intra-thoraciques ou intra-abdominales d'une solution de phosphate de Na à ^{32}P (1 à 2 μ c). La mesure de la radioactivité de poids équivalents de certains organes (les tubes de Malpighi, les ovaires, les testicules, le tube digestif, la 3e patte et l'aile postérieure) montre que 4-5 jours après l'administration de phosphate marqué ce sont les tubes de Malpighi qui ont emmagasiné le plus de matériel radioactif, vraisemblablement en vue de son excrétion. Par la suite, le ^{32}P se concentre dans les ovaires, phénomène qui doit être lié à la vitellogénèse.
- * Khudakov 1959 - [337]
- 284 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. 3. THE TURNOVER OF PHOSPHORUS IN ADULT D. MELANOGASTER AND D. SIMULANS. BNL-1405, Brookhaven National Lab., Upton, N. Y. 1953, 11p.
- The turnover of phosphorus by adult males and females of Drosophila melanogaster and D. simulans was studied utilizing P^{32} . The half times of phosphorus turnover by adult male and female D. melanogaster and adult D. simulans males and females are 3½, 2, 3½ and 3 d, respectively. All 4 classes of flies lose phosphorus by two phase systems. The turnover of phosphorus by female D. melanogaster is faster than that of males because their fast phase has a shorter half time than that of males. Male D. simulans lose phosphorus more slowly than females because of the longer half time of the slow phase of the males. (auth.)
- (This work is followed up in J. exp. Zool. 125 (1954) 331).

- 285 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. 4. THE DISTRIBUTION AND TURNOVER OF PHOSPHORUS IN THE TISSUES OF DROSOPHILA MELANOGASTER. BNL-1416, Brookhaven National Lab., Upton, N.Y. 1953, 24p.
- See King, J. exp. Zool. 125 (1954) 331, and King and Wilson, J. exp. Zool. 126 (1954) 401.
- The distribution, concentration, and turnover of phosphorus in the tissues of Drosophila were studied utilizing tracer techniques. Data are presented in tabular form on the distribution of P^{32} in various tissues of totally labelled adult flies of both sexes. (NSA 7: 5011, 1953)
- 286 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. II. TURNOVER AND DISTRIBUTION OF PHOSPHORUS IN ADULT DROSOPHILA. J. exp. Zool. 125 (1954) 331-52.
- Male flies of D. melanogaster (I) and D. simulans turn over phosphorus more slowly than females. Both sexes of I turn over about half of their phosphorus by a fast phase and half by a slow phase. Tissue studies of I indicate that the majority of P is in the thoracic region, with large amounts in the hemolymph and head; 94% of the P in the female reproductive system occurs in the ovaries. Large amounts of P occur in the various parts of the male reproductive system with 63% of this P in the testes. During development, over 99% of the total P resides in the metamorphosed insect; 1% remains in the pupal case. The hemolymph of freshly hatched adults of each sex is quite low in P, but it rises with feeding. Calculated values are given for P turnover in a 24-h period by various regions of the adult body of each sex of I. (CA 48: 7212b, 1954)
- 287 King, R.C. THE EFFECT OF A YEAST UPON THE INCORPORATION OF PHOSPHORUS INTO THE TISSUE OF ADULT FRUIT FLIES. Evolution 9 (1954) 93-4.
- (See article in Amer. Nat. 88 (1954) 155-8)
- 288 King, R.C. THE EFFECT OF YEAST ON PHOSPHORUS UPTAKE BY DROSOPHILA. Amer. Nat. 88 (1954) 155-8.
- The paper describes striking differences in the uptake of P^{32} by adults of two related species of Drosophila (melanogaster and simulans) feeding on different yeast species (Saccharomyces cerevisiae, Candida albicans, Debaryomyces hansenii, Hansenula subpelliculosa, and Schizosaccharomyces pombe). It was found that phosphorus uptake by both species is increased on medium containing live yeast. The rate is increased more in females than in males. Phosphorus uptake is sometimes strikingly different for flies of different species feeding on the same yeast.
- 289 King, R.C., Wilson, L.P. STUDIES WITH RADIOPHOSPHORUS IN DROSOPHILA. V. QUANTITATIVE STUDIES ON THE PHOSPHORUS BALANCE OF ADULT FEMALE FLIES FEEDING UPON YEAST. J. exp. Zool. 130 (1955) 71-82.
- P^{32} was employed as a tracer in a study of the phosphorus metabolism of yeast by adult Drosophila. Data are presented on the incorporation of P into tissues and eggs, P excretion, the relationship between endogenous and exogenous P and differences in P turnover demonstrated in male and female Drosophila. Female flies weighing 1.5 mg each, when fed P^{32} -labelled Saccharomyces cerevisiae ingested about 6×10^{-3} mg P per d per fly. An equal amount was lost during the day.
- (See also BNL-1979, Brookhaven National Lab., Upton, N.Y. 1954, 28p.)
- 290 King, R.C., Robinson, A.C. DISTRIBUTION OF CALCIUM IN ADULT DROSOPHILA MELANOGASTER. Science 125 (1957) 546.
- Autoradiographic studies of Ca^{45} localization in adult and larval stages of D. melanogaster indicate rapid transfer and storage in the excretory organs of the insect. It is concluded that the insect requires only trace amounts of Ca and that the concentration in the chromosomes is no higher than that in the cytoplasm and body fluids. (CA 51: 10772 c, 1957)
- 291 Kogure, M., Nakajima, M., Murai, K., Tsujii, T. STUDIES ON P^{32} IN THE SILKWORM. Zool. Mag., Tokyo 60 (1951) 24. (In Japanese)
- The uptake of P^{32} by silkworm larvae was studied, and the role of the digestive tract in phosphorus metabolism discussed.

- 292 Kogure, M., Yoshida, R., Murai, K., Minamizawa, K., Nakajima, M. STUDIES ON THE PHYSIOLOGY OF THE SILKWORM AND THE MULBERRY TREE BY MEANS OF RADIOACTIVE PHOSPHORUS. Annu. Rep. of the Research Committee on Application of Artificial Radioactive Isotopes in Japan 1, 1 (1951) 34-7.
- 5th instar silkworms were injected with $H_2P^{32}O_4$ diluted with $Na_2HPO_4 \cdot 12 H_2O$ solution. The distribution with time and the concentration of P^{32} is discussed for various tissues (alimentary canal, silk gland, sexual gland, Malpighian tubules) and for blood, following injection and also after the administration of P^{32} -labelled mulberry leaves. Results on the uptake and translocation of P^{32} in mulberry trees (seedlings) are also summarized.
- 293 Limpel, L.E., Casida, J.E. IODINE METABOLISM IN INSECTS. I. IN VIVO METABOLISM OF RADIO- IODIDE. J. exp. Zool. 135 (1957) 19-27.
- The fate of radioiodide was investigated in several insects: *Aeschna* sp., a dragon fly; the American cockroach, *Periplaneta americana* (L.); the German cockroach, *Blattella germanica* (L.); a cicada, *Tibicen* sp.; the squash bug, *Anasa tristis* (DeGeer); the larger cabinet beetle, *Trogoderma versicolor* (Creutz.); the locust borer, *Megacyllene robiniae* (Forst.); the greater wax moth, *Galleria mellonella* (L.); the gay harlequin caterpillar, *Euchaetias egle* Drury; a mud dauber, *Sceliphron cementarium* (Drury); the yellow fever mosquito, *Aedes aegypti* (L.); and the housefly, *Musca domestica* (L.). Iodide, iodine, 2(or 4)-monoiodo- histidine, 3-monoiodotyrosine, 3,5-diiodotyrosine, and thyroxine have been recovered from various tissues together with one or possibly two unidentified iodocompounds. Ratios of the I^{131} intermediates vary greatly among the organs of *Periplaneta* and within the class Insecta. (from auth. summary)
- 294 Limpel, L.E., Casida, J.E. IODINE METABOLISM IN INSECTS. II. IN VIVO DISTRIBUTION AND METABOLISM OF IODOAMINO ACIDS AND RELATED STUDIES WITH PERIPLANETA. J. exp. Zool. 136 (1957) 595-613.
- The distribution and metabolism of certain radioiodine compounds and radiobromide within *Periplaneta americana* L. were investigated. In vitro metabolism studies supported the findings reported in part I., and further demonstrated that thiouracil and thiosulfate do not inhibit the cuticle in iodine absorption. The biological half-life of iodine in cockroaches was established as about 27 h. An examination was made of the in vivo metabolism of I^{131} -labelled monoiodohistidine and iodide, and of the excretory products. Distribution studies with radioiodide revealed that the cuticle was able to absorb iodine from the blood, and the entire alimentary canal absorbed iodine more efficiently than the other internal tissues. Thiouracil and resorcinol did not decrease the ability of cuticle to absorb iodine from the blood; they did, however, promote the concentrating ability of most other tissues. The fumigant, methyl iodide, was concentrated by the cuticle and hindgut, apparently undergoing rapid excretion. Compared with radioiodide, radiobromide was concentrated from the blood by the cuticle, muscle, nerve cord and Malpighian tubules. Distribution studies with labelled monoiodohistidine, diiodotyrosine and thyroxine indicated rapid excretion via the Malpighian tubules and the hindgut. (from auth. summary)
- 295 Lüdcke, M., ÜBER DIE AUFNAHME VON RADIOAKTIVEM, SEKUNDÄREM NATRIUMPHOSPHAT BEI LUCANUS CERVUS L. (On the uptake of radioactive secondary sodium phosphate by *Lucanus cervus* L.) Z. vergl. Physiol. 34 (1952) 508-24. (In German)
- The uptake and distribution of orally administered $Na_2HP^{32}O_4$ solution in the wings, legs and antennae of *Lucanus cervus* L. was investigated. Relative concentrations of radioactivity in the different organs, and the effects of the level of the initially administered dose and of time are discussed. Use is also made of autoradiography. Thus, in addition to studying the distribution of radioactivity in the above organs, autoradiographs were further made of sternite fragments, muscle fibres, ovarioles, fat bodies, the intestine with the Malpighian tubules, the thoracic ganglion and the brain. The results are discussed.
- 296 Lüdcke, M. ÜBER DIE RADIOAKTIVE STRAHLUNG DES INSEKTENFLÜGELS NACH FÜTTERUNG MIT ^{32}P -DINATRIUMHYDROGENPHOSPHAT (Studies on the radioactivity of insect wings after feeding with P^{32} -labelled disodium hydrogen phosphate). Zool. Anz. Suppl. 18, Verh. dtsh. zool. Ges. 1953, 412-7. (In German)
- Different methods were used for labelling various insects by means of P^{32} -labelled Na_2HPO_4 (direct feeding, via a radioactive host, via an artificial membrane, etc.). The orthoptera, coleoptera, lepidoptera and heteroptera examined showed a distribution of radioactivity which corresponded to the system of veins in the wings. In the coleoptera examined (*Lucanus*, *Melolontha* and various carabidae) the elytrae were much more radioactive than the hind wings. The relative hemolymph distribution within the wing is discussed.

Among the orthoptera (Phyllodromia, Blatta and Gryllotalpa) the difference between the wing pairs is not so pronounced. In heteroptera (Rhodnius and Triatoma) radioactivity originates almost entirely from the corium portion. Lepidoptera studies (e.g. Inachis (Vanessa) io L.) showed an apparently similar distribution in both wing pairs. Results of other workers are discussed.

- 297 Lüdcke, M. ÜBER DIE VERTEILUNG DES IM RAUPENSTADIUM AUFGENOMMENEN ^{32}P -DINATRIUM-HYDROGENPHOSPHATS BEI DER SCHLÜPFENDEN IMAGO VON VANESSA IO L. (On the distribution in the emerging imago of Vanessa io L. of ^{32}P -labelled Na_2HPO_4 solution, taken up at the larval stage). Z. vergl. Physiol. 36 (1954) 508-30. (In German)

Distribution was tested by means of autoradiographs and a G-M counter. Both pairs of wings showed practically equal radioactivity, essentially concentrated in the veins of the wings. Radioactivity increases immediately after eclosion, followed by a drop. Dissected organs such as the intestine, the Malpighian tubules, muscles, fat bodies, the central nervous system, and chitin and the haemolymph were also tested for their activity, the intestine (in contrast to the Malpighian tubules) and muscles showing high values. The time for radioactive food to pass through the intestine of the larva is 124 ± 3 minutes. Experimental results on pupae of Deilephila euphorbiae L. are also recorded, and some work on orthoptera and coleoptera, the orthoptera being intermediate to coleoptera and lepidoptera with regard to the localization and relative distribution of radiation from the wings. Details are given.

The following were studied: orthoptera: Phyllodromia germanica L., Blatta orientalis L.

Gryllotalpa gryllotalpa L.

coleoptera: Carabus hortensis L., Carabus auratus L., Carabus ullrichi Germ., Melolontha vulgaris L.

lepidoptera: Deilephila euphorbiae L., Vanessa io L.

- 298 Poulsen, D.F., Bowen, V.T. THE COPPER METABOLISM OF DROSOPHILA. Science 114 (1951) 486.

The uptake, distribution, and excretion of copper by larvae of four species of Drosophila, D. ananassae, D. melanogaster, D. repleta, and D. virilis, were followed by determining activities of whole and dissected larvae at intervals after the feeding of Cu^{64} in various media, at a series of copper concentrations.

(Abstract of paper presented at the autumn meeting of the National Academy of Sciences, 5-7 Nov. 1951, Yale Univ., New Haven, Conn., USA)

- 299 Poulson, D.F., Bowen, V.T. ORGANIZATION AND FUNCTION OF THE INORGANIC CONSTITUENTS OF NUCLEI. Exp. Cell. Res., Suppl. 2 (1952) 161-70. "The Chemistry and Physiology of the Nucleus. Brookhaven Symposia in Biology Aug. 1951". Brookhaven National Lab., Upton, N.Y. 1952.

A review article. For this bibliography, the sections dealing with autoradiographic localization of minerals are of interest. Autoradiographic studies of iron metabolism in larvae of various species of Drosophila (virilis, repleta, melanogaster, funbris) by means of Fe^{59} , showed some tissues to contain considerably higher iron concentrations in the nucleus than others. Results obtained with Cu^{64} on the uptake, distribution and excretion of copper (D. repleta) are reviewed, and correlations between copper and fluorescence discussed. Radioactive calcium gave no indication of nuclear localization in D. repleta. Work with radiobarium is also mentioned. New methods and techniques and their possibilities are discussed.

- 300 Poulson, D.F., Bowen, V.T., Hilse, R.M., Robinson, A.C. THE COPPER METABOLISM OF DROSOPHILA. Proc. nat. Acad. Sci., Washington 38 (1952) 912-21.

The radioisotope Cu^{64} was produced by neutron irradiation. The uptake of copper by larvae of species of Drosophila (repleta, ananassae, melanogaster) traced by Cu^{64} is proportional to the copper concentration in the medium over the range 0.25 - $10 \times 10^6 \mu\text{g Cu/g}$. Above this level uptake falls off. Rates of excretion as well as distribution in the tissues have also been determined. From these data factors relating copper content of larvae to copper concentration in the medium have been calculated. Both counting and autographic methods demonstrate that a large fraction of the tissue copper of Drosophila is in a form not demonstrable with presently available histochemical techniques. Further support is lent to the hypothesis, previously advanced, of a profound difference in copper metabolism between two of the major subgenera (Drosophila and Sophophora) of this genus. It is shown that Cu^{64} ingested as part of the yeast cell is absorbed without an opportunity of mixing with stable ionic copper simultaneously ingested. Thus there appear to be at least two pathways of copper uptake, one for ionic, the other for bound forms. (from auth. summary)

- 301 Rodriguez, J.G. RADIOPHOSPHORUS IN METABOLISM STUDIES IN THE TWO-SPOTTED SPIDER MITE. *J. econ. Ent.* 47, 3 (1954) 514-7.

The numbers of *Tetranychus bimaculatus* Harvey developing on tomato leaves have been shown to be positively correlated with the phosphorus content of the latter up to about 0.3% dry weight of foliage. Since this P-content is common in food plants of the mite, bean plants were grown in a solution containing P^{32} and the radioactivity of the mites and eggs determined at intervals throughout 10 d. Almost half the acquired P^{32} was taken up during the first 8 h of feeding. Full capacity (2007 cpm) was reached in about 36 h; subsequently, uptake continued slowly as the mites increased in size. The P^{32} -content of the egg to that in the adult mite maintained an approximately constant ratio. Utilization of P in egg production proceeded at a similar rate to its uptake, but utilization in the body of the mite was much slower, since about 20 h were required for half the P^{32} to be used. P was 3 times as concentrated in the egg as in the mite body. The females lived for an average of 10.85 d, laying about 10.3 eggs/day during that time. Egg production therefore consumes relatively large quantities of P. On transferring radioactive mites to leaf disks, these became radioactive, showing that a P-containing secretion, thought to originate in the tracheal salivary gland was injected into the leaf.

- 302 Sasaki, R. SOME OBSERVATIONS ON THE BIOLOGICAL INFLUENCES OF RADIOACTIVE ISOTOPES UPON PHYSIOLOGICAL FUNCTIONS. Un International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/1067. 12 (1956) 330-3.

The absorption of orally administered radioactive Ca^{45} (as $Ca^{45}Cl_2$ solution) into certain tissues and organs of silkworm larvae (*Bombyx mori*) was studied on normal 5th instar larvae. Results are tabulated. The nervous system generally took up the largest amount of Ca^{45} , and the sexual organs, muscle and fatty tissue followed in that order. The injurious effects of Ca^{45} on respiration was checked. The distribution of P^{32} (administered intrahumoral or orally) was also investigated; further, the turnover of phosphorus compounds during metabolism, and the role of the alimentary canal in phosphorus metabolism. The excretion of considerable amounts of phosphorus in the later days of 5th instar is due to degradation in the silk glands and alimentary canal, and the diminution of absorption by the larva itself.

- 303 Semenova, L.M. STUDY OF THE PERMEABILITY OF THE INTEGUMENT OF SOIL INSECTS TO SALT BY THE METHOD OF TAGGED ATOMS, FOR EXAMPLE THE LARVAE OF THE CRANE FLY, *TIPULA PALUDOSA*. MTIG. (DIPTERA, TIPULIDAE). *Zool. Zh.* 36, 12 (1957) 1826-30. (In Russian, with summary in English)

Solutions of $Na_2HP^{32}O_4$ and $K^{42}H_2PO_4$ were made in concentrations employed for fertilizers in hydroponics: 0.005, 0.025, 0.05, 0.1%. The K^{42} penetrated the larval cuticle in greater amounts than did P^{32} . The quantity of isotope permeating the cuticle was related to the concentration in the medium, but the rate of absorption was depressed by the higher concentrations of phosphate. The permeability of cuticle of these larvae was one-sided for the salts tested. (CA 52: 12247 d, 1958)

- 304 Sivarama Sastry, K., Radhakrishna Murty, R., Sarma, P.S. ZINC TOXICITY IN THE LARVAE OF THE RICE MOTH, *CORCYRA CEPHALONICA*. *Biochem. J.* 69 (1958) 425-8.

The levels at which dietary Zn becomes toxic to rice-moth larvae have been determined. At lethal levels (1.6% $ZnCl_2$ in diet) supplementation of the diet with vitamin B_{12} or liver extract checked mortality. None of the B vitamins except thiamine and B_{12} was effective in reversing the inhibition of growth induced by 0.4% $ZnSO_4$. Vitamin B_{12} was more effective in prolonging the survival of the larvae than in promoting growth in this condition. Liver extract, as well as its alkaline-stable fraction, partially reversed the inhibition of growth from Zn toxicity. Deoxyribonucleic acid and ribonucleic acid at 0.5-1.0% levels in the diet reversed the inhibition of growth from Zn toxicity completely. Dietary deoxyribonucleic acid did not influence the uptake of Zn^{65} from the diet. (CA 52: 18919 d, 1958)

- 305 Slipka, J. INTAKE OF I^{131} THROUGH CUTICLE OF LARVA OF *TIPULA MAXIMA*. *Biol. Listy, Prague* 32 (1952) 316-22.

Preliminary experiments were performed in order to explain the metabolism of iodine in its relation to proteins, especially to arthropoidin, present in cuticle of arthropods. Iodine reacts with tyrosine present in arthropoidin, and mono- and di-iodotyrosine are formed. Living larvae were exposed in water to I^{131} for 24 h, then fixed in Carnoy's liquid, embedded in paraffin, and cut in sections 10μ thick. Histo-radiographic analysis demonstrated that I^{131} accumulated in the outermost layer of epicuticle (which is free of chitin). Greatest intensity of β - and γ -radiation was in the region of anal papillae. (CA 48: 7211 d, 1954)

- 306 Stich, H., Grell, M. INCORPORATION OF PHOSPHORUS-32 INTO THE MALPIGHIAN TUBES DURING THE METAMORPHOSIS OF *CULEX PIPIENS*. *Nature* 176 (1955) 930-1.
- Early and late 4th instar larvae of *C. pipiens* placed in tap water containing P^{32} for 24 h and then removed to plain tap water followed in 24 h by removal of the Malpighian tubes show great accumulation of P^8 in the tubes near the time of pupation, and the amount remains constant during the rest of metamorphosis. The majority of the P^{32} is in material soluble in 10% CCl_3CO_2H and is localized in granules (probably polyphosphate) of 1-3 μ diameter which appear in the Malpighian tubes near pupation and which show a strong affinity for basic dyes and are soluble in 10% $Cl_3 CCO_2H$ or 2% $HClO_4$. Accumulation of P^{32} in the granules also occurs if the gut does not show radioactivity; this shows it must be taken up from the blood. In the change from early 4th instar larvae to early pupae the amount of P^{32} extracted by $EtOH-Et_2O$ falls (35.4 to 24.7%), while the amount extracted by 2% $HClO_4$ rises (22.4 to 45.3%), and that extracted by 10% $HClO_4$ falls (28.8 to 21.6%). It has been shown (unpublished) that the phosphorus arises from histolyzed organs (especially the gut) during metamorphosis and this is taken up from the blood by the Malpighian tubes which are thus active in the regulation of the phosphorus balance. (CA 50: 6695a, 1956)
- 307 Tomizawa, C., Fukami, J. BIOCHEMICAL STUDIES ON THE ACTION OF INSECTICIDES. III. PHOSPHORUS METABOLISM OF INSECTS AND THE INFLUENCE OF INSECTICIDES. *Boryu-Kagaku*, (Bull. Inst. Insect Control) 21 (1956) 133-9.
- The influence of DDT (I), Lindane (II), methyl-Parathion (III), and Rotenone (IV) on the distribution of radioactive phosphate in the different tissues of the cockroach, *Periplaneta americana*, and the incorporation of radioactive phosphate into phosphorylated intermediates in the nerve cord and the femur muscle of the insect were studied. Radioactive phosphate injected into the abdomen of the insect translocated quickly to the head, legs, wings, nerve cord, and femur muscle. The feature of the distribution of radioactive phosphate in the different tissues of the insect body was similar to that of other insects which consumed orally radioactive phosphate: 6.5 h after the injection, the order of the accumulation of radioactive phosphate in the tissue was gut > nerve cord > legs > head > wings. The radioactive phosphorylated intermediates contained in the nerve cord and the femur muscle were traced by paper chromatography. Orthophosphate, ATP, ADP, glucose-1-phosphate, glucose-6-phosphate, fructose-6-phosphate, hexosediphosphate, 3-phosphoglycerate, and 2 unidentified compounds were found in the nerve cord, while the same 8 compounds and 6 unidentified compounds were found in the muscle. In both tissues, most radioactive phosphate esters which are known to be intermediates of glycolysis were also found to be present in both tissues, but in relatively small amounts. The ratio of orthophosphate- P^{32} to ATP + ADP- P^{32} was higher in the muscle than in the nerve cord. The incorporation of radioactive phosphate into phosphorylated intermediates in the nerve cord and the muscle was inhibited by treatment with insecticide in the following order: III > I > II > IV. Also, the incorporation of radioactive phosphate into lipid and residual parts in the trichloroacetic acid-insoluble fraction was inhibited by III or I. II and IV had a little effect on the incorporation of radioactive phosphate into the above fraction. (CA 51: 9070f, 1957)
- 308 Treheme, J.E. THE EXCHANGE OF LABELLED SODIUM IN THE LARVA OF *AEDES AEGYPTI* L. *J. exp. Biol.* 31 (1954) 386-401.
- The exchange of Na^{24} -labelled sodium between the external medium and the haemolymph and whole body was investigated in the larva of *A. aegypti*. The time for half exchange was ~62 h. Most of the exchange of labelled sodium was found to occur through the anal papillae, although smaller amounts entered the haemolymph through the gut and general body surface. Transfer constants were used to describe the resultant turnover of labelled Na in the whole system. The rate of uptake of Na was independent of the external concentrations used in these experiments. K-ions do not compete with Na for uptake, which suggests separate mechanisms for the accumulation of these two ions. The effect of temperature on the rate of uptake of labelled Na was also investigated.
- 309 Wheeler, B. HALOGEN METABOLISM OF *DROSOPHILA GIBBEROSA*. I. IODINE METABOLISM STUDIED BY MEANS OF I^{131} . *J. exp. Zool.* 115, 1 (1950) 83-107.
- I-metabolism in third instar larvae and pupae was studied by means of a Geiger counter, autoradiographs, and filter paper chromatography. The I was concentrated by the skeletal parts of the larva; the tanned larval structures, i.e., buccopharyngeal armature and spiracles, concentrated somewhat larger quantities of I than the untanned larval skin. The tanned puparia likewise showed an I concentration higher than that in the untanned larval skin. The pupa cases, in contrast to fresh larval skins, incorporated I non-metabolically when placed in an I solution. Data obtained from Geiger counts suggested that I was accumulated by the

larval ring gland. A region of extremely high I concentration located posteroventrally in the larva is described. Black pigment formation occurred in this same area when larvae were placed in methyl alcohol. The region is histologically distinguished by very large hypodermal cells, an epicuticle free of setae, and a somewhat narrowed endocuticle. One-dimensional filter paper chromatograms run in phenol were made from a $\text{Ba}(\text{OH})_2$ hydrolysate of larvae which had fed on ^{131}I . Four peaks of radioactivity were determined by scanning the chromatogram with a Geiger counter. One peak of radioactivity was identified as free iodine; it is suggested that the other peaks may indicate monoiodotyrosine, diiodotyrosine, and free iodine. (auth.)

- 310 Winteringham, F.P.W., Loveday, P.M., Hellyer, G.C. PHOSPHORUS METABOLISM IN THE HOUSEFLY MUSCA DOMESTICA. (abstr.) Biochem. J. 55,5 (1953) xxxiii-xxxiv

The distribution of phosphorylated intermediates in normal and poisoned flies was investigated in order to study the biochemistry of insecticidal action mechanisms *in vivo*. Adult flies were fed some P^{32} . The method of feeding and killing the flies is described, also the determination of P^{32} by autoradiography; phosphorus compounds contained in the muscle extracts are resolved by ascending unidimensional paper chromatography. Subsequent quantitative determinations of very small samples of labelled compounds are described. Autoradiographs demonstrated a high concentration of labelled material in the gut wall.

- 311 Winteringham, F.P.W., Bridges, P.M., Hellyer, G.C. MODE OF INSECTICIDAL ACTION STUDIED WITH LABELLED SYSTEMS. PHOSPHORYLATED COMPOUNDS IN THE MUSCLE OF THE ADULT HOUSEFLY, MUSCA DOMESTICA, L. Biochem. J. 59,1 (1955) 13-21.

As disturbance by an insecticide of the distribution of phosphorylated intermediates in an insect is likely to be of significance in the insecticide's mode of action, their distribution in normal and poisoned flies (Musca domestica L.) was studied by a technique that involves feeding the insects on P^{32} so that the intermediates become labelled, extracting the labelled compounds under conditions likely to preclude their decomposition resolving them by means of unidimensional paper chromatography, and scanning the chromatograms radio-graphically. This paper contains a description and discussion of the technique and the results obtained in an investigation of the intermediates in the thoracic tissue of normal flies. The effects of insecticides on the distribution found is described elsewhere.

- 312 Winteringham, F.P.W. PHOSPHORYLATED COMPOUNDS IN THE HEAD AND THORACIC TISSUES OF THE ADULT HOUSEFLY, MUSCA DOMESTICA L., DURING FLIGHT, REST, ANOXIA AND STARVATION. Biochem. J. 75 (1960) 38-45.

In order to facilitate interpretation of data on the effects of insecticides on the relative concentrations of the soluble phosphorus compounds in adult M. domestica, the effects of physical activity, starvation, etc. were studied alone. The techniques are described in some detail. Usually, soluble phosphorus compounds were uniformly labelled with P^{32} *in vivo*, to obtain the same specific radioactivity of the P for each compound. The presence of α -glycerophosphate was confirmed enzymically. The transition from cyclopropane-induced rest to normal activity was associated with a fall in thoracic α -glycerophosphate. Anoxia due to drowning caused an accumulation of thoracic α -glycerophosphate and a slower breakdown of ATP, with the formation of inorganic phosphate and possibly adenosine monophosphate. Starvation to the point of prostration caused a fall in head-ATP which could be reversed by injection of aqueous glucose. Extended cyclopropane anaesthesia, injected water or acetone were apparently without effect on P distribution. Changes in head and thoracic P compounds could occur independently in the same insect.

- 313 Wyatt, G.R. PHOSPHORUS COMPOUNDS IN INSECT DEVELOPMENT. p.161-78 (disc. p.179-84) in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbock, L., ed. London, Pergamon Press, 1959.

The importance of P metabolism in insect development is stressed, and work in the field reviewed. In metabolic studies on Cecropia silkworm, P^{32} was injected to study the exchange of inorganic phosphate between the blood and the tissues, the specific activities of orthophosphate in Cecropia plasma for both pupae in diapause and adults were determined and plotted. The shape of the curves and variations in the rate of exchange are discussed. At an early stage of adult development the rate of exchange has apparently increased above that in diapause, similar to the increase in respiration rate. Blood phosphates are considered to be produced more or less continuously, supported by experiments where radioactive inorganic phosphate had been injected into pupae and developing adults. The results are tabulated. In some studies of nucleic acids in insect development, tracer doses of P^{32} -labelled orthophosphate were injected into pupal Cecropia

wing. P^{32} incorporation into nucleotides of wing tissue RNA was determined, in diapause and on 2nd day of adult development. The activities of adenylic, uridylic, cytidylic and guanylic acids are shown graphically and discussed. Experiments on incorporation during 2 time intervals after injection showed that the rate of RNA synthesis increases sharply early in adult development and then declines again. The significance of the results is discussed.

I-B-6 VIRUS DISEASES

- 314 Bergold, G.H. RADIOACTIVE EXPERIMENTS WITH SILKWORMS. Canad. Dep. Agric., For. Biol. Div., Bi-monthly Progr. Rep. 10, 3 (1954) 2.

In the spring of 1953 about a hundred *Bombyx mori* L. larvae were injected with polyhedral virus suspended in C^{14} -labelled alanine and glycine (about 10 μ c per larva). Unexpectedly, the β -radiation inhibited the virus multiplication and about 40% of the silkworms overcame the virus infection and developed to adults. These produced eggs which still had enough radiation to be counted readily. The offspring from these eggs as well as the next following generation (in toto about 20 000 individuals) were reared. Possible genetic effects of the radiation are being studied in co-operation with Dr. G. Stehr. About 200 mg radioactive polyhedral bodies were purified from the 60 silkworms which died from polyhedral disease. This material was radioactive to the extent of about 1300 cpm per mg. The virus particles were liberated from the polyhedral bodies and separated from the polyhedral protein, and they gave about 3800 cpm per mg. Several injection experiments with this radioactive virus and polyhedral protein are under way with silkworm and gypsy moth. (auth.)

- 315 Yamafuji, K., Omura, H. STUDY OF POLYHEDRAL VIRUS FORMATION WITH RADIOACTIVE PHOSPHORUS. Enzymologia 17 (1954) 28-30.

Larvae of the silkworm, *Bombyx mori*, were either inoculated with the virus or fed KNO_3 and then given an injection of P^{32} . On testing the isotope concentration it was found to be highest in virus obtained from larvae which had been treated with P^{32} in the later stage of the development of the disease. Only a small amount of the administered dose, however, was incorporated into the polyhedral crystals.

- 316 Yamafuji, K., Omura, H., Watanabe, K. DISTRIBUTION AND TRANSMISSION OF RADIOACTIVE PHOSPHORUS DURING DEVELOPMENT OF VIRAL POLYHEDROSIS. Enzymologia 19, 3 (1958) 157-62.

Polyhedra were labelled with P^{32} and intact as well as inactivated P^{32} -polyhedral solutions were injected into larvae or pupae. About 0.1% of P^{32} is transferred from parental to offspring virus; the isotope in inactive polyhedral crystals is assimilated in viral particles to almost the same degree. The incorporation of inorganic P^{32} into polyhedra also was about 0.1%. Viral P is transferred very feebly from pupa to egg. (CA 53: 22535 b, 1959)

I-B-7 MISCELLANEOUS

- 317 Berwig, W. UNTERSUCHUNGEN ÜBER CUTICULARE STOFFABGABE BEI AMEISENWEIBCHEN, DURCHFÜHRT MIT RADIOISOTOPEN (A radioisotope study on cuticular excretion in female ants.). Naturwissenschaften 46, 21 (1955) 610-1. (In German)

No accurate data is, so far, available on the distribution by worker ants of cuticular substances given off by sexually potent animals. Work was done on *Formica polyctena* Först., P^{32} -labelled orthophosphate being injected by a glass capillary into the thorax. Autoradiography showed that radioactivity was distributed over the entire organism within 48 h. Precautions were taken to ensure that only cuticularly excreted radioactivity would be considered in subsequent measurements. Cuticular excretion in sexually potent ants was confirmed, and followed an exponential law. Worker ants were rendered radioactive by licking, and being licked in turn. The distribution of P^{32} was examined. Hypodermal gland cells and the gland complex of the metathoracic glands would appear to be responsible for substances excreted by the cuticle.

- 318 Boudreaux, H.B. FURTHER INVESTIGATIONS ON SEX-RATIO AND FERTILIZATION IN SPIDER MITES. Bull. ent. Soc. Amer. 6, 3 (1960) 155, abstr. 112.

The ratio of females to males is correlated with the amount of sperm furnished in a single mating. This supply depends upon the condition of the male and the time spent in copula. Males labelled with H^3 -thymidine were used to investigate the site of fertilization.

- 319 Craig, R., Olson, N.A. RATE OF CIRCULATION OF THE BODY FLUID IN ADULT TENEbrio MOLITOR LINNAEUS, ANASA TRISTIS (DE GEER), AND MURGANTIA HISTRIONICA (HAHN). Science 113 (1951) 648-50.
- The speed of mixing in the blood of an injected solution containing P^{32} was determined in the adults of the yellow meal worm, Tenebrio molitor Linnaeus; the squash bug, Anasa tristis (de Geer); and the harlequin cabbage bug, Murgantia histrionica (Hahn). Details of the techniques are given. The times required for uniform mixing of injected radiophosphorus are tabulated for the different species and appendages.
- 320 Day, M.F., Izzykiewicz, H. PHYSIOLOGICAL STUDIES ON THRIPS IN RELATION TO TRANSMISSION OF TOMATO SPOTTED WILT VIRUS. Aust. J. biol. Sci. 7, 3 (1954) 274-81.
- Thrips that are vectors of tomato spotted wilt cannot acquire the virus except by feeding on diseased plants as nymphs, though both nymphs and adults transmit it. The reason for this inability was investigated in tests with Thrips tabaci Lind. in the laboratory. Both nymphs and adults were fed on radioactive sucrose solution and on radioactive leaves, and no effective difference was noticed in the amount of food ingested at the different stages, nor could any physiological differences be detected. Some difference may nevertheless exist in the permeability of the midgut of the two stages, and it is further possible that the virus may be unable to multiply in the tissues of the adult.
- 321 Fuzeau-Braesch, S. FRACTIONNEMENT DES PIGMENTS OXYDORÉDUCTEURS DE L'HYPODERME ET DES YEUX D'UN GRILLON. C.R. Acad. Sci., Paris 245 (1957) 2401-4.
- Les pigments de l'hypoderme et des yeux du Grillon Gryllus bimaculatus de Geer comportent au moins trois fractions: omméline, xanthommatine et un pigment jaune, auxquelles il faut peut-être ajouter une quatrième fraction dont l'identité avec une rhodommatine est douteuse. L'origine de ces pigments a été étudiée à l'aide de tryptophane radioactif marqué au ^{14}C . (auth.)
- 322 Fuzeau-Braesch, S. RECHERCHE DE L'ORIGINE DES PIGMENTS CUTICULAIRES D'UN INSECTE PAR LA MÉTHODE DES ÉLÉMENTS MARQUÉS. C.R. Acad. Sci., Paris 248, 6 (1959) 856-8.
- Les expériences réalisées avec des substances marquées au ^{14}C montrent que les pigments noir et jaune de la cuticule d'un Insecte (le Gryllus bimaculatus de Geer (Orthop.)) - dont la formation est chimiquement distincte du processus de durcissement de cette cuticule - résultent tous deux du métabolisme de la tyrosine après la mue.
- 323 Henry, S.M., Cotty, V.F. THE REARING OF ASEPTIC ADULT HOUSE FLIES FOR PHYSIOLOGICAL STUDIES. Contr. Boyce Thompson Inst. 19, 2 (1957) 227-9.
- An improved method for the rearing of houseflies free of microorganisms is described. Eggs are subjected to tryptic digestion for 2 h, rinsed in water, placed in 1% calcium hypochlorite for 2.5 minutes, and rinsed again in sterile water. They are then suspended in 4% formaldehyde or tincture of Zephiran chloride, shaken, and finally rinsed with sterile water. Bacteria-free colonies are then reared on a sterile medium prepared from Gained dog food and yeast. A procedure for maintaining sterility while adult flies are feeding on a synthetic medium supplemented with isotopically labelled compounds is described. (auth. - M. S. H.)
- 324 Kaplan, W.D., Pelc, S.R. AUTORADIOGRAPHIC STUDIES OF DROSOPHILA GONADS FOLLOWING THE FEEDING OF CARBON-14-LABELED FORMALDEHYDE. Z. indukt. Abstamm.-VererbLehre 87 (1956) 356-64.
- Autoradiographs prepared of 24-96 h old male and female larvae of D. melanogaster which had been fed standard food containing added radioactive $HCHO$ (I) (cf. Auerbach, Heredity 8, Suppl. 247 (1953)) for varying lengths of time showed that I enters the male and female gonads with equal penetration in all regions. The differential sensitivity shown by genetic techniques appears to be a result of differential response to the presence of I rather than of differential penetration. A positive autoradiograph indicates the presence of C^{14} atoms but cannot determine the compounds in which they are present. (CA 50: 13308e, 1956)

- 325 Levenbook, L. INSECT BIOCHEMISTRY. A REPORT ON SYMPOSIUM XII. p.239-52 in "Proceedings of the 4th International Congress on Biochemistry, Vienna 1958", Vol.12. Levenbook, L., ed. London, Pergamon Press, 1959.
- The most important thoughts presented in the various papers are summarized. A number of these studies included work with radioisotopes (Florkin, Bheemeswar, Fukuda et al., Wyatt, Winteringham and Casida)
- 326 Levenbook, L. INTRACELLULAR WATER OF LARVAL TISSUES OF THE SOUTHERN ARMYWORM (PRODENIA ERIDANIA) AS DETERMINED BY THE USE OF C¹⁴-CARBOXYL-INULIN. J. cell. comp. Physiol. 52,2 (1958) 329-39.
- C¹⁴-carboxyl-inulin, injected into the 6th instar Prodenia eridania (Southern Armyworm) larva, can be recovered quantitatively from the blood, is not bound by the hemolymph proteins, and is neither metabolized nor excreted. A method employing C¹⁴-carboxyl-inulin for the determination of tissue extracellular water, and hence the intracellular water content of insect tissues, is described. The method serves also to measure the total extracellular fluid volume of insects. Values are presented for the intracellular water content of the fat-body, gut and combined internal tissues of the mature Prodenia eridania larva, together with measurements of the total extracellular fluid volume. (auth. summary)
- 327 Lindquist, A.W. RADIOACTIVE TRACER METHODS. p.76-82 in "Methods of Testing Chemicals in Insects", Vol.1. Shepard, H.H., ed. Minneapolis, Burgess. 1958, 356p.
- Brief review.
- 328 Lu, C.-P. EFFECTS OF ATOMIC ENERGY ON SILKWORM AND MULBERRY TREE. J. agric. Assoc. China (Taipei) 15 (1956) 99-103. (Summary in English)
- A review of Japanese investigations during 1950-6 on the uses of C¹⁴ and P³² in varietal and pest-control studies. (Ca 52: 4095f, 1958)
- 329 Marouzzi, G. ACQUA TOTALE E LIQUIDO INTERSTIZIALE NEGLI INSETTI. (NOTA PRELIMINARE) (L'eau totale et le liquide interstitiel chez les Insectes. Note préliminaire). Boll. Zool. 23, 2 (1959) 609-20. (In Italian)
- A l'aide de colorants vitaux et de ³⁵S, il est possible de déterminer le volume des liquides organiques composant l'hémolymphe. Ce volume est beaucoup plus élevé que celui que l'on trouve par "saignée" directe. Il semblerait que les Insectes ne possèdent pas de sang véritable, mais un liquide extra-cellulaire assimilé à l'hémolymphe, correspondant au sang liquide interstitiel des Vertébrés. (BS 19-145,573, 1958)
- 330 McEnroe, W., Forgash, A. THE IN VIVO INCORPORATION OF CARBON-14 FORMATE IN THE UREIDE GROUPS OF URIC ACID BY PERIPLANETA AMERICANA. Ann. ent. Soc. Amer. 50 (1957) 429-31.
- C¹⁴-labelled formate (I) injected into the female roach was incorporated into the ureide C atoms of the uric acid recovered from the fat body. A rapid decrease in the rate of C¹⁴O₂ production during the 15-h period following injection indicates that I rapidly becomes unavailable for oxidation. No significant amount of I was found in the excreta. Since the activity in the fat body uric acid accounted for only 3-5% of the injected activity, the major portion of the I must be incorporated into urates not located in the fat body or into other metabolic pathways. It is postulated that a transformylase system similar to that found in other organisms accounts for the metabolism of I in the roach. (CA 52: 8389a, 1958)
- 331 McEnroe, W.D., Forgash, A.J. FORMATE METABOLISM IN THE AMERICAN COCKROACH, PERIPLANETA AMERICANA (L.). Ann. ent. Soc. Amer. 51,2 (1958) 126-9.
- Studies with C¹⁴-formate show that the adult roach metabolizes injected formate to serine and proline. In vitro studies with fat body tissue show that incorporation of formate into serine occurs primarily in the β position and the addition of glycine accelerates this process. Fat body can also incorporate C¹⁴-formate into uric acid, the majority of activity appearing at carbons 2 and 8 (ureide carbons). (auth.)
- 332 Takahashi, J., VITAMIN B₁₂ IN SILKWORM. III. Nippon Nōgei-Kagaku Kaishi 30 (1956) 563-5.
- Larvae of Bombyx mori were fed with Morus bombycis leaves, which were previously soaked in Co⁶⁰Cl₂ solution. Vitamin B₁₂(I) was assayed with the Euglena gracilis method on several organs of larvae, and the radioactivity of I fraction measured. A I fraction containing Co⁶⁰ was found in the intestinal canal, and the amount of the fraction increased by administering Actinomycetes and/or non-labelled Co as the I precursor. It was suggested that I was synthesized by Actinomycetes in the digestive tract of the worm. (CA 52: 11298a, 19

I - C Insect Labelling

Survey Articles

- * Ankersmit 1958 - [1]
- * Comar 1955 - [769]
- * Jenkins and Hassett 1950 - [808]

Flies

- * Donnelly 1958 - [259]

- 333 Foott, W.H. PHOSPHORUS-32 LABELLING OF THE ADULTS OF THE CABBAGE MAGGOT, HYLEMYIA BRASSICAE (BOUCHÉ) (DIPTERA: ANTHOMYIIDAE). Rep. ent. Soc. Ont. 85 (1954) 56-61.

Two methods for tagging H. brassicae (Bch.) with P^{32} were developed for studying the dispersal of adults, and consisted of spraying P^{32} -labelled phosphoric acid or of feeding labelled sucrose solution. Although some radioactive eggs were laid, following the first treatment, it was generally found to reduce the life span and not all flies in a group necessarily received sufficient spray. The second method produced a significant count within a few days which was maintained for a considerable period beyond that of feeding radioactive material. Since there was no apparent effect on survival or oviposition, this method was considered satisfactory. It consisted of feeding P^{32} in dilute $\frac{1}{2}$ -1 mc in 100 cc of 5-7% sucrose solution.

- 334 Fredeen, F.J.H., Spinks, J.W.T., Anderson, J.R., Amason, A.P., Rempel, J.G. MASS TAGGING OF BLACK FLIES (DIPTERA: SIMULIIDAE) WITH RADIOPHOSPHORUS. Canad. J. Res., D-Canad. J. Zool. 31, 1 (1953) 1-16.

A method for tagging large numbers of Simulium spp. for flight-range investigations, devised in the course of work in Saskatchewan during 1950-51, is described. Radioactive larvae, pupae and adults that were readily detected with a Geiger counter were obtained by keeping the larvae for 24 h in a very dilute solution of a compound containing P^{32} (0.2 μ C/ml) and then returning them to non-radioactive water to complete their development. The treatment did not visibly harm the larvae or adults. Larvae were treated in the laboratory in small containers of water that was circulated and aerated with air jets, and in the field in galvanized iron tubs placed in the river and filled to a depth of 8 in with river water, which was kept in motion by means of a paddle wheel on a shaft driven by a larger paddle wheel dipping into the river. In field tests, tagged larvae and pupae were found as far as 520 yd downstream from the point at which they were returned to the river. Tagged adults were taken in cages placed over radioactive larvae and pupae in the stream, but only one was caught in the open, and this only 100 yd from the stream. Failure to find more tagged adults was believed to be due mainly to inadequate collecting methods. (from auth. summary)

- 335 Hoffman, R.A., Lindquist, A.W., Butts, J.S. STUDIES ON TREATMENT OF FLIES WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44, 4 (1951) 471-3.

In 1949 studies on the treatment of houseflies, Musca domestica L., with P^{32} were undertaken at Corvallis, Oregon, to determine its possibilities as a means of tagging flies for flight studies, and also to learn the effect on egg production and subsequent generations of flies. A few tests were also conducted with the blow fly Phaenicia sericata (Meig.). The flies were either fed sugar solutions of radioactive phosphoric acid or reared in a medium containing this radioactive material. In the preliminary tests flies were made radioactive by both feeding and rearing, the treatment had some effect on fertility, and when large dosages were fed some radioactivity was carried over into the next generation. Subsequent tests with known amounts of P^{32} supported the results. It was also indicated that feeding adult flies a solution containing P^{32} was the more economical and efficient method of tagging with P^{32} . (auth. summary).

- 336 Jensen, J.A., Fay, R.W. TAGGING OF ADULT HOUSE FLIES AND FLESH FLIES WITH RADIOACTIVE PHOSPHORUS. Amer. J. trop. Med. 31, 4 (1951) 523-30.

A method is described for labelling adult Musca domestica (L.), Callitroga macellaria (F.) and Lucilia cuprina cuprina (Wied.) [Phaenicia pallidescens (Shann.)], the most prevalent flies in trap catches in south-eastern Georgia. P^{32} was either incorporated in ground fish or in milk fed to larvae and to adults respectively. Low activity was shown by adult flies from larvae reared in P^{32} -containing media. Females took up more P^{32} than did the males on all the feeding routines. Females took up and retained appreciably more P^{32} when the feeding period was longer than one day, but males did not. C. macellaria attained the highest level of radioactivity and M. domestica the lowest. Adults from 1-6 d old showed only minor differences in initial

uptake of P^{32} with a 1-d feeding period. The initial uptake of P^{32} was approximately proportional to the concentration of P^{32} in the various milk solutions within the range tested. Decline in radioactivity was influenced by different diets of the adult flies after P^{32} feeding and may be correlated with the phosphorus content of these diets. Practical tests have shown that tagged flies can be detected in dead samples from trap catches or in living material at bait stations. The former method is more efficient.

- 337 Khudakov, G.D. A METHOD OF TAGGING INSECTS BY GIVING THEM RADIOACTIVE ISOTOPES WITH FOOD. Bull. Moskov. Obshchestva Ispytatelei Priro., Ordei Biol. 64, 3 (1959) 35-45. (Tr. from Russian) *)

- 338 Kilpatrick, J. W., Fay, R. W., Baker, J. T. THE REARING AND RADIOACTIVE TAGGING OF FANNIA CANICULARIS. Bull. ent. Soc. Amer. 3, 3 (1957) 35, abstr. 26-7.

Adults of Fannia canicularis, were allowed to feed for 24 to 48 h on cotton pads saturated with milk or honey water containing concentrations of 0.5, 1.0, 2.0, 2.5, and 5.0 millicuries P^{32} /liter. Measurement of radioactivity at daily intervals after feeding showed that F. canicularis could be satisfactorily tagged for a period of 10-12 d with either honey water or milk containing 2.0 or 2.5 mc P^{32} /liter. Feeding for 48 h was not considered necessary. Dosages of less than 2.0 mc P^{32} /liter provided insufficient activity. A technique for rearing F. canicularis using a standard CSMA media with twice the normal volume of water, was devised. The method provided unlimited production of adults, the cycle from egg to adult requiring 14 d. Tightly-rolled corrugated cardboard placed over the rearing medium provided a highly satisfactory pupation site.

- * King and Wilson 1954 - [391]

- * MacLeod and Donnelly 1957 - [77]

- 339 Oughton, J. "TAGGING" ROOT MAGGOT FLIES (HYLEMYIA spp., ANTHOMYIDAE) BY MEANS OF RADIOACTIVE PHOSPHORUS. Rep. ent. Soc. Ont. 1950 81 (1951) 91-2.

An account is given of experiments carried out in Ontario in 1950, in a field of early turnips that was heavily infested with Hylemyia spp. early in the season. On 4th July, a dilute solution containing P^{32} was poured on the soil at the base of the plants, so that two lots of 24 plants received totals of 0.8 and 0.2 mc P^{32} , respectively, and a third lot was left untreated. Half the plants in each series were covered with a cheese-cloth cage from 13th July to 14th August, and adults of Hylemyia taken in the cages were tested for radioactivity with a G-M counter. Of 10 taken on the plot treated with 0.8 mc P^{32} , 3 (all males) were radioactive, whereas none of 6 taken on that treated with 0.2 mc and none of 3 taken on the untreated plants were radioactive. Net sweeps were made twice in July and six times in August at 4 positions in the field, one including treated plants and the most distant being about 300 yards away. The Anthomyids taken were killed and examined, but none was radioactive. Examination of one turnip and the surrounding soil from the heavily treated lot on 19th July revealed 4 puparia and 2 larvae of Hylemyia, all of which were strongly radioactive. Marking in this way with P^{32} may facilitate the study of the dispersal, local distribution and habits of Hylemyia spp. and their parasites. (RAE-A 41: 379, 1953)

- 340 Radeleff, R.D., Bushland, R.C., Hopkins, D.E. PHOSPHORUS-32 LABELING OF THE SCREW-WORM FLY. J. econ. Ent. 45, 3 (1952) 509-12.

Experiments are described in which Callitroga americana were produced, labelled with phosphorus 32, by rearing in artificial medium containing P^{32} , and in natural hosts by administering P^{32} -labelled phosphoric acid to the host. Several dosages and variations of technique are described. The regional distribution of P^{32} in larvae and adults was determined and the counting rates of eggs and larvae from flies reared on radioactive media are given. Callitroga americana is easily labelled with P^{32} . Only minor manipulation is required. For field studies a concentration of 0.2 μ c P^{32} /g of artificial medium appears to give adequate labelling for positive identification of flies and their egg masses. (auth. summary)

- * Roan 1952 - [95]

- 341 Roth, A.R., Hoffman, R.A. A NEW METHOD OF TAGGING INSECTS WITH P^{32} . J. econ. Ent. 45, 6 (1953) 1091.

The authors describe a method for rendering insects radioactive by dipping them in a solution of phosphoric acid prepared from P^{32} , with or without a wetting agent, and give the results of experiments in which it was applied to flies. It was also used successfully with wasps, several species of Coleoptera, grasshoppers and

* The abstracts (Russian and English) have become available since going to press and are given on p.104.

leafhoppers, but caused about 80% mortality of aphids in 24 h. All took up the P^{32} , but the radioactivity per insect depended on its size and the amount of cuticle wetted. (RAE-A 47: 214, 1958)

- 342 Ворожик, М.В. АППАРАТ ДЛЯ НАНЕСЕНИЯ РАДИОАКТИВНЫХ ИЗОТОПОВ НА НАРУЖНЫЕ ПОВЕРХНОСТИ НАСЕКОМЫХ. Бюл. научно-техн. Инф. Всес. науч.-иссл. Инст. Вет., Санит. и Эктопаразитол. 1 (1956) 26-7.

Ввиду трудностей кормления кровососущих насекомых методами меченых их путем окраски радиоактивных веществ не всегда применима. Описывается аппарат, специально сконструированный для меченых насекомых путем орошения растворами радиоактивных веществ. Раствор радиоактивного фосфора - P^{32} (Na_2HPO_4 и др.) циркулирует в аппарате и орошает находящиеся в нем насекомые, не попадая в то же время в воздух или на окружающие предметы и не загрязняя их. Таким образом, персонал защищен от бета-излучения применяемых радиоактивных веществ. Исследованиями установлено, что радиоактивный фосфор, нанесенный на наружные покровы слепней и мух, хорошо сохраняется на них не менее 10 дней и может быть выявлен с помощью радиометрической установки даже при содержании этих насекомых в заведомо неблагоприятных метеорологических условиях.

- Voronin, M.V. APPARATUS FOR APPLICATION OF RADIOACTIVE ISOTOPES ON EXTERNAL COVERING OF INSECTS (abstr.). Vsesoiuzn. nauch.-issled. Inst. Vet. Sanit. i Ektoparazitol. B. nauch.-tekhn. Inform 1 (1956) 26-7.

The difficulties of feeding blood-sucking insects makes labelling by feeding radioactive substances inapplicable sometimes. An apparatus is described designed for labelling them by sprinkling with radioactive substances. Radioactive solutions of P^{32} (e.g., Na_2HPO_4) are made to circulate and to cover the insects inside without getting outside the apparatus (into the air or the surroundings) thus avoiding pollution. Operators are therefore protected from the β -radiation emitted. P^{32} applied to the external covering of horseflies (*Tabanidae*) and other flies is still well retained after 10 d and can be detected even when these insects have been maintained under deliberately unfavourable atmospheric conditions.

Mosquitoes

- 343 Aragão, M.B., Frota-Pessôa, E., Margem, N. NOVO MÉTODO RADIOATIVO PARA MARCAR MOSQUITOS (New radioactive method of marking mosquitoes). Rev. bras. Malariol. 5, 1 (1953) 69-73.

The larvae are bred in a solution of thorium nitrate 1:100 000, and are identified as adults by means of a nuclear emulsion. The thorium is found in the Malpighian tubules and, to trace the particles, the mosquitoes must be dissected or incinerated. Mosquitoes could still be identified after 2 months of adult life. (BA 28: 7098, 1954)

- 344 Aragão, M., Frota-Pessôa, E., Margem, N. A NEW RADIOACTIVE METHOD FOR MARKING MOSQUITOES AND ITS APPLICATION. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.8/P/140, 10 (1956) 525-8.

A method is described in which mosquitoes, made radioactive by being hatched in a solution of 1/100 000 thorium nitrate, were identified by the tracks left on plates covered with a special emulsion. The cultivation of the mosquitoes, *Anopheles* (Kerteszia) spp., and the preparation, development, and fixation of the plates is described. The results obtained indicate a maximum flight range of at least 800 m.

- * Dissanaïke et al. 1956 - [404]

- 346 Dissanaïke, A.S., Dissanaïke, G.A., Niles, W.J. PRODUCTION OF RADIOACTIVE INFECTIVE LARVAE OF *WUCHERERIA BANCROFTI* IN *CULEX FATIGANS*. Exp. Parasitol. 6, 1 (1957) 52-9.

Attempts to obtain radioactive infective larvae of *Wuchereria bancrofti* were made by making adults of *Culex pipiens fatigans* Wied. radioactive by inclusion of P^{32} or Sr^{90} in the breeding medium of the 2nd and 3rd instar larvae or, in a few cases, by feeding adults on sugar solution containing orthophosphate to give 7.5 μCi /or strontium chloride to give 5 μCi /ml. The intake of P^{32} from sugar solution was low, and that of Sr^{90} negligible. Marking with Sr in the rearing medium was not successful, as mortality of larvae was high, even in baths giving as little as 0.05 μCi /ml, and the few adults emerging had low β -activities but could not feed. The results, which were not in agreement with some obtained with *Aedes aegypti* (L.) suggest that the observed ill-effects were chemical. Rearing larvae in water containing P^{32} at 0.025, 0.1 and 1 μCi /ml produced adults of high radioactivity, which increased with increasing concentration of P^{32} , but adults

emerging from the strongest concentration showed signs of retarded growth and the females did not feed. For the production of radioactive infective larvae of *W. bancrofti*, see Trans. R. Soc. trop. Med. Hyg. 50 (1956) 425. (RAE-B 47: 67, 1959)

- 346 Fay, R.W., Baker, J.T., Jensen, J.A. RADIOACTIVE TAGGING OF *CULEX QUINQUEFASCIATUS* (SAY) WITH P^{32} . Mosquito News 19, 3 (1959) 139-43.

Since larvae of uniform age are suited for tagging with $Na_2HP^{32}O_4$ solution, laboratory studies were undertaken to determine (a) the rate of egg production of adult females, and (b) the possibilities of delaying egg hatch so that eggs from several days could be combined. Experimental details are given. One million tagged females for dispersion studies can be obtained by (a) the collection of 100 000 pupae in a 2-day period and the rearing of the eggs produced in the first 4 days by the resultant adults, (b) by the collection of about 16 000 egg rafts within a 4-day period and the rearing of the resultant larvae, or (c) by a combination of methods (a) and (b). Based on insectary studies, production values are as follows: 35 egg rafts/100 females in a 4-day period, a mean of 158 eggs/raft, 98% egg hatch, 87% pupation and 92.4% adult emergence, with equal sex division. Exposure of 6- to 8-day-old larvae at concentrations of 10 000 larvae/ft² of water surface for periods of 24 h or longer in 0.05 to 0.1 mc $Na_2HP^{32}O_4$ solutions will yield adults with activity levels detectable for a period of at least 2 weeks.

- * Hassett and Jenkins 1951 - [272]

- 347 Ильинская, Н.Б., Трошин, А.С. МАРКИРОВКА МУХ И КОМАРОВ ПРИ ПОМОЩИ РАДИОАКТИВНОГО ФОСФОРА. Зоол. Журн. 33, 4 (1954) 841-7.

1. При помощи радиоактивного фосфора (в форме $Na_2HP^{32}O_4$ или $K_2HP^{32}O_4$) можно легко пометить любое количество мух и комаров на достаточно длительный срок. 2. Маркировку мух легко производить кормлением имаго в течение 1 - 1,5 суток сахарным раствором с примесью P^{32} при удельной радиоактивности раствора 1 микрокюри на 1 мл. 3. Для маркировки комаров личинки не позднее чем за 2 - 3 дня до окукливания помещаются (в количестве 10 - 20 шт. на 100 мл) в богатую микрофлорой среду, к которой добавлен P^{32} . Удельная радиоактивность среды доводится до 0,075 микрокюри на 1 мл. 4. Маркировку мух при помощи радиоактивного кальция (Ca^{45}) производить нецелесообразно, так как он очень быстро выводится из организма этих насекомых, ввиду чего радиоактивность их во времени очень быстро уменьшается.

- Ilinskaya, N.B., Troshin, A.S. TAGGING FLIES AND MOSQUITOES WITH RADIOACTIVE PHOSPHORUS. Zool. Zh. 33, 4 (1954) 841-7.

Any quantity of flies (*Musca domestica*, Calliphora) or mosquitoes [*Culex*, *Aedes* (*dianthus*, *cataphylla*)] may easily be labelled by means of $Na_2HP^{32}O_4$ or $K_2HP^{32}O_4$. Flies are easily labelled by feeding the imago on sugar solution with added P^{32} (specific activity 1 μ c/ml) for 1-1.5 d. Mosquito larvae, not more than 2-3 d before pupation (10 - 20 mosquitoes per 100 ml) are placed in a P^{32} -containing medium, rich in microflora. The specific radioactivity of the medium is 0.075 μ c/ml. Labelling of flies with Ca^{45} proved unsuitable since it was quickly lost from the insect body, with subsequent very rapid loss of radioactivity.

- * Jenkins and Hassett 1951 - [110]

- * Kuper and Pelc 1952 - [405]

- * Provost 1957 - [112]

- * Provost 1960 - [113]

- 348 Shemanchuk, J.A., Spinks, J.W.T., Fredeen, F.J.H. A METHOD OF TAGGING PRAIRIE MOSQUITOES (DIPTERA: CULICIDAE) WITH RADIOPHOSPHORUS. Canad. Ent. 85 (1953) 269-72.

Tagged adults were obtained from 4th instar mosquito larvae [mostly *Aedes spencerii* (Theo.), and *A. campestris* (D. & K.)] kept for 24 h in a 0.1 μ c/ml solution of $P^{32}O_4$, at a density of 1 larva/ml of radioactive solution. After exposure the larvae could be returned to their normal, non-radioactive habitat for further development. Adults were found to retain readily detectable amounts of radioactivity. Field experiments were carried out with the above and, in addition, with *A. flavescens* (Mill.) and *A. dorsalis* (Meig.) from

spring flood pools. The short exposure method reduced the possibility of over-exposure to surface irradiation, and reduced mortality caused by prolonged artificial rearing conditions. There is also less chance of the larvae assimilating lethal doses of P^{32} . The simplicity of the equipment and method is stressed.

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Жадин, В.И., Ильинская, Н.Б., Световидов, А.Х., Трошин, А.С. ЗАДАЧИ И МЕТОДЫ МЕЧЕНИЯ НАСЕКОМЫХ И РЫБ РАДИОАКТИВНЫМИ ИЗОТОПАМИ. Труды научной сессии по достижениям и задачам Советской биофизики в сельском хозяйстве, Москва (1955) 276-84.

Описываются методы мечення *Musca domestica*, *Calliphora vomitoria* радиоактивным фосфором (P^{32}) путем добавления молока $K_2HP^{32}O_4$ или $Na_2HP^{32}O_4$ на стадии личинки и куколки или же для взрослых особей $K_2HP^{32}O_4$ к 2% раствору глюкозы или галактозы. Удельная активность раствора глюкозы составляла 1 мкюри/мл. В течение 24 часов все мухи стали радиоактивными и сохраняли эту радиоактивность на всю жизнь. Также описана методика мечення комаров с помощью P^{32} (*Aedes* и *Culex*). Она представляет значительную модификацию метода Дженкинса и Хассета, 1951. Личинки комаров отбирались в водоемах и прудах и помещались в деревянные лужи, заполненные речной водой, из расчета 10 мл/личинку. P^{32} вводили в воду (средняя удельная активность 0,075 мкюри/мл, или 0,008 мкюри/личинку) на 3 или 4 стадии развития, во всяком случае не позже чем через 2-3 дня до окукливания. В этих условиях личинки хорошо развиваются, окукливаются и производят взрослые особи с высокой радиоактивностью на протяжении всей их жизни.

Zhadin, V.I., Ilyinskaya, N.B., Svetovidov, A.Kh., Troshin, A.S. PROBLEMS AND METHODS OF TAGGING INSECTS AND FISH WITH RADIOISOTOPES. p. 276-84 in Trudy nauchnoy sessy po dostuzheniyam i zadacham Sovetskoy biofiziki v selskom khozyaistve, Moskva 1955.

Methods of labelling *Musca domestica* and *Calliphora vomitoria* by P^{32} in the larval and pupal stage, by adding $K_2HP^{32}O_4$ or $Na_2HP^{32}O_4$ to milk or, for adults, $K_2HP^{32}O_4$ to a 2% glucose or galactose solution are described. The glucose solution had a specific activity of 1 mc/ml. Within 24 h all flies were radioactive and remained easily detectable throughout their lives. A P^{32} -tagging technique for mosquitoes (*Aedes* and *Culex*) is also described which represents a rather substantial modification of the technique of Jenkins and Hassett, 1951. Mosquito larvae were obtained from reservoirs and pools, and put into wooden boxes filled with river water (10 ml/larva). At the 3rd or 4th stage, in any case not later than 2-3 d before pupation, P^{32} was introduced into the water (average specific activity 0.075 μ c/ml, or 0.008 μ c/larva). Under such condition larvae develop well, form pupae, and later adults whose radioactivity remains high throughout their lives.

Miscellaneous

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Arnason, A.P., Fuller, R.A., Spinks, J.W.T. AN ELECTRONIC METHOD OF TRACING THE MOVEMENTS OF SOIL-INHABITING INSECTS. Science 111 (1950) 5-6.

The wireworm, *Ctenicera serripennis destructor* Brown, was labelled by inserting a Co^{60} -wire into the body cavity of the larvae rather than by feeding, which has proved impractical for several reasons. External application is only appropriate between molts, because activity is shed at each ecdysis. The worm can be followed through a depth of several inches by means of an outside G-M counter. The method is applicable to studies on response to different conditions and investigations on other species.

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Babers, F.H., Roan, C.C., Walker, R.L. TAGGING BOLL WEEVILS WITH RADIOACTIVE COBALT. J. econ. Ent. 47 (1954) 928-9.

A preliminary note. In order to study the overwintering habits of the boll weevil, *Anthonomus grandis* Boh., it became necessary to tag several thousand adults with a material the activity of which could still be detected 5 months after application. The solutions used were 1) stock solution: 5 mc of Co^{60} (chloride) in 0.2 ml of 0.34 N HCl was diluted to 10 ml with distilled water; 2) working solution: 2 ml of stock diluted with 198 ml of distilled water, giving a specific activity of 6.6×10^5 cpm/ml. A wetting agent ("Tergitol No.7") greatly increased the amount of radioactive solution retained and reduced the amount removed by washing. It was found possible to obtain slow labelling of cotton plants by a Co^{60} solution.

* Banks 1954 - [58]

* Banks 1955 - [59]

- * Berwig 1959 - [37]
- * Bjorling et al., 1951 - [407]
- 352 Cornwell, P.B. TECHNIQUES FOR LABELLING TREES WITH RADIOACTIVE PHOSPHORUS. Nature 175 (1955) 85-7.
- The methods described are suitable for obtaining radioactive host plants of insect populations in the field. All three techniques mentioned suffer from two disadvantages, namely, the translocation of P^{32} from the point of application is small and the distribution of tracer within the tree is localized. Similar results were obtained with Ca^{46} and rubidium-86 injected into yellow birch. Future methods will be carried towards methods of root application. These techniques were studied with a view to investigating the movement of the mealybug vectors of swollen-shoot disease of cacao. Since the artificial release of labelled insects in the field is unsatisfactory in this case, it is aimed to achieve labelling of insects at their feeding sites under field conditions.
- 353 Courtols, G., Lecomte, J. SUR UN PROCÉDÉ DE MARQUAGE DES ABEILLES BUTINEUSES AU MOYEN D'UN RADIOISOTOPE (Concerning a method for marking worker bees by means of a radioisotope). C.R. Acad. Sci. 247 (1958) 147-9.
- Colloidal radioactive gold, Au^{198} , was added to food. Bees from a particular hive and from neighbouring hives were tested for radioactivity after certain time intervals. Radioactivity was found in nearly all bees of the hive within a few hours, and some bees were occasionally found erring to neighbouring hives. It could also be shown that the flight range was relatively small, and that the bees from each hive had their own narrowly circumscribed field of action.
- 354 Davis, J.M., Nagel, R.H. A TECHNIQUE FOR TAGGING LARGE NUMBERS OF LIVE ADULT INSECTS WITH RADIOISOTOPES. J. econ. Ent. 49, 2 (1956) 210-1.
- Techniques were devised for applying enough γ -emitter (ca. 20 μ Ci/insect) to forest insects, in this case primarily to Engelmann spruce beetles (Dendroctonus engelmanni Hopk.) to permit their being rapidly located when under the bark of trees or under debris on the forest floor. Na^{24} , $Sc^{46}Cl_3$ and $Na_2H^{36}Cl_4$ were used successfully, whereas $Ag^{110}NO_3$ and $Rb^{86}Cl$ were toxic in the amounts required. The insects were apparently unaffected by the treatment.
- * Donnelly 1958 - [259]
- 355 Entomol. Soc. Ontario, PHOSPHORUS-32 LABELLING THE ADULTS OF THE CABBAGE MAGGOT, HYLEMYA BRASSICAE (BOUCHÉ) (DIPTERA: ANTHOMYIDAE). Rep. ent. Soc. Ont. 85 (1955) 51-61.
- In the course of investigations in Ontario on the dispersal of adults of Hylemya brassicae (Bch.), two methods of tagging the flies with P^{32} were developed. In 1951, spraying about 40 caged adults with 0.5 μ Ci P^{32} (in phosphoric acid) diluted to 5 cm³ with distilled water resulted in counts per minute of 1 200 - 1 600 after 24 h, 200 - 1 600 after a week and 400 after a fortnight, when only one fly survived. In 1952, similar treatment of 50 flies with 0.25 mCi P^{32} in 5 cm³ resulted in averages of 245 cpm after one day and 75 after 12, when all but two flies were dead. The radioactivity was not removed by washing, and radioactive eggs were laid by some females, indicating that the solution had been absorbed, but as the length of life was reduced and all the flies in a group might not receive sufficient spray, the method was considered unsatisfactory. About 100 flies that were allowed to feed on a solution of 0.5 mCi P^{32} in 100 cm³ 7% sucrose solution from a wick of dental cotton which was soaked in the solution every day, showed on average of 340 cpm after a week in 1951. In 1952, when flies were provided with a solution of 0.75 - 1 mCi P^{32} in 100 cm³ 5% sucrose solution daily for 13 d, the average cpm rose from 300 on the second day to 980 on the 12th and fell thereafter to 150 on the 42nd, when only one fly survived. Females developed significantly more radioactivity than males, and some laid radioactive eggs; larvae from the latter showed no radioactivity. As a significant count for a considerable period after feeding with radioactive material ceased, and as there was no apparent effect on survival or oviposition, this method is considered satisfactory. (RAE-A 45: 344, 1957)
- * Flemion et al., 1952 - [33]

- 356 Food and Agriculture Organization of the United Nations, Rome. European Commission on Agriculture. REPORT OF THE FIRST MEETING OF THE EUROPEAN CONTACT GROUP ON THE USES OF ISOTOPES AND RADIATION IN AGRICULTURAL RESEARCH. Held in Wageningen, Netherlands, 10-14 December 1956. FAO/57/3/1837, NP-6353, 41p.
- Very general survey of European research programs engaged on so far, and to be envisaged for the future. Mention is made of Finnish studies with C^{14} on the wheat bugs *Dolycoris baccarum* and *Lygus rugulipennis*. No details are given. - Some introductory reading is listed for the whole field.
- 357 Fredericksen, C.F., Lilly, J.H. MEASURING WIREWORM REACTIONS TO SOIL INSECTICIDES BY TAGGING WITH RADIOACTIVE COBALT. *J. econ. Ent.* 48, 4 (1955) 436-42.
- Wireworms of the genus *Melanotus* were tagged with Co^{60} by having a small piece of cobalt wire (initial activity about 0.07 mc) cemented to the dorsal surface of the caudal segment after which the wireworm reactions to 4 different soil insecticides (Aldrin, Dieldrin, heptachlor or Lindane - almost pure γ BHC -) were studied. The subsequent vertical and horizontal positions were determined by a G-M counter. Movement was found to be greatest in untreated soil, with greatest reduction in soil treated with Aldrin or BHC. Dieldrin had the least effect. However, all wireworms that entered treated soil and stayed in it were dead or moribund after 4 d, so that all the insecticides were toxic to them, and all from the boxes containing some treated soil were dead within 2 weeks, even though they had not actually entered the treated areas; some fumigant effect is thus implied. The wireworms in untreated soil survived normally.
- 358 Fuller, R.A., Spinks, J.W.T., Arnason, A.P., McDonald, H. USE OF RADIOACTIVE TRACERS IN INVESTIGATIONS ON SOIL-INHABITING INSECTS. *Rep. ent. Soc. Ont.* 81 (1961) 7-15.
- The authors describe experiments carried out in Canada, in which wireworms [*Ctenicera aeripennis destructor* (Brown)] and cutworms [*Euxoa ochrogaster* (Gn.) and *Agrotis orthogonia* (Morr.)] were marked with Co^{60} for observations on their behaviour in the soil. This material was chosen because the comparatively high energy of its γ -radiation makes detection possible through several inches of soil, and its long half-life minimizes corrections for decay; the larvae studied are slow-moving and unlikely to be lost, so that an isotope with a long half-life could be used without much danger. The technique and its effects on the worms are described, including the distribution of radioactivity within them. A number of experiments were carried out by means of a probe which allowed the positions of radioactive larvae to be determined to within $\frac{1}{4}$ in to a depth of 5 in. Curves are given to show absorption of γ -rays from Co^{60} by soil of different thickness. The effect of temperature on wireworms was tested. Wireworms were also offered alternative soil-moisture conditions. In another experiment, the paths of several wireworms seeking food were followed; both rates and routes varied greatly. Insertion of Co^{60} on wire into the body cavity proved highly toxic for wireworm larvae, but gave only a small percentage of mortality in cutworms.
- * Gillies 1958 - [771]
- * Godwin et al. 1957 - [99]
- 359 Gösswald, K., Kloft, W. ZUR LABORATORIUMSPRÜFUNG VON TEXTILIEN AUF TERMITENFESTIGKEIT MIT *CALOTERMES FLAVICOLLIS* FABR. (Laboratory testing of textile fabrics for termite resistance by means of *Calotermes flavicollis* Fabr.). *Ent. exp. et appl.* 2 (1959) 268-78.
- Experiments were made over a period of two years on the resistance of various materials, especially textiles, to termites. The dry wood termite, *Calotermes flavicollis* Fabr. was used as a test animal, as this insect is resistant to environmental conditions and it readily attacks hard materials. Quantitative radio-biological investigations (the insects were rendered radioactive by feeding them P^{32} -labelled filter paper) showed that fifth-instar larvae and "Pseudergates", which both feed actively, are good test animals. After moulting, larvae do not feed for 4 d. It is advisable therefore to use large batches (30 larvae in each) to ensure that some are trying to feed at any time. Experiments should last 21 d at least. The method used in testing the effects of *C. flavicollis* on textiles, and the way the insect is acclimatized, are described. A useful new technique for these tests consists of pulling the textile into the metal frame of a projector-slide. Termites can gnaw through materials otherwise resistant when they are covered by a thin perforated film of termite-proof material. If the perforations are of the same diameter as the termite's head they serve as innate releasing mechanisms for "food-tunnel gnawing". This method should only be used in special cases, e.g. testing for repellency, surface hardness, etc. (auth. summary)

- * Green et al. 1957 - [123]
- * Holling 1958 - [1560]
- * Hyland and Hammar 1959 - [190]
- 360 Jacob, J., Sirlin, J.L. LABELLING OF INSECT SPERMATOZOA BY ADENINE-8- ^{14}C . Experientia 14, II (1958) 402-3.
- A labelling technique for mature spermatozoa of *Prinus hirtellus* (Coleoptera) and of *Drosophila melanogaster* is described. About 0.01 cm³ of a solution of adenine-8- ^{14}C (10 $\mu\text{C}/\text{cm}^3$, 9.6 pc/mM) was injected into each larva of *P. hirtellus* using a microneedle. *Drosophila* larvae fed on dead yeast medium containing adenine-8- ^{14}C (10 $\mu\text{C}/\text{cm}^3$ of medium). Autoradiographs of sections, squashes or smears of adult testes were made.
- * Kartman et al. 1958 - [406]
- 361 Kettlewell, H.B.D. LABELLING LOCUSTS WITH RADIOACTIVE ISOTOPES. Nature 175, 4462 (1955) 821-2.
- Experiments are described in which hoppers and adults of *Schistocerca gregaria* were fed on materials containing P^{32} . This method would make it possible to mark hoppers, for which external markings are of no use because they shed their skins frequently. However, it would be costly and difficult. Unless some automatic recording device can be found, it seems that the radioactive isotopes have no advantages over colour paints for labelling adult locusts. (BA 29: 27205, 1955)
- 362 Kettlewell, H.B.D. LABELLING OF LOCUSTS WITH RADIOACTIVE ISOTOPES. UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF. 8/P/1079, 12 (1956/214-5.
- Locusts (*Locusta migratoria* L. and *Locusta pardalina* Walk.) were labelled with P^{32} in the nymph and adult stages. P^{32} was rapidly absorbed in the organic or inorganic form. Autoradiography showed differences in localization of radioactivity, depending on whether the P^{32} had been acquired before or after reaching the adult stage. The author concludes, however, that without the use of some automatic recording device, radioactive labelling of locusts has little advantage over colour paints since these can be recorded by untrained workers.
- * Kloft 1960 - [27]
- * Kloft and Ehrhardt 1959 - [41]
- 363 Knapp, S.E., Farinacci, C.J., Herbert, C.M., Jr., Saenger, E.L. A METHOD FOR LABELING THE LONE STAR TICK WITH A RADIOACTIVE INDICATOR (P^{32}). J. econ. Ent. 49,3 (1956) 393-5.
- About 1 300 ticks (*Amblyomma americanum* (L.)) were made radioactive by submersion in a solution containing P^{32} as sodium dihydrogen phosphate and having a specific activity of 10 $\mu\text{C}/\text{ml}$. The ticks (in lots of up to 200) were confined in a Blichner funnel by a disk of 36-mesh brass wire, with a 1/4-inch hole in the centre through which they were inserted. The solution was poured into the funnel, allowed to stand for one minute and then drawn off. This procedure was carried out three times with the same solution. The ticks were then transferred to clean petri dishes. They were measured for uptake and retention of P^{32} with a mica end-window G-M tube attached to an autoscaler. They were held in place individually under the window and 1/4 inch from it in a rubber retaining ring with a lens-paper cover on a stainless steel planchet. The mean counts per minute for lots of about 25 individuals treated 14 d before in solution containing no wetting agent were 278 for males and 397 for females. Addition of a wetting agent to the solution did not increase uptake or retention of P^{32} but substantially reduced survival of female ticks. The use of wetting agents is therefore not recommended. (RAE-B 45: 115, 1957)
- 364 Корш. МЕЧЕНИЙ ШЕЛКОПРЯД. Наука и Жизнь, Москва 6 (1959) 61-4.
- Korsh, Y.M. THE MARKED SILKWORM. Sci. and Life, Moscow 6 (1959) 61-4.

- 365 Levin, M.D. COMPARISON OF TWO METHODS OF MASS-MARKING FORAGING HONEY BEES. J. econ. Ent. 53 (1960) 696-8.
- Experimental bees may be identified by using the genetically marked strain of Apis mellifera L. called cordovan, or by radioactive tagging. Black Caucasian bees were tagged by feeding them sugar sirup marked with P^{32} . Natural nectar was no abundant at that time that the bees were slow to take up sirup, and it was therefore sprinkled on the frames inside each colony. Bees collected in the field were assayed for radioactivity either by Geiger counter or autoradiograms. Of 6880 bees collected, 429 (6.2%) were cordovan and 735 (10.7%) were radioactive. In spite of this difference both types of bees seemed to show similar gradations in population with increasing distance from the apiaries. The relative merits of the two types of marking are discussed. Radioactive tagging requires special equipment and facilities not readily accessible to all investigators, and removes treated colonies from normal production for the remaining season; it has the advantage, however, of immediate application to available colonies. P^{32} was chosen because it is relatively harmless and has a convenient half-life.
- * Liesering 1960 - [408]
- 366 Mortreuil, M. MARQUAGE RADIOACTIF DU PUCERON DE L'ARACHIDE (APHIS LEGUMINOSAE) ET DE SA DESCENDANCE PARTHÉNOGÉNÉTIQUE. C.R. Soc. Biol., Paris 153, 5 (1959) 755-7.
- L'auteur décrit une technique de marquage radioactif du Puceron de l'Arachide par voie nutritionnelle telle qu'une fraction du radiophosphore ingéré par les femelles parthénogénétiques soit transmise jusqu'à la seconde génération. Il n'a pas observé de modifications significatives des caractères de développement et de reproduction d'Aphis leguminosae.
- 367 Quan, S.F., Hartwell, W.V., Scott, K.G., Peng, C.T. CERIUM 144 AS A TAG FOR ARTHROPODS OF MEDICAL IMPORTANCE. Trans. R. Soc. trop. Med. Hyg. 51, 1 (1957) 87-8.
- Radioactive cerium (Ce^{144}) which emits β - and γ -radiation has a considerably longer half-life (282 d) than P^{32} and I^{131} . It has a short-lived daughter, praseodymium (Pr^{144}) of 17.5 min. half-life, with very energetic β -emission, easily detected and measured. Cerium appears to form stable combinations with tissues. Fleas [females of Malareus telchinum (Roths.), Xenopsylla cheopis (Roths.) and Hystriohopsylla sp.] and ticks [Ixodes sp.] were marked by immersion for less than 5 min in aqueous solutions of Ce^{144} - Pr^{144} containing 10 μ Ci/ml, mosquitoes (Aedes aegypti (L.)) by rearing them from late 4th instar larvae and pupae kept in water containing less than 10 μ Ci/ml, and anaesthetized individuals of Triatoma protracta (Uhl.) and Blattella germanica (L.) by the topical application of < 1 μ l solution containing about 1 μ Ci/ml to their backs. No detectable amount of the isotopes could be removed by washing the arthropod with a 5% solution of ethylenediaminetetraacetic acid. The amounts of the isotope mixture retained by the various species after 7 d were only very slightly below those obtained after 1 d. The method of tagging is simple, rapid and needs no special equipment. A disadvantage of the use of cerium is that further studies with other γ - or β -emitters cannot be carried out in an area in which it has been used until the tagged insects have died or until enough time has elapsed for decay of the Ce^{144} to background levels.
- 368 Raudszuz, I.O. MARKING THE QUEENS WITH A RADIO-ACTIVE SUBSTANCE. Cleanings of Bee Culture* 86 (1958) 18-9.
- 369 Rings, R.W. COMPARATIVE EFFECTIVENESS OF FIVE RADIOISOTOPES AS TRACERS IN STUDYING THE DISPERSAL OF PLUM CURCULIOS (CONOTRACHELUS NENUPHAR). Ohio J. Sci. 54 (1954) 231-6.
- Laboratory and field investigations were conducted with 8 radioisotopes to determine the most effective material for tagging adult plum curculios for dispersal studies. The radioelements tested were P^{32} , S^{35} , Cl^{36} , Ca^{45} , Co^{60} , Zn^{65} , Sr^{89} , and I^{131} . They were fed $KH_2P^{32}O_4$, $Co^{60}Cl_2$, $Zn^{65}Cl_2$, $Sr^{89}Cl_2$, or I^{131} in solution or on peach foliage. Sr^{89} proved the most useful since it could be given to insects in solution or via plant tissue, has a relatively long half-life, and a comparatively strong radiation. Co^{60} was a very persistent tagging agent but could only be given in solution. P^{32} and I^{131} were unsatisfactory for these particular field studies because of their short half-lives. Zn^{65} had too low a specific activity to allow reliable results.
- 370 Rings, R.W., Layne, G.W., Jr. RADIOISOTOPES AS TRACERS IN PLUM CURCULIO BEHAVIOUR STUDIES. J. econ. Ent. 46, 3 (1953) 473-7.
- A good account is given of the difficulties of tagging adults of Conotrachelus nenuphar. Topical application (immersion or direct individual application) and feeding (directly or via previously labelled plant foliage)

were used. P^{32} and Sr^{88} were quickly absorbed by the peach foliage, optimum concentrations being 100 $\mu\text{C}/\text{ml}$ and 2 $\mu\text{C}/\text{ml}$ respectively. $Sr^{88}(\text{NO}_3)_2$ was unsatisfactory and replaced by $Sr^{88}\text{Cl}_2$. P^{32} is suitable for dispersal studies but not for determining hibernation sites. Zn^{65} was found to be either extremely toxic to foliage or else not to activate the beetles sufficiently. Attempts to produce P^{32} -labelled foliage proved unsuccessful, partly because of uneven distribution. Co^{60} was absorbed unevenly by the weevils. Whereas they did not retain sufficient activity for exact site determinations, overwintering in the orchards could be confirmed after 8.5 months.

- 371 Speers, C.F. RADIOISOTOPES IN FOREST INSECT STUDIES. Proc. Ass. Sth. agric. Wks 53 (1956) 130.

Ir^{192} was used in an attempt to determine flight range of the Southern pine beetle, Dendroctonus frontalis Zimmermann. Some preliminary results are given. For determining the movement of white grubs through the soil, pieces of activated tantalum were injected into the body cavity of each grub. Details of the technique are given. The grubs were replaced in the soil under 5 different conditions of ground cover to determine whether the type of ground cover affected larval movement. Ant predation proved annoying. Treated larvae were able to transform to adult stage and still retain their activity.

- * Spinks 1956 - [12]

- * Sullivan 1953 - [101]

- 372 Sundby, R. THE MARKING OF THE MOTH PHYLLOCNISTIS LABYRINTHELLA BJERK. WITH RADIOACTIVE PHOSPHORUS. Oikos 9,2 (1958) 253-9.

Phyllocnistis labyrinthella (Lepidoptera) is a small leaf-mining moth. Mass emergence of imagoes occurs in July, after which the moths disappear and cannot be traced by usual methods. The following spring they reappear and breed. Newly emerged imagoes were fed a mixture of sugar, water and P^{32} -labelled phosphoric acid in the laboratory. They survived well, even when fed with a solution containing 100 μC of P^{32} per ml. Moths fed with this concentration could be detected by a Geiger counter 0.5 m away. Two hundred tagged moths were liberated in the field and then detected 8 d later. They were in the ground, some distance below the surface. Subsequent searches showed very little change of location by the moths up until the first frost arrived in September. Unfortunately, the short half-life of P^{32} prohibited detection of the imagoes the following spring. (BA 33: 27682, 1959)

- 373 Vanderplank, F.L. STUDIES ON THE COCONUT PEST, PSEUDOTHERAPTUS WAYI BROWN (COREIDAE), IN ZANZIBAR. I. METHOD OF ASSESSING THE DAMAGE CAUSED BY THE INSECT. Bull. ent. Res. 49,3 (1958) 559-84.

Nymphs were reared on coconut inflorescences placed in distilled water containing P^{32} or S^{35} at the rate of 2 mc per pint. The P^{32} was in the form of carrier-free orthophosphate in dilute HCl (pH 3-5), with original activity 8.83 mc/ml. The S^{35} was in the form of a sulphate containing a little NaCl (pH 1-2) with the carrier-sulphate not exceeding 100 $\mu\text{g}/\text{ml}$ and an activity 5 mc/ml. The inflorescence became radioactive within 24 h and sections (autoradiographed) showed that, whereas the P was distributed chiefly in the meristematic tissues, on some of which P. wayi feeds, the distribution of the S was more uniform. Nymphs reared on these inflorescences became strongly radioactive. Adults reared from such nymphs gave 600 cpm above the 100 cpm background. For release-capture studies, the longer-lived S^{35} is more suitable than P^{32} . Several hundred radioactive adults were released in a relatively isolated plantation, with palms spaced roughly 10 x 10 yd apart. The method used for tracing insects proved too clumsy for use as a basis for determining the size of a population. (Summary of radioactive marking technique)

- 374 Yates, W.W., Gjullin, C.M., Lindquist, A.W., Butts, J.S. TREATMENT OF MOSQUITO LARVAE AND ADULTS WITH RADIOACTIVE PHOSPHORUS. J. econ. Ent. 44,1 (1951) 34-7.

Studies were made to determine how to introduce P^{32} -labelled phosphoric acid into both larvae and adult mosquitoes in amounts that would be detectable with radioactive measuring devices. Aedes sticticus (Meig.) and A. vexans (Meig.) mosquitoes gave 544 to 897 cpm above background after they had been allowed to feed on the blood of rats that had received 0.375 mc of P^{32} in aqueous solution intraperitoneally 24 h earlier. In three dissected specimens an average of 72% of the radioactivity was found in the abdomen and 4% in the legs. Second- and third-instar larvae of Culex tarsalis (Coq.) reared in water having an unknown concentration of P^{32} had radioactivity ranging from 164 to 417 cpm. Fifteen percent of this radioactivity was present in the legs and 45% in the abdomen. Aedes sticticus females fed on water having an unknown con-

centration of P^{32} gave readings of 577 to 1192 cpm 1 to 13 d after. The legs had approximately 9% and the abdomens 41% of the total radioactivity. *Aedes sticticus* and *A. vexans* adults reared from the second-stage larvae in water containing 0.05% μ c of P^{32} /ml gave average readings of 41 147 cpm for females and 39 072 cpm for males. In later tests dosages of 0.01, 0.001, and 0.0001 μ c per ml gave 14 911, 1 612, and 522 cpm, respectively, for the females. It is suggested that a concentration of approximately 0.0001 μ c of radioactive phosphoric acid per ml may be a practical dosage for the larvae in flight studies of adults. Adults may be readily tagged by feeding them sugar solutions containing small amounts of P^{32} . (auth. summary)

I - D Developmental and Genetic Effects Incurred Through Labelling

H³

Kaplan and Siskin 1960 - [220]

- 375 Pavan, C. EFFECT OF RADIATION ON PUFFS OF POLYTENIC CHROMOSOMES OF *RHYNCHOSCLARA ANGELAE*. p. 42-52 in "Radioisotopes and Radiation in the Life Sciences, 2nd Inter-American Symposium on the Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union, 1960.

Radiation effects from internally applied tritium (by injecting H^3 -labelled thymidine) or external x-irradiation do not appear to have any appreciable effect on puff formation. Techniques and implications of the results are discussed.

C¹⁴

- 376 Suomalainen, E., Turpeinen, O., Niini, R. MUTATIONS IN *DROSOPHILA MELANOGASTER* GROWN ON MEDIA CONTAINING CARBON-14-LABELED SUGARS. *Nature* 178 (1956) 357-8.

The mutagenic action of C^{14} was investigated by rearing *D. melanogaster* individuals from eggs to adults on media containing C^{14} -labelled sugars prepared photosynthetically by *Canna Indica* leaves. The culture media contained 1, 0.1, or 0 mc radioactivity per culture bottle. The male offspring of the first and second generations reared on these media were tested for the presence of the X-chromosome lethals by the Muller-5-technique of Demerec (cf. CA. 42: 7453c). The number of mutations observed in flies reared on the 0.1-mc-medium (total radiation approximately 75 r) was not significantly different from 0. For the 1-mc-medium (800 r) a significant frequency of mutation (2.2-2.8%) was observed. (CA 50: 17211f, 1956)

P³²

- 377 Amason, T.J., Irwin, R.L.B., Spinks, J.W.T. P^{32} -INDUCED LETHAL MUTATIONS IN *DROSOPHILA*. *Canad. J. Res., D-Canad. J. Zool.* 29, 3 (1951) 234-9.

X-chromosomes of P^{32} -treated wild-type *D. melanogaster* were tested for recessive lethal mutations. Treated larvae were reared in food medium containing initially 6.5, 32.5, 65.0 or 162.5 mrd. P^{32} /ml. Of 838 tested chromosomes 42 had recessive lethals. The frequency of mutation was roughly proportional to P^{32} content of the food. An initial concentration of 18.8 mrd P^{32} in larval food is expected to produce about the same frequency of recessive lethal mutations as is obtained with 1000 r of x-rays applied to mature sperm. A fly reared in a medium having an initial concentration of 32.5 mrd per ml receives, prior to mating, a calculated total radiation dose of 0.82 gram roentgens. At this dosage 4.2% recessive lethals were recorded. For equivalent amount of ionization P^{32} is here apparently 2.3 times as effective as x-rays. (auth.)

- 378 Bateman, A.J. THE TIME FACTOR IN P^{32} -INDUCED MUTATIONS IN MALE *DROSOPHILA*. *Heredity* 9, 2 (1955) 187-98.

♂♂ fed as larvae on medium containing P^{32} were mated daily to fresh batches of attached-X yellow ♀♀. The mutation rate in daily sperm samples was measured as the incidence of non-yellow daughters (hyperploid for a deleted-X). The P^{32} content varied greatly during the life of the fly, according to the rates of absorption and excretion as well as radioactive decay. The variation in mutation rate between daily sperm samples was related to the P^{32} content of the fly, pupa, or larva and to the presence or absence of active food medium, when the sperm sampled was in its hypersensitive stage, 7-8 d before maturity. (auth.)

- 379 Bateman, A.J., Sinclair, W.K. MUTATIONS INDUCED IN DROSOPHILA BY INGESTED PHOSPHORUS-32. Nature 165 (1950) 117-8.
- P^{32} was administered to the larvae of D. melanogaster in order to determine the number of mutations which could be induced by the radioisotope. The highest specific amount introduced in the larvae bottles was 1 mc per bottle; this resulted in the death of all the insects before pupation. A 0.1 mc amount resulted in the death of an appreciable number of the specimens, while the introduction of 0.01 mc of P^{32} resulted in no appreciable number of deaths. Flies emerging from the 0.1 mc bottles were further studied; their activity was measured and, though it was variable, the mean figure was 0.0122 μ C/fly 2-3 d after emergence. The overall lethal mutation rate observed (7.3%) is the rate which would be expected for an x-ray dose of 2500 r. The lethal mutation-rate/g-r was derived for the P^{32} and for a dose of 2500 r of x-rays, and was found to be similar, but the authors caution against attaching too much significance to this similarity. The high mutation rate of visibles produced by the P^{32} corresponds to the expectation from 12000 r of x-rays. It is concluded that additional work is necessary to confirm whether P^{32} is really four times as efficient as x-rays in the production of visible mutations. (NSA 4: 1629, 1950)
- 380 Blumel, J. THE ACTION OF RADIOPHOSPHORUS IN DROSOPHILA. Science 111 (1950) 205-6.
- In the present investigation, P^{32} was used to study the action of β rays on D. melanogaster and D. virilis. Pairs of mature flies were placed in shell vials containing a culture medium, consisting of a standard Drosophila culture medium and added radioactive $H_2P^{32}O_4$; the original volume (about 300 ml) of medium, with a count of 265000 cpm/ml, was distributed among 50 vials in 6 ml amounts. Twelve days after exposure, the distribution of radioactivity in the various tissues of the insects was determined; few of the D. virilis generation hatched in the radioactive solution survived, and none of the adults were tested, but in the case of D. melanogaster, the hatch was normal and all present, adults and larvae, were examined. All hatched individuals of D. virilis strain were morphologically abnormal, the abnormalities pertaining mostly to the eyes, legs, abdomen, wings, and genitalia. Other data indicate that radioactive P^{32} not only produces mutations in D. virilis but also chromosomal rearrangements. The tolerance to such irradiation is considered to be high. (NSA 4: 2507, 1950)
- * Darwish et al. 1958 - [253]
- * Dissanaik et al. 1957 - [345]
- * Gamô et al. 1950 - [262]
- * Grosch and Sullivan 1954 - [132]
- 381 Grosch, D.S. LETHALITY INDUCED BY FEEDING RADIOPHOSPHORUS TO MALE HABROBRACON. Amer. Nat. 90 (1956) 200-2.
- Feeding of P^{32} -labelled honey to male wasps (starved) and subsequent mating under the experimental conditions described gave rise to a sex ratio of nearly 1:1 instead of the typical 60-70% predominance of females. In females similar feeding can cause permanent cessation of egg production. Even when successful, radiophosphorus feeding experiments show considerably less effect when males rather than females are used. In order to corroborate evidence of dominant lethality, the cocoons holding unclosed pupae were opened and the contents identified where possible. Nearly twice as many unemerged females were obtained from treated fathers as from controls. Possible reasons for the relative ineffectiveness of P^{32} fed to males are suggested in terms of recent studies.
- * Grosch 1958 - [1137]
- 382 Grosch, D.S., Sullivan, R.L. THE EFFECT OF INGESTED RADIOPHOSPHORUS ON EGG PRODUCTION AND EMBRYO SURVIVAL IN THE WASP HABROBRACON. Biol. Bull. 102, 2 (1952) 128-40.
- Unmated females of Habrobracon juglandis, wild type 33, starved for 5 d at 30°C and then fed a droplet of white-clover honey containing varying doses of P^{32} delivered to the side of the storage vial to prevent external irradiation, were permitted to oviposit on two pre-stung caterpillar wasps. Collected eggs were incubated in mineral oil (nujol) at 30°C for 48 h to test viability. At doses of higher than 200 μ C/g egg production was halted in a few days, between 50 to 200 μ C/g initial egg production was reduced, followed by recovery; below 50 μ C/g no decrease in egg production was observed. With doses above 200 μ C/g the viability

of embryos from eggs oviposited within the first 2/3 of life were correlated with the level of radioactivity ingested. With doses above 200 $\mu\text{C/g}$ the viability of embryos from eggs produced during the 2/3 of life was correlated with the level of ingested radioactivity. None of the animals showed a decrease in longevity as a result of radioexposure. (CA 46: 7664a, 1952)

- 383 Grosch, D.S., Sullivan, R.L., LaChance, L.E. THE COMPARATIVE EFFECTIVENESS OF FOUR BETA-EMITTING ISOTOPES FED TO HABROBRACON FEMALES ON PRODUCTION AND HATCHABILITY OF EGGS. Radiation Res. 5,3 (1956) 281-9.

Precision weighing is used to determine the amount of radioisotope required to cause temporary and permanent sterility. The entire wasp, Habrobracon juglandis, is weighed before and after feeding an honey adulterated with radioisotope. As shown by lowered egg production and hatchability, the descending order of effectiveness of the ingested radioisotopes is the same as the ascending order of physical half-life: P^{32} , Sr^{89} , S^{35} , Ca^{45} . Permanent sterility was obtained only after feedings of P^{32} and Sr^{89} . Experimental results support the concept that effectiveness of a given isotope is correlated with the number of particles received by an organism within a critical period of time after ingestion, and with the energy of these emissions. (auth. D.S.G.)

- * Grosch et al. 1957 - [830]

- 384 Hahn, P.F., Haas, V.H., Wilcox, A. ARREST OF DEVELOPMENT OF PLASMODIUM GALLINACEUM IN MOSQUITOES (Aedes Aegypti) BY RADIATION EFFECT OF P^{32} . Science 111 (1950) 657-8.

A total of 250 Aedes aegypti mosquitoes were allowed to engorge on chicks which were infected with Plasmodium gallinaceum and that showed many gametocytes in their peripheral blood. Thereafter 150 of the mosquitoes were provided daily with 5% glucose solution containing radioactive sodium acid phosphate (with a radioactivity of about 30 mc of P^{32}). The remaining mosquitoes served as controls and were provided with nonradioactive glucose solution. Nine days following the blood feeding, 10 mosquitoes from each group were dissected for determination of the presence of oöcysts in their stomachs; all 10 of the irradiated specimens contained oöcysts, as did 8 of the controls. Five days later, mosquitoes from the two groups were dissected and no sporozoites were found in the salivary glands of the irradiated specimens, but 11 out of 15 control specimens showed these forms. The lowest activity for any salivary gland in the specimens administered the P^{32} solution was 334 cpm, while the average was 2400 cpm; calculations suggest a very high equivalent roentgen dosage was delivered to the salivary gland tissue, despite the apparent absence of any deleterious effects. The author concludes that the radiation delivered by the ingested P^{32} was sufficient to arrest the development of the parasites during the oöcyst stage. (NSA 4: 4425, 1950)

- * Hassett and Jenkins 1951 - [272]

- * Hoffman et al. 1951 - [335]

- 385 King, R.C. GENETIC CHANGES ACCOMPANYING THE UPTAKE OF P^{32} BY DROSOPHILA MELANOGASTER. Genetics 35,1 (1950) 118-9.

Males show a higher percentage of sex-linked lethals than females. Developmental stages are very sensitive to radiation and fail to survive treatments which would result in very low mutant induction in adults. P^{32} is distributed among the head, thorax, gut, gonad and abdominal shell in the ratio of 20:50:10:10:10 regardless of the total activity of the fly for males labelled as adults. Radioautographs (spermathecae, associated organs of inseminated females) showed radioactive sperm. As high as 26% sex-linked lethal mutation rates have been induced in adult males of an inbred Canton-S stock by the M5 technique. Out of a total of some 1951 X's treated so far, 90 sex-linked recessive lethals and 11 viable mutations have been recovered. By changing the initial activity - feeding time relations or by increasing the number of P^{32} atoms in the medium while keeping the number of P^{32} atoms constant it is possible to expose different groups of flies to an equal flux of high energy β -particles from the medium but to an entirely different internal radiation dose from the radioactive decay of P^{32} atoms incorporated into tissue.

Abstract of paper presented at the 1949 meetings of the Genetics Society of America, New City, 28-30 Dec. 1959.

- 386 King, R.C. CALCULATION OF RADIATION DOSES TO P^{32} -LABELED MALE DROSOPHILA MELANOGASTER. Nucleonics 10,11 (1952) 88-9.

A method is described for calculating the geometrical factor necessary for determining the radiation dose absorbed by the gonad of the male. A very simple model of a male fruitfly is proposed, consisting of 3 spheres of water, corresponding in weight to the head, thorax, and abdomen. A homogeneous distribution of P^{32}

atoms is assumed. It is calculated that about 12.6% of the total energy dissipated by particles originating from internally decaying P^{32} is absorbed by the tissue of male *D. melanogaster*. Radiation contributed to the gonad by P^{32} -labelled tissue of the head and thorax is negligibly small when compared to that contributed by abdominal tissue.

See also BNL-1230, Brookhaven National Lab., Upton, N.Y. 11p.

- 387 King, R.C. THE MUTAGENIC EFFECTIVENESS OF RADIOACTIVE PHOSPHORUS IN *DROSOPHILA MELANOGASTER* (abstr.). *Genetics* 37 (1952) 595.

The mutagenic effectiveness of radiophosphorus in *D. melanogaster* has been studied using the Muller-5 method for recovering sex-linked recessive lethal mutations. Methods are described for varying the radiation dose from the radioactive medium and the dose from P^{32} within tissue with respect to each other. The radiation dose from the medium is determined by actual measurement, while the radiation dose to the male gonad from P^{32} in tissue is calculated. It is shown that radiations from internally located P^{32} atoms are mutagenically effective. However, in the case of male *Drosophila* fed upon P^{32} as adults there is no indication that internal P^{32} is more efficient mutagenically than external P^{32} . Among the genetic changes recovered following P^{32} treatment are sex-linked recessive lethal and viable mutations, inversions and dominant lethals. P^{32} treatment also increases somatic crossing over and produces potential chromosome breaks leading to the production of unilateral mosaicism. The importance of this work in the study of genetic effects ascribable to the actual transmutation of P^{32} to S^{32} is discussed.

Abstract of paper presented at the 1952 meetings of the Genetics Society of America, Ithaca, New York 8-10 Sep. 1952.

- 388 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN *DROSOPHILA*. 2. THE EFFECT OF P^{32} TREATMENT UPON DEVELOPMENT. BNL-1406, Brookhaven National Lab., Upton, N.Y. 1953, 13p.

Exposure of developmental stages of *D. melanogaster* to media of activities above $5 \mu\text{C/g}$ results in the killing of embryos, larvae, and pupae, in the retardation of development, and in the production of sterile adults. Females are more resistant to P^{32} treatment than males. The external radiation from the medium is shown to be relatively unimportant in killing insects. (auth.)

- 389 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN *DROSOPHILA*. 1. THE MUTAGENIC EFFECTIVENESS OF RADIOACTIVE PHOSPHORUS IN ADULT MALE *DROSOPHILA MELANOGASTER*. *J. exp. Zool.* 122 (1953) 541-75.

Freshly hatched males were given P^{32} -labelled food. Methods are described for varying the radiation dose from the radioactive medium and from P^{32} in tissue with respect to each other. The former is determined by actual measurement, the latter by calculation from the dose to the σ gonad from P^{32} in tissue. Radiations from internally located P^{32} atoms are shown to be mutagenically effective. Calculations lead to an erroneously high value describing gonad absorption of energy liberated by decaying P^{32} in tissue. Only 2% of such energy is absorbed in the gonad; 1.5×10^5 disintegrations/adult σ will produce a 1% sex-linked lethal mutation frequency. Some sex-linked recessive lethal and sex-linked viable mutations, inversions and dominant lethals were among the genetic changes recovered following treatment with P^{32} . It also increased somatic crossing over. Potential chromosome breaks leading to unilateral mosaicism were also produced. The significance of this work in the study of genetic effects in the transmutation of P^{32} to S^{32} is examined.

See also BNL-1237, Brookhaven National Lab., Upton, N.Y. 36p.

- 390 King, R.C. STUDIES WITH RADIOPHOSPHORUS IN *DROSOPHILA*. III. THE LETHAL EFFECT OF P^{32} - TREATMENT UPON DEVELOPING FLIES. *J. exp. Zool.* 128 (1954) 323-36.

The effect of various concentrations of P^{32} in the medium upon the development of *Drosophila* was studied. Flies reared from a medium containing $50 \mu\text{C/g}$ of $\text{H}_3\text{P}^{32}\text{O}_4$ showed high embryonic, larval and pupal mortality, and there was a retardation in development depending on the concentrations involved. Fertile adults appeared in cultures containing $5 \mu\text{C/g}$ or lower. Concentrations low enough to allow complete development may produce sterility. Females, probably as the result of their X-chromosomal diploidy are more resistant to treatment than males. Under the experimental conditions applied here radiation from the medium is relatively unimportant in producing lethality. Of the energy liberated by β -particles from decaying P^{32} in tissue sufficient is absorbed by the fly to account for the lethal effects observed.

- 391 King, R.C., Wilson, L.P. STUDIES WITH RADIOPHOSPHORUS IN *DROSOPHILA*. IV. EXPERIMENTS ON FLIES HOMOGENEOUSLY LABELED WITH P^{32} . *J. exp. Zool.* 126 (1954): 401-17.

Drosophila homogeneously labelled with P^{32} have been produced by rearing flies for their entire life cycle on homogeneously labelled yeast growing on a solid P^{32} -labelled synthetic medium. Drosophila adults contain 3 mg P/g wet weight and maintain their phosphorus content at this level, even when forced to feed on media abnormally rich in phosphorus. Death to adults occurs when the overall phosphorus content of all tissues rises above 0.4%. A study of the variation of P content during development showed the egg to contain the highest P concentration of any stage. The relation between total P and wet weight for 1st and 2nd instar larvae was found to be bradyauxetic; for 3rd instar larvae tachyuxetic. The daily radiation dose to homogeneously labelled Drosophila developing on labelled medium was calculated. Under the experimental conditions ($1.24 P^{32}/1 \times 10^8 P^{31}$ at T_0) no detectable difference was noted between labelled and control Drosophila with respect to egg hatchability, eclosion, time required for development from egg to adult, and sex ratio of the resting adults. Fecundity and fertility of F_1 -labelled females was lowered, and evidence is presented relating this to transmutation of internal P^{32} to S^{32} rather than to ionization. (auth.)

- 392 Kogure, M., Nakajima, M. THE EFFECT OF P^{32} ON THE SILKWORM, ADMINISTERED TO THE BODY WITH MULBERRY LEAVES. J. sericul. Sci., Tokyo 25 (1956) 238.

* Kogure and Nakajima 1958 - [1147]

- 393 Mossige, J. TRANSLOCATIONS AND RECESSIVE SEX-LINKED LETHALS INDUCED IN DROSOPHILA MELANOGASTER BY INGESTED RADIOPHOSPHURS (ABSTR.). p.197 in "Proceedings of the 10th International Congress on Genetics, Montreal 1958", Vol.2, Toronto, University of Toronto Press, 1958.

The findings of Oftedal and Mossige that incorporation of P^{32} in sperm followed the same curve as the mutation rate for sex-linked recessive lethals in daily broods suggested the possibility that some of the mutations might be due to the disintegration of P^{32} incorporated in the genetic material. In an attempt to elucidate this question the day-to-day mutation curve for II-III translocations was determined. After an acute dose of radiation to newly eclosed males, the daily sensitivity pattern for translocations and recessive lethals has been determined. If, after ingestion of P^{32} , an appreciable number of mutations is due to disintegrations in the genetic material, and if these disintegrations are able to produce breaks leading to translocations as well as to sex-linked lethals, translocations should be found among the progeny of days 9 and later as these could be induced by disintegration in postmeiotic sperm. No such translocations have been found.

- 394 Mossige, J., Oftedal, P. THE MUTAGENIC EFFICIENCY OF P^{32} CONTAINED IN DROSOPHILA MELANOGASTER MALES. Radiation Res. 9 (1959) 166.

In previous communications concerning the incorporation and mutagenicity of radiophosphorus during Drosophila spermatogenesis, the authors have emphasized the difficulty of calculating the fraction absorbed in the testes of the total dose delivered by the phosphorus contained in the fly. In the present paper this fraction has been estimated genetically. The genetic experiments have been made on mature sperm only, feeding 3-day old males which have not previously been mated, storing them for an additional 24 h, and then mating them for a few hours only so as to limit the variation in exposure time of the sperm utilized for testing. The recessive sex-linked lethal mutation rate in these sperm is then compared with mutation rates obtained with acute doses of X-rays. Taking into consideration the biological decay of P^{32} in the fly during the first 24 h after ingestion, the result is found to be equivalent to between 1 and 2 r per hour per 1000 cpm in the fly as measured by our technique. Calculations based on the total amount of radioactivity contained in the fly give a total dose of some 50 rad/h/1000 cpm. Thus only a very small amount of the energy, approximately 2-4%, is absorbed in the testes. This agrees with King's (1958) results obtained by a different technique.

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

- 395 Oftedal, P. THE PREDICTION OF MUTATION PATTERNS AFTER EXPOSURE TO CHRONIC IRRADIATION. 2nd UN International Conference on the Peaceful Uses of Atomic Energy, A/CONF.15/P/588 22 (1958) 298-30

Biological decay curves of P^{32} and Y^{91} in Drosophila males are shown, and recessive sex-linked lethal mutations after 1000 r X-rays, and mutation curves after P^{32} feeding, together with theoretical curves. Efficiency factors are given. A mutation curve is also shown for Y^{91} citrate injection, with theoretical curves. It is not possible, from the curves, to obtain insight into whether all the mutations observed after P^{32} -ingestion could be explained on the basis of radiation effects of P^{32} in the fly or whether some mutations were caused by the transmutation of the P^{32} incorporated into the sperm. The significance of the results is discussed.

* (This paper was also published in p.82-91 in "Progress in Nuclear Energy. Series 6: Biological Sciences". Bugher, J.C., Coursaget, J. Loutit, J.F., eds. London, Pergamon Press, Ltd. 1956, 205p. There are some differences in the references cited).

- 396 Oftedal, P. STUDY OF THE RETENTION AND THE MUTAGENIC MODE OF ACTION OF RADIOACTIVE PHOSPHORUS IN DROSOPHILA MELANOGASTER. Hereditas 45, 2-3 (1959) 245-331.

The retention of P^{32} by Drosophila females after a single meal of contaminated sugar solution may be adequately described as a sum of three exponential processes, all of which are influenced by diet and/or mating. Differences in retention between groups on diets of low or normal phosphorus content are in the expected direction. P^{32} incorporated into the DNA of mature sperm is recovered 7 or 8 d after a single meal, under conditions of excessive mating, which coincides with maximum genetic effect. The number of P^{32} atoms per sperm is calculated. Radioactive yttrium is retained completely after injection in the form of citrate. The fraction of dose absorbed in the tests is calculated to be 5.8%. On the basis of this absorbed fraction of dose, the pattern of sensitivity to acute irradiation, the retention curve for P^{32} , and the shift in P^{32} distribution and the mutations to be expected from P^{32} radiation are calculated. Discrepancies between the observed genetic effect and calculations are found on days with high incorporation of P^{32} into sperm DNA, and transmutation of P^{32} to S^{32} is taken to be responsible for the unexplained genetic effect. The efficiency of the transmutation in producing recessive lethals is found to be 1 in 100. (from auth. summary)

- 397 Oftedal, P., Mossige, J. INCORPORATION OF PHOSPHORUS-32 AND MUTAGENESIS DURING SPERMATOGENESIS IN DROSOPHILA. Nature 179 (1957) 104-5.

The incorporation of P^{32} was followed during spermatogenesis at the same time as the genetic effect of the radioactive decay was measured. Experimental procedure is described. Results are tabulated, and mutations and incorporation given in a graph. The close correlation found between incorporation and mutation might tempt one to suggest the following alternatives: (1) mutations are caused by transmutation of P^{32} atoms incorporated in the genetic material, and the correlation reflects a true causal relationship, and (2) mutations are caused by radiation emitted from the P^{32} contained in the whole fly, and the whole correlation reflects a coincidence in time of incorporation activity and mutagenesis.

- 398 Oftedal, P., Mossige, J.C. INCORPORATION AND MUTAGENICITY OF P^{32} IN DROSOPHILA SPERM. p. 457 - 62 in "Advances in Radiobiology. Proceedings of the 5th International Conference on Radiobiology. Stockholm 15-19 Aug. 1956". de Hevesy, G.C., Forsberg, A.G., Abbatt, J.D., eds. London, Oliver and Boyd, 1957.

Newly eclosed Drosophila males were fed a sugared solution of P^{32} . The procedures for testing male productivity and for assaying P^{32} incorporation during spermatogenesis are described. Two graphs show corrected P^{32} incorporation and mutation curves. The amount of P^{32} incorporated during spermatogenesis was found to vary with time. A close correlation between the mutation curve and time was noted. The significance of the results is discussed.

- 399 Ray-Chaudhuri, S.P., Sarkar, I. THE EFFECT OF P^{32} ON THE MEIOTIC CHROMOSOMES OF THE GRASSHOPPER, GEONULA PUNCTIFRONS. Nucleus 1,1 (1958) 123-30.

A quantitative and qualitative study is described in which adults were injected with P^{32} (3.75-60 $\mu\text{C}/\text{cm}^3$ concentrations) and the resulting meiotic anomalies observed. Chromatid breaks, dicentric bridges, sticking, etc. occurred as after x-ray treatment. Considerable quantitative fluctuations were observed under similar experimental conditions. The frequency of bridges and fragments increased with concentration and with duration of treatment. The variation with concentration of the bridge: fragment ratio is discussed.

* Sullivan and Grosch 1953 - [1295]

S³⁵

* Grosch et al. 1956 - [383]

Ca⁴⁵

* Gamô and Nishiyama 1956 - [263]

- * Gamô et al. 1958 - [264]
 * Gamô et al. 1960 - [265]
 * Grosch et al. 1956 - [383]

400 Steffensen, D., LaChance, L.E. RADIOISOTOPES AND THE GENETIC MECHANISM: CYTOLOGY AND GENETICS OF DIVALENT METALS IN NUCLEI AND CHROMOSOMES. p.132-45 in "Symposium on Radioisotopes in the Biosphere". Caldecott, R.S., Snyder, L.A., eds. Minneapolis, Univ. of Minneapolis. 1960, 597p.

Cytological studies with Tradescantia have indicated that metal deficiencies result in higher frequencies of spontaneous chromosome breakage and that calcium, magnesium and strontium are likely metals involved in chromosome stability. The frequency of chromosome breakage in microspores is dependent on the temperature at which the cells passed through meiosis. Isotope studies with Lilium longiflorum and Habrobracon juglandis have shown that Ca^{45} and Sr^{90} are incorporated into the chromatin material of nuclei and is apparently firmly bound in the chromosomes. The possibility of mutational consequences resulting from the incorporation of isotopes in the hereditary material and the possible role for divalent metal ions in the chromosome structure are discussed. 28 references. (auth.)

Co⁶⁰

- * Grosch 1958 - [1137]

Sr⁸⁹ or 90

401 Grosch, D.S., LaChance, L.E. FATE OF RADIOSTRONTIUM FED TO HABROBRACON FEMALES. Science 123 (1956) 141-2.

The tissue distribution of Sr^{89} was studied in virgin females (wild stock 33) of H. juglandis, following feeding with Sr^{89} -labelled citrate in honey (277 μ g of mixture), and maintained at 30°C. Eggs laid within the first days of feeding only showed some slight radioactivity. The radioactivity was mainly concentrated in the abdomen. Half the Sr absorbed is eliminated within a day. Irreversible sterility was produced in Habrobracon females.

- * Grosch et al. 1956 - [383]
 * Grosch et al. 1957 - [830]

402 Mitlin, N., Babers, F.H. THE ACTION OF RADIOSTRONTIUM IN THE HOUSE FLY AND THE GERMAN COCKROACH. J. econ. Ent. 49, 5 (1956) 714-5.

The feeding of radiostrontium, Sr^{89} , to houseflies, Musca domestica L. for 18 h caused varying degrees of sterility. Continuous feeding inhibited oviposition entirely, while feeding for shorter periods, although allowing oviposition, caused a marked decrease in egg viability. Fly eggs apparently slowly absorb and retain Sr^{89} . The average biological half-life for the element was 15.4 h. A similar experiment performed with the German cockroach, Blattella germanica L., gave inconclusive results concerning sterility. The biological half-life for this species was 3.5 d for males and 0.95 d for females. (BA 31: 10254, 1957)

- * Steffensen and LaChance 1960 - [395]

Y⁹¹

- * Oftedal 1958 - [395]

I-E Insects as Disease Vectors in

I-E-1 MAN

Survey Articles

403 Jenkins, D.W. PARASITOLOGICAL REVIEW. ADVANCES IN MEDICAL ENTOMOLOGY USING RADIOISOTOPES. Exp. Parasit. 3, 5 (1954) 474-80.

Radiotracer techniques applied to ecology and dispersal studies are reviewed. In experiments on the radioactive marking of Plasmodium gallinaceum, however, it was observed that ingestion of P^{32} by Aedes aegypti (L.) during the period of extrinsic incubation caused the development of the parasite to be arrested in the oöcyst stage. The results are cited of unpublished experiments by the author and his associates in which bacteria labelled with P^{32} were used to study the persistence and multiplication of Escherichia coli in Musca domestica L. when ingested with food. The difficulty was to ensure that the tracer was chemically bound. Thus in one experiment in which the time and amount of regurgitation and excretion of the bacteria by the flies was checked quantitatively by plating bacteria and determining radioactivity, correlation between radioactivity and bacterial counts was good during the first few days of the test. Subsequent accumulation of P^{32} in the flies implied that the bacteria were probably not tagged molecularly. Radiotracers for insecticides have proved very valuable for studying the site of entry or physiological action, and have also facilitated distribution studies on a treated surface. They have shown promise in assessments of the dissemination of sprays applied from aircraft.

* Jenkins 1956 - [73]

* Bruce-Chwatt 1956 - [109]

404 Dissanaïke, A.S., Dissanaïke, G.A., Niles, W.J. INFECTED MOSQUITO LARVAE TAGGED WITH PHOSPHORUS-32. Trans. R. Soc. Trop. Med. Hyg. 50 (1956) 425.

Culex fatigans larvae reared in baths containing varying concentrations of P^{32} as the orthophosphate developed into radioactive adults, the females having an activity 3 times greater than that of the males. Only adult females reared in a medium containing $0.1 \mu\text{C } P^{32}/\text{cm}^3$ took a blood meal, and they were fed on patients having a high count of filarial larvae of Wuchereria bancrofti. The activity of the microfilarial larvae isolated from the dissected mosquitoes was consistent at about 22 8-counts/min. The successful tagging of filarial larvae will aid in studying their further development in the definite host. (CA 51: 12365g, 1957)

* Dissanaïke et al. 1957 - [345]

* Dissanaïke et al. 1957 - [258]

* Hartwell et al. 1958 - [71]

* Jackson and Maier 1955 - [68]

* Knapp et al. 1956 - [363]

405 Kuper, S.W.A., Pelc, S.R. RADIOACTIVE LABELLING EXPERIMENTS WITH PLASMODIUM. Parasitology 42 (1952) 269-71.

Plasmodium gallinaceum was selected for tests because of the ready availability of gametocytes, the occurrence of cryptozoites at the site of inoculation, and the ease of rearing and maintaining the insect host, Aedes aegypti. An account is given of the methods used to produce radioactive oöcysts of P. gallinaceum. Both P^{32} and S^{35} were used. Feeding the radiotracer to mosquitoes that had already become infected with malaria finally proved most appropriate as technique. Autoradiographs demonstrated early pre-erythrocytic forms of the malarial parasite.

I - E - 2 ANIMAL

* Dissanaïke et al. 1957 - [258]

* Hahn et al. 1950 - [384]

406 Kartman, L., Prince, F.M., Quan, S.F., Stark, H.E. NEW KNOWLEDGE ON THE ECOLOGY OF SYLVATIC PLAGUE. Ann. N.Y. Acad. Sci. 70 (1958) 668-711.

In the course of this review article data is presented on the direct observations of flea transfer between host species. Fleas and other arthropods were labelled with Ce^{144} . Fleas were bathed for less than 5 min in aqueous solutions of Ce^{144} - Pr^{144} containing $10 \mu\text{C}/\text{ml}$. Tagging was accomplished by a stable combination of Ce with

exoskeleton. Work is described on 2 rodents, Microtus californicus and Rattus norvegicus, and tagged fleas, Malariae telchinum. Fleas were found to transfer between individual Microtus. The data are tabulated. Radioactive fleas were also recovered from vole nests; radioactive feces confirmed some ingestion of fleas. Tests with domestic rats showed that the fleas would transfer readily from the field vole to domestic rats under certain conditions. Fleas were combed from rats and also obtained from rat nests. Data are tabulated. In all trials, tagged fleas showed an initial average count of 6.2 to 8.5×10^2 counts/flea/min and, after 56 days, 3.6 to 5.1×10^2 counts/flea/min. Undoubtedly, other important wild-rodent flea vectors of plague will also transfer to rats.

I-E-3 PLANT

- 407 Björling, K., Lihnell, D., Ossiannilsson, F. MARKING VIRULIFEROUS APHIDS WITH RADIOACTIVE PHOSPHORUS. Acta agric. Scand. 1 (1951) 301-17.

Preliminary experiments (laboratory) showed that aphids (Myzus persicae Sulz. and Aphis fabae Scop.) became radioactive when living on broad bean plants watered with labelled sodium orthophosphate (0.05 - 0.35 mc P^{32}). The radioactivity of the aphids could easily be demonstrated autoradiographically. Details of techniques are given. Aphids retained their radioactivity for at least 2-3 weeks after removal to non-radioactive plants. The radioactivity was "inherited" by the offspring for at least 2 generations. The main experiments which were carried out on sugar beets in the field, were arranged in such a way that the distribution of aphids (M. persicae and A. fabae) from a radioactive centre (plants watered with 0.4 - 1.5 mc P^{32} as sodium orthophosphate) to the surrounding plants in the plot and the spread of yellow virus from the same centre could be studied. The conclusions drawn on the movements of the aphids, their average speed, the distances covered, the effectiveness of the aphids as virus vectors, etc. are discussed from different points of view, including the limitations of the method in its present form.

(An abridged report was read by D.L. at the Potato Virus Conf. in Wageningen, 13-16 Aug. 1951, and is published in the proceedings of the conference)

- * Cornwell 1956 - [104]
- * Cornwell 1958 - [105]
- * Day and McKinnon 1951 - [32]
- * Day and Irzykiewicz 1953 - [23]
- * Day and Irzykiewicz 1954 - [320]
- * Kloft and Kunkel 1960 - [28]

- 408 Lieserling, R. BEITRAG ZUM PHYTOPATHOLOGISCHEN WIRKUNGSMECHANISMUS VON TETRANYCHUS URTICAE KOCH (TETRANYCHIDAE, ACARI). (Contribution to an understanding of the phytopathological mechanism of action of Tetranychus urticae Koch (Tetranychidae, Acari). Z. PflKrankh. 67 (1960) 524-42.

In order to settle the question of whether the spider mite injects material into the plant during suction, mites were labelled with P^{32} . This was done via the host plant (young bean leaves, placed in solutions of a specific activity from 1 - 2 mc/ml P^{32}). These were left in the solution for 3 d and then populated with spider mites. A further 2 d were required before the spider mite acquired a sufficiently high activity to be measurable in its saliva. Intermediate passages were introduced in order to avoid faulty deductions from possible radioactive contamination of the mandibles (cf. Kloft's methods for aphids). It was clearly established by measurement and autoradiography that Tetranychus urticae releases substances to the plant tissue during suction. This result is of great importance phytopathologically, particularly for the mechanism by which plant diseases are transmitted by insects and spider mites.

337*) Худакон, Г.Д. МЕТОД МЕЧЕНИЯ НАСЕКОМЫХ ПОСРЕДСТВОМ ДАЧИ ИМ РАДИОАКТИВНЫХ ИЗОТОПОВ С КОРМОМ. Бюллетень Моск. Общества Испытателей Природы, Отдел биологич. 64, 3(1959)35-45.

1. Для целей маркировки насекомых посредством дачи им радиоизотопа с кормом пригодны те радиоактивные изотопы, которые обладают бета-излучением со средней энергией высших энергетических уровней бета-спектров порядка 0,5 Мэв и выше, а также имеющих период полураспада не меньше недели. 2. При увеличении концентрации радиоизотопа в корме пропорционально увеличивается и радиоактивность насекомых, питающихся на нем. 3. Для проведения опытов с мечеными насекомыми в течение 10-20 дней можно их метить посредством дачи им корма, содержащего радиоизотопы в концентрации 1-3 микрограмм на 1 мл. Для проведения более длительных опытов концентрации изотопа в корме необходимо соответственно увеличивать.

Khudakov, G.D. A METHOD OF TAGGING INSECTS BY GIVING THEM RADIOACTIVE ISOTOPES WITH FOOD. Byull. Moskov. Obshchestva Ispytatelei Priro., Otdel Biol. 64, 3 (1959) 35-45. (Tr. from Russian)

A study was made to determine the best method of labelling insects (*Musca domestica* and *Blattella germanica*) using radioactive food. Flies and roaches were used in the study which compared P^{32} , Ca^{46} , Fe^{59} , Zn^{65} , Sr^{90} , Y^{91} , Cd^{115} , I^{131} , Ba^{140} , and La in various food preparations. It was found that a 24-h exposure was required for 100% tagging, the best results being obtained with P^{32} in a mixture of 3 parts milk and 1 part 10% sugar water. A direct relation was found between P^{32} concentration in food and the radioactivity of the flies, and the females were twice as radioactive as males, being twice as heavy. The effects of elimination, isotope decay, and energy of the emitted ray were considered. Radioisotopes with a beta emission above 0.8 MeV and a half life not less than 1 week are suitable. The food for studies running 10 to 20 d should contain 1 to 3 μ c. (NSA 14: 13548, 1960)

*) Post-script to reference 337, cited on p. 86.

II INSECTICIDES

II-A Survey Articles

- 409 Dahm, P. A. RADIOACTIVE TRACERS IN INSECTICIDE RESEARCH. Soap, N.Y. 29 (1953) (9) 136-7, 139, 161; (10) 148-9, 151, 153, 163, 165; (11) 141, 143, 145, 147, 165; (12) 167-8, 175.
Review Article. The principles of applying radioisotopes generally and in this field, in particular, are discussed. A survey of the way in which radiotracers have already been applied is given, references to individual research being given.
- * Dahm 1953 - [805]
- * Dahm 1957 - [806]
- 410 Haller, H. L. RADIOACTIVE MATERIALS IN INSECT CONTROL. p.215-21 in "Conference on Radioactive Isotopes in Agriculture, 12-14 Jan. 1956 at Michigan State Univ.". TID-7512, Argonne National Lab., Council of Participating Institutions, Lemont, Ill. 1956.
Review article. Applications of radioisotopes to chlorinated hydrocarbon, organic phosphorus, and systemic insecticides are reviewed, followed by a discussion on penetrating radiations. Radioisotopes have been applied for tagging insects used in flight, migration and dispersal studies.
- * Hinton 1954 - [6]
- * Jenkins 1954 - [403]
- 411 Kirchberg, E. ZUR VERWENDUNG RADIOACTIVER ISOTOPE IN DER SCHÄDLINGSBEKÄMPFUNG (On the application of radioisotopes to pest control). Prakt. Schädlingsbekämpfer 8, 11(1956) 129-32. (In German)
Short review article.
- 412 Kováč, J., Talmr, L. RÁDIOIZOTÓPY V OCHRANE RASTLÍN POUŽITIE RÁDIOIZOTÓPOV VO VÝSKUME INSEKTICÍDOV A TOXIKOLÓGII HMYZU (Use of radioisotopes in research on insecticides and the toxicology of insects). Českoslov. Akad. Zeměděl. Věd, Šorn. Rostlinná Výroba 32,3 (1959) 447-56. (In Slovak)
Except for the very end where some research in Leningrad is described, the paper is a review article of foreign publications. Experiments (USSR) are described on the decomposition products and isomers of S^{35} -labelled Parathion, identified by a paper-chromatographic technique. Fatty solutions of Parathion were shown to possess greater penetrating powers than water emulsions. This was also true of cold aerosols relative to "water"-sprays. Autoradiographically, the insecticide could be proved to have greater spread when applied as a fatty solution. A radiometric separation method (Gar) was employed for testing the stability of fatty solutions of Parathion. No hydrolysis was found after they had been subjected to 110°C. for 48 h. The importance of being able to measure the penetrating ability of aerosols is stressed. Further useful applications of radioisotopes to related problems are discussed.
- * Lindquist 1957 - [9]
- * McCormick 1958 (Bibliography) - [797]
- 413 Metcalf, R. L. RADIOISOTOPES IN THE STUDY OF THE MECHANISMS OF ACTION OF INSECTICIDES. p.237-52 in "Radioisotopes and Radiation in the Life Sciences. 2nd Inter-American Symposium on the

Peaceful Application of Nuclear Energy, Buenos Aires 1959". TID-7554. Washington, D.C., Pan American Union, 1960.

A review article, illustrated by specific examples. Ancillary techniques valuable with radiotracer insecticides are discussed: paper chromatography, column chromatography, partition coefficients, and radioautography. Further sections are devoted to tracer work on the chemistry of insecticides, plant systemic insecticides (absorption, translocation and metabolism), insect resistance to insecticides and the study of the mechanisms of action of insecticides by the labelled metabolic pool technique of Winteringham. An appendix gives a source list for descriptions of syntheses of most of the labelled insecticides reported up to 1958.

- 414 Ripper, W.E., Greenslade, R.M., Hartley, G.S. SELECTIVE INSECTICIDES AND BIOLOGICAL CONTROL. J. econ. Ent. 44, 4 (1951) 448-59.

Review article. The respective efficacy and application of selective insecticides are discussed, also the usefulness of radioisotopes in investigations on translocation, decomposition, etc.

- 415 Talmir, L. RADIOISOTOPES DANS LES RECHERCHES SCIENTIFIQUES SUR LES INSECTICIDES. Bull. radiobiol. Komise 3 (1958) 241. (In Czech)

- 416 Thomas, W.D.E. AN INTRODUCTION TO WORK ON RADIOACTIVE TRACERS. Sci. Hort. 12 (1955/56, pub. 1957) 104-9.

A general article, dealing with radioisotope tracers in plant nutrition and insecticide research.

- 417 Winteringham, F.P.W. SOME ASPECTS OF INSECTICIDE BIOCHEMISTRY. Endeavour 11 (1952) 22-8.

Review article. Investigations into insecticide biochemistry are surveyed, concerned with such problems as insecticide absorption, distribution, their decomposition or metabolic products and residues, etc. The application of radioisotopes (e.g. a radioactive Br-analogue of DDT was used, C^{14} -labelled fumigants, I^{131} -labelled methyl iodide) and their scope in such studies, also in combination with other techniques (paper chromatography, autoradiography, etc.) is discussed.

II - B Fumigants

- 418 Winteringham, F.P.W. RADIOISOTOPES IN MICRO-BIOCHEMICAL RESEARCH. p.305-18 in "Proceedings of the International Symposium on Microchemistry", (1958)

The impact of the combined application of radioactive tracers and micro-fractionation techniques such as chromatography in bringing new fields of biochemical research within the range of quantitative analysis are discussed. Successful application involves first the introduction of suitable radioisotopes into the system to be studied followed by adequate techniques of fractionation and identification. Methods of using labelled reagents, radioactivation, and the labelled pool technique for fulfilling the first condition are described. Methods for characterizing and identifying labelled compounds separated on paper chromatograms in amounts below the limits of chemical detection are also discussed. (from auth.)

- 419 Андреева, О.И., Костякова, Г.И. ИЗУЧЕНИЕ РЕАКЦИЙ ИЗОТОПНОГО ОБМЕНА УГЛЕРОДА МЕЖДУ ЦИАНИСТЫМ КАЛИЕМ И КАРБОНАТАМИ И ПРИМЕНЕНИЕ ИХ ДЛЯ ПОЛУЧЕНИЯ ЦИАНИСТОГО КАЛИЯ, МЕЧЕНОГО ИЗОТОПОМ C^{14} . Труды Конференции по Использованию радиоактивных изотопов в физ. науках и пром., Копенгаген, 6-17 сентября 1960 г., том 3, стр. 141-22. Вена, Международное агентство по атомной энергии, 1962.

Разработана методика получения меченого цианида калия, которая базируется на следующих основных операциях: 1) Проведение реакции изотопного обмена $KC^{14}N - BaC^{14}O_3$ при 600° в течение 2-х часов. 2) Разделение смеси $KCN + BaCO_3$ путем экстракции KCN хлидом аммиака в циркуляционном экстракторе. При обмене эквимолекулярных количеств KCN и $BaCO_3$ получен цианистый калий с химическим выходом выше 90% и содержанием основного вещества 96 - 97%. При применении $BaCO_3$ с высокой удельной активностью (60 - 70 мкюри/г) удельная активность KCN получается выше 80 мкюри/г. Углекислый барий, обедненный изотопом C^{14} , регенерируется после экстракции аммиаком без заметных потерь.

Andreeva, O.I., Kostikova, G.I. STUDY OF CARBON-ISOTOPE EXCHANGE REACTIONS BETWEEN POTASSIUM CYANIDE AND SOME CARBONATES, AND THEIR USE FOR OBTAINING C^{14} -LABELLED POTASSIUM CYANIDE. p. 111-22 (disc. p. 122) in "Radiotopes in the Physical Sciences and Industry. Conference Proceedings, Copenhagen, 6-17 Sep. 1960", Vol. 3. Vienna, International Atomic Energy Agency, 1962. (In Russian)

The authors obtained cyanide-labelled potassium by the following method: (1) The isotope exchange reaction $KC^{14}N + BaCO_3$ is produced at $800^\circ C$ in 2 h. (2) The mixture $KCN + BaCO_3$ is separated by extracting the KCN with liquid ammonia in a circulating extractor. By exchanging the equimolecular quantities KCN and $BaCO_3$, potassium cyanide is obtained with a chemical yield of more than 90% and a basic-substance content of 96-97%. By using $BaCO_3$ with a high specific activity (60-70 mc/g), a KCN specific activity of over 80 mc/g may be obtained. The barium carbonate depleted of isotope C^{14} regenerates after the ammonia extraction without appreciable loss.

- 420 Belleau, B., Heard, R. D. H. SYNTHESIS OF C^{14} -SODIUM CYANIDE FROM CARBON DIOXIDE. *J. Amer. chem. Soc.* 72 (1950) 4268-9.

The method of preparation described offers several worthwhile advantages: (a) in one convenient reaction, a gaseous low-molecular-weight starting material ($C^{14}O_2$; mol. wt. 46) leads to a solid high-molecular-weight product (triphenylacetic acid- $1-C^{14}$, mol. wt. 290, melting point 267); (b) it is equally adaptable to a micro- or macro-scale; and, (c) other useful one carbon compounds such as formate, methylamine, etc., may be obtainable directly (in the course of exploration).

- 421 Bond, E. J. THE METABOLISM OF HYDROGEN CYANIDE BY *SITOPHILUS GRANARIUS* (L.) *Bull. ent. Soc. Amer.* 5, 3 (1959) 120 abstr. 92.

The uptake of hydrogen cyanide by this species increased linearly during fumigation even after absorption of a lethal dose. Respiratory inhibition did not appear to be the direct cause of death by this poison. The fate of C^{14} -labelled hydrogen cyanide within the insect was studied.

* Bridges 1955 - [765]

* Bridges 1956 - [766]

- 422 Cox, J. D., Warne, R. J. SYNTHESIS WITH ISOTOPIC TRACER ELEMENTS. III. THE PREPARATION OF ETHYLENE OXIDE AND ETHANOL LABELLED WITH CARBON ISOTOPES. *J. chem. Soc.* 1951: 1893-6.

A synthesis of ethylene oxide-1, 2- C^{14} is described. The compound is of interest as a fumigant. Details are given of apparatus and methods for the preparation from $BaC^{14}O_3$ of C_2H_2 through barium carbide (in 97% isotopic yield), C_2H_4 (quantitative yield) and $ClCH_2CH_2OH$ (82% recovery of isotope); KOH gives 85-95% $(CH_2)_2O$; reduction with $LiAlH_4$ gives 93% α, β -labelled EtOH (over-all isotopic recovery of 76% based on $BaCO_3$).

- 423 Foreman, W. W., Murray, A. III., Ronzio, A. R. MICROSYNTHESIS WITH TRACER ELEMENTS. II. METHYLIS-(2-CHLOROETHYL)AMINE HYDROCHLORIDE (NITROGEN MUSTARD) AND METHYL BROMIDE LABELLED WITH CARBON 14 . *J. org. Chem.* 15 (1950) 119-22.

$MeN(CH_2-CH_2Cl)_2$ (I) has been labelled in the Me group with C^{14} for a study of the mechanism of the cell damage caused by I. $C^{14}H_3OH$ (0.8-10 mmol.) is converted in a specially designed apparatus by means of 5 cc of a mixture of 3.6 cc concentrated H_2SO_4 and 23.03 g 48% HBr into 84-6% $C^{14}H_3Br$ (II). II is allowed to react in a special apparatus with $HN(CH_2CH_2-OH)_2$ (III) in absolute EtOH, and the mixture, containing $C^{14}H_3N(CH_2CH_2OH)_2$ and III, treated in C_6H_6 saturated with HCl with the calculated amount of $SOCl_2$, giving 52.5% (based on the CH_3OH used) $C^{14}H_3N(CH_2CH_2Cl)_2HCl$, melting point $109-110^\circ C$, with an activity corresponding to 22 $\mu c/mg$ ($HAuCl_4$ salt, m. $82-4^\circ$). When the ratio of II and III is 1:1, 20-35% $(C^{14}H_3)_2N(CH_2CH_2Cl)_2Br$, m. $217-18^\circ$ is obtained. (CA 44:4419c, 1950).

- 424 Gordon, H. T., Thornburg, W. W., Werum, L. N. HYDROXYETHYL DERIVATIVES IN PRUNES FUMIGATED WITH C^{14} -ETHYLENE OXIDE. *J. agric. Food Chem.* 7, 3 (1959) 196-200.

Dried prunes fumigated with ethylene oxide- C^{14} react with the fumigant to give non-volatile and relatively nontoxic alkylation products. Over 50% of the total radioactivity is combined as insoluble hydroxyethyl cellulose in the prune skin, 30% as hydroxyethylated sugars in the pulp, and 3% as glycols

(mostly diethylene glycol). The remainder has been tentatively identified as hydroxyethylated amino acids and proteins. (auth.)

- 425 Johnson, R. K., Huston, J. L. PREPARATION OF RADIOACTIVE SULFUR DIOXIDE FROM BARIUM SULFATE. J. Amer. chem. Soc. 72 (1950) 1841-2.

The combustion in oxygen of an intimate mixture of barium sulfate and red phosphorus was found to give a good yield of pure $S^{35}O_2$. Experimental and analytical procedures are described. The method is rather tedious.

- 426 McCarter, J. A. PREPARATION OF C-14-CYANIDE FROM C-14-CARBONATE. J. Amer. Chem. Soc. 73 (1951) 483.

The author describes a relatively simple and inexpensive procedure for obtaining a 90% yield of $HC^{14}N$ with a specific activity essentially unchanged from that of the $K_2C^{14}O_3$ used as starting material.

* McCollister et al. 1951 - [744]

* Perlowagora-Szumlewicz 1953 - [456]

- 427 Seliff, R. E., Tolbert, B. M. NOTES ON THE PREPARATION OF HYDROGEN CYANIDE- C^{14} FROM $BaC^{14}O_3$. UCRL-1299, California Univ., Berkeley, Radiation Lab. 1951, 5p.

Experimental details are presented on the preparation of $HC^{14}N$ from $BaC^{14}O_3$ by reduction with K metal in the presence of NH_4 . The procedure used was essentially that of Cramer and Kistiakowsky (J. Biol. Chem. 137, 547 (1943)), as modified by Loftfield (Nucleonics 1, (3) 54 (1947)) except that dilute H_2SO_4 was used to generate the HCN. No difficulties were encountered, and yields of 80 to 90% were obtained. (NSA 5: 4406, 1951).

- 428 Strittmatter, C., Peters, T., Jr., McKee, R. W. METABOLISM OF LABELED CARBON DISULFIDE IN GUINEA PIGS AND MICE. Arch. Industr. Hyg. 1 (1950) 54-64.

When CS_2 containing S^{35} was administered intraperitoneally, subcutaneously, intracardially, or by inhalation to guinea pigs and mice, the distribution was general throughout the body tissues, with more retained in the liver than other tissues. The nonmetabolized CS_2 was excreted rapidly, but the tissues retained a large proportion and gave it up slowly. Approximately 30% of the retained CS_2 was excreted in the urine, largely as inorganic sulfates. (CA 44: 4131e, 1950)

- 429 Tomisek, A. J., Mahler, H. R. THE SYNTHESIS OF ETHYLENE OXIDE-1,2- C^{14} . J. Amer. chem. Soc. 73 (1951) 4865-8.

Ethylene oxide-1,2- C^{14} was isolated in 30% yield from the reaction of ethylene-1,2- C^{14} with perbenzoic acid in tetrachloroethane solvent in the presence of iodine catalyst. A procedure was developed for the determination of ethylene oxide in tetrachloroethane solution. (auth.)

* Winteringham and Hellyer 1954 - [729]

* Winteringham 1955 - [767]

* Winteringham 1955 - [764]

* Winteringham 1957 - [761]

* Winteringham et al. 1958 - [730]

II - C Halogenated Hydrocarbons

Survey Articles

- 430 Perry, A. S. FACTORS ASSOCIATED WITH DDT-RESISTANCE IN THE HOUSE FLY MUSCA DOMESTICA L. p. 157-72 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1958", Vol. 2. Becker, E. C. ed. Ottawa, Mortimer Ltd. 1958.

The author reviews the protective mechanisms concerned with DDT-resistance in *M. domestica*, which may be characterized as morphologic, physiologic and behavioural. They are discussed in some detail. Numerous studies from which data are drawn have used radioisotopes. Among the factors reported, some are directly concerned with protecting the insect from the lethal action of DDT; others supplement a protective mechanism already present. Still others, i.e., certain structural differences, etc., are incidentally associated with resistant strains but offer no protection to the fly ("resistance-markers"). The complex nature of DDT-resistance makes it difficult to characterize this phenomenon in terms of a single common factor. It is likely that each strain possesses a combination of attributes for resistance which are different from that found in other strains.

- 431 Perry, A. S. BIOCHEMICAL ASPECTS OF INSECT RESISTANCE TO THE CHLORINATED HYDROCARBON INSECTICIDES. p. 119-37 in "Research Progress on Insect Resistance. Symposium, Washington, D. C. 7-8 Oct. 1959", Vol. 2, No. 1. Miscellaneous Publications of the Entomological Society of America, College Park, Md., 1960, 175p.

An excellent review article, discussing detoxication mechanisms, which may bring about (a) conversion of insecticide to nontoxic metabolites which are either excreted or retained within the tissues; (b) excretion in the unchanged form; or (c) storage in non-sensitive tissues of toxic metabolites or of the unchanged chemical. Work with radioisotopes is cited freely. Reference is also made to unpublished work by Perry (1957) on the metabolism of Cl^{36} -labelled Lindane in houseflies. Topical application (4 μ g/resistant fly) led to rapid toxicant metabolism. After 24 h 60% of the total radioactivity was in the excreta. Partition of the Cl^{36} -labelled compounds in excreta between water and cyclohexane showed 44% to be water-soluble. The amount of Cl^{36} in the fly also indicated a non-toxic, dechlorinated product. Investigations with the Cl^{36} - α -isomer of BHC indicated that both resistant and susceptible flies metabolized and excreted the product at an approximately equal rate. However, smaller amounts of water-soluble metabolites were indicated.

- 432 Murray, A., III., Williams, D. L. ORGANIC SYNTHESIS WITH ISOTOPES. COMPOUNDS OF ISOTOPIC CARBON. ORGANIC COMPOUNDS LABELED WITH ISOTOPES OF THE HALOGENS, HYDROGEN, NITROGEN, OXYGEN, PHOSPHORUS, AND SULFUR. New York, Interscience Publishers, Inc. 1958. 2096p.

A reference book. The various compounds are listed with their formulae, procedures for their preparation, notes, references and other preparations. To quote just the example of DDT, the Br^{82} analogue is discussed on pages 1157, 1158, the I^{131} analogue on p. 1229, DDT labelled at C_1^{14} on p. 888, and at C_1^{14} on p. 892.

- 433 Winteringham, F. P. W., Barnes, J. M. COMPARATIVE RESPONSE OF INSECTS AND MAMMALS TO CERTAIN HALOGENATED HYDROCARBONS USED AS INSECTICIDES. *Physiol. Rev.* 35 (1955) 701-39.

A review article. It includes a discussion of biochemical, physiological effects, the metabolic fate and possible mode of toxic action of MeBr, CH_2BrCH_2Br , CH_2ClCH_2Cl , dichlorobenzenes, DDT and its analogues, hexachlorocyclohexane isomers, Aldrin, Dieldrin, and Chlordane. Amongst the 335 references are numerous references to work utilizing radioisotopes although these are not mentioned specifically in the text.

Aldrin and Dieldrin

- 434 Chang, S. C., Kearns, C. W. STUDY OF DIELDRIN METABOLISM IN HOUSE FLIES. *Bull. ent. Soc. Amer.* 5, 3 (1959) 118, abstr. 77.

Tagged Dieldrin was used in a metabolism study in susceptible and resistant houseflies. Paper chromatographic separation of the benzene-extracted dose demonstrated only one radioactive spot with identical R_f value of reference Dieldrin in three solvent systems. A constant specific activity was shown for three successive crystallizations.

- 435 McKinney, R. M., Pearce, G. W. SYNTHESIS OF C^{14} -LABELLED ALDRIN AND DIELDRIN. *J. agric. Food. Chem.* 8 (1960) 456-9.

The insecticides 1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo-exo-5, 8-dimethanonaphthalene (Aldrin) and 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, -8a-octahydro-1, 4-endo-exo-5, 8-dimethanonaphthalene (Dieldrin) were prepared labelled with carbon-14. They were synthesized by labelling hexachlorocyclopentadiene and subsequent reaction with 2,5-norbornadiene. Starting with

BaC¹⁴O₂, a 28% yield of Aldrin (melting point 102.5°C) and a 22% yield of Dieldrin (melting point 181°C) were obtained. The specific activities were 3.6 and 3.5 ± 0.1 mc per gram for Aldrin and Dieldrin, respectively. (auth)

- 436 Winteringham, F. P. W., Harrison, A. ABSORPTION AND METABOLISM OF ¹⁴C-LABELLED ALDRIN BY SUSCEPTIBLE AND RESISTANT MOSQUITO LARVAE (Unpublished observations) WHO Information Circular on Insecticide Resistance No. 21, (1959) item 55.

The absorption and metabolism of C¹⁴-labelled Aldrin by susceptible and Dieldrin-resistant larvae of Anopheles gambiae have been compared. Both strains absorbed about one quarter of the Aldrin initially added to the water (5 ppm) after 4 h at 25°C but this was largely recovered by rinsing the cuticles in acetone and relatively little had penetrated the internal tissues of either strain. There were similar but small conversions of Aldrin to Dieldrin in the tissues of both strains. The data suggest that resistance of the larvae is not due to lack of cuticular penetration or detoxication in the tissues as a whole.

- 437 Winteringham, F. P. W., Harrison, A. MECHANISM OF RESISTANCE OF ADULT HOUSEFLIES TO THE INSECTICIDE DIELDRIN. Nature 184 (1959) 608-10.

The sulphur analogue of Dieldrin (S³⁵-labelled) was shown to be partly metabolized by resistant and susceptible houseflies. The results were determined as S³⁵-radioactivity, corrected for decay, self-absorption, etc., and expressed as a percentage of the dose applied. Unchanged insecticide and metabolites were determined by radio-paper-chromatographic techniques. The rate of accumulation of S³⁵-metabolites in the abdomen of adult M. domestica is illustrated. A table gives details of the fate of the S³⁵ analogue of Dieldrin three hours after topical application to Dieldrin-resistant and susceptible adult houseflies, at a dose of 2 µg per insect. A bromine analogue of Dieldrin (Br⁸²-labelled) was shown to be excreted unchanged in equal proportion by both resistant and susceptible houseflies. Small amounts of water-soluble metabolites were also produced.

BHC and isomers

- 438 Barragat, P. A DISTRIBUIÇÃO DE INSECTICIDA EM SUPERFÍCIES TRATADAS E A PRECISÃO DO TESTE BIOLÓGICO, CONTROLADOS COM RÁDIO-ANÁLISE. Rev. bras. Malariol. 5, 1 (1953) 85-93. (Distribution of an insecticide on treated surfaces, and the accuracy of biological tests controlled by radio-analysis).

Benzene hexachloride was mixed with thorium and its distribution studied by analysis of its radioactivity. This gives depth of penetration as well and is useful in explaining discrepancies shown by biological tests. (BA 28; 4567, 1954)

- 439 Bradbury, F. R. ABSORPTION AND METABOLISM OF BHC IN SUSCEPTIBLE AND RESISTANT HOUSEFLIES. J. Sci. Food Agric. 3, 2 (1957) 90-6.

Experiments on the absorption and metabolism of BHC isomers in houseflies (Musca domestica L.) are described for a strain normally susceptible and a strain resistant to γ BHC. The flies were exposed to vapours of the isomers at 25°C [77°F], the isomers being labelled with Cl³⁶ or C¹⁴. Radioactive material was recovered from the treated flies by extraction with carbon tetrachloride and with water. The ultimate production of 11 water-soluble compounds from both α and γ BHC was deduced from chromatographic data, and is discussed. The part played by metabolism in making an insect resistant to poisoning is discussed in terms of the effect of the product of concentration and time, and it is concluded that detoxication by metabolism is essential for the complete recovery of an insect following absorption of insecticide. Figures are given showing the extent to which α and γ BHC were metabolized to water-soluble material in susceptible insects of several species, including mosquitoes and cockroaches. It is evident from them that the susceptible strain of the housefly is in a class by itself in its ability to eliminate γ BHC as water-soluble products. It is thought that the existence in normal houseflies of a metabolic way of dealing with BHC predisposes the species to the acquisition of resistance. (from RAE-B 46; 52, 1958)

- 440 Bradbury, F. R., Nield, P., Newman, J. F. ACCOUNT OF GAMMA-BENZENE HEXACHLORIDE PICKED UP BY RESISTANT HOUSEFLIES BRED ON A MEDIUM CONTAINING BENZENE HEXACHLORIDE. Nature 172 (1953) 1052.

The gamma-benzene hexachloride was labelled with C¹⁴. Normal flies (Hawthorne stock of Musca domestica) were used, with another strain originating in Uruguay, having a very high resistance. Results of

the particular techniques used might be taken to indicate that (1) the resistance by houseflies is not due to resistance to penetration of the insecticide; and (2) a detoxification mechanism is unlikely in flies resistant to benzene hexachloride since these carry over in their tissues from the larval stage enough insecticide to kill normal flies in a few minutes.

- 441 Bradbury, F. R., Standen, H. THE FATE OF γ -BENZENE HEXACHLORIDE IN NORMAL AND RESISTANT HOUSEFLIES. I. J. Sci. Food Agric. 6 (1955) 90-9.

The fate of γ -benzene hexachloride in both normal and benzene hexachloride-resistant houseflies (*Musca domestica*) has been studied by radiochemical methods by means of C^{14} -labelled γ -benzene hexachloride. After exposure to the insecticide the resistant flies showed less radioactivity in carbon tetrachloride extracts than did the normal flies, but paper chromatography of these extracts showed the radioactive compound present to be γ benzene hexachloride. A proportion of the absorbed benzene hexachloride in both kinds of flies is converted into water-soluble products which are not extracted by carbon tetrachloride, and the amount of this product is greater for resistant flies, being approximately 50% of the total benzene hexachloride absorbed during 6 hours' exposure of the insects to the insecticide. (auth.)

- 442 Bradbury, F. R., Standen, H. BENZENE HEXACHLORIDE METABOLISM IN *ANOPHELES GAMBIAE*. Nature 178 (1956) 1053-4.

The absorption and metabolism of BHC was examined in two laboratory strains of *Anopheles gambiae* Giles, of which one (R) was 26 times as resistant to γ BHC as the other. Deposits of the α or γ isomer of BHC labelled with C^{14} were made from carbon tetrachloride solution in flasks, and weighed batches of mosquitoes (50-100 of mixed sex) were exposed in the stoppered flasks at 25°C [77°F] for 24 h with pieces of untreated filter paper for them to rest on. The radioactive material was then recovered and estimated as fractions soluble in CCl_4 and in water. The α isomer was included as it is known that γ -resistant flies [*Musca domestica* L.] can metabolize it as easily as the γ isomer, and it allows of longer survival of the S strain. The (tabulated) results show that the R strain absorbs as much BHC as the S strain and converts a smaller proportion (about 6 as compared with 11% in the case of the γ isomer) to water-soluble products. The radioactivity in the CCl_4 extracts revealed almost entirely unchanged BHC. As the S strain was knocked down by γ BHC after some 30 min and the R strain only after about 3 h, a further experiment was carried out in which the mosquitoes were exposed to γ BHC for 1 h and then kept for 24 h at 25°C in a clean flask. The pattern of absorption and metabolism was very similar to that shown with the longer exposure. Thus, insecticide resistance can occur in a strain of insects that is no more able to metabolize the poison than is a susceptible strain. *A. gambiae* can convert only 11% or less of absorbed γ BHC to excretable products, whereas houseflies of a resistant strain under similar conditions can convert more than 90%.

- 443 Bradbury, F. R., Standen, H. THE FATE OF γ BENZENE HEXACHLORIDE IN NORMAL AND RESISTANT HOUSEFLIES II. J. Sci. Food Agric. 7, 6 (1956) 389-96.

Studies were made of the pick-up and metabolism of BHC isomers by normal and resistant houseflies, employing the compound labelled with C^{14} . The α -, β -, γ -, and δ -isomers were all metabolized, conversion to water-soluble metabolites being in the order α - and $\gamma \rightarrow \delta \rightarrow \beta$ -. Resistant flies showed a more rapid metabolism of the insecticide than did normal flies. They also absorbed less, with the result that their content of the γ -isomer was $\frac{1}{4}$ of that of normal flies 4 h after a 15-min exposure to the insecticide vapour. (CA 50: 13355i, 1956)

- 444 Bradbury, F. R., Standen, H. THE FATE OF γ -BENZENE HEXACHLORIDE IN RESISTANT AND SUSCEPTIBLE HOUSEFLIES. III. J. Sci. Food Agric. 9 (1958) 203-12.

A detailed study of the minor constituents of the carbon tetrachloride extracts of flies treated with C^{14} -labelled γ -BHC has established the presence of pentachlorocyclohexene, trichlorobenzene and acidic substances. Under various conditions of exposure and different dosage rates these compounds occur only in small amount (3% or less of the absorbed dose of γ -BHC). Pentachlorocyclohexene was never found in quantities greater than 3% of the γ -BHC absorbed and it is concluded that if this compound is an intermediate in the metabolism of γ -BHC by resistant houseflies, it has, in the γ -BHC-resistant Uruguay strain, only a very transient existence. One result of the discovery of these minor constituents in carbon tetrachloride extracts is to show that the resistant strain enjoys a greater advantage over the susceptible in rate of detoxication of γ -BHC than had previously been supposed. (from auth.)

- 445 Bradbury, F.R., Standen, H. METABOLISM OF BENZENE HEXACHLORIDE BY RESISTANT HOUSEFLIES *MUSCA DOMESTICA*. Nature 183 (1959) 983-4.

The Jealotts Hill strain of flies resistant to benzene hexachloride was exposed to α - or γ -benzene hexachloride labelled with C^{14} . The experimental procedures adopted are described. Alkaline hydrolysis of the metabolic products was found to give dichlorothiophenols. The results are tabulated, which show that about 68% of the water-soluble products from the α -isomer and 61% from the γ -isomer are produced. It is inferred that the metabolism of benzene hexachloride by the flies to produce water-soluble compounds involves the formation of a C—S bond. A scheme which would satisfactorily account for the production of dichlorothiophenols from benzene hexachloride is put forward.

- 446 Bradbury, F.R., Whitaker, W.O. THE SYSTEMIC ACTION OF BENZENE HEXACHLORIDE IN PLANTS: QUANTITATIVE MEASUREMENTS. J. Sci. Food Agric. 7, 4 (1956) 248-53.

Tests with seedlings grown for 14 days in solutions of γ BHC labelled with C^{14} showed that the plants did not convert the insecticide into water-soluble products, so that the loss of insecticide must be ascribed to evaporation from the plant of either the unchanged insecticide or a volatile decomposition product. The results indicate that virtually all the γ BHC applied in a seed dressing may be absorbed and that the main effects of such treatment are systemic.

- 447 Bridges, R.G. FATE OF LABELLED INSECTICIDE RESIDUES IN FOOD PRODUCTS. VI. RETENTION OF γ -BENZENE HEXACHLORIDE BY WHEAT AND CHEESE. VII. THE FATE OF γ -BENZENE HEXACHLORIDE RESIDUES IN FLOUR DURING BAKING. J. Sci. Food Agric. 9, 7 (1958) 431-9, 439-48.

As γ BHC is being increasingly used for the control of insects and mites that infest stored foodstuffs and is persistent enough to leave a residue, especially in fatty materials, the fate of the residues in certain products was investigated. The results are given in these two parts of a series. BHC labelled with C^{14} was used to study the rate of loss of the insecticide from whole wheat and its distribution between the flour and bran fractions after milling. Loss from exposed wheat was rapid, but when it was stored in closed containers no loss was detected. After milling the wheat, 40-50% of the initial residue was still present in the "fine" flour fraction, while the residue in the bran was increased between 2- and 4-fold. Loss of the insecticide from Cheddar and Stilton cheeses was slow, about 40% of the weight applied remaining after 44 weeks. Penetration of the insecticide into both types of cheese was slow, although appreciably more rapid in the Stilton cheese. Repeated applications caused a build-up of the insecticide in the outer few millimetres of the cheeses, but had little effect on the amount penetrating more deeply. The toxicological significance of such residues is discussed. C^{14} -labelled γ BHC was used to study the effect of heating at baking temperatures on the insecticide when present in wheat starch, gluten and milled wheat. The amounts of C^{14} -activity retained by the starch and gluten after heating for $\frac{1}{2}$ h at 180°C (356°F) depend on the initial moisture content of the materials. With milled wheat at moisture contents between 0.4 and 17.3%, little difference in the amount of C^{14} -activity retained was observed, but when mixed into a dough with water prior to heating, a greater proportion of the initial C^{14} -activity was retained. The residue remaining after heating was "locked up" in desiccated starch granules and could not be extracted with acetone until the heated material was treated with water. The residue in the heated starch consisted mainly of unchanged BHC, but that in the flour was shown to be mainly a mixture of tri-, di- and monochlorobenzenes. The toxicological significance of these breakdown products in bread is discussed. (RAE-A 47: 233, 1959)

- 448 Bridges, R.G. PENTACHLOROCYCLOHEXENE AS A POSSIBLE INTERMEDIATE METABOLITE OF BENZENE HEXACHLORIDE IN HOUSEFLIES. Nature 184 (1959) 1337-8.

A Dieldrin-resistant (R-strain) and susceptible strain of *Musca domestica* were used. A simultaneous high resistance to γ -BHC was encountered. Studies of the resistance mechanism were made using C^{14} -labelled α -, γ - and δ -isomers of BHC. Details of the methods and their applications are given. Results suggest that monodehydrochlorination is not the first step in any major pathway for the metabolism of γ -BHC by houseflies. Detection of γ -PCCH together with other chlorinated benzenes may mean that an alternate pathway by dehydrochlorination is possible, though of secondary importance.

* Craig et al., 1953 - [778]

* Craig 1956 - [779]

* Craig 1960 - [780]

- 449 Elias, H., Lieser, K.H., Kohlschütter, H.W. RADIOCHEMISCHE UNTERSUCHUNG DER ISOMERISIERUNG DES 1,2,3,4,5,6-HEXACHLORCYCLOHEXANS (Radiochemical investigation into the isomerization of 1,2,3,4,5,6-hexachlorocyclohexane). Chem. Ber. **93**, 9 (1960) 2128-37. (In German)
- With the use of C^{14} -labelled γ - and α -HCH (i.e. 1,2,3,4,5,6-hexachlorocyclohexane) it was possible to follow quantitatively the isomerization of γ -HCH and α -HCH in the homogeneous system $HCH/AlCl_3/1,1,2,2$ -tetrachlor ethane as a function of time in the temperature range from 100-130°C. Calculations based on experimental data showed that isomerization may be considered as equilibrium reactions of the type $\gamma\text{-HCH} \rightleftharpoons \delta\text{-HCH} \rightleftharpoons \alpha\text{-HCH}$. In the region 100-130°C the equilibrium is very markedly displaced towards α -HCH. Velocity constants and activation energies of intermediate stages were determined, assuming second order bimolecular reactions. (Tr. auth./MB)
- 450 Hill, R., Jones, A., Palin, D. THE DETERMINATION OF GAMMA ISOMER IN CRUDE BENZENE HEXACHLORIDE BY A CARBON-14 ISOTOPE DILUTION METHOD. Chem. and Industry (Rev.) (1954) 162-3.
- A method of preparing C^{14} -labelled γ -BHC 1,2,3,4,5,6-hexachlorocyclohexane, is described. It was used as a laboratory check on other analytical procedures.
- 451 Hornstein, I. [ANALYSIS OF] BENZENE HEXACHLORIDE. J. Ass. off. agric. Chem. **38** (1955) 290-2.
- The results for the γ isomer of benzene hexachloride obtained by the present AOAC method (AOAC Methods of Analysis, 7th ed., 1950, 5.153 (CA 45, 2824e)) were similar to those obtained by the modified procedure reported previously. Therefore no change in the present procedure is recommended. The results by the Craig and Tryon radioactive isotope dilution method (Craig et al., CA 48, 2967d) showed excellent agreement with those found by the infrared method. (CA 49: 9865g, 1955)
- 452 Hornstein, I. [DETERMINATION OF] BENZENE HEXACHLORIDE. J. Ass. off. agric. Chem. **39** (1956) 373-7.
- As a result of a collaborative study, the present official partition chromatographic method for the determination of γ -benzene hexachloride (I) was revised (details given). The following average values were obtained on a 6% I dust (5.6% by infrared analysis): present method 5.70; revised 5.38; on a 13% I dust (13.1 by infrared and 13.0 by radioisotope dilution analysis): present 13.07; revised 12.90. (CA 50: 9681c, 1956).
- 453 Hornstein, I. [DETERMINATION OF] BENZENE HEXACHLORIDE. J. Ass. off. agric. Chem. **40** (1957) 737-43.
- The Craig et al. radioactive-isotope dilution method for the determination of the γ -isomer content of technical BHC (I) was applied by 6 collaborators to 2 samples of technical I containing 13 and 15% of γ -I, a 35% concentrate of γ -I, and γ -I-reinforced samples prepared by adding known amounts of pure γ -I to technical grade I of previously established γ -I content. Statistical analysis of all samples except the concentrate revealed an over-all relative precision of $\pm 4.2\%$ at the 95% confidence level. The accuracy and precision of the method is considered excellent. It was difficult to obtain representative samples of the concentrate. (CA 51: 13304b, 1957)
- 454 Palin, D. DETERMINATION OF GAMMA ISOMER IN CRUDE BENZENE HEXACHLORIDE BY A CARBON-14 DILUTION METHOD (abstr.). Analyt. Chem. **26** (1954) 1856.
- A C^{14} -isotope dilution method for determining the Lindane content in crude BHC is described.
- 455 Pearce, G., Krause, S. CHLORINE EXCHANGE BETWEEN ALUMINIUM CHLORIDE AND γ -1,2,3,4,5,6-HEXACHLOROCYCLOHEXANE. J. Amer. chem. Soc. **79** (1957) 271-3.
- Chlorinated hydrocarbon insecticides labelled with Cl^{36} represent a most effective tool in studies of the fate and toxicology of this class of compounds in resistant strains of arthropods as well as in higher animals. The use of exchange reactions appeared to offer a simpler way of preparing Cl^{36} -labelled compounds than their complete synthesis. Chlorine exchanges readily between aluminium chloride and γ -1,2,3,4,5,6-hexachlorocyclohexane (γ -HCC) at temperatures above 100° with some decomposition and isomerization, primarily to α -HCC and δ -HCC. Mechanisms for both exchange and isomerization are proposed.

- 456 Perlowagora-Szumlewicz, A. THE TOXIC ACTION OF THE VAPORS OF HEXACHLOROCYCLOHEXANE ON TRIATOMA INFESTANS. Rev. bras. Malariol. 5,2 (1953) 171-81.

The toxic action of hexachlorocyclohexane (H), both as vapour and as a solid residue, was determined against all stages of development of T. infestans (Hemiptera), a vector of Trypanosoma cruzi. To test the action of solid residue the H solution in C_6H_6 was taken up by filter paper and, by the addition of thorium salts of known radioactivity, it was found that H spread evenly. The vapours are slow but effective; they are very dangerous for 1st-instar nymphs, adults are affected next, and 4th instar nymphs are hardest to kill. The vapours lose their efficiency over 1½ months, but a spraying of huts, etc., once every 2 months is effective to rid them of the insects. If one succeeds in keeping the insects in constant contact with a surface containing solid H, the rate of knockdown is still greater. The results show that a spray of H will kill insects in crevices, cracks, etc., as vapours and solids are insecticidal.

Chlorobenzene

- 457 Gessner, T., Smith, J. N. COMPARATIVE DETOXICATION. VII. THE METABOLISM OF CHLOROBENZENE IN LOCUSTS: EXCRETION OF UNCHANGED CHLOROBENZENE AND CYSTEINE CONJUGATES. Biochem. J. 75 (1960) 185-72.

The excretion and metabolism of C^{14} -labelled chlorobenzene was studied in the locust Schistocerca gregaria. About half the dose was excreted unchanged. The probable presence, in excreta, of *o*-, *m*-, and *p*-chlorophenyl-L-cysteine and smaller amounts of *m*- and *p*-chlorophenylmercapturic acid was shown by isotope-dilution techniques. These compounds were excreted as acid-labile precursors. A weak acylase is present in crop fluid and excreta which slowly hydrolyzes L-*p*-chlorophenylmercapturic acid to *p*-chlorophenyl-L-cysteine. *p*-Chlorophenyl-L-cysteine is enzymically degraded to unidentified products by crop fluid and excreta.

- 458 Gessner, T., Smith, J. N. COMPARATIVE DETOXICATION. VIII. THE METABOLISM OF CHLOROBENZENE IN LOCUSTS: PHENOLIC METABOLITES, A COMPARISON WITH SOME VERTEBRATE SPECIES. Biochem. J. 75 (1960) 172-9.

Phenol, *o*-, *m*-, and *p*-chlorophenol, and 4-chlorocatechol have been detected in the excreta of locusts dosed with chlorobenzene. The amounts of these phenols present were determined by isotopic-dilution procedures after dosing locusts with chlorobenzene- C^{14} . Determination of *o*-, *m*-, and *p*-chlorophenol in locust excreta was carried out by a chromatographic-colorimetric method, and the results were compared with similar estimations on the urine of rats, cats, ferrets, and rabbits dosed with chlorobenzene. The significance of the ratio of *o*-chlorophenol: *m*-chlorophenol: *p*-chlorophenol excreted by different species is discussed. (CA 54: 15723a, 1960)

- 459 Kikal, T., Smith, J. N. METABOLISM OF CHLOROBENZENE- C^{14} IN THE LOCUST. Biochem. J. 69 (1959) 52P.

The studies were carried out on Schistocerca gregaria. Half of an injected dose of chlorobenzene- C^{14} (ring labelled) is eliminated unchanged in 48 h. The remaining C^{14} is found in the excreta as *m*- and *p*-chlorophenols, 4-chlorocatechol, *p*-chlorophenylcysteine.

DDT

- 460 Babem, F. H. THE SOLUBILITY OF DDT IN WATER DETERMINED RADIOMETRICALLY. J. Amer. chem. Soc. 77 (1955) 4666.

In a brief note the author described how the water solubility of C^{14} -labelled DDT was determined at 3 temperatures by radiochemical methods. It was found that in very thin layers and microgram quantities DDT is appreciably volatile at room temperatures.

- 461 Bowman, M. C., Acree, F., Jr., Corbett, M. K. SOLUBILITY OF DDT- C^{14} IN WATER. J. agric. Food Chem. 8 (1960) 406-8.

A knowledge of the solubility of DDT in water was required to study the effect of dissolved and undissolved toxicant on bioassays with mosquito larvae. The DDT was analyzed radiometrically, undissolved particles (~41 Å) were removed by an average ultracentrifugal force of 84 150 g. The solubility of DDT in water was found to be 1.2 parts per 10^9 or less at 25°C. Data on sizes of undissolved DDT particles and on recovery of DDT after ultracentrifugation at 1 g are presented.

- 463 Bowman, M.C., Acree, F., Jr., Schmidt, C.H., Beroza, M. FATE OF DDT IN LARVICIDE SUSPENSIONS. J. econ. Ent. 52, 3 (1959) 1038-42.
- The toxicity of DDT in aqueous-acetone suspensions to mosquito larvae is affected by the volume of suspension and the type of the test container. To learn whether the differences are due to settling, settling rates for different concentrations of DDT suspensions were determined. Settling does take place at the 1 ppm level but not at 0.01 ppm, a concentration approximating that normally used in mosquito larvicide tests. In further studies of such suspensions, a high proportion of the DDT was found deposited on the inner walls of glass, aluminium, or paper containers when the liquid phase was withdrawn within minutes after preparation of the suspensions. The concentration of the DDT in suspension was thereby reduced. Another surprising finding was that more than 50% of the DDT from 0.001 ppm suspensions was lost by volatilization with the liquid phase during 24 hours. This volatilization plus the deposition on the walls of the container appear to account for the loss of DDT from larvicide test suspensions. A physicochemical explanation for these findings is presented. C^{14} -labelled DDT was used. (auth.)
- 463 Buhler, D.R., Wang, C.H., Christensen, B.E. SYNTHESIS OF TERTIARY CARBON 14 -LABELED DDT. J. Amer. chem. Soc. 75 (1953) 4336.
- A method is described very briefly to meet the need for uniquely labelled DDT; it represents a microscale adaptation of Fry's technique (J. Amer. chem. Soc. 71 (1949) 3238). The overall yield for this procedure was found to be 10%. The isolated product DDT gave a melting point 104-104.5° (lit. 108-108.5°), with a specific activity of 1.49×10^8 cpm/mM.
- 464 Butts, J.S., Chang, S.C., Christensen, B.E., Wang, C.H. DDT DETOXIFICATION PRODUCTS IN AMERICAN COCKROACHES. Science 117 (1953) 699.
- 2- C^{14} -labelled DDT was synthesized with a specific activity of 1.5 mc/mM, and injected into cockroaches. Among 29 roaches, each injected with 3 μ l of ethanol containing 20 μ g of radioactive DDT, 22 survived after 48 h in a respiratory chamber at 3-35°C. Various fractions were tested for radioactivity. The findings led the authors to speculate that the water-soluble radioactive principle in this case is probably a conjugated compound composed of a DDT derivative and another, possibly carbohydrate, fragment. This formation of a conjugate might be related to the detoxification mechanism of DDT in roaches.
- 465 Fields, M., Gibbs, J., Walz, D.E. THE SYNTHESIS OF 1,1,1-TRICHLORO-2,2-BIS-(4'-CHLOROPHENYL)-4'- C^{14} -ETHANE. Science 112 (1950) 591-2.
- The authors undertook the synthesis of DDT labelled with C^{14} in the benzene ring. Both benzene-1- C^{14} and aniline-1- C^{14} are readily available; the preparation of tagged chlorobenzene by direct chlorination of benzene was investigated, as well as by the Sandmeyer reaction with aniline. Experimental conditions and results are described. A sample of 1,1,1-trichloro-2,2-bis-(4'-chlorophenyl)-4'- C^{14} -ethane from chlorobenzene-1- C^{14} under the condition described in the paper had a specific activity of approximately 54 μ c/mM.
- 466 Gjullin, C.M., Lindquist, A.W., Butts, J.S. ABSORPTION OF RADIOACTIVE DDT BY RESISTANT AND NON RESISTANT MOSQUITOES. Mosquito News 12, 3 (1952) 201-5.
- The amounts of C^{14} -labelled DDT absorbed by mosquito larvae and pupae were determined with a commercial type windowless gas-flow counter attached to a scaler. Fourth-instar larvae of Aedes vexans and A. sticticus absorbed from 0.00310 to 0.00371 g of DDT in 24 h when subjected to kerosene films and from 0.00173 to 0.00324 g when treated with acetone suspensions of radioactive DDT. The mortalities ranged from 21-97%. Dead larvae absorbed about two-thirds as much DDT as did live larvae. Larvae tested in acetone suspensions of DDT absorbed nearly twice as much DDT at 90°F as at 70° and the mortality was lower at 90°. Further details are given of the absorption of pupae of these species, and of the reaction to treatment of the resistant Aedes nigromaculid larvae which absorbed six times as much DDT as non-resistant larvae treated with 0.02 ppm. Bioassay of the extracts of these larvae with second-instar larvae of vexans and sticticus indicated that both resistant and non-resistant larvae had degraded a large amount of the DDT to non-toxic substances. (from auth. summary) (The salient features of this article were also briefly reported in Agric. Chemist. 7, 8 (1952) 70 under "Radio-DDT studies")
- 467 Hagley, E.A., Morrison, F.O. THE SYNERGISTIC ACTION OF CERTAIN CHEMICALS USED IN COMBINATION WITH DDT. p. 175-85 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E.C., ed. Ottawa, Mortimer Ltd. 1958.

Four methylene dioxyphenyl compounds, 1,1 bis (p-chlorophenyl) chloromethane (DBC); 1,1 bis (p-chlorophenyl) ethanol (DMC); and 1,1 bis (p-chlorophenyl) ethynyl carbinol (EC) were tested for synergistic action when applied topically to adult houseflies of two strains. The (p-chlorophenyl) compounds were all effective in increasing the lethal action of DDT. The other chemicals showed no synergism. The fly strain did not affect the results. Increasing the proportion of synergist from 1:1 to 1:10 increased the effect. Studies using C^{14} -labelled DDT revealed no increase in DDT penetration due to the synergist. When either DDT or synergist was applied in advance of the other, or when applications were made to different loci on the body, the synergistic effect was the same, but mixtures applied directly to the brain tissue were little more effective than DDT alone. When the synergist was applied to the proboscis, and the DDT to the thorax after the cervical region had been tightly ligated, the effect of the ligation in reducing mortality was still evident but was not so marked as with DDT alone applied to the thorax. (auth.)

- 468 Halleanavar, N. L., Cutkomp, L. K., Patel, N. G. DENSITY OF GRANARY WEEVILS IN RELATION TO INSECTICIDAL EFFECTIVENESS. Bull. ent. Soc. Amer. 6, 3 (1960) 152, abstr. 44.

Sitophilus granarius (L.) mortality in wheat treated with DDT was greater when small numbers of weevils were present. C^{14} -labelled DDT was used to determine pickup. Several possible causes of the differences in mortality were investigated.

- 469 Hoffman, R. A., Roth, A. R., Lindquist, A. W. EFFECT ON HOUSE FLIES OF INTERMITTENT EXPOSURES TO SMALL AMOUNTS OF DDT RESIDUES. J. econ. Ent. 44, 5 (1951) 734-63.

Knockdown tests with non-resistant females showed that the total exposure time needed to effect knockdown also increased as the interval between exposures was lengthened. In a series of tests with radioactive DDT (containing C^{14}), resistant flies exposed intermittently for a total of 7 h to 5 mg per ft² had a mortality of 16%, whereas resistant flies exposed continuously for the same time had a mortality of 45%, although the radioactivities of the two lots (and therefore the amounts of DDT absorbed by them) did not differ significantly.

- 470 Hoffman, R. A., Roth, A. R., Lindquist, A. W., Butts, J. S. ABSORPTION OF DDT IN HOUSEFLIES OVER AN EXTENDED PERIOD. Science 115 (1952) 312-3.

The authors emphasize the importance of timing the analyses in absorption studies with DDT. A 5-day delay in the analysis of flies succumbing within 24 h after treatment increased the amount of DDT absorbed as much as 45%, and a one-day delay 62%. About the same increase was obtained for flies that survived the DDT treatment for five days, indicating that absorption of DDT proceeded at about the same rate in dead as in living flies. Treated flies radioassayed after a lapse of more than a year showed a large increase in the amount of DDT penetrating the integument.

- 471 Hoskins, W. M., Witt, J. M. TYPES OF DDT METABOLISM AS ILLUSTRATED IN SEVERAL INSECT SPECIES. p. 151-6 in "Proceedings of the 10th International Congress on Entomology, Montreal 17-25 Aug. 1956", Vol. 2. Becker, E. C., ed. Ottawa, Mortimer Ltd. 1958.

The metabolism of DDT in 30 spp. of insects fell into 3 types: (a) absorbed DDT remained unchanged and could be recovered by solvents, (b) much of the DDT was converted to dichlorobis-(p-chlorophenyl) ethylene (DDE), and (c) the products of metabolism of DDT did not respond to the Schechter-Haller (SH) test (cf. Schechter et al., CA 40, 2260) and hence were not DDT nor bis(chlorophenyl)acetic acid (DDA). The recovery of DDT from survivors of LD₅₀ dosages in 6 spp. were as follows: Bombyx mori, DDT 88, DDE 12, and non-SH 0%; Nymphalis antiopa, DDT 69, DDE 2, and non-SH 29%; Malacosoma americanum, DDT 15, DDE 66, and non-SH 19%; Musca domestica, DDT 6, DDE 60, and non-SH 34%; Piodia interpunctella, DDT 18, DDE 26, and non-SH 56%; and Ornithodoros coriaceus, DDT 4, DDE none, and non-SH 96%. The large milkweed bug (Oncopeltus fasciatus), the resistant housefly (Musca domestica), and the cockroach (Periplaneta americana) illustrated the 3 types of metabolism. Results of studies of these 3 spp. of insects with DDT tagged with C^{14} were given. There was a definite sequence of metabolites in the 3 insect spp. The paper chromatogram strips were scanned by a gas-flow scanner of novel design. The C^{14} on the strips could be measured if the counts were 100/min. or more. The apparatus was described. (CA 53: 22548d, 1959)

- 472 Jackson, P. C., Hopkins, H. T. STUDY OF THE PERSISTENCE OF C^{14} -LABELED p,p'-DDT IN VARIOUS SOILS. Bureau of Plant Industry, Soils, and Agricultural Engineering, Div. of Soil Management and Irrigation, Beltsville, Md. Progress Report 237 (1952).

Radioactive p,p' -DDT was incorporated in 18 representative soils at a normal rate of application. After storage periods of one and 6 months the soils were extracted with acetone and the amount of a radioactivity recovered from each soil was measured. Identification of the degradation products of DDT was made on soil extracts by means of paper partition chromatography. The following conclusions were reached: (1) Decomposition of p,p' -DDT is generally greatest in soils with a pH higher than 7.0; (2) the principal degradation products of p,p' -DDT found in 16 of the 18 soils was p,p' -DDE; (3) the phytotoxic derivative, p,p' -DDA, is not persistent in any of the soils studied in this work. (auth. summary)

(See also ARS 33-63)

* Jensen et al., 1957 - [738]

473 Jensen, J. A., Pearce, G. W. SYNTHESIS OF RADIOACTIVE IODINE¹³¹ ANALOG OF DDT. J. Amer. chem. Soc. **74** (1952) 2436.

(Brief note). DDT has been labelled in various ways, particularly by means of C¹⁴. The authors briefly discuss a technique for preparing 2,2-bis-(p -iodophenyl)-1,1,1-trichloroethane, the I¹³¹ analogue of DDT.

A detailed description is given in Document 3488, American Documentation Institute, 1719 N Street, N.W., Washington 6, D.C.

474 LeRoux, E. J., Morrison, F. O. THE ADSORPTION, DISTRIBUTION, AND SITE OF ACTION OF DDT IN DDT-RESISTANT AND DDT-SUSCEPTIBLE HOUSE FLIES USING CARBON¹⁴ LABELLED DDT. J. econ. Ent. **47**, 6 (1954) 1058-66.

Experimental techniques are described, and the results tabulated and discussed. When DDT is topically applied to adult houseflies, the locus of application greatly influences the rate of penetration, distribution and accumulation at the site of action. The DDT is distributed by way of the haemolymph, but not accumulated in it. Other tissues and organs, particularly the integument, absorb the DDT or its metabolites from the hemolymph. The rate at which DDT enters the hemolymph and is distributed to the various parts of the body is directly related to the area of contact. Distribution from the point of application continues at a reduced rate in dead flies. The site of action appears to be some organ or product in or produced within the head of the adult fly. Median lethal doses calculated from the topical application of DDT and estimates of the difference in susceptibility between fly strains are both influenced by the locus of application. The nearer it is to the site of action (in the case of the housefly the inside of the head), the lower the observed median lethal dose and the less the observed differential in strain susceptibility. The greater susceptibility of individuals treated near or on the site of toxic action offers a method of increasing the sensitivity of bioassay methods. (from RAE-B 43: 192, 1955)

475 LeRoux, E. J., Morrison, F. O. DOSAGE OF DDT NEEDED TO KILL A HOUSE FLY. J. econ. Ent. **46**, 6 (1954) 1109-10.

DDT was applied to the tibio-femoral joint of the metathoracic leg or to the labella of males of the housefly, Musca domestica L., by Fisher's method at at 2 μ g per fly. Amputations of the treated leg after 30 minutes considerably reduced mortality, but amputation of the leg after 4 h or of labella after 30 min had no effect. When flies were similarly treated with radioactive DDT and later sectioned, the percentages of the total radioactivity that were in severed treated appendages were 91 in legs and 90 or 93 in labella after 30 minutes, and 80 in legs after 4 h. Thus, absorption and distribution of 10-20% of the applied dose produced the full lethal effect, and the site of application did not influence the rate of absorption but did influence effectiveness. (RAE-B 42: 139, 1954)

476 Lichtenstein, E. P., Schulz, K. R. TRANSLOCATION OF SOME CHLORINATED HYDROCARBON INSECTICIDES INTO THE AERIAL PARTS OF PEA PLANTS. J. agric. Food Chem. **8**, 8 (1960) 452-6.

The increased use of chlorinated hydrocarbon insecticides in soil has often raised the question of whether or not these insecticides might translocate into the aerial parts of plants from the soil in spite of their extremely low solubility in water. This was tested by resorting to very high concentrations of insecticide and using a soil of minimum sorptivity and complexity. Plants were also grown in insecticide-free sand within a glass container surrounded by insecticide-treated sand. Lindane, Aldrin, Dieldrin and heptachlor as well as C¹⁴-labelled p,p' -DDT was used. Because a relatively small amount of DDT was available only one aluminium foil-covered pot containing DDT-treated quartz sand (30 ppm) was planted with peas. Pea plants grown in sand treated with C¹⁴-labelled DDT did not show any translocation of this insecticide. On the basis of extraction of plant material and radioassay, less than 0.01 ppm of C¹⁴ derived from DDT was found.

- 477 Lindquist, W. A., Dahm, P. A. METABOLISM OF RADIOACTIVE DDT BY THE MADEIRA ROACH AND EUROPEAN CORN BORER. J. econ. Ent. 49, 5 (1956) 579-84.
- The absorption, metabolism and excretion of C^{14} -ring-labelled p,p'-DDT in adult females of the Madeira cockroach (Leucophaea maderae (F.)) and fifth-instar larvae of the European corn borer (Pyrausta nubilalis (Hb.)) were studied. The cockroach absorbed DDT rather slowly (about 90% in 20 days) and excreted 50% of the total applied radioactivity over a period of 36 days. Separation of the radioactive compounds excreted in faeces by DDT-treated cockroaches was accomplished by paper chromatography. The presence of DDT, DDE (2,2-bis(p-chlorophenyl)-1,1-dichloroethylene) and three unidentified metabolites was demonstrated. DDT was the predominant radioactive compound excreted in the first 24 hours after treatment, after which a metabolite with an R_f value of about 0.88 was the major radioactive compound excreted. Metabolic pathways for the DDT in the cockroach are proposed. Fifth-instar larvae of P. nubilalis, have some tolerance of DDT and convert significant amounts of absorbed DDT to DDE. No evidence of DDT metabolites other than DDE was found. Both colorimetric and radiometric analyses were used in the study of P. nubilalis. (from auth. summary)
- 478 Lindquist, A. W., Roth, A. R., Hoffman, R. A., Butt, J. S. THE DISTRIBUTION OF RADIOACTIVE DDT IN HOUSE FLIES. J. econ. Ent. 44, 6 (1951) 931-4.
- The distribution of C^{14} -labelled DDT in various internal organs and external parts of resistant houseflies, Musca domestica L., was studied. Flies topically treated with 8 to 11.25 mg of DDT each showed from 28-34% of the total absorbed in the internal organs and the remainder distributed throughout the cuticle. Flies exposed to a residual deposit of the DDT showed a similar distribution of the toxicant, but only $\frac{1}{3}$ to $\frac{1}{2}$ as much as in the topically treated flies. The prevention of ingestion of the DDT by removal of the proboscises did not appreciably alter the percentage recovery in the different parts. In another series of tests it was found that 13% of the total DDT absorbed was present in the body fluids. The intestinal tract, thoracic ganglion, reproductive system, and thoracic muscles of all flies examined showed some radioactivity. (auth. summary)
- 479 Lindquist, A. W., Roth, A. R., Yates, W. W., Hoffman, R. A., Butts, J. S. USE OF RADIOACTIVE TRACERS IN STUDIES OF PENETRATION AND METABOLISM OF DDT IN HOUSE FLIES. J. econ. Ent. 44, 2 (1951) 167-72.
- Penetration of an insecticide through the cuticle of resistant Musca domestica was studied by applying $15 \mu g$ of C^{14} -labelled DDT. After 24 h, both the dead and surviving flies were washed in acetone to remove exterior DDT, and then macerated and the DDT or metabolites extracted with acetone. The quantities of DDT recovered in the wash and extract were determined by radioactivity measurements and calculating the equivalent weights and percentages. From the flies surviving the topical treatment 78% of the DDT applied was recovered and 82% of the recovered DDT was in the wash. Of the flies given a topical treatment an average of 2.1 and 2.3 μg of DDT or toxic metabolites was recovered, respectively, from surviving and dead flies. Approx. 1/10 less DDT or metabolites was recovered from the flies exposed to a residue. Bioassays of the fly extracts with mosquito showed that 63% of the total DDT absorbed by topically treated surviving flies was nontoxic and therefore metabolized. The 27% that was toxic was probably DDT, since neither of the metabolic products, 2,2-bis(p-chlorophenyl) acetic acid or 2,2-bis(p-chlorophenyl)-1,1-dichloroethylene, killed mosquito larvae.
- 480 MacDonald, R., Baker, B. E. SYNTHESIS OF CARBON 14 -LABELED DDT. Canad. J. Chem. 31 (1953) 517-9.
- The authors described a method for synthesizing tertiary- C^{14} -labelled DDT, 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane-2- C^{14} . The various steps in synthesis are discussed. $MeC^{14}O_2Na$ from labelled $BaCO_3$ was heated with p- $MeC_6H_4SO_2Cl$ 30 min at 180-200°C to give $(MeC^{14}O)_2O$. The labelled Ac_2O with PhCl gave p- $ClC_6H_4C^{14}OMe$ by a Friedel-Crafts reaction. Direct chlorination yielded p- $ClC_6H_4C^{14}(OH)CCl_3$. This product was condensed with PhCl by H_2SO_4 to give $(p-ClC_6H_4)_2C^{14}HCCl_3$ (DDT). The DDT contained 4.76% of the original C^{14} .
- 481 Miles, J. W., Pearce, G. W. RAPID METHOD FOR MEASUREMENT OF RATE OF SORPTION OF DDT BY MUD SURFACES. Science 126 (1957) 169-70.
- A rapid method of assessment of loss of insecticidal activity of DDT and related compounds from mud surfaces has now been evolved, based on loss of radioactivity from surfaces dusted with C^{14} -labelled DDT. The C^{14} -labelled compound migrates to only slightly beneath the surface, and the weak β -rays are shielded