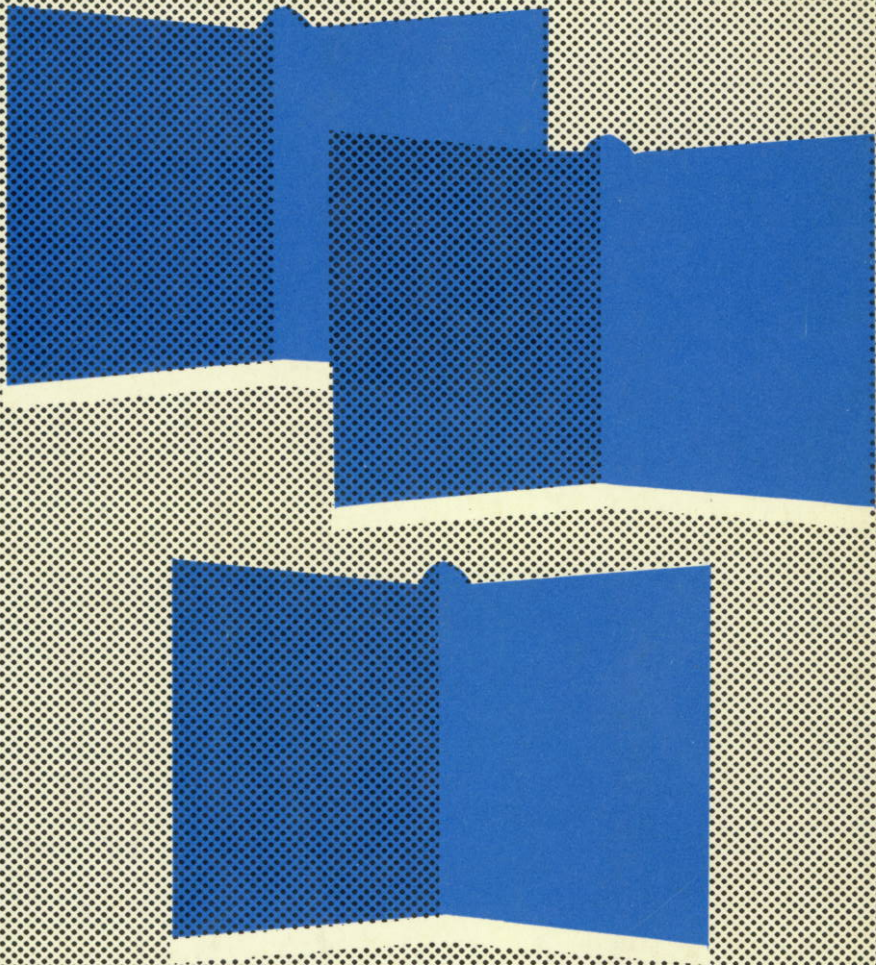


bibliographical series



**No. 15 RADIOISOTOPES AND
IONIZING RADIATIONS
IN ENTOMOLOGY
(1961-1963)**

1965

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA 1962



**RADIOISOTOPES AND IONIZING RADIATIONS
IN ENTOMOLOGY**

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No. 15

**RADIOISOTOPES
AND IONIZING RADIATIONS
IN ENTOMOLOGY
(1961-1963)**

INTERNATIONAL ATOMIC ENERGY AGENCY

VIENNA, 1965

BIBLIOGRAPHICAL SERIES, No. 15: RADIOISOTOPES AND IONIZING
RADIATIONS IN ENTOMOLOGY (1961-1963), IAEA, VIENNA, 1965
STI/PUB/21/15

FOREWORD AVANT-PROPOS ПРЕДИСЛОВИЕ PREFACIO

The present bibliography on Radioisotopes and Ionizing Radiations in Entomology*, covering 1961 to 1963 inclusive, is a direct continuation of the first volume** which covered the period of 1950 to 1960. It is significant of the tremendous increase in research that the amount of work published during the three-year interval of 1961 to 1963 exceeds that of the preceding eleven years. An attempt has been made to maintain a fully annotated documentation for reference purposes in this broad field.

As before, a special effort has been made to present sufficient detail with each reference. Abstracts have therefore been included. A special feature of the detailed subject index available is the indication of the particular radioisotope or radiation used, given with individual reference citations. Some data on insect dispersal and sterilization, and on insecticides are shown in tabular form. It is hoped that the bibliography will prove of practical use to the specialist requiring a rapid survey of relevant publications in related disciplines, the person in search of detailed documentation on some particular aspect, and the scientist in a developing country whose access to the world literature might be somewhat limited.

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, Kärntner Ring 11, Vienna I, Austria.

* Bibliographical Series of the IAEA No. 15.

** Bibliographical Series of the IAEA No. 9.

La présente bibliographie consacrée aux radioisotopes et aux rayonnements ionisants en entomologie* couvre les années 1961, 1962 et 1963 et fait suite au premier volume** qui correspond à la période 1950-1960. Le fait que le volume consacré aux trois années 1961-1963 contienne plus de références que le précédent, qui couvrait un intervalle de 11 ans, souligne l'essor rapide de la recherche. On s'est efforcé de présenter, comme précédemment, une documentation complètement annotée sur ce vaste domaine à des fins de référence.

Comme dans le précédent volume, on s'est efforcé surtout de donner suffisamment de détails sur chaque ouvrage cité, notamment en donnant un bref résumé et l'index détaillé par sujets spécifie le radioisotope ou le rayonnement utilisé et donne des indications sur chaque cas. Certains renseignements sur la dispersion et la stérilisation des insectes sont donnés sous forme de tableaux. On espère que cette bibliographie intéressera les spécialistes qui désirent consulter rapidement la liste des publications dans

les disciplines connexes, et les hommes de science des pays en voie de développement qui peuvent avoir des difficultés à accéder aux ouvrages publiés dans le monde.

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, Vienne I, Kärntner Ring 11, Autriche.

* Collection «Bibliographies» (AIEA), n°15.

** Collection «Bibliographies» (AIEA), n°9.

Настоящая библиография по вопросам использования радиоактивных изотопов и ионизирующих излучений в энтомологии* охватывает период 1961—1963 гг. включительно и является продолжением первого тома**, в который вошли материалы, опубликованные в 1950—1960 гг. Показателем того огромного размаха, который приняли за это время научно-исследовательские работы в данной области, является то, что с 1961 г. по 1963 г. было опубликовано больше трудов, чем за предыдущие одиннадцать лет. Для того, чтобы облегчить читателю справочно-библиографический поиск в рассматриваемой широкой области, особое внимание было уделено тому, чтобы во всех без исключения разделах библиографии документационный материал был представлен полно.

Как и в первом томе, были приложены все усилия, чтобы библиографические описания были как можно более информативными; с этой целью в каждую библиографическую справку было включено по возможности больше элементов и в каждое библиографическое описание — аннотация. Отличительной чертой подробного предметного указателя является то, что радиоизотопы и излучения приведены с указанием номеров библиографических описаний, в которых они упоминаются. Ряд данных по дальности миграции и стерилизации насекомых, а также по инсектицидам представлен в форме таблиц. Библиография рассчитана как на специалистов, работающих в смежных с рассматриваемой областях науки, для которых она может оказаться источником готовой экспресс-информации по интересующим их темам, так и на лиц, ведущих доскональный документационный поиск по какой-нибудь из проблем, являющихся предметом рассмотрения данной библиографии, а также на ученых развивающихся стран с ограниченными книжными ресурсами.

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

Просьба все замечания, пожелания и предложения, касающиеся "Библиографической серии", направлять по адресу: Австрия, Вена I, Кернтнер Ринг, 11—13, Международное агентство по атомной энергии, Директору Отдела научно-технической информации.

* "Библиографическая серия", №15.

** "Библиографическая серия", №9.

La presente bibliografía sobre el empleo de radioisótopos y radiaciones ionizantes en entomología*, que abarca los años 1961, 1962 y 1963, es continuación directa del primer volumen**, que recogía las obras publicadas entre 1950 y 1960. El enorme auge que ha cobrado la investigación se demuestra por el hecho de que sólo en el trienio 1961-1963 se han publicado más obras que en los once años anteriores. Se ha procurado completar la bibliografía con gran número de notas y referencias para facilitar la consulta de las obras que tratan de esta extensa esfera.

Como en el primer volumen, se ha procurado dar cada referencia con suficiente detalle, y con cada obra citada se da un breve resumen de su contenido. Una característica especial del detallado índice de materias de esta publicación es que con la referencia se indican los radioisótopos o radiaciones utilizados. Algunos datos sobre dispersión y esterilización de los insectos y otros sobre los insecticidas se presentan en cuadros. Se espera que la bibliografía sea de utilidad para los especialistas que necesiten un breve análisis de las publicaciones importantes en materias afines a su especialidad, para las personas que busquen una documentación detallada sobre cuestiones determinadas y para los científicos de los países en desarrollo que a veces tropiezan con dificultades para obtener las obras publicadas.

Ha preparado la bibliografía la Sra. M. Binggeli, de la División de Información Científica y Técnica del Organismo.

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

* Colección de Bibliografías del OIEA, N° 15.

* * Colección de Bibliografías del OIEA, N° 2.



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INTRODUCTION

GUIDE ON COMPILATION

SOURCES

The bibliography was compiled from the open literature. A first routine search consisted of scanning selected secondary sources:

(a) Abstracting journals

Biological Abstracts (BA)

Bulletin Bibliographique (BB): Isotopes. Rayonnements. Agriculture. (Includes keywords but no abstracts)

Chemical Abstracts (CA)

Dissertation Abstracts (DA)

Nuclear Science Abstracts (NSA)

Nuclear Science Abstracts Japan (NSA/J)

(b) Title listings

Agricultural Index (AI)

Bibliography of Agriculture (BAG)

Current Science

Subsequently, primary sources were scanned, abstracts being prepared where necessary, and references cited in original papers followed up: Numerous books, conference proceedings, bibliographies, reports, and selected journals were scanned, including review series such as: "Advances in Pest Control Research", Vol. 5 (Metcalf, R.L., Ed.), Interscience Publishers, New York (1962). "Annual Review of Entomology", Vol. 7 (1962), Vol. 8 (1963), (Steinhaus, E.A., Smith, R.F., Eds), Annual Reviews, Inc., Palo Alto, Calif. "Advances in Genetics", Vol. 10 (1961); Vol. 11 (1962), (Caspari, E.W., Thoday, J.M., Eds), Academic Press, New York.

The source of each abstract is indicated by means of the abbreviations above or by "(Auth.)" where the author's own abstract has been used; when no source is cited the abstract has been prepared by the compiler. Papers published as abstracts only were cited verbatim.

Reports

Some progress reports, preprints and abstracts of, so far, unpublished Conference Papers have been included; they are considered to be valuable as indications of future developments.

REFERENCES

References are arranged according to subject matter as laid out in the table of contents. Articles reviewing the particular subject or of a general

or introductory nature are placed at the beginning of a section. Such reviews are more specific than those contained in BIBLIOGRAPHIES AND GENERAL SURVEYS, where broad fields are surveyed. Within a section, references are listed alphabetically by first author. References which were published prior to 1961 but had not been included in the preceding bibliography are marked by an asterisk.

Cross-References

These are cited at the end of each section, giving the (English) title, first author, the year of publication and the reference number. Despite the very complete subject index cross-referencing has been used extensively.

TECHNIQUES

Selected papers representative of particular techniques (e. g. autoradiography, dosimetry, neutron activation analysis, etc.) have been grouped together.

ADDENDUM

As in the first volume, documentation on radioisotope and radiation studies on nematodes of agricultural interest has been included.

INDEXES

(1) Author Index

Underlining is used to indicate the first author, in cases of joint authorship. As far as possible, up-to-date affiliations have been indicated for each author.

(2) Subject Index

A complete subject index is provided. The radioisotopes or radiations used are indicated with each reference. The following convention has been adopted concerning the position in which they are cited with regard to a particular study. When the radioisotopes or radiations represent the cause they precede the phenomenon, when used as a tool for analyzing existing conditions they follow the phenomenon under study. This is illustrated below.

Radioisotopes

Studies using the same radioisotope are listed under that isotope, with the exception of H³, C¹⁴, and P³²; since these isotopes have been applied particularly widely, they are more logically approached via the problem investigated.

Radioisotope	Radiation
<p>P^{32}: genetic effects: 479 (genetic effects <u>incurred</u> through use of P^{32})</p> <p>dispersal, P^{32}: 72 (dispersal <u>traced</u> by means of P^{32})</p>	<p>γ: ovary: 1185 (effects of γ-irradiation <u>on</u> ovary)</p> <p>x: malformations: 1286 (effects of x-irradiation in terms of malformations <u>produced</u>)</p> <p>B/MEA: radiosensitivity: 1160 (/= <u>additional experimental factor</u>, introduced before, during or after irradiation)</p> <p>development, x: 1507 (development <u>detected</u> and studied by means of x-rays)</p>

Radiations

Due to the large number of references involving the use of γ - and x-rays, these ionizing radiations have not been entered as separate headings in the subject index.

Insects

Scientific and common names have been given. In order to facilitate the use of the index for the non-specialist, insects have not been listed by order or family, but rather under common names. Thus, aphids, ants, cockroaches, grasshoppers, fruit flies, locusts, mosquitoes, and silkworms have been used as group headings rather than applying the scientific approach of, e.g., classing cockroaches, and grasshoppers and locusts together under Orthoptera, or under Blattidae and Acrididae, respectively.

Insecticides

Metabolic studies are not indicated specifically: where particular attention has been paid to residue analysis or insecticide synthesis this is mentioned with the citation. Special indexes (No. 3 and 4) have been compiled.

(3) *Common and Manufacturers' Insecticide Name Index*

(4) *Letter-and-Number Insecticide Index*

APPENDIX

Table I on the dispersal of radioisotope-marked insects indicates one area in which radioisotopes have been used widely and with considerable

success. The complexity of factors which enter into range determinations do not allow easy tabulation of data, and the table represents an illustration rather than a comprehensive summary of results obtained by means of radioisotopes.

Table II summarizes data on the radiation-induced sterilization of 42 species of insects, and lists the insect, the stage irradiated, the dose and radiation used and, where applicable, additional variables which modified the effects of irradiation.

Table III lists radiotracer studies on insecticides; the chemical names and other designations are indicated for the various metabolic and other studies tabulated. The particular radioisotope used is listed, together with the animal or plant investigated, or the analysis or synthesis carried out.

ACKNOWLEDGEMENTS

The compiler of the bibliography is greatly indebted to Dr. J.C. Keller, of the Joint FAO/IAEA Division of Atomic Energy in Agriculture, who has been very helpful throughout its preparation; to Dr. J. Monro, of the Division of Research and Isotopes, for his comments and advice on various occasions, and to Dr. E.E. Kenaga, of the Dow Chemical Company, Midland, Michigan, USA, for permission to use the chemical names and other designations for certain compounds* as set out in his article "Commercial and Experimental Organic Insecticides", in Bull. ent. Soc. Amer. 9, 2 (1963) 67-103.

SURVEY

The following introduction is a commentary on the main lines of research in which radioisotopes and ionizing radiations have been used in the period under review. For detailed information reference is made to the relevant sections of the bibliography. The discussion on isotopes (p.4) is more extensive than on radiations (p.21) because of the great variety of problems investigated. The main applications of radiation have been summarized, particular emphasis being given to those fields in which the IAEA is actively engaged.

PROBLEMS IN THE USE OF RADIOISOTOPES

(1) Choice

The choice of an isotope in entomology is governed to a considerable extent by its toxicity to the insects, its effective half-life, and its suitability as an emitter. The energy and type of emission (β or γ) determines in turn the equipment required for its detection. For example P³² has most often been used for dispersal studies (Table I) because it is easily detected, fairly

* See Table III

safe in use, and has an adequate half-life; its relatively weak β -emission is, however, useless for tracing insects underground, and for this purpose a powerful γ -emitter such as Co^{60} must be used. Problems involved in the choice of isotopes have been reviewed by various authors (4, 453, 451, 481). The extent to which tagging has become a routine operation may be gauged from the fact that the release of lots of 3×10^6 P^{32} -labelled mosquitoes has been reported (66).

In labelling insects several methods have been used, depending on the radioisotope, the species, the developmental stage to be labelled, and the conditions and period of observation envisaged. Commonly insects are reared in a labelled medium or with access to labelled water (457). Thus P^{32} -labelled honey was used for tagging ants (43), Au^{198} -labelled nutrients for bumble bees (44), and other labelled foods for various other species (65, 72, 84, 449, 450, 452). Alternative techniques include labelling via radioactive plant hosts (12, 15, 16, 21, 25) and animal hosts (39, 140-1, 448, 459, 462, 483, 485-7, 489-91), dipping (63, 83, 89, 98), painting (459, 463), spraying (71, 455), direct injection (175), exposure to radioactive gases, and the attachment of labelling strips (12, 13). In some cases two lots of the same insect have been labelled with different isotopes in order to identify different release sites (69).

Apart from the above examples, a number of additional labelling techniques and devices have been developed to suit particular needs (e.g. 64, 455, 463).

(2) Detrimental effects of radioisotopes

The possibility of detrimental effects from ingestion or topical application of radioisotopes must be considered. Such effects may take the form of delayed, abnormal or inhibited development, reduction in life-span or of the reproductive potential, or genetic effects.

The occurrence of developmental effects will, apart from other factors, depend on the radioisotope concentrations and insect stages used (21). P^{32} , applied in the larval medium of Culex pipiens molestus Forsk., affected growth and development (466), but efficient labelling of emerging adults was possible at $\sim 0.1 \mu\text{c/ml}$. Ephestia kühniella, reared on Sr^{89} -treated food invariably suffered a delay in development (471); similar effects and even abnormalities were found in Habrobracon (472).

A reduction in life-span was caused in Habrobracon juglandis by Pu^{239} (469, 470) and Sr^{89} (472), and in the parasite Meniscus agnatus by P^{32} (22). In the boll weevil, Anthonomus grandis Boheman, mortality from P^{32} -ingestion was higher at the larval than the adult stage (476). Co^{60} did not seriously affect Pissodes strobi when an activity of $\sim 250 \mu\text{c}$ was used for short (1-2 months) periods; but for periods exceeding 9 months only $\sim 50 \mu\text{c}$ Co^{60} could be used (463).

Effects on the reproductive potential can be considerable. Ingested Pu^{239} caused a marked drop in fertility and fecundity in Habrobracon juglandis (469, 470), and progressively fewer progeny were found in Ephestia kühniella from adults reared on Sr^{89} -treated food (471). Effects following the ingestion of Zn^{65} may in part be ascribed to its toxicity (168). The genetic

effects of fourth period metals are considered in 159. Oviposition has, however, been found to be inhibited by even such a weak β -emitter as L-methionine-methyl- C^{14} . Its injection into the haemolymph of last instar nymphs of Gryllus assimilis (F.) induced radioactivity in the male and, subsequently, in the female (465). A similar effect was observed in the cotton leaf worm, Prodenia litura (F.), (467) after injection of labelled methionine into the haemolymph of newly emerged moths (467).

Genetic effects have been observed in a number of cases. A mutagenic effect due to tritium labelling was found in Drosophila melanogaster (473-4), and genetic effects were sometimes found when DNA-precursors labelled with H^3 (475) and C^{14} (477) were used. A direct comparison has been made of the effects of ingested P^{32} and x-irradiation in terms of induced chromosomal aberrations in Drosophila melanogaster (479) and the grasshopper, Gesonula punctifrons (970). In Drosophila the peak production of sex-linked recessive lethals proved to be the same for P^{32} and x-rays (479). Incidental genetic effects of ingested Sr^{89} have been observed in Habrobracon (472).

INSECT ECOLOGY

(1) Behaviour

Various aspects of insect behaviour have been profitably studied by means of radioisotopes. Feeding has been investigated from the points of view of the mechanism of feeding, feeding habits and, in the case of social insects, the transmission of food*.

Feeding activity

Some radioisotope studies have been made on the rhythm of feeding activity of a particular stage, which is influenced by such factors as the season, time of day (13), light (25), temperature, wind, etc. The daily activity and feeding behaviour of Eurygaster integriceps Put. was followed with Ta^{182} , and revealed a change in behaviour pattern prior to migration (12, 13); P^{32} -labelling was used in another study (53). Feeding rates in aphids (12) and individual feeding activity (23), which was then correlated with the course of the labelled food were investigated with P^{32} . When Aphis fabae Scop. are attended by ants (12), a significant increase in feeding and excretion rates occurs. Feeding rates were also studied in the beetle Chrysomela knabi (143); the rate of Cs^{137} -elimination allowed overwintering and newly emerged adults to be distinguished. The consumption of vegetation in a contaminated area (14) was estimated using Cs^{137} and Sr^{90} . A mathematical expression for the feeding and elimination rates of adults and larvae has been proposed (27). The feeding activity of fleas has been studied in the field (33) and in the laboratory (26). Fe^{59} allowed the amount of blood ingested by various insects to be determined (158). Differences in feeding habits of Hessian fly (Phytophaga destructor) larvae on both resistant and

* Nutritional requirements are considered in I: I-8.

susceptible wheat seedlings (21) were investigated using P³²-labelled plants. The existence of different feeding regimes was established in larvae of Apanteles glomeratus L. parasitizing Pieris brassicae; at the last stage the insect switched from haemolymph to feeding on the host's fat (32).

The specificity of plant feeding was investigated in some mosquitoes when only 3 out of 24 (P³²-labelled) plant hosts proved acceptable (10).

Mechanism of feeding

Feeding mechanisms can have interesting bearings on plant damage by a particular pest and on possible disease transmission (23, 486-7, 489-91). Damage by the tarnished plant bug, Lygus lineolaris (P. de B.) was estimated in terms of the quantity of salivary secretion, using P³², and the amount of fluid imbibed during feeding, using Ag¹¹⁰ and Ce¹⁴⁴ (17-19). P³² was used to study intercellular and intracellular puncturing of plant tissue and the subsequent deposition of saliva by aphids (23-25). Aphis fabae Scop. could be shown to feed on phloem (16, 21-a). The mechanism of feeding of other aphids has been studied in detail (23-25).

Damage as a secondary effect of feeding, e.g. lysis of young plant tissue as a result of insect excreta, was found in maize (31).

Food transmission. Trophallaxis

Transmission of food is a complex process (39). The rate of food exchange varies with the species, the number of individuals, their social function, developmental stage, temperature, total time allowed, the quantity of food offered and available, and other factors (e.g. size differences between similar individuals).

The food, usually collected by "workers", has been shown to be transmitted to other members of a colony within a certain time, secondary transmission taking care of the distribution of available food throughout the colony. Much interesting work has been done on ants [8, 42; 43, 47 (P³²); 35-36, 38-39 (Au¹⁹⁸)], termites [9, 45 (P³²); 46 (Co⁵⁷, Sr⁸⁵); 42 (I¹³¹)], bees [58 (P³²); 37, 39, 48 (Au¹⁹⁸)], and wasps [60-61 (Au¹⁹⁸)]. The location of the (labelled) food in the insect was determined (35), the quantity carried by individuals varying between wide limits (36). In some ants, e.g. Proformica nasuta Nyl., the tendency for independent and secondary food-uptake proved subject to marked individual fluctuations. Food intake appeared to increase with body size [49 (P³²)]. The rate of food transmission differed markedly even in sub-families (42). In many species, individual participation in trophallaxis appeared to vary greatly with caste. In honey bees, Apis mellifera, where the most rapid trophallaxis takes place, queens, workers and drones were found to participate in it; drones proved capable of feeding themselves but preferred to be waited upon by the workers (42). Among wasps (Vespa), too, males had been observed to feed themselves (61) but this ability appeared to fluctuate with certain activities in the colony. Soldiers of the termite, Cryptotermes brevis, depended entirely on nymphs in the colony for being fed (46). Two kinds of trophallactic exchange, regurgitated food and saliva, were observed in another termite population, Cubitermes fungifaber (34).

The first to receive saliva was the queen. In colonies of the bumble bee, Bombus hypnorum, the queen appears to participate actively in food transmission [44 (Au198)].

P³² showed food secretion in ants (Formica polyctena and F. nigricans) to be mainly formed in the pharyngeal gland and stored in the crop, and on stimulus to be released to male and female ants, larvae as well as workers (47). Food formation in nurse bees (62) was investigated by labelling with C¹⁴. Not all larvae received food of the same quality. Those destined for sexual activity on reaching maturity were given preferential treatment in the quality and complexity of food made available to them. Even the quantity offered appeared to vary (61).

Neighbouring ant colonies are frequently inter-connected by subterranean passages. Radioisotopes may be used to determine the size, structure, location (55) and extent of such colonies (458), and interactions between them. Intensive food exchange between different nests of an ant colony has been observed up to 200 m (42) by labelling single nests. Food was shared unequally among inter-linked colonies of Formica polyctena (36). Transmission between colonies of different species (F. polyctena and F. rufa) was confirmed (35, 57). In a bee hive food is rapidly carried to the centre, with subsequent outward transmission (37).

Gradations in the ability to fend for themselves exist in different species and castes. Radioisotopes have served to throw some light on differences in group and individual behaviour (41, 42). In two species of ants and in termites (I¹³¹-labelled) food proved to circulate longer in groups, due to trophallaxis.

Miscellaneous

Other aspects of behaviour studied included the mating behaviour of mosquitoes (53-4, 56) females mated with P³²-labelled males showed spermathecal radioactivity. P³² was also used to investigate the oviposition habits of the leafhopper, Scaphoideus luteolus Van Duzee (51).

A definite avoidance reaction to P³²-malathion baits was demonstrated in malathion-resistant houseflies (56). The reaction of Aedes aegypti to repellent in blood varied with different concentrations (58).

The behaviour of pollinating agents (75, 77, 78; see also Apis mellifera) is now receiving increasing attention, and a marked rise in the number of publications may be expected in the future.

(2) Population dynamics

In studies on population dynamics a variety of radioisotopes have been used. Due to the number of factors which influence dispersal and migration, values tend to show considerable scatter; even within one experimental series. It is therefore essential to know the conditions under which particular values were obtained.

Some data have been summarized in Table I. P³² is used predominantly (e.g. for Apis mellifera 77-8; blowfly 80-1, 84, 93, 100, 1442; Ceratitis capitata 67, 72, 95-6, 786, 1452; Lampronota nitida 82; mosquitoes 53, 66, 69, 70, 461; etc.) although Co⁶⁰ (463) and S³⁵ have also been employed.

The effect of wind is not clearly defined (64, 70). The developmental stage (82), sex (66, 82), population density, availability of food, natural barriers (80, 84), temperature, and time of day are merely some of the factors which have to be considered. For example, one species required a minimum light intensity (0.2 Langley) for sustained flight (97). Two types of dispersal (81) have been observed: exodus, consisting of fast (200 yds at 7 miles/h or more) and sustained dispersal, and random dispersal where less or no net displacement occurs.

Flight ranges measured for different insects show a very wide variation. Cnephalia cinerascens (Rond.), a parasite of the grain Noctuid, Hadena sordida (Bkh.), has been known to cover 18-20 km in search of supplementary hosts (82). The record is held by a migratory moth which had become labelled accidentally, presumably by nuclear fission products, and is estimated to have covered the astonishing distance of 1500 miles (73).

Migration and dispersal may be of direct public health interest. Cockroach dispersion from sewer manholes was studied using P^{32} . Considerable attention has been paid to fly dispersal in urban and suburban areas (84), from inhabited premises (74), and especially from refuse dumps and garbage bins (68, 92, 457). P^{32} was also used to test the ability of synanthropic flies to cross water obstacles (93): a river ~500 m wide proved no obstacle.

Various species of blowflies (80) were found to disperse beyond a 50-yd belt of conifers and a 90-yd deciduous belt. Suburban dispersion was also studied in a Japanese city (84), the effects of natural barriers and a highway being noted. Due to their extensive breeding in the highlands, a special study of housefly populations was made in Malaya, with special reference to the Cameron Highlands (100).

Large scale (3×10^6) releases of Aedes taeniorhynchus (66, see Table I) indicated maximum distances of 2 miles and 18 miles for males and females, respectively. Studies on Anopheles gambiae [69, 70 (P^{32} , S^{35})] showed mosquito movement to be non-random and related primarily to human settlements. Prevailing winds played a minor role.

A non-random distribution of foraging honey bees (Apis mellifera) was found to exist between apiaries (77). By mass-marking with P^{32} , the distribution of foragers from colonies placed in the middle of a large alfalfa field was found to be maintained for two weeks; a second group placed in the field later dispersed in much the same way (78).

Eurygaster integriceps Put. were labelled with Co^{60} for dispersal and population studies (89). By labelling larval stages with P^{32} vertical migration could be shown to be a function of temperature, and horizontal migration a function of the developmental stage. Mobility is evidently connected with the physiological condition as characterized by the fat index (63).

P^{32} permitted the movement of the black currant gall mite, Cecidophrys ribis (Westw.) (79) to be followed, and hibernation survival of two insects without diapause to be assessed (67).

Radioisotopes have been used for determining population density in blowfly (80) and ants (83, 1561), Co^{60} being used with Eurygaster integriceps in place of P^{32} (89).

(3) Disease transmission

The place of radioisotopes in entomological studies of endemic and tropical diseases in man has been reviewed in detail by several authors (480-1); the labelling of epidemiologically important arthropods is discussed in 482.

The natural ecology of such vectors requires careful study. Considerable work has been done on Rhodnius prolixus, the principal vector of Schizotrypanum (i.e. Trypanosoma cruzi) in Venezuela. Co⁶⁰ was used for studying insect distribution in and out of doors (782). As a result, the concepts on its local behaviour required modification. In other work on R. prolixus H³ was used (301, 359).

Since fleas are known potential vectors of plague, data on their dispersal, migration, feeding activity and host-parasite relationships are being collected. In one migration study, rodents and their flea parasites were labelled with Sr⁸⁹ (139), the host remaining radioactive for at least two months. Ectoparasite interchanges within a host population were studied using S³⁵ (140)*. Seasonal effects on feeding activity (33, 141) indicated that spring epizootia of plague may be due to intensified feeding of fleas at that time, autumn fleas by virtue of their ecological indices assuring preservation of the plague bacillus for long periods. The predominance of females, with their higher feeding activity, indicates their significance in disease transmission (33).

Anopheles stephensi is known as the main vector of malaria in southern Iran (53). P³² was used in basic studies (53-4) on dispersal, mating behaviour, feeding, maturation of ovaries and length of gonadotrophic cycles.

Radioisotopes (P³², Cs¹³⁷, I¹³¹) were used for studying helminth life cycles, by allowing larvae transmitted by invertebrate hosts to develop in the (labelled) vectors Culex fatigans and Armigeres obturans (137).

The way in which animal disease is transmitted by blackflies (Simulium rugglesi) was studied on P³²-labelled duck-hosts (483).

Fly dispersal was studied in connection with the spread of dysentery and the eradication measures required (68).

Insect vectors play an important part in the transmission of diseases in plants. Pineapple wilt is caused by Pseudococcus brevis Ckll. Since this pest increases very rapidly when raised by the ant Pheidole megacephala (F.), a knowledge of the extent and structure of such ant colonies becomes of utmost importance in combating the disease and its spread. By labelling the ant with P³² such information can be obtained with precision, without causing any disturbance (458).

The transmission of plant viruses has received particular attention from Japanese scientists (488). Radioisotopes may be used not only to confirm transmission but also to throw light on the location of infective material within the insect. The transmission of dwarf disease of rice by the green rice leafhopper, Nephotettix cincticeps Uhler was confirmed with the aid of P³² (485). Following feeding on S³⁵-labelled diseased rice plants, radioactivity was concentrated in the Malpighian tubules. In another study (486),

* See also 459, 462.

P³² was used in an attempt to establish host preferences of the green peach aphid, Myzus persicae Sulzer, known to be a vector of the Daikon mosaic virus. A study on four species of aphids showed the extent of virus infection and the rate of transmission to vary with the species (491). In the course of work on the varietal resistance of garden crops to virus disease, mosaic virus transmission by three further species of aphids was traced with P³² or S³⁵ (490); S³⁵ was identified in the rostrum, pharynx, salivary gland, and alimentary canal of the aphid.

The acquisition and transmission of aster yellows virus by the aster leafhopper, Macrostelus fascifrons (Stål), was related to the feeding site (487). Transmission peaks occurred.

P³² and S³⁵ were used to study the fate of turnip yellow mosaic virus in the non-vector aphid Hyadaphis brassicae (L.) (444). Virus appeared to persist intact in the gut for several days.

(4) Insect-host relationships

The significance of the microorganism-insect relation in insect nutrition has been reviewed (134). C¹⁴ was used to clarify the role of intestinal symbionts in cellulose metabolism (135) and in sterol metabolism (373), and of intracellular symbionts in amino acid synthesis (232).

Identification of some predators was achieved by labelling their prey (the pink bollworm, Pectinophora gossypiella (Saund.; 136)) and of parasites by labelling the host (e.g. Noctuidae: 82, 138). P³² was also used for studying the parasitization of Pieris brassicae by Apanteles glomeratus (32).

In an investigation of the host-parasite relation between Mallophaga and its chicken-host Fe⁵⁹ was used (484), injected intravenously into the chicken.

A number of studies published on rodent-flea relationships (33, 139-141, 459, 462) have already been mentioned. (For other parasitic relationships, see under I-C Insect Labelling).

The life cycles of two helminths, Wuchereria bancrofti and Setaria digitata were studied in their P³²-labelled mosquito vectors, Culex fatigans and Armigeres obturans (137).

Food chains

The degree of transfer of fission products through plant to insect food chains (104-6, 116), relevant herbivore-predator relationships, the accumulation of radionuclides within the insect*, possible changes with time in the radionuclide distribution within a particular ecosystem, and the radioactive contamination of adjacent land by the dispersal of aquatic insects from contaminated water bodies (123-4, 126-7) have been receiving a great deal of attention**.

Surveys were made of the relative concentrations of β -emitters in parts of the Columbia River (114); aquatic insects within the Hanford Reservation below the reactor were found to concentrate P³², Cu⁶⁴, Cr⁵¹, Zn⁶⁵ and Na²⁴.

* The possibility of using certain insects as monitors of radioactive contamination has been considered.

** For radiation effects on aquatic insects see 108-12, 117-8, 122.

Interspecies differences in radionuclide accumulation were influenced by ecological and metabolic factors (115). Radionuclide accumulation has been widely studied (104, 167, 183-4) for a variety of radioisotopes, amongst them P^{32} , S^{35} , Fe^{59} , Zn^{65} , Sr^{90} , Y^{91} , Ru^{106} , Ag^{111} , I^{131} , Cs^{137} , Ce^{144} , Pm^{147} and Hg^{203} . The larval build-up factor varied from one to thousands depending on the element, with some species variation (184). Many differences could not be explained by size differences (relative growth and metabolic turnover) only (104). (See also 128-30 for the specific accumulation of individual radionuclides in fresh-water insects).

INSECT BIOCHEMISTRY AND PHYSIOLOGY

Examples have been selected to illustrate ways in which radioisotopes have been employed in research on various topics of insect biochemistry (412) and physiology.

Numerous studies have been published on the uptake, accumulation, distribution and elimination of individual radioisotopes or elements (154-7, 164-5, 167). Radioisotope excretion rates served as indices of certain metabolic rates (174).

The persistence, decay and distribution of P^{32} were investigated in grasshoppers and the Madeira cockroach (171). Other studies were concerned with its incorporation into phosphorus compounds of wax moth larvae (185), its uptake by various organs of locust (152) and by different stages of a mosquito (153), and with the transmission to descendants of P^{32} incorporated in the (*Drosophila*) parents (162-3).

The accumulation of Zn^{65} in mosquito was found to be 5-10 times higher than for other trace elements (172). Data are available on its distribution, persistence, genetic effects and effects on reproduction in wasps (168-9).

The distribution and retention of yttrium (Y^{91}) in flies was found to vary according to whether yttrium had been administered by injection (175) or ingestion (176).

Great variability in the localization of iron (Fe^{59}) in tissue and its association with cellular components occurred in *Chironomus plumosus* (177). Assimilation and elimination rates were studied at nymphal and adult stages of *Triatoma infestans* (Klug) (159).

The kinetics of sodium transfer have been studied intensively; both Na^{24} and K^{42} have been used a great deal in work on the insect nervous system (429, 431, 433-7).

(1) Carbohydrates

C^{14} -glucose was used in the majority of investigations on carbohydrates, e.g. on metabolic conversions during pupation in the Cecropia silkworm, particularly the deposition and utilization of nutrient reserves with reference to the larval cuticle (187). Information was also obtained on the carbohydrate metabolism in silkworm pupae following injury (151) and on some biochemical changes associated with larval growth and development in the blowfly, *Phormia regina* (Meig.) (202).

Some aspects of intermediary carbohydrate metabolism were studied in Triatoma infestans nymphs (186) and in the desert locust, Schistocerca gregaria Forsk. (193). Biosyntheses of glucosides and glycogen were also studied in the locust (200).

A great deal of work has been done on Periplaneta americana. Mucopolysaccharides were studied during moulting (196); mole ratios of bound carbohydrates were found to vary throughout the entire moulting cycle. Polysaccharide and glycoprotein formation (197), glucose catabolism in DDT-treated insects (199) and glycogen synthesis in insect fat body (201) were investigated. The level of inorganic phosphate proved rate-limiting for anaerobic glycolysis in muscle tissue of the cockroach (194). Trehalose is of considerable interest from various points of view; its biosynthesis (427) was studied in the fat body of locust (189) and of blowfly (190), where the concentration of blood trehalose was found to determine the rate of energy expenditure during flight (190-1). A study on the exchange and metabolism of sugars in the central nervous system of cockroach (430) indicated rapid conversion of glucose to trehalose (see p. 19).

Silverfish, Ctenolepisma lineata, was found capable of digesting cellulose without the help of symbionts (195) which proved necessary, however, in cricket and locusts (135).

(2) Amino acids and proteins

Nutritional requirements throughout their life cycle, and the composition and synthesis of their amino acids have been studied in a variety of insect species. Radioactive amino acids have been used widely in order to study protein turnover and synthesis. Some examples will be given.

Some amino-acid requirements of the green peach aphid, Myzus persicae (Sulzer) were determined by means of C^{14} -glucose (291). The important role played by intracellular symbionts of Blattella germanica in amino acid synthesis (134) has already been mentioned (p. 11). Amino acid requirements were also studied in nematodes (1587), in the pale western cutworm, Agrotis orthogonia Morr., (247), and the prairie grain wireworm, Ctenicera destructor Brown, (248). Nutritionally essential and non-essential amino acids were determined. The utilization of C^{14} -labelled protein was also investigated in Agrotis (225).

Amino-acid incorporation in larvae of Drosophila melanogaster was studied (285) by injecting C^{14} -labelled amino acids into the haemolymph. Very rapid incorporation into peptides was observed (286). *In vitro* incorporation of amino acids into proteins of Drosophila pupae was followed by means of C^{14} -leucine (239) and H^3 - and C^{14} -leucine in cell-free preparations (223). Amino-acid metabolism (266) and the effect of anoxia on it (267-8) were studied in the adult housefly by means of $[2-C^{14}]$ acetate. In the roach, Periplaneta americana (221), a quantitative comparison was made between amino acids in haemolymph from DDT-poisoned and from DDT-treated but symptom-free insects.

The metabolism of sulfur amino acids (210) and of related compounds (230) was studied in Blattella germanica, using S^{35} -cystine, cysteine, cysteine-sulfonic acid, taurine, methionine, methionine sulfoxide, methionine sulfone, and C^{14} -serine. Similar studies on the blowfly, Phormia regina (Meig.),

revealed (231) that, unlike *B. germanica* (210), *P. regina* was incapable of using sulfate in the synthesis of S-containing amino acids. The effect of the intracellular symbionts of *B. germanica* was studied using glucose-U- C^{14} (232), and once more (210) illustrated their necessity for the synthesis of cystine and methionine from inorganic sulfur. Some data on the cystathionine pathway in *B. germanica* were obtained, using S^{35} -cystathionine (233), and in some species of silkworm (250) using DL-methionine- S^{35} .

Tyrosine metabolism, studied intensively in a number of species, has been reviewed by Brunet (204) and Karlson (206) who also published a series of papers (240-4; see also 278-9). The incorporation of tyrosine metabolites in the puparium (240) and the incorporation of [α - C^{14}]N-acetyl-dopamine and generally labelled N-acetyl-tyramine (241) into the cuticle were studied in the blowfly, *Calliphora erythrocephala*. N-acetyl-dopamine was subsequently concluded to be the phenolic precursor of the sclerotizing quinones (see also 280, 245). The biogenesis and fate of the acetyl group of N-acetyldopamines was studied further (244). The C^{14} -labelled acetyl grouping was incorporated into the cuticula during sclerotization. The catabolic degradation of tyrosine and the biogenesis of N-acetyldopamine are discussed in 278. Hydroxylation of tyrosine to dopa, decarboxylation of dopa to dopamine, and N-acetylation of dopamine to N-acetyldopamine formed intermediate steps in the biosynthesis of N-acetyldopamine (280). The purification, properties, and substrate specificity of dopa-decarboxylase were investigated, using a C^{14} -labelled substrate (279).

The control of tyrosine metabolism by ecdysone was studied in developing *Calliphora* larvae with generally labelled preparations, L-[C^{14}]tyrosine, and L-[2'- C^{14}]dopa (243): ecdysone appeared to induce decarboxylating enzyme. *Periplaneta americana* proved able to synthesize protocatechuic acid from either generally labelled tyrosine or glucose- C^{14} (217).

A great deal of research on amino acids and proteins has been done in silkworm. The incorporation of valine-1- C^{14} into proteins of the *Cecropia* silkworm (289) was confirmed in various tissues and cell fractions (296), and of acetic acid- C^{14} into silk proteins of *Attacus ricini* (253). The mechanism of fibroin biosynthesis based on its chemical structure (264-5) was considered in a series of papers; the kinetics of fibroin synthesis were analysed in 282. C^{14} and P^{32} labels (254) were used in order to correlate fibroin synthesis with RNA metabolism (254). A further* series of papers dealing with biochemical studies on the amino acid composition of fibroin in *Bombyx mori* has been published by Bricteux-Grégoire et al. (213-6), C^{14} -labelled compounds being used throughout. Glycolic acid(1- C^{14}) appears to be used for glycine formation via glyoxylic acid (227, 236), the reaction playing an important part in larval glycine synthesis. A study on the metabolic pathway of amino acids in silkworm larvae in relation to silk production (237) showed synthesis of glyoxylic acid from citric acid(-1, 5- C^{14}) to take place via the glyoxylate cycle. Studies on the biosynthesis of glycine in the silkworm indicate a direct conversion of serine(-1- C^{14}) to glycine (261, see also 214); the conversion of glyoxylic acid to glycine in the intact silkworm was traced using glyoxylic acid-1, 2- C^{14} and glycine- C^{14} (262). A variety of studies

* See preceding volume (Bibliographical Series No. 9).

on protein synthesis (256-60, 269-70, 274, 276-7, 281, 292-3, 295, 297) have been reported, including work on particulate fractions in cell-free systems (256-8, 296-7).

Some work is reported on yolk formation (209) where protein synthesis in the ovary of Calliphora erythrocephala Meig. was studied by means of H^3 -L-histidine. Chromosomal syntheses of protein were investigated, using S^{35} - and C^{14} -labelled methionine and H^3 -leucine (288). RNA synthesis was shown to precede protein synthesis in Tribolium confusum (222).

Other investigations dealt with such topics as juvenile hormone in Samia cynthia (275), the role of the gonadotropic hormone in protein synthesis (301) in Rhodnius prolixus, and the biogenesis of ecdysone in Calliphora were cholesterol proved to be the precursor (246). The study of acetylcholinesterase activity over a wide range of substrate concentrations was facilitated by radiometric methods (303-4; see also 302).

(3) Nucleic acids

Asynchrony and differential rates of DNA synthesis in hetero- and euchromatin were confirmed in various Diptera (311), heterochromatin lagging behind in the meiotic chromosomes of grasshopper (325). The heterochromatin contained 2-3 times more DNA per unit area than euchromatin (326). Heterochromatic DNA, as derived from the Y-chromosome of Drosophila did not contain any associated RNA (334). In mealybug, Pseudococcus brevis, DNA synthesis in euchromatin occurred during the first half of the synthetic period, replication in heterochromatin in the second half (308).

The synthesis of DNA (in the nuclei of the ovary, fat body, and midgut of Rhodnius prolixus) and protein (mostly in the ovarian follicular epithelium and the fat body), and their transport were studied in the course of vitellogenesis (359). Nucleoside incorporation in DNA was studied in cricket ovary (315), as were variations during vitellogenesis. Accumulation of DNA reserves in oocyte cytoplasm of Coreus marginatus was investigated using H^3 -thymidine (318).

Investigations on salivary gland chromosomes and their organization (361) revealed different physiological conditions along their length (343); differential DNA-replication was observed in Chironomus thummi (322) and in meiotic chromosomes of grasshopper spermatocytes (327) DNA synthesis was found to occur at specific segments. Discrete points of synthesis were also indicated along polytene chromosomes in Drosophila (338). The apparent absence of DNA in interbands was deduced from quantitative autoradiographic data (357). Two kinds of DNA were found in Chironomus plumosus: one associated with the chromonemata, the other in the nucleoplasm surrounding the chromosomes and, in some cases, apparently extruded from the nucleus into the cytoplasm (340). A thymidine "pool" in grasshopper neuroblasts gave results supporting intracellular persistence of thymidine derivatives between periods of DNA synthesis (324).

DNA metabolism in pupal tissues was studied in some saturniid Lepidoptera (323) and in Diptera (342). Some chromosome regions seemed still capable of synthesizing DNA during digestion in the pupae (342), DNA synthesis thus apparently not being related to multiplication of chromonemata.

Some genetic effects induced by labelled DNA precursors have been observed (475, H^3 ; 477, H^3, C^{14}).

RNA and the control of cellular processes have been reviewed by Zalokar (363). Synthesis and breakdown of proteins and RNA were studied in Tribolium confusum (222). Isolated polytene nuclei of Rhynchosciara angelae and controls showed a similar pattern of nucleoside incorporation but differed for amino acids (351); the effects of various pre- and co-treatments were examined (352). Differential RNA synthesis was observed for the X-chromosome and autosomes in male locust (319). The role of gonadotropic hormones in RNA synthesis was studied in Rhodnius prolixus (301). Experiments with DL-leucine-4, 5- H^3 and uridine-5, 6- H^3 on Drosophila showed the cytoplasm to be the main site of protein formation (362), confirmed in Smittia (347). Further data in support of the hypothesis of a nuclear origin of RNA were obtained (362).

The role of the nucleolus in RNA synthesis was studied in oöcytes of Blattella germanica (364). It is suggested that nucleoli serve for intermediate storage or as a processing place for a certain kind of RNA from particular regions of the chromosome. Synthesis of nucleolar RNA, studied in Smittia (349), appears to begin in the nucleolus proper and is dissociable from the synthesis in the nucleolar organizer (355).

RNA metabolism was investigated in pupal tissues of saturniid Lepidoptera. Malpighian tubules, nervous tissue and haemocytes of Hyalophora cecropia synthesized RNA at a significant rate whereas all tissues of non-diapausing Samia cynthia synthesized RNA throughout the pupal stage (323). Synthesis rates vary with the tissue.

Earlier results on the composition of RNA from Lepidopteran silk glands were confirmed in a study on metabolism (310). Synthesis, intercellular transport, and breakdown of RNA were studied in the ovary of the housefly (312) and of the cricket, Gryllus bimaculatus (313, 314). At 5th instar, a RNA with a rapid turnover appears to be synthesized in the silk gland of Bombyx mori (321), with a base composition different from that of a ribosomal RNA but resembling that of DNA. No such RNA was observed at a later stage. The metabolic characteristics of nucleolar, chromosomal and cytoplasmic RNA in salivary glands of Drosophila were studied by analysis of the incorporation and retention of adenine-8- C^{14} and $P^{32}O_4$ (332-3). Two types of DNA-associated RNA were distinguished in Drosophila (335).

An extrinsic and an intrinsic nucleolar RNA were demonstrated in a study on the relation of messenger to nucleolar RNA (350), the extrinsic being chromosomal RNA. Messenger primes nucleolar RNA. Free messenger RNA was observed in the nucleus and followed to the cytoplasm. The synthesis of messenger RNA was studied in polytene chromosomes of Dipteran salivary gland (317), using H^3 -uridine. H^3 -labelled precursors showed puffs in the midge Chironomus to be active centres of chromosomal RNA synthesis (309).

(4) Pigmentation

Several studies have been reported on pterins and leucopterins. Experiments on Drosophila (211-2) have shown that the C atoms of glucose are

specifically used to build up the pyrazine ring of the pterins. A synthesis of biopterin-2-C¹⁴ is described in 271. The metabolism of biopterins in the honey bee was studied in queen bee and worker larvae, through pupation to the imago. The biosynthesis and structure of leucopterin were studied in pupae of the cabbage moth, Pieris brassicae (305-7). In biochemical studies on cuticle pigmentation in Gryllus bimaculatus de Geer and Locusta migratoria, S³⁵- and C¹⁴-labels were used (228-9). Yellow wing pigments were studied in papilionid butterflies (299, 300).

(5) Sterols and lipids

Insects generally have been found to require a dietary source of sterol for normal larval growth and metamorphosis, which implies some enzyme deficiency for sterol synthesis. In the housefly, a dietary source of sterol proved essential also for sustained viable egg production, cholesterol being involved in mobilizing and utilizing nutrient reserves associated with the initiation of ovarian maturation (395). The nature of housefly sterols (365-6) and their metabolism (367) has been studied in some detail, frequently with cholesterol-4-C¹⁴. Cholesterol metabolism was further studied in cockroach (367, 381). The presence of at least three functionally distinct sterol pools was indicated in the tissues of Eurycotis floridana (387). A general procedure for the isolation of its sterol esters was given (368). Dietary cholesterol was efficiently utilized in Blattella germanica, more than 90% of the ingested sterol being retained (393). The fate of dietary H³- β -sitosterol in the nymphal roach and in adult housefly (383) showed considerable differences. Some data were obtained on essential cholesterol requirements of cockroach (E. floridana) tissue (374) and on the role of intestinal symbionts in the sterol metabolism of B. germanica (373).

The sterol esters of housefly eggs and their fatty acid content have been analysed (379). In a study on sterol utilization by the hide beetle, Dermestes vulpinus (376), the structure of various sterols and their cholesterol-sparing efficiency were correlated. The conversion of cholestanol to Δ^7 -cholestenol was studied in cockroach (389).

A study of steroid biosynthesis in silkworm (396) suggests C¹⁴-acetate to be a precursor of sterol in pupae in the same way as in mammals. Biosynthesis of cholesterol was confirmed in silverfish, Ctenolepisma (375); it failed to be confirmed in another primitive insect, Thermobia domestica (384). Cholesterol metabolism was studied in the rice moth, Corcyra cephalonica (392). The previously reported absence of sterol synthesis from C¹⁴-acetate in adult housefly proved not to be due to a metabolic block in the biosynthesis pathway between acetate and mevalonate (382); the whole sterol-synthetic pathway is probably lacking. Larvae of aseptically reared blowfly (Calliphora erythrocephala) were unable to synthesize cholesterol from acetate or to synthesize or use squalene in its place (397).

A micromethod for tritiated steroids has been described (385).

The main differences between housefly and mammal phospholipids appear to be low plasmalogen content, absence of sphingomyelin, occurrence of a sphingolipid containing phosphorus, and the predominance of phosphatidylethanolamine (378). The biosynthesis of phospholipids in insects was studied

in selected moths in terms of their incorporation of P^{32} -phosphocholine (370) and P^{32} -orthophosphate (371-2), and synthesis and lipogenesis from C^{14} -acetate in cockroach (388, 404) and the boll weevil (386). Phospholipids, particularly those of the thoracic ganglion, were studied in dieldrin-resistant and susceptible houseflies (369). Two phospholipid components were found to be stable to hydrolysis with mild alkali and acid (377).

The biochemistry of the insect fat body was reviewed by Kilby (427). The *in vivo* synthesis of fatty acids was studied in the green peach aphid (400) and in the fat body of the moth *Prodenia eridania* (406) which contains a system enabling acetate to be incorporated into long-chain fatty acids (predominantly palmitic acid). The biosynthesis of fatty acids was investigated in aseptically reared blowfly larvae (398). The rate of fatty acid synthesis was found to be 2.5-4.7 times greater in male than in female cockroach (388). Fat synthesis in cell-free preparations of fat-body (402) and fat transport were studied in locust (401).

(6) Nervous system

Functional aspects of the organization of the insect nervous system have been reviewed in the light of recent work (429). Nucleotides and other phosphorus compounds of the central nervous system (CNS) of cockroach were studied by means of the labelled pool technique using P^{32} -orthophosphate (421-2). Concentrations of the various compounds in the abdominal nerve cord were comparable to those found in mammalian nervous tissue except that cytidine and uridine nucleotides were higher (422). The amount of phospholipid in cockroach nerve was similar to that in mammalian peripheral nerve. Permeability and perilemma function were studied by observing the uptake of some C^{14} -labelled molecules by the abdominal nerve cord of *Periplaneta americana* (411).

The exchange of Na ions and Na^{24} efflux from isolated abdominal nerve cord, single connectives, and ganglia (433-6) were studied in the roach. An initial fast phase was attributed to a rapid diffusion from extracellular space, demonstrated with C^{14} -inulin, a second (rate-limiting) phase being interpreted as slower extrusion from tissues lying at a deeper level in the CNS (432). Na appears to be extruded from the nerve cord by a metabolically maintained secretory mechanism which is also associated with the uptake of K (432-3), an earlier (431) calculation of ionic fluxes being based on an oversimplification. The efflux of tritiated water from the ligated nerve cord also occurred as a 2-stage process. By means of Na^{22} , Na^{24} , K^{42} , Ca^{45} , Cl^{36} and H^3OH the levels of the various ions in the extracellular fluid could be shown to differ markedly from those in the external medium, the cations being more and the chloride ions less concentrated (437). The efflux of Na^{24} from desheated terminal abdominal ganglia was also found to approximate to a 2-stage process. The rapidly exchanging fraction (identified with the ions in the extracellular spaces) represents $\sim 1/3$ of the total exchangeable Na in the ganglion. The extracellular space was measured using C^{14} -inulin, and could be shown to contain 18.2% of the ganglion water (436-7). The concentration of Na ions in the extracellular fluid exceeded the concentration in the haemolymph and cellular Na by factors of 1.8 and 2.5, respectively.

The transfer of substances between the blood and the CNS was analysed, particularly with reference to exchanges of labelled (C^{14} , Na^{24} , K^{42}) sugars with the haemolymph, the size and structure of the extracellular space, and the composition of the extracellular fluid as compared with the haemolymph (438). Injected C^{14} -glucose was rapidly converted to trehalose; 90% of the carbohydrate material crossed the perilemma as large trehalose molecules, the glucose molecules passing at 2.5 times the rate of trehalose. Results indicated the existence of the Krebs tricarboxylic-acid-cycle enzymes in the CNS (430).

Cholinesterases in insect muscle innervation were investigated in several species, with special reference to the insecticidal effects of DDT and DFP (420). The toxic effect of DDT apparently results from modified permeability and not cholinesterase inhibition. Moderate DDT poisoning reduced K^{42} - (but not Na^{24} -) uptake by peripheral nerves and ganglia from surrounding aqueous media.

(7) *Tissues and organs*

It might be of interest to consider briefly some of the tissues and organs which have been studied.

Cuticle

The biochemistry of sclerotization has been the subject of numerous studies (e.g. 241-2, 245, 280 on Calliphora erythrocephala). Chitin synthesis was investigated in the locust Schistocerca gregaria (218), chitin synthetase in cell-free extracts of Prodenia eridania (238). Penetration rates into cockroach cuticle were found to increase with the polarity of the compounds in tests on certain inorganic salts and insecticides labelled with C^{14} or P^{32} (428). In a soil insect K^{42} penetrated the cuticle more rapidly than P^{32} (178). A one-sided permeability was observed for the salts tested. The spread of oil films and the penetration of oily solvent (1555, H^3 ; 1553-5, I^{131}) and C^{14} -insecticide (1555) were studied on blowfly cuticle.

Haemolymph

Investigations on its chemistry included an analysis of acid-soluble compounds in the haemolymph plasma of several Lepidoptera by means of ion-exchange chromatography (440) and P^{32} . Attempts were made to determine changes in haemolymph volume during the moulting cycle of Periplaneta americana (439). A possible explanation of the patterns in average total haemocyte counts observed in grasshopper (414) was put forward.

Fat body

Its complex biochemistry (427) and some studies (e.g. 402, 406) have already been mentioned. Some work has also been done on glycogen (201) and trehalose (189-90) synthesis, and on protein and nucleic acid syntheses (359, 273) in the fat bodies of various species.

Reproductive tissue

The metabolic activity of ovarian tissue has been analysed in a variety of species with regard to phosphate metabolism (23), nucleic acid metabolism (313-5, 345-6, H³; 348, 426, C¹⁴) and yolk formation (209, H³). Absorption and subsequent breakdown of C¹⁴-urea was studied in diapausing eggs in Acheta commodus (Walk.) (423).

Tritiated thymidine was used to time the spermatogenetic cycle in Drosophila (418).

Silk gland

The mechanism of protein synthesis, and particularly the role of RNA in governing synthesis have been studied in the silk gland of various species of silkworm. The gland is an organ of exceptionally high RNA content. Much of the work was done on Bombyx mori by means of C¹⁴-labelled substances (256-62, 269, 270, 274, 276-7, 292-3, 296-7, 310), particular attention being paid to fibroin synthesis (213-6, 254, 264-5, 270, 277, 282-4, 292, 295) and its composition.

Salivary gland*

The use of radioisotopes in studying salivary gland function is reviewed in 413. The structure and function of giant chromosomes in the salivary gland of various Diptera (e.g. Chironomus plumosus 309, 322, 337, 339, 340; Rhynchosciara angelae 316; Simulium 341; Drosophila 342) were studied by means of tritiated compounds. Differences in physiological condition of the chromosomes along their length, puff formation, and sites and sequence of RNA and DNA syntheses (317) were some of the problems analysed.

INSECTICIDES

The application of radioisotopes in insecticide studies has been widespread and varied (684, 657, 550), ranging over such aspects as synthesis and biosynthesis, insecticide composition, purity, degradation products, insecticide metabolism (including insecticide uptake, translocation, tissue distribution and excretion), in insects, other animals and plants, toxicity, persistence and residue analysis, and soil sorption. C¹⁴ and P³² are the most frequently employed radioisotopes although others, e.g. Cl³⁶, Br⁸² and I¹³¹, have also been used. Relevant studies have been summarized in Table III.

There are a number of major practical difficulties in assembling documentation on radiotracer studies on insecticides. First, growing sophistication with regard to radioisotopes which have now for some time been a familiar tool for this type of research has led many authors to omit all mention of radioisotopes in their titles and, frequently, even in the abstracts.

* A review of the vast amount of work based on the salivary gland chromosomes of Drosophila (e.g. 832) is clearly outside the range of this discussion.

As a result, there is an increasing need for consulting original articles rather than to rely on abstracting journals, particularly when no detailed cumulative index of the type supplied by Chemical Abstracts is available at the time of consultation. Furthermore, abstracts are not necessarily very informative on the methods and tools used in a particular study. Secondly, there is a very marked diffusion of the literature over a large variety of publications; apart from certain major journals, scanning has to be very wide and the yield is relatively poor. Thirdly, information assembled on insecticides must inevitably be considered to be very incomplete since many industrial laboratories which are very active in this field do not permit their work to become available to the general scientific public. One further difficulty lies in the task of keeping abreast of current and past development on chemical control measures. There is still some confusion over the identities of certain compounds. A very large number of commercial and experimental compounds are and have been tested and used, and have become known under various synonymous chemical or trade names. When results were first published a coded number may have been used, to be followed by an abbreviated chemical name or some other incomplete designation. A table has therefore been set up (Table III) in which chemical names and other designations are given for insecticides cited in this bibliography (see Kenaga's "Commercial and Experimental Organic Insecticides", 1963 revision, in Bull. ent. Soc. Amer. 9, 2 (1963) 67-103). Where chemical names are in accordance with the principles of Chemical Abstracts this is indicated. The tabulated data have been assembled in separate categories, i.e. botanicals and derivatives, chlorinated aryl hydrocarbons (containing 6 or more chlorines), DDT relatives (diphenyl aliphatics), fumigants, heterocyclic compounds, phosphorus-containing compounds [aliphatic derivatives, aryl(phenyl) derivatives, heterocyclic derivatives], radiomimetic agents (chemosterilants)*, sulfonates, carbamates and miscellaneous. Corresponding tracer studies on insecticide metabolism, synthesis and properties, and residue analysis are tabulated, together with the radioisotope used. Two special indexes (a common and manufacturers' name index and a letter-and-number index) of insecticide references have also been prepared.

IONIZING RADIATIONS AND THEIR APPLICATIONS

The effects of ionizing radiations on insects may be broadly divided into genetic and cellular effects (II:I-A), and effects on development and on the organism (II:I-B). At the present time there are two main ways in which radiation may be harnessed for insect control: by using its genetic effects, as has been done in the sterile-male technique (II:II-B), and by using doses that are either lethal or capable of interrupting the life cycle, such as would

* Chemical control measures by means of chemosterilants are receiving increasing attention, and some interesting results have been obtained for mosquitoes and also such insects as the screwworm, the house- and the stable fly. Only those papers have been included in which radioisotopes have been used in the course of testing the chemosterilants, e.g. P^{32} -metopa (735, 737), and papers in which chemical and radiation-induced sterilization have been compared, e.g. sterilization of Drosophila (1169, 1172) and of mosquitoes (1173, 1180, 1378).

lend themselves to routine disinfection of, for example, stored commodities (II:II-C).

(1) The sterile-male techniques

The sterile-male technique consists basically of the mass rearing and release of males which have been sterilized or which carry a dominant lethal factor resulting from exposure to ionizing radiation (usually γ -rays); the native population is then overflooded repeatedly until the desired effects are achieved. Following the highly successful eradication of the screw-worm fly, Cochliomyia hominivorax, from Curaçao and the southeastern United States the sterile-male technique caught the imagination of scientists all over the world. An ever increasing number of pests is being investigated (see II:II-B), to determine whether the technique would be feasible for their eradication or control.

Considerable research is necessary before radiation can be employed as an effective autocidal technique in any one species. Radiosensitivity varies with the species, the stage, and sex (II:II-A. 10, 2; B. 1, 8). The optimum stage for irradiation has to be determined, and is usually found to be at the pupal or adult stage when the imaginal tissues have differentiated and cell division is most active in the gonads. Dose rate and dose fractionation have a marked effect on lethal dose and recovery phenomena, the degree of recovery being a function of dose, the interval between successive doses, the extent of fractionation, and the temperature at which insects are maintained before, during and after irradiation. Temperature effects such as occur when there is a high population density at the time of irradiation must also be taken into account. Doses must be standardized, and administered under controlled conditions of aeration, etc. A suitable irradiation procedure must therefore be established for a particular species, capable of producing the desired effect (sterilization, dominant lethal factor) whilst ensuring good survival, and the vigour and ability to compete effectively with the normal males. Much of the preliminary research data is found in part II: I Basic Research, under Genetic and Cellular Effects, where dominant lethality, sterility, and cell killing (A. 2), mitotic and meiotic stage sensitivity (5), modifying factors (6), and genetic effects on different species, strains and lines (7) are considered. Developmental effects of radiation (II:I-B.1) vary with a number of factors, such as age, the intensity of irradiation, conditions during treatment, etc. The effects may range from delayed to inhibited development or even death, and from minor anomalies to major detrimental malformations (B. 2). Some deformation is often found in the insect wing. Malformations have been observed in Blaberus craniifer (1266), Diatraea saccharalis (1434), Ephestia kühniella (1237, 1244, 1250), Laphygma frugiperda (1434), Tenebrio molitor (1238), Tribolium confusum (1298, 1300-3, 1367-8), Trogoderma granarium (789, 1238), and others. Radiation may cause changes in behaviour, for example, with regard to feeding, stinging, mating, orientation, pigmentation or affect the structure or physiology of certain tissues (B. 3), [e.g. the ovarian organs, as in Cochliomyia hominivorax (1265), Dacus oleae (1185), Drosophila melanogaster (1169), Habrobracon (1307, 1361), and Trogoderma granarium (1238)].

Effects on aging and longevity (B. 5), [e.g. Drosophila pseudoobscura (1384), Tribolium confusum (778, 1372)] are of great importance in testing sterilized males for their effectiveness in the field. Differences in the susceptibility of different species (B. 8) also require attention.

A thorough knowledge of the habits and ecology of the species under consideration is therefore essential. Data on dispersal under prevailing conditions, the effectiveness of existing natural barriers (in the region to be controlled), mating habits, the number of annual generations, seasonal fluctuations in population density, the duration of different stages under given conditions, and the rate of emergence in natural habitats are just some of the questions that need to be answered before any control measures by means of the sterile-male technique can be envisaged. Very useful information can be obtained by means of radioisotopes on dispersal (see Table I), population density (80, 83, 89, 1561), the distribution and longevity of irradiated insects, mating behaviour (53-4, 56, 1375) etc. (see I:I-A. 2c, 3).

Table II summarizes data obtained on the radiation-induced sterilization of forty-two species of Coleoptera, Diptera or Lepidoptera, together with the radiation and dose employed for a particular stage. Radiosensitivity can be seen to differ widely. Thus, x- and γ -ray doses of only 3000 r and 3200 r will sterilize pupae of the housefly (812) and nymphs of the German cockroach (1354), respectively, whereas 15 000 r of γ -radiation (789) are required to sterilize the Khapra beetle. Sex differences in radiosensitivity are very noticeable in the beet armyworm, Spodoptera exigua, where female pupae only require 5000 r for sterilization against 9000-11 000 r for males (810). Sterilization doses for mosquitoes vary very considerably with the species. Thus adults of Anopheles maculipennis atroparvus may be sterilized with only 8000 r of x-radiation, whereas 8865-12 900 r of γ -radiation are required for A. quadrimaculatus (1180, 1446); Culex fatigans requires only 7700 r (1447) against 11 000-18 000 r for Aedes aegypti (1444). The influence of age on susceptibility (at a particular stage) is very marked in, for example, Ephestia kuehniella where the sterilization dose ranges from 10 000 to 30 000 and 60 000 rad (1235, 1468), depending on the age of the male pupae which are irradiated at 3, 6 and 15 d, respectively. The effect of varying such factors as temperature (1357-8, 1060, 1076, 1080, 1103, 1106, 1158-9, 1161, 1163) and the composition of the environment during irradiation (1045, 1055, 1075, 1116) are also brought out.

The sterile-male technique has for some time been of particular interest to the IAEA. Two panels on the sterile-male technique have been held at the IAEA, one in 1962, and another in 1964. A comprehensive report on the first panel, No. 21 in the Technical Report Series, was published in October 1963; the second panel report, No. 44, will be published in the same series in June 1965. In 1962, nine countries (Australia, Belgium, Canada, France, Greece, Israel, the United Arab Republic, the United Kingdom, and the United States of America) were represented, with delegates from the Food and Agriculture Organization and the World Health Organization. In 1964, Costa Rica, El Salvador, Italy, Southern Rhodesia and Tunisia were also represented, indicating the increasing interest in the subject throughout the world. A large number of species is being considered for possible inclusion in sterile-male release programmes (1434): The Australian sheep blowfly, Lucilia cuprina

(Wied.), which has proved rather unpromising; the New Guinea screw-worm, Chrysomya bezziana Villen, also unpromising at present; the tropical ox warble, Dermatobia hominis (Linn.), of Latin America, where the aspects are promising; the tsetse fly, which shows promise (those of the 25 species of Glossina known to be vectors of trypanosomiasis are of particular interest); the Mediterranean fruit fly, Ceratitis capitata (Wiedman), where encouraging results have already been obtained in field trials on Hawaii and Costa Rica (1452-3), important research also being carried out in France, Israel, Tunisia and the UAR; the Mexican fruit fly, Anastrepha ludens (Loew), where mass releases at two locations have proved encouraging; the oriental and melon fruit flies, Dacus dorsalis (Hendel) and D. cucurbitae (Coq.) where field trials on Rota, an island in the Pacific, near Guam, proved very informative for further development, although the overflooding ratio of 10:1 was not reached; the Queensland fruit fly, Dacus tryoni (Frogg) where mass rearing of 10⁶ pupae/week has already been achieved and field trials carried out; the olive fly, Dacus oleae (Gmelin), which is promising, interesting results being obtained in Greece, Israel and in Italy; the codling moth, Carpocapsa pomonella (L.), now being tested in the field in Canada, which proves promising. Amongst the crop pests tested in the USA are also the sugarcane borer, Diatraea saccharalis (Fab.), where difficulties are being encountered in sterilizing without affecting moth emergence; the European corn borer, Ostrinia nubilalis (Hübner) which shows promise; the pink bollworm, Pectinophora gossypiella (Saunders), where the most suitable stages (ages) for irradiation were determined; the boll weevil, Anthonomus grandis Boheman, where preliminary sterilization data have been collected; the fall armyworm, Laphygma frugiperda (J.E. Smith), where radiation tolerance was studied; Drosophila melanogaster (Meig.), where field trials in Beltsville, Md., and other work indicate that population growth may be inhibited by a flooding ratio of 16:1; the Mediterranean flour moth, Anagasta (Ephestia) kuehniella Zell., where mass rearing and sterilization proved feasible but ecological circumstances unfavourable.

It must be remembered that the sterile-male release method cannot always be used against an insect species despite its tremendous eradication potential for some. Various factors may be responsible for such failure. Mass production of the insect may prove too difficult or too costly; sterilization may affect insects detrimentally, in terms of life-span, development, mating behaviour, etc.; distribution of the sterile males may be unsatisfactory because of local conditions (wind, predators, etc.); serious damage may be inflicted on man, animals or plants as the result of releasing additional insects into an area; the size of the infested may be too large to be treated economically, the existing population too great for overflooding and too widely scattered for effective preliminary reduction by other means; and a lack of adequate geographical barriers may leave the area wide open to subsequent reinfestation.

The application of the technique to Mediterranean pests, such as the olive fly, the Mediterranean fruit fly, and some others appears, however, to be promising. This possibility has attracted a great deal of attention, and the Agency is supporting projects in Greece, Israel, Pakistan and Tunisia. Under a United Nations special Fund a one-million dollar project was approved recently (January 1965). The joint FAO/IAEA Division of

Atomic Energy in Agriculture will attack the Mediterranean fruit fly problem in Central America, following a request submitted by Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. Present losses due to the insect are estimated at \$7 million/year and may be expected to reach \$82 million/year if the infestation spreads further.

The pests of grain and other stored foods (mostly Coleoptera and Lepidoptera) do not lend themselves to control measures employing the sterile-male technique (1434). There are a number of reasons for this, apart from frequent multiple-species infestation. Bulk storage would not allow efficient release and distribution of the sterile males, particularly when needed in "hot" spots. Contamination of foods to any great extent by insect debris would be inadmissible. Many Lepidoptera are sterilized only at the expense of longevity with the necessary doses (~50 000 rad). Disinfestation by means of ionizing radiation can, however, be approached in a different way by the bulk irradiation of stored commodities which will be discussed next.

(2) Disinfestation

Interest in the irradiation of stored commodities has caused a technology of its own to be developed, with emphasis on irradiator design and on research into biochemical and other effects of irradiation. Most of this lies outside the scope of this bibliography.

Studies dealing with infestation detection, disinfestation measures by means of specific irradiators, and economic considerations are found in part II:II-C, 1-4. Disinfestation measures rely chiefly on lethal effects, mainly at the egg stage, or on breaking the life-cycle at some stage thus preventing reproduction. The time required to affect an entire insect population will depend on the experimental conditions employed. Some of the preliminary investigations on the radiation susceptibility of different species at various developmental stages and on optimum condition for irradiation (including possibly synergistic factors) can be found in II:II-B and A. 2.

The practical economics (II:II-C. 3) of irradiation compared with conventional control measures such as fumigation of, for example, grain and grain products have been calculated for a number of irradiators; operating costs will depend on such factors as cheapness of the particular sources at that time, handling capacity, capacity exploitation throughout the year, and on depreciation (1487, 1490, 1492). The design of a production-facility has to cope with two major groups of problems. The shape and size of the particular source must be arranged to provide maximum usable radiation energy with minimum absorption in the source itself, and the conveyor system must be arranged around the source at maximum absorption of radiation without over-exposure of parts of the products and without holding up an unduly large volume of product in the facility. A large number of irradiators have been designed and tested (1492, 1487), using different shapes, sizes and types of source arrangements and conveyor systems. The majority of irradiators use a γ -source (1487-91), although a variety of sources (reviewed in 1421) have been tested, including accelerated electron sources (768, 1484). Since high voltage electron beams are limited to about 5 MeV to avoid possible induced radioactivity, this necessitates a very high handling speed for grain.

Conveyor belts prove impractical, and pneumatic or gravity-flow systems become necessary. Some (γ)-irradiators are mobile, mounted on board ship for grain treatment (1490, 1492, 1494, 1496) or on a railway car (1236), thus allowing bulk irradiation of different products at widely separated localities as and when required. The railway mobile irradiator is designed for a capacity of 10 t/h with a 10 000-rad dose, and is aimed at the disinfection of, for example, citrus fruit. Thus grape fruit from an area where the Mexican fruit fly, Anastrepha ludens, is found could then be safely exported. The practical significance of irradiation for subsequent transportation and as a quarantine safeguard is obvious. Mobile units appear particularly suitable for seasonal products which have to be handled directly.

Since irradiation can produce 100% insect sterilization repeated fumigation and ventilation, both of which are costly, could be replaced by a single irradiation of e.g. wheat products (1490, also 1488-9, 1491). This is true provided subsequent storage is in insect-free and insect-proof containers, whether special grain silos, polyethylene-lined bags for wheat and other products, or small-scale packaging as for dried figs (1481, 1500) or spices are considered. The irradiation of packaged commodities is itself of considerable interest: with suitable packaging material (i.e. material which is insect-proof yet permeable to gases while remaining impermeable to water vapour) no reinfestation can occur and no further treatment is required.

Disinfestation of wood by irradiation [whether of termites (1501) or other wood-boring insects (1486)] presents some difficulties. According to Bletchley (1486) ~10 000 r (γ -rays) would probably be adequate for controlling wood-boring insects but an additional safety margin plus a correction factor for attenuation in the wood is necessary. Considerable work is still required before such a method could be exploited in practice.

Irradiation cannot be applied as a disinfection measure against plant-infesting nematodes (1468) since the radioresistance of the nematodes is so high that the plant would be destroyed long before the nematodes were affected (e.g. 320 000 rad eliminate infestation by Heterodera rostochiensis).

Other areas of research in which radiation has been used are, for example, the development of strains with different nutritional requirements or of differently coloured eggs for immediate sex-differentiation, as in sericulture. In apiculture, it has been possible to control Nosema apis by irradiating the infected combs with γ -rays (1536). Strains of entomopathological fungi of increased virulence have been produced by exposure to ionizing radiations (1535, 1569, 1570).

(3) Radiological Studies*

X-rays have proved very useful in radiological studies of a variety of ecological and physiological problems. These included investigations of

* It might be argued that an application of this type should not be included here, on the grounds that in all other cases we have been concerned with an effect on or change in the specimen as a result of irradiation. Here, on the other hand, the radiation is used for detecting and studying the insect, frequently in its natural habitat, without affecting the insect.

Electron microscope studies have been omitted altogether since vacuum and other working conditions involved necessitate using already fixed and, usually, stained specimens.

crop-function, in particular crop-emptying, in Periplaneta americana (1557) and Phormia regina (1560), and a comparison of the rates at which food passes through the intestines of different species of locusts (1559). In the shipworm, Teredo sp. (1556), it was possible to study its boring habits, burrow building, preferred positions for settlement, and activity at different stages of development. Insect infestation in a number of stored commodities has been detected routinely by means of x-rays (as in, e.g., grain: 1508, 1526; wheat: 1510; dried peas: 1515; cocoa: 1514; wood: 1503-5; 1507, 1517, 1521, 1523, 1556). Seed quality, particularly of forest seed, has been assessed radiologically (1513, 1524-5); the stage of the infesting insect, the harvouring within a cocoon of a live or dead insect, possible parasitization, and traces of past infestation can be recognized.



PART I
RADIOISOTOPES



I INSECTS

I-A Ecology

I-A-1 GENERAL ARTICLES. SURVEYS

- 1* Андреев, С.В. ИЗУЧЕНИЕ И РАЗРАБОТКА МЕТОДОВ БОРЬБЫ С ВРЕДИТЕЛЯМИ И БОЛЕЗНЯМИ РАСТЕНИЙ С ПОМОЩЬЮ РАДИОАКТИВНЫХ ИЗОТОПОВ И ИЗЛУЧЕНИЙ. Стр. 621-? в сб. "Всесоюзное совещание работников сельскохозяйственной науки". М. 1957.

Andreev, S.V. STUDY AND FORMULATION OF METHODS OF CONTROLLING PLANT PESTS AND DISEASES BY MEANS OF RADIOISOTOPES AND RADIATION. p.621-? in "Proceedings of the All-Union Conference of Workers in Agricultural Science, Moscow, 1957".

- 2 Auerbach, S.I. RADIATION ECOLOGY. p.47-72 in "Health Physics Division, Annual Progress Report for Period Ending 31 July 1962". ORNL-3347, Oak Ridge National Lab., Tenn. 12 Nov. 1962.

Samples taken in 1961 from White Oak Lake bed showed that concentrations of radionuclides in herbivorous insects were essentially unchanged since 1958, for both Sr^{90} and Cs^{137} . Results are presented of tracer studies on insects and arthropods (including the millipede, *Dixidesmus erasus* with Co^{60} , Sr^{90} , Cs^{134} , Fe^{59} and Zn^{65}). Studies were continued on the aquatic ecology of the Clinch River and the fate and effects of radionuclides released in waste solutions. The mean chromosomal aberration per individual per month of larvae of *Chironomus tentans* exposed to radiation 20-1000 times above the background intensity was computed for testing for a change in frequency of chromosomal polymorphism. An analysis of variance among these monthly means showed no significant difference among them.

- 3 Auerbach, S.I., Schultz, V. ONSITE ECOLOGICAL RESEARCH OF THE DIVISION OF BIOLOGY AND MEDICINE AT THE OAK RIDGE NATIONAL LABORATORY. TID-16890, Oak Ridge National Lab., Tenn. and Division of Biology and Medicine, AEC. Oct. 1962, 146p.

The programme is described for the period 1955-63, with details of investigators, techniques, aims and results where available (including lists of reports and outside publications). The following investigations cited are relevant to this bibliography: - investigations on sterility and deformities of *Onthophagus* (Coleoptera, Scarabaeidae) induced by γ -radiation (1955); differential effects of γ -radiation on predator and prey species of mites (1955-6); effects of γ -radiation on Collembola population growth (1956-7); effects of acute and fractionated doses of γ -radiation on *Trogoderma* (Coleoptera, Dermestidae) (1956-7); arthropods associated with litter breakdown on decimeter litter bags (1959-60); gross effects of soil arthropods on leaf litter breakdown and release of radionuclides (1961-2) [4 levels of naphthalene at 100, 36, 10 and 0 g/m², 5 litter bags containing oak leaves tagged with Cs^{137} per plot, bags to be checked periodically for radioactivity, arthropods, respiration and microfloral counts]; insect invaders of pioneer vegetation on White Oak Lake bed (1958-8); gross aspects of movement of fission products in the soil-to-plant-to-insect food chain (1958-9); Sr^{90} and Cs^{137} accumulation in plant-insect-bird food chain (1958-9); accumulation and elimination of Cs^{137} by a grasshopper, *Rumex microptera* (1957); accumulation of Sr^{90} and Cs^{137} by grasshopper species on White Oak Lake bed (1959-60); turnover of Cs^{137} by *Chrysomela knabi* (1960); the effect of effluent atomic wastes on a *Chironomus tentans* Fabricius population as determined by salivary gland chromosome analysis (1960-3).

(See also 108 - 11, and 123 - 4).

- 4 Jenkins, D.W. RADIOISOTOPES IN ECOLOGICAL AND BIOLOGICAL STUDIES OF AGRICULTURAL INSECTS. p.3-20 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency. 1962.

Very comprehensive review article with 118 references. The varied uses to which radioisotopes have been and can be put in basic biological and ecological studies of insects of agricultural and veterinary importance

are summarized. New possibilities of insect control are discussed. Three tables are included, amongst them a listing of radioisotopes utilized so far.

- 5 Jenkins, D.W. USE OF RADIONUCLIDES IN ECOLOGICAL STUDIES OF INSECTS. p.431-40 in "Radioecology. Proceedings of 1st National Symposium on Radioecology, Colorado State University, Fort Collins, 10-15 September 1961". New York, Reinhold Publishing Corp. 1963.

Review article, divided into sections dealing with the selection of radionuclides and methods of labelling; forest and orchard insects; crop insects; social insects; insects affecting man and animals; parasites and predators; insect transmission of disease; and population studies. 108 references are cited (up to 1961).

- 6 Kansu, A. BÖCEK BİYOLOJİ VE ÖKOLOJİSİNE AIT ARAŞTIRMALARDA RADYOİZOTOPLARDAN İSTİFADE. (The use of radioisotopes for research in insect ecology and biology). Bitki Koruma Bül. 2, 7 (1961) 24-45. (In Turkish, with English summary).

Review article, with 65 references.

See also:

- 1575 Radyoizotopların entomoloji alanında kullanılması. (Use of radioisotopes in entomology). (Kansu, 1963).

I- A- 2 BEHAVIOUR

I- A- 2- a FEEDING

General

- 7 Dadd, R.H. FEEDING BEHAVIOR AND NUTRITION IN GRASSHOPPERS AND LOCUSTS. p.47-109 in "Advances in Insect Physiology. Vol. I". Beament, J.W.L., Treherne, J.E., Wigglesworth, V.B., Eds. New York, Academic Press. 1963.

Review article, divided into sections on feed and feeding (food-plant preferences, feeding behaviour, theories of food-plant selection), and nutrition (general considerations, specific requirements, and idiosyncracies of locust nutrition). Radioisotopes have been used in a number of studies but are not mentioned specifically. A total of about 180 references is cited.

- 8 Gösswald, K., Kloft, W. EINBLICKE IN DAS STAATENLEBEN VON INSEKTEN AUF GRUND RADIO-BIOLOGISCHER STUDIEN (Aspects of life in an insect colony, based on radiobiological studies). Imkerfreund 16, 1 (1961) 7-12. (In German).

Review article. Radioisotope techniques have been applied in studies of food distribution amongst ants, bees and termites, dealing with such aspects as the relative and actual speed, method, and the quantity of food distributed, and its dependence on such factors as temperature and humidity. The quality of food has also been investigated and found to vary, i.e. queen bees are given more complex food incorporated in gland secretions, and not merely regurgitated food. New light is also thrown on the roles played by sexually potent and other castes in the social structure of the different insects. (No references are given).

* * *

- 9 Gösswald, K. ON THE METHODS OF CONTROLLING MATERIALS FOR TERMITE RESISTANCE WITH PARTICULAR CONSIDERATION OF BIOLOGICAL DATA UNDERLYING THE TECHNIQUE OF CONTROL. p.169-78 in "International Symposium on Termites in the Humid Tropics, New Dehli, 4-12 October 1960". Paris, UNESCO. 1962.

After discussion of the necessity and feasibility of laboratory tests, test techniques are reviewed. Suitable standard termites are required. Most of the work considered was done on the dry-wood termite, Kaloterms flavicollis Fabricius, being in the author's opinion, the most suitable test insect; materials resistant to Kaloterms are generally so to wet-wood termites (Reticulitermes lucifugus Ross) and others. Data on temperature and humidity, other physiological conditions of the test room, test periods, and different tests are discussed. Some radioisotope (P^{32}) work is described on the stages which actually take in food and on the quantity consumed, and details of the technique are given.

- 10 Abdel-Malek, A.A., Baldwin, W.F. SPECIFICITY OF PLANT FEEDING MOSQUITOES AS DETERMINED BY RADIOACTIVE PHOSPHORUS. Nature, Lond. 192, 4798 (1961) 178-9.
Flowers and leaves of 24 different species of native plants were labelled with P^{32} solutions (20 $\mu\text{C}/\text{ml}$). Preliminary tests with cotton wicks using different concentrations of P^{32} (as $\text{H}_2\text{P}^{32}\text{O}_4$ in 5% dextrose solution) had proved that this concentration, on feeding, gave easily detectable counts in both male and female mosquitoes. The technique of labelling is described. Larvae of native mosquitoes (Aedes imbecillilis (Walker), A. dianeus H.D. and K., and A. punctor (Kby.)) were collected from temporary pools and swamps, and reared to the adult stage in the laboratory. Laboratory tests showed that feeding had taken place on only 3 species: Viola conspersa, Trillium grandiflorum, and Spiraea latifolia. Under the conditions of the experiments, mosquito feeding was confined to plant sap from the leaves.
- 11 Auclair, J.L. APHID FEEDING AND NUTRITION. Annu. Rev. Ent. 8 (1963) 439-80.
Comprehensive review article, including numerous studies in which radioisotopes had been utilized. Different aspects of feeding are considered on p.439-54. Very little is known about the nutritional requirements of aphids; a technique (used elsewhere) which could easily be applied to determine essentiality of amino acids in aphids makes use of injection into the haemolymph of glucose- $\text{U}-\text{C}^{14}$ or L-glutamic acid- $\text{U}-\text{C}^{14}$, followed by a determination of the radioactivity of each amino acid subsequently isolated from the insect. Further sections deal with enzymes of the alimentary tract; honeydew (p.459-71); and symbiotes (with special reference to the nitrogen economy of aphids).
- 12 Banks, C.J. SOME RECENT STUDIES, INVOLVING THE USE OF RADIOISOTOPES, OF THE FEEDING BEHAVIOUR OF TWO PHYTOPHAGOUS INSECTS. p.175-7 in "Radioisotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency, 1962.
Three examples of researches made on insect pests with radioisotopes are given. The feeding and excretion rates of Aphis fabae Scop. were estimated by allowing the insects to feed on bean leaves made radioactive with P^{32} , and then relating the radioactivity of the aphids to that of the leaves. The results are presented and the method criticized. By allowing groups of A. fabae to feed on bean plants made radioactive with P^{32} , the hypothesis that ant-attendance significantly increases the aphid's feeding and excretion rates was confirmed. The movements and feeding behaviour in the field of adult Senn bugs (Eurygaster integriceps, Put.) were studied in Iran by tagging individual insects with small pieces of Ta^{182} so that they could be detected from a distance with a suitable instrument. The results are described. (Auth)
- 13 Banks, C.J., Dezfoulian, A., Brown, E.S. FIELD STUDIES OF THE DAILY ACTIVITY AND FEEDING BEHAVIOUR OF SUNN PEST, Eurygaster integriceps Put., (Hemiptera, Scutelleridae) ON WHEAT IN NORTH IRAN. Ent. exp. appl. 4 (1961) 289-300.
The horizontal and vertical movements and the daily feeding activity of 6 young adult Sunn Pest (or "Senn"), each tagged with a small piece of Ta^{182} so that it could be located, were studied in wheat fields in north Iran for 3-4 d at the start and at the end of the adults' feeding period in June 1960. Insects could be detected in the wheat or in the soil at from ~40 cm with a portable G-M-probe. Microclimatic records (temperature and humidity) were maintained, and the methods and labelling described. Labels were cut from an irradiated strip of Ta^{182} , ca. 0.05 mm \times 0.16 mm \times 0.46 mm, av. weight 0.06 mg, av. specific activity 8 μC (120 $\mu\text{C}/\text{mg}$). An adult bug (young) is ~12 mm long and 7 mm wide, av. weight 11 mg. Observations indicate a change in behaviour pattern prior to migration, presumably associated with accumulating food reserves.
- 14 Crosley, D.A., Jr. CONSUMPTION OF VEGETATION BY INSECTS. p.427-30 in "Radioecology. Proceedings of 1st National Symposium on Radioecology, Colorado State University, Fort Collins, 10-15 September 1961". New York, Reinhold Publishing Corp, 1963.
Radioactive tracers were used to estimate the consumption of vegetation by populations of insects. Such estimates were made for insects on the contaminated White Oak Lake bed, Oak Ridge, Tennessee, where insect populations contained Cs^{137} and Sr^{90} concentrations which were in equilibrium with concentrations in the plants. The rate of feeding was estimated from the whole body burden of Cs^{137} , the biomass, and an average elimination rate for the insects, plus Sr^{90} concentrations and biomass of the host plants. The calculations indicate that approximately 6% of the plant biomass was consumed by insects during a growing season. The insects considered were grasshoppers (Romalea microptera, Melanoplus differentialis, M. femur-rubrum) and the willow chrysomelid Chrysomela knabi.

- 15 Cavalloro, R. STUDIES ON THE NUTRITION OF Myzus persicae USING P^{32} . Tobacco, Rome 65 (1961) 287-97.
Nicotiana tabacum var. Samsun infested with M. persicae were labelled by placing the roots in a mineral solution containing neutralized $H_2P^{32}O_4$ (2 mc/ml) for 4 h. Leaves and insects were then separated, frozen, and homogenized. After lyophilization, the extracts were separated by paper electrophoresis and the radioactive bands located by autoradiography and counted. 4 bands were detected: phospholipids and inorganic phosphate, nucleotides, sugar phosphates, and additional inorganic phosphates. The percent distribution of the radioactivity in each band for the leaf extracts was 9.3, 0.8, 8.5 and 81.4, respectively. For the insect extracts, it was 7.9, 5.1, 10.9, and 76.0, respectively. (CA 56: 1962, 9244).
- 16 Ehrhardt, P. ON THE PROBLEM OF FOOD PLANT SELECTION BY APHIDS. Experientia 19, 4 (1963) 204-5. (In German, with English summary).
Megoura viciae pierces the sieve tubes of non-host plants, Allium schoenoprasum and Poa pratensis, but does not take up P^{32} from the parenchyma. Aphids apparently effect a probe before settling on the sieve tubes of the plant.
- 17* Fleming, F. PENETRATION AND DESTRUCTION OF PLANT TISSUES DURING FEEDING BY Lygus lineolaris. p.1003-7 in "Report of the XIVth International Horticultural Congress, Netherlands 1955". Wageningen, H. Veenman and Zonen.
In an attempt to determine the cause of the notoriously poor germination of seeds of the Umbelliferae, it was found that an insect (Lygus) destroyed the embryo without disturbing the other parts of the seed. In the section dealing with the mechanics of the damage caused by Lygus, (p.1005), reference is made to results obtained earlier with P^{32} , Ag^{110} and Ce^{144} .
- 18* Flemion, F. PENETRATION AND DESTRUCTION OF PLANT TISSUES DURING FEEDING BY Lygus lineolaris P. de B. Proc. 10th Int. Congr. Ent. 3 (1958) 475-8.
It has not yet been determined whether the lesions produced by the tarnished plant bug, L. lineolaris, are produced solely by the mechanics of piercing and sucking or whether in addition the saliva deposited during feeding produces secondary infections and/or is phytotoxic. The amounts of fluid imbibed and the quantity of oral secretions deposited in the host tissue were determined by the use of radioisotopes. Estimates of 0.05-0.25 μ l were obtained by means of P^{32} for the quantity of secretion deposited, estimates of 0.2-2.0 μ l (by means of Ag^{110} and Ce^{144}) for the amount of fluid imbibed. Techniques are described for detecting and assessing the damage done to the host.
- 19 Flemion, F. INSECT DAMAGE AS A FACTOR AFFECTING FRUIT SET. p.163-71 in "Proceedings of Campbell Soup Company - Plant Science Symposium, 1962".
Studies (Fleming et al.) of internal damage caused, as well as of the feeding mechanisms involved in the common and extremely destructive tarnished plant bug, Lygus lineolaris (P. de B.) [L. obliqueatus (Say)], are reviewed. Reference is made to earlier (pre-1961) work in which P^{32} was used for estimating the quantity of secretion and Ag^{110} and Ce^{144} for the amount of fluid imbibed during feeding (p.167).
- 20 Gallun, R.L., Langston, R. HESSIAN FLY FEEDING STUDIES UTILIZING RADIOISOTOPE $P-32$. Proc. N. Cent. Br. ent. Soc. Amer. 17 (1962) 32.
(See 21)
- 21 Gallun, R.L., Langston, R. FEEDING HABITS OF HESSIAN FLY LARVAE ON P^{32} -LABELED RESISTANT AND SUSCEPTIBLE WHEAT SEEDLINGS. J. econ. Ent. 56, 6 (1963) 702-6.
At Purdue University during 1960 and 1961, experiments in which P^{32} -labelled potassium dihydrogen phosphate was utilized, showed that: (1) Hessian fly larvae (Phytophaga destructor (Say)) fed on both P^{32} -treated and untreated resistant wheat Purdue 4217A3-1-6-3 for not more than 2 d and on the treated susceptible wheat Michigan Amber for at least 15 d; (2) maximum growth and radiation was detected from 6-d-old larvae dissected from treated susceptible wheat plants; (3) treated resistant wheat plants, at an age when Hessian fly larvae began to feed in previous experiments, had more detectable P^{32} than treated susceptible wheat plants of a similar age; (4) the growth of Hessian fly larvae, when subjected at 4 d of age to β -radiation at the rate of 10 mc/10 ml, was adversely affected, whereas the growth of larvae subjected at 5 to 14 d was not. (Auth.)

- 21 a Henning, E. NEUERE UNTERSUCHUNGEN ÜBER DIE BEDEUTUNG DER SOGENANTEN PROBESAUGSTICHE BEI APHIDEN. (Recent investigations on the importance of the so-called probing punctures by aphids). Z. Pfl. Krankh. 69, 6 (1962) 321-30. (In German, with English summary).
- In investigations on the shallow punctures caused by the probing of Aphis fabae Scop. on the leaves and stems of plants, as distinct from the deep punctures that follow prolonged resting of the aphid in one position, no taking up of any substance from plants of broad bean (Vicia faba) could be demonstrated by either histological or P^{32} tracer methods. The aphids appeared to feed from the phloem, and penetration of the stylets to this depth took an average of 45-60 min. The probing seemed to be merely a mechanical testing of the surface for a suitable site for penetration. (From auth. summary)
- 22 Каменкова, К.В., Молчанова, В.А. УСТАНОВЛЕНИЕ ФАКТОВ ДОПОЛНИТЕЛЬНОГО ПИТАНИЯ НАСЕКОМЫХ С ПОМОЩЬЮ РАДИОАКТИВНОГО ФОСФОРА И ЕГО ВЛИЯНИЕ НА СОЗРЕВАНИЕ ЯИЦ МЕНИКУСА, ПАРАЗИТА ЗЕРНОВОЙ СОВКИ. Стр. 29-30 в сб. "Материалы Симпозиума по применению биофизики в области защиты растений". Л. 1961. Р. Ж. Биол. № 18Ж374. 1962.
- Kamenkova, K.V., Molchanova, V.A. DETERMINATION OF FACTS ON SUPPLEMENTARY FEEDING OF INSECTS WITH THE AID OF RADIOACTIVE PHOSPHORUS AND ITS EFFECT ON THE MATURING OF EGGS OF Meniscus agnatus, A PARASITE OF Hadena basilinea Sch. p.29-30 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961. R. Zh. Biol. No. 18Zh374. 1962.
- The study concerned feeding of M. agnatus, a parasite of H. basilinea, and the development of its germ cells, using food plants tagged with P^{32} by placing them in a P^{32} solution (10 $\mu\text{C}/\text{H}_2\text{O}$). Flowering Onobrychis, Phacelia, Euphorbia, Peucedanum oreoselinum and Sisymbrium were used in the experiments. Parasites in the control group were fed on nectar of the named species of plants and a sugar solution. The number of mature eggs increased to 306 (94%) when feeding on nectar from radioactive Onobrychis; the corresponding figures for Sisymbrium nectar were 38 (24%), for Phacelia to 36 (22.8%) and for Euphorbia to 11 (7%). Span of life of M. agnatus was curtailed on the average by 20 d when feeding on a 20% sugar solution (with isotope), while the number of mature eggs in the female proved to be lower. Same results were obtained by feeding M. agnatus on nectar of P. oreoselinum, whose stems rapidly absorb the aqueous isotope solution.
- 23 Kloft, W., Ehrhardt, P. STUDIES ON THE ASSIMILATION AND EXCRETION OF LABELLED PHOSPHATE IN APHIDS. p.181-89 in "Radiotopes and Radiation in Entomology. Proceedings of a Symposium, Bombay, 5-9 December 1960". Vienna, International Atomic Energy Agency. 1962.
- Measurements show that aphids take up food only some time after stinging, at a moment which corresponds with reaching the phloem. The activity then suddenly increases to an approximate maximum, which is reached after the intestinal tract has become full of labelled phloem sap. Subsequently, however, the activity increases slowly because of resorption from the midgut. In the meantime, incorporation (assimilation) and excretion of radioactive material begins in different ways. The interval between the uptake of the tracer from a plant to its re-excretion with the saliva is 5 h at 22-24°C. This period, as well as the exact course of excretion of saliva during sucking and the distribution of saliva in the plant itself, were analyzed in detail. Tracer experiments indicate how the problem of virus transmission (especially of persistent ones) by plant-sucking insects may be attacked. Further excretion of the radioisotope takes place in the honeydew as well as through the bearing of larvae. On hatching, these larvae have only a low activity but this increases after longer periods of resorption in the maternal organism. On account of continuing ovoviviparie and by the use of P^{32} it was possible to obtain a record of the phosphate metabolism of the ovary in the live aphid. By measuring the different kinds of excretion as well as the remaining activity, the biological half-life and the amount of tracer actually assimilated may be determined. Any circulating radioactivity may be detected by measuring the haemolymph. Constant temperature must be ensured since the processes are highly sensitive to changes in temperature. (From auth.)
- 24 Marek, J. DIE WIRKUNG VON APHIDENSTICHEN AUF PFLANZLICHE ZELLEN. (Effects on plant cells of aphid punctures). Ent. exp. appl. 4 (1961) 20-34. (In German)
- Aphids, Myzus ascalonicus Donc., were allowed to prick detached bulb scales of Allium cepa, in green light, and subsequently anaesthetized with CO_2 . The stylets were then severed, and the epidermis dissected off and examined under a phase microscope. Intercellular and extracellular puncturing could be distinguished. In cells which had been pierced directly a saliva sheath was formed. The limits of saliva

action were studied with P^{32} -labelled aphids. After they had pierced the epidermis the part containing the stylets was mounted on a slide, and the preparation kept in the dark for 14 d, with a special film (Kodak, autoradiographic) covering it. After developing and fixing, darkened spots indicated cell portions which had been rendered radioactive by the saliva. Mechanical stimulus by needles only a few μ in diameter caused streaming in the cell plasma and a shortening of deplasmolysis time. The importance of these mechanical effects must clearly not be underestimated. Increased plasma streaming was apparently caused by amino acids in the saliva and by the amino acids derived from proteins on cell injury. Piercing with fine glass capillaries containing amino acids also cut down deplasmolysis time.

- 25 Marek, J. ÜBER DAS EINSTICH- UND SAUGVERHALTEN DER ZWIEBELLAUS, *Myzus ascalonicus* Doncaster. (Study on the piercing and sucking behaviour of the aphid *Myzus ascalonicus* Doncaster). Z. Pfl. Krankh. 68 (1961) 155-65. (In German, with English summary).

Aphids were rendered radioactive via P^{32} -labelled host plants. The techniques used subsequently are described in detail. Aphids which had been sucking for some time showed a greater tendency to pierce fresh plants than starved insects. By means of green light *M. ascalonicus* could be induced to pierce such unfamiliar material as filter paper. The aphids deposit saliva in all tissues if penetrated even for only a short time. This was demonstrated by G-M-counters and autoradiography. *M. ascalonicus* is able to distinguish different degrees of concentration in solutions of an acid, bitter or salty character. Sweet-tasting liquids were absorbed, no matter how highly concentrated. Buffer solutions of pH 6.2-8.4 represent the preferred pH range.

- 26 Новокрещенова, Н.С., Солдаткин, И.С., Левашина, А.И. СРАВНИТЕЛЬНАЯ ЧАСТОТА ПИТАНИЯ РАЗЛИЧНЫХ ВИДОВ БЛОХ, ОПРЕДЕЛЕННАЯ В ЛАБОРАТОРНЫХ УСЛОВИЯХ С ПРИМЕНЕНИЕМ МЕТОДИКИ РАДИОАКТИВНЫХ ИНДИКАТОРОВ. Вопр. Экол., Киев 4 (1962) 135-6.

Novokreshchenova, N.S., Soldatkin, I.S., Levoshina, A.I. THE COMPARATIVE FREQUENCY OF FEEDING OF VARIOUS KINDS OF FLEA, AS DETERMINED UNDER LABORATORY CONDITIONS, USING THE RADIO-TRACER METHOD. p.135-6 in "Voprosy ekologii, Vol.4, Kiev, 1962".

- 27 Oak Ridge National Lab., Tenn. STUDIES ON *Chrysomela knabi*. p.91-5 in "Health Physics Division, Annual Progress Report for period ending July 31, 1961". ORNL-3189.

Laboratory measurements were made on feeding and elimination rates for both larvae and adults. The investigation was aimed at testing the precision of $ra = \lambda Q_e$ where

r = rate of ingestion of a given radionuclide,

a = proportion absorbed from the intestines

λ = ratio of $\ln 0.5$ to the biological half-life T_b (or the effective half-life if the physical half-life is short) for the given radionuclide

Q_e = body concentration at equilibrium of that nuclide in the insects.

- Work is proceeding along the lines of (1) comparison of the rate of feeding, r , as calculated and as measured in laboratory experiments for a single insect species (*Chrysomela knabi*), and (2) investigation of rate of elimination of radioisotopes as a function of size of insect. The consumption and elimination of Cs^{134} is discussed.

- 28 Orenski, S.W., Maramorosch, K. THE FEEDING OF NORMAL AND ASTER YELLOWS-INOCULATED CORN LEAFHOPPERS. Phytopathology 52 (1962) 1219.

The earlier finding, that the corn leafhopper (*Dalbulus maidis*) can extend its host range after acquisition of aster yellows virus, has been studied further. Normal and viruliferous corn leafhoppers, fed on plant juices and sugar solutions through semipermeable animal membranes, experienced high mortality. None of the leafhoppers survived more than 7 d, whether food or distilled water was supplied through the membranes. Anal feeding also was attempted, but discontinued because of poor survival. Normal corn leafhoppers fed no better on aster leaves from which the epidermis was stripped, than on normal leaves. Feeding on isotope-labelled leaves, using aster leafhoppers *Macrostelus fasciatus* as controls, showed that normal and viruliferous corn leafhoppers fed equally well on corn leaves and acquired as much isotope as did aster leafhoppers. On the other hand, corn leafhoppers acquired only 1-10% as much isotope from aster leaves as aster leafhoppers did. Although viruliferous corn leafhoppers fed slightly better on aster leaves than normal ones, this difference was found only with corn leafhoppers confined to young aster leaves. (Auth.)

- 29 Orenski, S.W., Staples, R.C., Maramorosch, K. THE UPTAKE OF C^{14} AND P^{32} FROM LABELED LEAVES BY TWO SPECIES OF LEAFHOPPER VECTORS. Phytopathology 52 (1962) 1220.
- A study was made of food uptake by Dalbulus maidis Delong & Wole and Macrostelus fascifrons (Stål) on detached leaves of Zea mays and Callistephus chinensis labelled with C^{14} or P^{32} . Measurements of isotope uptake and distribution throughout a leaf showed a general decrease in radioactivity from the base toward the tip. Large variations were encountered between corresponding samples cut from opposite sides of a given leaf. A clearly defined linear correlation was found between the isotope content of a leaf and isotope uptake by feeding leafhoppers. There was no significant difference between isotope uptake by males and females, although wide variations were found between individual insects feeding for 24 h or longer. During short feeding periods, insects acquired only small amounts of isotope and up to 50% of radioactivity accumulated in their heads. The distribution of radioactivity changed with increased isotope uptake and after 24 h only about 10% of the total isotope was concentrated in the heads. When D. maidis were placed on upper and lower surfaces of a corn leaf, those on lower surfaces acquired more isotope. (Auth.)
- 30 Quraishi, M.S. WATER AND FOOD RELATIONSHIP OF THE EGGS AND FIRST INSTAR NYMPH OF Eurygaster integriceps WITH THE AID OF P^{32} . J. econ. Ent. 56, 5 (1963) 666-8.
- The eggs and 1st instar nymphs of E. integriceps Put. were studied. The eggs can withstand extreme dry conditions and can develop in a desiccator of $CaCl_2$. Three series of experiments were conducted in order to discover whether food is essential for its growth and moulting. In one series of experiments, freshly-emerged nymphs were maintained for 48 h on P^{32} -labelled wheat plants. Their changes in weight and radioactivity were recorded. In another series, nymphs were kept in a Petri dish with small filter paper disks soaked in P^{32} -solution. Weight and radioactivity were again checked after 48 h. It could be demonstrated that in order to moult, the nymph must feed, though the food may consist only of water absorbed through a filter paper. The length of life of a starving nymph shows positive correlation with humidity.
- 31 Shapiro, I.D., Khotyanovich, A.V., Vedeneva, N.A. PHYSIOLOGICAL EFFECT OF FRIT-FLY (Oscinotoma frit L.) ON EMBRYONIC TISSUES OF MAIZE. Dokl. Akad. Nauk SSSR 140 (1961) 978-80. (In Russian). English Translation: Proc. Acad. Sci. USSR. biol. Sci. Sect. 140 (1962) 886-8.
- The pattern of lysis of young maize tissues (by excreta) was investigated. The authors found that the excretory products of the larvae contain proteolytic enzymes, and enzymes of the amylase and invertase type which do not play any part in lysis. The results of some experiments with C^{14} -labelled glucose (glucose-1- C^{14}) indicated that frit-fly larvae utilize simple sugars. Maize shoots (at 3-4 leaf stage) were labelled by immersion in a glucose solution (specific activity 5 μ C/ml) for 48 h at 25-27°C. The plant stems (without leaves) were put into wide tubes containing larvae. After 48 h the larvae were removed, washed thoroughly, and homogenized. The radioactivity of the homogenate was then assayed. The average specific activity of such larvae was 89 cpm for a specific activity of 2210 cpm in the plant.
- 32 Шапиро, В.А., Хотянович, А.В. К ВОПРОСУ О ВОЗРАСТНЫХ ОСОБЕННОСТЯХ ПИТАНИЯ ЛИЧИНOK Apanteles glomeratus L. Стр. 67-9 в сб. "Материалы Симпозиума по применению биофизики в области защиты растений". Л. 1961. Р. Ж. Биол. №18Ж355. 1962.
- Shapiro, V.A., Khotyanovich, A.V. AGE CHARACTERISTICS INVOLVED IN THE FEEDING OF Apanteles glomeratus L. LARVAE. p.67-9 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961. R. Zh. Biol. No.18Zh355. 1962.
- Caterpillars of Pieris brassicae infested by the parasite A. glomeratus were fed on cabbage leaves infiltrated by a P^{32} -radioactive solution of KH_2PO_4 with a specific activity of 0.95 μ C/ml. The caterpillars and the parasites were desiccated after the feeding and their radioactivity was determined per 100 mg of dry weight. Radioactivity of the haemolymph was computed separately. It was established that the P^{32} penetrated into the host as well as the parasite. The haemolymph showed highest radioactivity in the host. In the parasite, the radioactivity varies in the development process. It is highest in the penultimate larval stage (51.4%) and decreases through the last stage and pupas to 15%. This is explained in terms of the varying feeding regimen of parasite larvae at different stages. Young larvae, up to the penultimate stage, feed on haemolymph and, in consequence, intensively accumulate the P^{32} . Larvae of the last stage discontinue feeding on haemolymph and change to feeding on the host's fat, hence the quantity of the isotope decreases in them. (BA 43: 1963, 12513)

Солдаткин, И.С., Новокрещенова, Н.С., Руденчик, Ю.В., Островский, И.Б., Лёвошина, А.И. ОПЫТ ИЗУЧЕНИЯ АКТИВНОСТИ ПИТАНИЯ БЛОХ БОЛЬШИХ ПЕСЧАНOK В ПРИРОДНЫХ УСЛОВИЯХ С ПРИМЕНЕНИЕМ РАДИОАКТИВНЫХ ИНДИКАТОРОВ. Зоол. Ж. 40, 11 (1961) 1647-50. Р. Ж. Биол. №12К139. 1962.

Soldatkin, I.S., Novokreshchenova, N.S., Rudenchik, Yu.V., Ostrovskii, I.B., Levoshina, A.I. EXPERIMENTS ON STUDYING THE FEEDING ACTIVITY OF FLEAS PARASITIZING GERBILLINAE UNDER NATURAL CONDITIONS BY MEANS OF RADIOISOTOPES. Zool. Zh. 40, 11 (1961) 1647-50. R. Zh. Biol. No.12K139. 1962.

In May and October of 1959 and April, May and Oct. of 1960, in colonies of *Rhombomys opimus* in the northwestern Kyzylkum, all the animals were captured, given glycine or acetic acid containing C^{14} in a dose of 200 μ c intragastrically, and then released. After varying periods of time the colony was excavated and among the fleas (*Xenopsylla gerbilli caspica* Ioffe) collected the percentage having ingested the radioactive label was determined by autoradiography. A marked seasonal difference in feeding habits was apparent in the spring and autumn. Other ecologico-physiological indices were also found to vary, such as the level of reproduction, the number of fleas gorged with blood (Ioffe's alimentary index), and the ratio of fleas simultaneously feeding on a rodent to the total number of fleas. Thus, in the spring, 75-85% of *Xenopsylla gerbilli caspica* had ingested the blood of a gerbil by 0.5-3 d, 42-46% were found on a gerbil at any one time, and 74-83% of the females were engaged in reproduction. In the fall, after 5-15 d, 25-40% had ingested the blood, 7-10% were found on the gerbils, and only 0.8-1.3% of these females were ready to lay eggs. In the fall the greater part of the flea population was in the young imago stage, with large fat-bodies, distinguished by their resistance to the effect of unfavorable conditions. Some of the labeled fleas admitted to the burrow in Oct. were recovered in April, but the fleas penetrating the burrow in May could not be found in Sept. The seasonal variations in feeding habits must be taken into account in experiments to eradicate fleas by systemic poisons. It is suggested that spring epizootics of plague may be due to intensified feeding activity of fleas at that time, whereas autumn fleas may assure preservation of the plague microbe for long periods, by virtue of their ecological indices.

See also:

- 35 Sur la transmission d'isotopes radio-actifs entre deux fourmilères d'espèces différentes (*Formica rufa* et *Formica polyctena*). (Chauvin et al., 1961)
- 49 Radiobiological study on the social feeding organization of the honey ant, *Proformica nasuta* (Nyl). (Stumper, 1961)
- 53 Use of isotopes for investigating the behaviour and ecology of insect pests in some recent studies. (Qurashi, 1963)
- 125 Experimental isolation of food chains in an old-field ecosystem with the use of phosphorus-32. (Odum and Kuenzler, 1963)
- 135 Assimilation de la cellulose et microorganismes intestinaux chez *Gryllus bimaculatus* De Geer Insecte, Orthoptère, Grylloidea. (Martoja, 1962)
- 136 Some predators and scavengers feeding upon pink bollworm moths. (Clark and Glick, 1961)
- 140 Application of radioactive isotopes to the study of some problems of flea ecology. II. The contact between rodents and the degree to which ectoparasites are interchanged in a population of *Rhombomys opimus*. (Sviridov, 1963)
- 141 Use of radioactive isotopes for the study of certain problems of flea ecology. I. Alimentary relations of fleas of the *Xenopsylla* with *Rhombomys opimus* Pall. under natural conditions. (Sviridov et al., 1963)
- 143 Use of radioactive tracers in the study of insect-plant relationships. (Crossley, 1963)
- 144 Note préliminaire sur l'utilisation des radioisotopes dans l'étude des parasites du coucouier en Afrique. (Delattre, 1963)
- 158 Determination by radioactive iron (Fe^{59}) of the amount of blood ingested by insects. (De Freitas and Da Silveira Guedes, 1961)
- 166 The problem of the excretion of radioactive isotopes by various aquatic invertebrates. (Getsova, 1961)
- 225 Rate of equilibration of the contents of the gut of *Anopheles quadrimaculatus* larvae with the surrounding medium. (Friedman, 1963)
- 489 Studies on the character and prevention of the virus disease of garden crops. II. Studies on the mechanism of aphid transmission of mosaic disease of Japanese radish, using radioactive phosphorus. (Nishi, 1959)
- 486 Ecological and therapeutical studies on the virus diseases of garden crops - Studies on the transmission of plant viruses by aphids. (Japan, Kyushu Agricultural Experiment Station, 1963)

- 487 Acquisition and transmission of aster yellows virus. (Maramorosch, 1962)
- 490 Studies on the varietal resistance of garden crops to the virus disease. V. On the course of aphid transmission of the mosaic disease of Japanese radish determined by P^{32} or S^{35} (1). (Nishizawa et al., 1958)
- 491 Studies on the mechanism of aphid transmission of mosaic disease of Japanese radish using radioactive phosphorus ^{32}P . (Nishizawa et al., 1959)
- 1570 Use of radioisotopes and radiation in the control of plant and animal insect pests. (Andreev, et al., 1963)

I - A - 2 - b TRANSMISSION OF FOOD

- 34 Alibert, J. ÉCHANGES TROPHALLACTIQUES CHEZ UN TERMITE SUPÉRIEUR. CONTAMINATION PAR LE PHOSPHORE RADIOACTIF DE LA POPULATION D'UN NID DE Cubitermes fungifaber. Insectes sociaux 10, 1 (1963) 1-12. (In French, with English summary).
- Des nids de C. fungifaber sont mis en élevage sur de l'humus contaminé (^{32}P). La radioactivité des insectes, mesurée après un temps de contact variable, permet de séparer deux catégories d'échanges trophallactiques: les échanges d'aliment régurgité, décelables dès les premières expériences, et les échanges de liquide salivaire apparaissant plus tardivement, 25 à 30 h après la mise en contact du nid avec l'humus marqué. On n'observe pas de différence significative dans la répartition du ^{32}P selon la zone de prélèvement des échantillons de population, sauf chez des soldats des nids isolés un temps court sur l'humus. La contamination des ouvriers est très rapide et la distribution du P dans cette caste, hétérogène. Certains ouvriers ne se nourrissent pas directement d'humus pendant le temps de l'expérience; ils reçoivent, ainsi que les soldats, de l'aliment régurgité (stomodéal). La reine est la première contaminée par le liquide salivaire des ouvriers, et sa radioactivité prouve une absorption constante de nourriture. Les aliés proches du vol nuptial sont gavés de salive, ainsi que les soldats blancs. Le couvain, les nymphes de l'avant-dernier stade et le roi ne reçoivent qu'une faible quantité de salive; le roi a un rythme d'alimentation lent et peu de besoins; les nymphes ont, sans doute, recours à un autre mode d'alimentation pendant l'avant-dernier stade.
- 35 Chauvin, R., Courtois, G., Lecomte, J. SUR LA TRANSMISSION D'ISOTOPES RADIOACTIFS ENTRE DEUX FOURMILIÈRES D'ESPÈCES DIFFÉRENTES (Formica rufa et Formica polyctena). Insectes sociaux 8, 2 (1961) 99-107.
- Pour le marquage, 50 mc d'une solution colloïdale standard du CEA d' ^{199}Au mélangés à 50 cm d'une solution sucrée très épaisse, ont été versés sur la surface de la fourmilière. Les F. polyctena qui ont reçu un radioisotope l'ingèrent rapidement et peuvent le transmettre aux fourmilières voisines de F. rufa. La radioactivité se localise dans l'abdomen des fourmis. Il est probable qu'il s'agit d'un échange par voie buccale. Les fourmilières présentent souvent, avant tout marquage, une certaine radioactivité très faible, due sans doute, d'après des recherches en cours, à la présence naturelle de potassium dont l'isotope 40 est naturellement radioactif.
- 36 Chauvin, R., Lecomte, J. LES ÉCHANGES SOCIAUX DU «DEUXIÈME DEGRÉ» CHEZ Formica polyctena. C.R. Acad. Sci., Paris 257, 20 (1963) 3049-51.
- Les auteurs ont voulu étudier les échanges de glucides entre les différentes colonies (?) d'une «fédération» de F. polyctena. Le marquage a été effectué à l'aide de ^{199}Au mélangé à un demi-litre de sirop de sucre à 30% versé sur la fourmilière. Le sucre ingéré par une colonie n'est pas également distribué aux autres colonies auxquelles elle est reliée. Les mesures étaient effectuées au scintillomètre, en principe toutes les heures. Les mesures au compteur Edith montrent que la «charge» individuelle en isotopes des ouvrières peut varier énormément, ce qui interdit les comparaisons trop poussées entre le taux de transfert de l'isotope et l'activité brute sur les pistes. L'échange de glucides est assez limité.
- 37 Courtois, G., Lecomte, J., Salleron, F. ÉTUDE DES ÉCHANGES DE NOURRITURE À L'INTÉRIEUR DE LA RUCHE ENTRE LES ABEILLES OUVRIÈRES Apis mellifica L. C.R. Acad. Sci., Paris 252, 7 (1961) 1057-9.
- Trois essais ont été effectués, en utilisant une ruche expérimentale de Chauvin, décrite en détail. Une population de 3 à 4000 abeilles l'occupaient. Les essais ayant été effectués durant les mois de décembre et de janvier, il n'y avait pas de couvain. Au moment des essais, la grappe était bien formée. Avec sa période de 2,7 j et son émission γ de 0,411 MeV, ^{199}Au présente un intérêt particulier pour ce type de recherches. Un petit nombre d'abeilles (5-10) devenait radioactif (par voie d'un nourrisseur contenant

~0,5 ml de miel marqué à ^{198}Au , la radioactivité introduite dans la ruche ne dépassant pas quelques microcuries. Les trois essais ont donné des résultats très parallèles. Les échanges de nourriture ne se font pas à partir du nourrisseur vers le centre de la grappe mais il apparaît de manière certaine que les ouvrières, après avoir empli leur jabot de miel, se dirigent très rapidement vers le centre de la grappe, en ne procédant ainsi qu'à des échanges très restreints. C'est de ce point privilégié que s'effectue la diffusion de la nourriture à travers l'ensemble de la population.

- 38 Courtois, G., Lecomte, J. ÉTUDE DES ÉCHANGES DE NOURRITURE ENTRE BUTINEUSES DE *Formica polyctena* TRAVAILLANT DANS DES SECTEURS DIFFÉRENTS MAIS APPARTENANT A LA MÊME FOURMILIÈRE. *Insectes sociaux* 9 (1962) 323-7.

Un marquage à l'or radioactif de butineuses de *F. polyctena* a été effectué le long d'une piste de butinage. Les auteurs ont constaté que les échanges de nourriture étaient très faibles entre ouvrières travaillant sur des pistes différentes. (Aut.)

- 39 Courtois, G., Lecomte, J. QUELQUES EMPLOIS DES RADIOÉLÉMENTS ET DES RAYONNEMENTS EN ENTOMOLOGIE. p. 5-21 In "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.

Le mémoire passe en revue les applications des radioéléments en entomologie qui ont été mises au point au CEN et à l'INRA durant ces dernières années. Les premiers travaux concernèrent l'abeille, plus particulièrement la dispersion des butineuses en provenance d'une colonie; l'étude a été réalisée par des marquages à ^{198}Au . Suite à ces considérations sur la dose reçue par l'individu dans de tels marquages, la radio-résistance de l'abeille a été déterminée et la dose létale estimée à 90 kr environ. ^{198}Au a également servi à étudier les échanges de nourriture à l'intérieur d'une ruche. Par contre, c'est ^{32}P qui fut utilisé pour des études d'échanges de nourriture à l'intérieur de nichettes entre individus de fonctions (mâles, ouvrières, reines) ou de colonies différentes. Des études analogues de trophallaxis ont récemment été faites sur des guêpes. ^{198}Au a été également le radioélément de base de travaux sur les fourmilères. Le résultat le plus intéressant d'une première étude a été la découverte d'échanges de nourriture entre fourmilères distantes de plus de 50 m et d'espèces différentes (*Formica rufa* et *Formica polyctena*). Dans une deuxième étude, par marquage d'un chemin de fourmis et non de la fourmière elle-même, on a mis en évidence une division des responsabilités à l'intérieur de la fourmière, les fourmis marquées prospectant toujours le même chemin et n'ayant que peu d'échanges avec les autres individus de la même colonie. Dans cette même expérience, on a constaté avant tout marquage une radioactivité anormale des fourmis, due notamment à $^{90}\text{Zr} + \text{Nb}$. Cette découverte aurait tendance à montrer un amasage des retombées radioactives dans les fourmilères. En période de faibles retombées, une radioactivité naturelle attribuée au ^{40}K avait été constatée et avait servi à faire un dosage du potassium dans les fourmis et dans les abeilles. Un essai de marquage d'acridiens à ^{192}Ir a été fait. Enfin, une étude de la répartition de certains radioisotopes (^{32}P , ^{35}S) dans le corps de l'abeille au moyen de la méthode autoradiographique a été effectuée. (Aut.)

- 40 Dajoz, R. LA «TROPHALLAXIE» DES FOURMIS ÉTUDIÉE PAR LES RADIOISOTOPES. *Nature*, Paris 3328 (1962) 345. (In French).

Revue des publications récentes.

- 41 Gösswald, K., Kloft, W. UNTERSUCHUNGEN ZUR AUSSCHIEDUNG RADIOAKTIV MARKIERTER STOFFE BEI AMEISEN UNTER VERGLEICH VEREINZELTER TIERE MIT GRUPPEN. (Study on the elimination of radioactively labelled ants by individuals and groups). p. 9-17 in "Symposia Genetica et Biologica Italica. Atti del IV Congresso dell'U.I.E.I.S. Pavia, 9-14 Settembre 1961. Vol. XII, Pavia, Tipografia del Libro S.A.S. 1963. (In German, with English summary).

Drosophila virilis, *Formica nigricans* Emery and *Myrmica scabrinodis* Nyl were labelled with saturated sucrose solution to which NaI^{131} had been added (specific activity 1 mc/ml). Sources of error are discussed. Ants were tested either singly or in groups of 5-15 workers. It was found that individual workers excrete the labelled substances at twice the rate of those in worker groups, indicating that I^{131} circulates longer in groups. A comparison of biological half-life thus offers a method of expressing group effects numerically.

- 42 Gösswald, K., Kloft, W. TRACER EXPERIMENTS ON FOOD EXCHANGE IN ANTS AND TERMITES. p. 25-40 in "Radiation and Radiolotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.
- Trophallactic food exchanges can be studied by the use of labelled food. In comparative studies, the most rapid rate of exchange was found in honeybees, but extreme differences were observed among the different subfamilies of ants to be considered in a field experiment. The greatest tendency towards trophallactic exchanges was found in the subfamily Camponotinae. Ants of the genus Formica, especially Formica polyctena Först. and related polygenous and polycalous species known to be important factors in the preventive biological control of forest insect pests were intensively analysed. It was found that the rate of food exchange within one nest is conditioned by temperature, time, the number of individuals, and saturation. Intensive food exchanges with different nests in the colony, up to distances of 200 m, were observed by labelling single nests with radioactive food. The collected food flows in most of the surrounding nests of the colonies of the useful wood ant, thus acting as a complex system with high ecological effectiveness. Termites (Kaloterms flavicollis Fabr.) were given labelled food in order to study which stages and castes are capable of direct feeding or are receptors of stomodaeally or proctodaeally given trophallactic food. Pseudoworkers are most effective. Tracer (131) was found to remain longer in groups (viewed as a unit) than in isolated individuals and can be explained by the measured trophallactic exchanges of food and repeated circulation among members of a group. Similar results were obtained with 2 ant species from different subfamilies. (Note: termites living in groups are more aggressive and live longer than isolated individuals). - Special problems of comparable measuring techniques for groups and isolated insects are discussed.
- 43 Kneitz, G. TRACERVERSUCHE ZUR FUTTERVERTEILUNG BEI WALDAMEISEN. (Tracer studies of food distribution in forest ants). p. 38-50 in "Symposia Genetica et Biologica Italica. Atti del IV Congresso dell' U. I. E. I. S. Pavia, 9-14 Settembre 1961. Vol. XII, Pavia, Tipografia del Libro S. A. S. 1963. (In German, with English summary).
- P^{32} -labelled honey was fed to individual workers of different species of forest ants (Formica rufa L., Formica polyctena Först., Formica nigriganticus Emery and Formica exsecta Nyl.). Marked individuals were released in groups of workers under defined conditions. The number of workers to whom radioactive food was transferred was found to vary with time, temperature, number of ants in the group, starvation and quantity of food offered. No food is taken up by hibernating workers. The results are shown graphically and discussed in relation to the biology and life-cycle of the forest ant colony.
- 44 Lecomte, J. ÉTUDE DES ÉCHANGES DE NOURRITURE DE LA COLONIE DE BOURDONS AU MOYEN DE RADIOISOTOPES. C.R. Acad. Sci., Paris 257, 23 (1963) 3664-5.
- Une ouvrière d'une colonie de bourdons (Bombus hypnorum), maintenue en captivité et s'alimentant sur un nourrisseur contenant de l'eau miellée, reçut, à l'aide d'une pipette, une dizaine de mm³ de miel contenant quelques μ c d'or, 198 Au. 1 h après le marquage, 6 sur 9 individus se révélaient positifs; dans les 6 h suivant le marquage, 28 sur 54 (51%) avaient reçu de la nourriture venant d'une seule ouvrière. Une prospection de l'intérieur du nid a permis de constater que la reine avait activement participé à cette distribution et que, d'autre part, un «pot à miel» était fortement actif. On peut donc supposer l'existence d'une trophallaxie indirecte. L'hypothèse sur le rôle du pot à miel dans cette trophallaxie indirecte a été renforcée par un marquage similaire, effectué sur une ouvrière appartenant à une colonie de Bombus terrestris qui ne comportait pas de pots à miel. Il fut impossible de déceler par la suite la moindre trace de radioactivité due à un échange de nourriture.
- 45 McMahon, E. A. NEW RADIOACTIVE TESTS SHOW HOW TERMITES FEED. Pest Control 31, 2 (1963) 32-4.
- A study of food exchange between Cryptoterms brevis individuals by the tracer technique using radioisotopes. Termites made radioactive by feeding on wood that had been soaked in a radioisotope solution were paired with non-radioactive termites. The amount of food acquired by the non-radioactive recipients from radioactive nymphs could be measured by the increase in radioactivity. The author calls attention to the fact that the habit of food exchange between members of a termite colony offers a way of distributing poison throughout a colony. (BA 43:1963, 12048)
- 46 McMahon, E. A. A STUDY OF TERMITE FEEDING RELATIONSHIPS, USING RADIOISOTOPES. Ann. ent. Soc. Amer. 56, 1 (1963) 74-82.

Food exchange relationships of large (N) and small (n) nymphs were studied in a drywood termite, *Cryptotermes brevis* (Walker). Nymphs of both sizes were allowed to feed for 5 d on wood that had been labelled with either Sr^{88} or Co^{57} , and were then confined as "donors" with non-radioactive N and n recipients in non-radioactive termitaries. After 2 d comparisons were made of relative amounts of radioactivity acquired by N and by n recipients when confined with N as opposed to n as donors. Large and small nymphs appeared to feed at approximately the same rate when relative size was taken into account. Soldiers and supplementary reproductives had smaller feeding capacities than had nymphs of the same weight, although differences in radioactivity acquired may also have reflected relative numbers of micro-organisms in the hindgut. Termite size did not appear to influence feeding relationships under the experimental conditions. Sr -labelled donors lost a much larger percentage of their nuclide via pellets than did Co -labelled donors; Sr tended to be concentrated in the Malpighian tubules, Co in the hindgut. It is suggested that the symbiotic protozoa and bacteria concentrated Co . Pellet production was at the rate of about 0.65 pellets/termite/d. Soldiers confined in radioactive termitaries only become radioactive when a nymph is also present, supporting past observations that soldiers are entirely dependent on colony mates for food. The molting phase, as expected, affected the amount of radioactivity acquired and donated, with cessation of pellet production. (From auth.)

- 47 Nearmann, H. UNTERSUCHUNGEN ÜBER BILDUNG UND WEITERGABE VON DRÜSENSEKRETEN BEI Formica (Hymenopt. Formicidae) MIT HILFE DER RADIOISOTOPENMETHODE. (A study on formation and transmission of glandular secretions in *Formica* (Hymenopt. Formicidae) by means of a radioisotope technique). *Experientia* 19, 8 (1963) 412-3. (In German, with English summary).

A technique was elaborated for studying food-secretion. Ants of *Formica polyctena* Först and *F. nigricans* Em. were labelled with P^{32} . The secretion was found to be mainly formed in the pharyngeal gland, whence it reaches the crop through the exit channel of the gland, where it is stored. On regurgitation stimuli it is released again to female and male ants, and to larvae as well as workers.

- 48 Nordau, C.G. L'ABEILLE ET LA RADIOACTIVITÉ. *Industr. atomiques* 6, 3/4 (1962) 75-84.

Cet article apporte quelques précisions sur l'état actuel des recherches effectuées par M.J. Lecomte, Mlle F. Salleron et M.G. Courtois concernant le marquage à ^{138}Au , sur la radio-résistance de l'abeille, sur les aspects d'ensemble du butinage et sur les échanges de nourriture à l'intérieur de la ruche. ^{138}Au se répand un peu partout mais se fixe en majeure partie dans le tube digestif. Il est presque toujours peu évacué. L'or en suspension colloïdale se mélange bien au sirop à 50% (ramené à pH 5,5 avec l'acide tartrique). Si l'on introduit 40 mc dans une ruche normale comportant 40 000 abeilles, chaque abeille recevrait une dose totale de 600 r pendant 3 j. Des expériences sur la sensibilité aux rayons X ont été faites sur *Blattella fusca* Br. (25 000 et 10 000 r), et sur l'abeille avec 450 c de ^{60}Co . Selon Courtois et Lecomte, la dose de 90 000 r se trouve la première à se manifester nocive d'une manière nettement significative. Seulement après 39 h les abeilles arrivent à se déplacer mais restent incapables de voler. L'état physiologique de l'abeille influe fort sa radiosensibilité. Les butineuses ne s'éloignent pas beaucoup de la ruche (< 1,5 km à vol d'oiseau, la plupart restent à 500 ou 600 m). En automne les abeilles sont actives et le centre de diffusion n'est plus à l'endroit de la reine. Les échanges hivernaux de la nourriture sont plus lents qu'en d'autres saisons. - Les abeilles semblent s'habituer à la longue, par la fréquentation, à négliger les différences d'origine.

- 49 Stumper, R. RADIOBIOLOGISCHE UNTERSUCHUNGEN ÜBER DEN SOZIALEN NAHRUNGSHAUSHALT DER HONIGAMBEISE *Proformica nasuta* (Nyl). (Radiobiological study on the social feeding organization of the honey ant, *Proformica nasuta* (Nyl)). *Naturwissenschaften* 48, 24 (1961) 735-6. (In German).

The ant is markedly polymorphous, the workers consisting of minor, major and major-repleta forms. P^{32} -labelling was used in this study. The investigation showed that (1) the tendency for independent and secondary food-uptake was subject to marked individual fluctuations, and (2) honey²-intake increased with body size. *P. nasuta* was found to be supremely well adapted to its exothermic environment. The food requirements appear extraordinarily low. The honey supply of 10 mg of one repleta suffices for 100 workers for the period of 30 d, allowing 4.1×10^{-3} cal/*nasuta* worker/d or, in terms of body weight, 3 cal/g. (Note that a bee in 24-h flight uses 240 mg carbohydrate or 984 cal/d or 9840 cal/g. According to G. Schmidt, Würzburg, a value of 60 cal/g has been determined for a resting *Formica polyctena* worker at 28°C).

See also:

- 50 Comparative study on some aspects of the behaviour of Polyergus rufescens Latr. and Raptiformica sanguinea Latr. (Beck, 1961)
- 57 Sur les échanges entre fourmillières de deux espèces différentes mis en évidence par les radio-isotopes. (Chauvin, et al., 1961)
- 58 Étude au moyen des radioisotopes des échanges de nourriture entre reines, mâles et ouvrières d'Apis mellifica L. (Delvert-Salleron, 1963)
- 60 Étude préliminaire des relations entre les adultes et le couvain chez les guêpes sociales du genre Vespa au moyen d'un radioisotope. (Montagner, 1963)
- 61 Données nouvelles sur le comportement alimentaire et les échanges trophallactiques chez les guêpes sociales. (Montagner and Courtois, 1963)
- 62 Queen bee food juices of the honey bee. V. Formation of the food in the nurse bee. (Rembold and Hanser, 1960)

I-A-2-c GENERAL BEHAVIOUR

- 50 Beck, H. VERGLEICHENDE UNTERSUCHUNGEN ÜBER EINIGE VERHALTENSWEISEN VON Polyergus rufescens Latr. und Raptiformica sanguinea Latr. (Comparative study on some aspects of the behaviour of Polyergus rufescens Latr. and Raptiformica sanguinea Latr.). Insectes sociaux 8, 1 (1961) 1-11. (In German).

An attempt was made to obtain quantitative results on the degree of social-parasitic degeneration or modification in the behaviour of the ant. P. rufescens compared with R. sanguinea. Experiments with P^{32} -labelled honey showed that P. rufescens is capable of independent feeding but that it is insufficient for complete nutrition. In feeding-tests with food-bearers, P. rufescens took far less honey than did R. sanguinea. Trophallaxis (distribution of food and other substances in a colony) thus takes place only to a very limited extent in P. rufescens. In experiments with Serviformica pupae, behavioural differences were marked. Whereas R. sanguinea transported $3\frac{1}{2}$ times as many pupae as dummies and stocked them in piles away from the light, P. rufescens only made half the number of trips, picked up an excess of dummies, and showed no collecting instinct.

- 51 Hay, C.J., Myser, W.C. USE OF P^{32} AS AN AID IN BIOLOGICAL STUDIES OF THE LEAFHOPPER, Scaphoideus luteolus. J. econ. Ent. 54, 6 (1961) 1260-1.

In an attempt to trace the oviposition habits of Scaphoideus luteolus Van Duzee, the vector of elm phloem necrosis, elm trees (Ulmus spp.), 1.5-2 ft tall and having at least 2 stems, were made radioactive by introducing P^{32} in solution into the cut end of one of the stems. Late-instar nymphs were caged on the treated plants. Once adult, the males were destroyed, and females registering at least 5000 cpm were released with non-radioactive males in cages containing elm plants and bolts (3 x 24 in). They laid radioactive eggs 8-30 d after mating, and possibly later, in the corky layer of the bark on the elm bolts. The leafhoppers showed no ill effects. More activity could probably be attained in the eggs if the females had been kept on the activated elm plants for 2 to 4 weeks past the nymphal stage. After mating, it appears to take several weeks for the eggs to develop and oviposition to begin.

- 52 Liu, H., Lee, S.M., Teng, W.S. STUDIES ON THE BEHAVIOR OF LARGE LADYBIRD (Synonycha grandis Thunberg) IN SUGARCANE FIELD BY RADIOISOTOPE TECHNIQUE. I-II. Rep. Taiwan Sug. Exp. Sta. 31 (1963) 83-105. (In Chinese, with English summary).

Effective natural enemy of woolly aphid Ceratothrips lanigera Zehnt. (B. Ag. 27: 1963, 103052).

- 53 Quraishi, M.S. USE OF ISOTOPES FOR INVESTIGATING THE BEHAVIOUR AND ECOLOGY OF INSECT PESTS IN SOME RECENT STUDIES. p. 98-8 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.

Anopheles stephensi, the main vector of malaria in southern Iran, was labelled with P^{32} and the dispersal, behaviour, digestion of blood meal, maturation of ovaries and length of gonotrophic cycles studied. It was found that about 80% of Anopheles needed two blood meals for completing the 1st cycle (4-5 d, depending on temperature). Labelled mosquitoes which had emerged overnight were released in an isolated village. From the ratio of active mosquitoes to total catch/d and on the assumption that the natural population remained constant, the mortality rate was determined and found to be exponential for the first

6 d. The mating behaviour of the female was also studied by using normal females which had mated once with P^{32} -labelled males. The female mates more than once and after mating the spermatheca become active. Counts up to twice the background (12 cpm) were obtained with males of 15000 cpm. Saliva injected by P^{32} -labelled mosquitoes into glucose solution was studied. - The feeding behaviour of Eurygaster integriceps Put. was studied on P^{32} -labelled wheat plants. Other foods (labelled) were also studied; feeding is evidently essential for the first moult.

- 54 Onraishi, M.S., Arthur, M. MATING BEHAVIOUR OF Anopheles stephensi. Nature, Lond. 197, 4864 (1963) 312-3.

The possible application of the sterile-male technique to Anopheles stephensi is considered, particularly in view of its marked resistance to DDT, BHC, and dieldrin. It seemed feasible since (1) it can be easily reared in the laboratory, (2) male and female are easily separated mechanically in the pupal stage, (3) males are powerful fliers (up to 4.3 km) and form big swarms for mating, (4) the males are completely harmless, and (5) the longevity of the sexes is comparable. As a preliminary, the mating behaviour of the female was studied by using P^{32} -labelled males of 7000-13000 cpm activity; (3rd and 4th instar larvae were labelled in water containing 10-20 μ Ci P^{32} /l giving rise to adults of 2500 - 38000 cpm activity). Spermathecal radioactivity was recorded. Females clearly mate more than once.

- 55* Riordan, D.F. THE LOCATION OF THE NESTS OF CARPENTER ANTS (Camponotus spp., Hymenoptera-Formicidae) BY MEANS OF A RADIOACTIVE ISOTOPE. Insectes sociaux 7, 4 (1960) 353-5. (In English).

P^{31} was used, since its γ -radiation penetrates wood, and its 8-d half-life reduces radiation hazards. Overwintering larvae of the sawfly, Neodiprion lecontei (Fitch) were selected as suitable prey. Storage at a low temperature had made the larvae sluggish and they were further immobilized by short immersion in water at 140°F. As the body tissues of these larvae had shrunk through dehydration, a relatively large amount of fluid could be injected into them. The P^{31} -solution was used at 300 μ Ci/ml and 16 μ l were injected into each larva, each thus carrying 4.8 μ Ci of P^{31} . A portable scintillation counter was used, capable of detecting 3 μ Ci P^{31} through 5 $\frac{1}{2}$ inches of wood. Ants and their nests could thus be traced as ants appropriated their prey and removed it to their nests. The usefulness of the method also for ecological studies is stressed.

- 56 Schmidt, C.H., Smith, C.N. THE ROLE OF RADIONUCLIDES IN INSECT BEHAVIOR STUDIES. p.441-3 in "Radioecology. Proceedings of 1st National Symposium on Radioecology. Colorado State University, Fort Collins, 10-15 September 1961". New York, Reinhold Publishing Corp. 1963.

Experiments are presented to illustrate the role of radionuclides in insect behaviour studies. Adults of lone star ticks, Amblyomma americanum (L.), were dipped in a solution containing Fe^{59} , released in the field and their dispersion pattern followed over an 11-week period. Sperm from 2 species of mosquitoes (Aedes aegypti (L.) and Anopheles quadrimaculatus Say) were labelled by introducing P^{32} into the 3rd-instar larval medium. When the males mated with normal females, radioactivity could be detected in the spermathecae. Treating blood or a membrane with P^{32} revealed that A. aegypti females reacted differentially to 2 concentrations of diethyltoluamide in blood. Addition of P^{32} to honey solution revealed that at least 3 d were necessary for all A. aegypti adults in a cage to feed. Malathion-resistant houseflies showed a definite behavioral resistance (avoidance) as well as physiological resistance to Malathion sugar baits labelled with P^{32} , demonstrated by avoidance reaction of the females.

See also:

- 13 Field studies of the daily activity and feeding behaviour of Sunn pest, Eurygaster integriceps Put., (Hemiptera, Scutelleridae) on wheat in North Iran. (Banks, et al., 1961)
- 39 Quelques emplois des radioéléments et des rayonnements en entomologie. (Courtois and Lecomte, 1963)
- 48 L'abeille et la radioactivité. (Nordau, 1962)
- 78 Distribution of foragers from honey bee colonies placed in the middle of a large field of alfalfa. (Levin, 1961)
- 1375 The importance of competitiveness of radiosterilized males in mosquito-control programmes. (Dame and Schmidt, 1962)

- 57 Chauvin, R., Courtois, G., Lecomte, J. SUR LES ÉCHANGES ENTRE FOURMILIÈRES DE DEUX ESPÈCES DIFFÉRENTES MIS EN ÉVIDENCE PAR LES RADIOISOTOPES. C.R. Acad. Sci., Paris 252 (1961) 4060-1.
- ¹³⁸Au (50 mc), mélangé à un sirop de sucre concentré, a été versé sur une fourmilière de Formica polyctena établie dans un bois au milieu d'une dizaine de nids de F. rufa. Après 24 h, et surtout après 36 h, on a pu constater l'existence d'une radioactivité incontestable dans trois fourmilières de F. rufa éloignées de 30 à 60 m de celle de F. polyctena. Il paraît peu probable que la contamination des rufa puisse se faire en traversant seulement les pistes de polyctena, ni qu'une régurgitation des matières radioactives auprès des pucerons (régurgitation ensuite absorbée par les ouvrières de rufa) en soit responsable. Le fait que les pistes de polyctena soient inactives aussi bien que leurs pattes supporte l'hypothèse d'un contact buccal avec échange de nourriture entre polyctena et rufa, bien qu'elles soient d'espèces différentes. La rapidité avec laquelle des rapports s'établissent (24 h environ) paraît un argument de plus en faveur d'une telle transmission.
- 58 Delvert-Salleron, F. ÉTUDE AU MOYEN DES RADIOISOTOPES DES ÉCHANGES DE NOURRITURE ENTRE REINES, MÂLES ET OUVRIÈRES D'Apis mellifica L. Ann. Abeille 6, 3 (1963) 201-27.
- Le marquage à ³²P était effectué par une solution de $\text{NaH}_2\text{P}^{32}\text{O}_4$ ajoutée aux aliments. Pendant les premières 48 h on a pu constater une certaine préférence des nourrices entre elles. Plus tard, on a pu voir que les mâles se montrent capables de se nourrir eux-mêmes, malgré une préférence à être nourris par les ouvrières. Les ouvrières reçoivent de la nourriture soit par alimentation directe, soit par voie d'ingestion de matière régurgitée. Les reines transmettent de la nourriture ou des substances qui contiennent des radioisotopes aux ouvrières; dans un groupe bien limité, certaines ouvrières privilégiées ont pu participer davantage. L'auteur donne quelques précisions sur la méthodologie nucléaire (technique de mesure, compteur GM type cloche, etc.) employée.
- 59 Kloft, W. PROBLEMS OF PRACTICAL IMPORTANCE IN HONEYDEW RESEARCH. Bee World 44, 1 (1963) 13-18, 24-29.
- The possibility and desirability of exploiting coniferous forest resources in terms of honeydew production, as a means of offsetting the decrease in honey yields from modified agricultural practices, are reviewed. The following aspects require detailed consideration: (1) the plants producing phloem sap rich in carbohydrates, (2) the plant-sucking insects which excrete the honeydew, and (3) the bees which use it as a source for making honeydew honey. The part played by wood ants in stabilizing honeydew production is very important, and considerable work on it is cited. - Radioisotopes, although used in some of these studies, have not been mentioned specifically in the text.
- 60 Montagner, H. ÉTUDE PRÉLIMINAIRE DES RELATIONS ENTRE LES ADULTES ET LE COUVAIN CHEZ LES GUÊPES SOCIALES DU GENRE Vespa AU MOYEN D'UN RADIOISOTOPE. Insectes sociaux 10, 2 (1963) 153-66. (In French, with German summary).
- Au moyen d'incorporation de l'or radioactif (¹⁹⁸Au) en solution colloïdale dans la nourriture de l'espèce Paravespula vulgaris ou P. germanica, une certaine orientation a été mise en évidence dans les tâches chez les ouvrières, au sein de petites colonies artificielles. Il est apparu nettement que la larve était nourrie de façon constante en fonction de son degré d'évolution. La taille et l'intégrité de la cellule interviennent également. Les larves d'ouvrières sont bien approvisionnées à une époque caractérisée par l'apparition du couvain abortif, alors que les nourrices disposent d'une source de nourriture abondante. Mais, si les larves sont élevées en concurrence avec du couvain de fondatrices, elles sont moins bien nourries et parfois négligées, au bénéfice de ces dernières. Il est donc probable que la quantité de nourriture distribuée aux larves peut influencer ou même provoquer leur différenciation en ouvrières ou en fondatrices. - L'auteur n'a jamais pu constater une véritable attraction ou exploitation des régurgitations des larves par les ouvrières. Il est donc hasardeux de conclure que la société de guêpes doit sa survie à l'attrait de ces « sécrétions ».
- 61 Montagner, H., Courtois, G. DONNÉES NOUVELLES SUR LE COMPORTEMENT ALIMENTAIRE ET LES ÉCHANGES TROPHALLACTIQUES CHEZ LES GUÊPES SOCIALES. C.R. Acad. Sci., Paris 256, 19 (1963) 4092-4.

La technique utilisée est celle de Courtois et Lecomte (C.R. Acad. Sci. 247:1958, 147) pour marquer des insectes de genre *Vespa* avec de l'or (^{199}Au) en solution colloïdale, telle que chaque individu absorbe l'équivalent de 1 μC . Les échanges de nourriture se font plus facilement entre les ouvrières de la même colonie mais ce comportement s'estompe avec le temps (2 j). Tous les jeunes mâles s'alimentent bien d'eux-mêmes. Les capacités d'alimentation des mâles diminuent avec l'activité du nid et l'apparition des fondatrices filles. Elles reprennent après les fécondations. Les mâles se nourrissent essentiellement en sollicitant les régurgitations des larves. Les larves de fondatrices sont nourries davantage que celles d'ouvrières. Il est probable que la quantité de nourriture donnée aux larves joue, seule, un rôle dans la différenciation des deux castes femelles.

- 62* Rembold, H., Hauser, G. QUEEN BEE FOOD JUICES OF THE HONEY BEE. V. FORMATION OF THE FOOD IN THE NURSE BEE. *Hoppe-Seyl. Z.* 319 (1960) 206-12.

The presence of 10-hydroxy-2-decenoic acid, bipterin, and purines was demonstrated in the pharyngeal glands, but not in the labial glands of nurse bees. Bipterin-2- C^{14} fed to nurse bees was incorporated into the pharyngeal glands. Pollen contains no bipterin, and bees do apparently not require it in the diet. The joint functioning of the pharyngeal and mandibular glands in the production of the bee food is discussed. (CA 55: 1961, 23851F)

See also:

- 12 Some recent studies, involving the use of radioisotopes, of the feeding behaviour of two phytophagous insects. (Banks, 1962)
- 34 Echanges trophallactiques chez un termité supérieur. Contamination par le phosphore radioactif de la population d'un nid de *Cubitermes fungifaber*. (Alibert, 1963)
- 35 Sur la transmission d'isotopes radioactifs entre deux fourmilières d'espèces différentes (*Formica rufa* et *Formica polyctena*). (Chauvin et al., 1961)
- 36 Les échanges sociaux du "deuxième degré" chez *Formica polyctena*. (Chauvin et Lecomte, 1963)
- 38 Etude des échanges de nourriture entre butineuses de *Formica polyctena* travaillant dans des secteurs différents mais appartenant à la même fourmilière. (Courtois et Lecomte, 1962)
- 39 Quelques emplois des radioéléments et des rayonnements en entomologie. (Courtois et Lecomte, 1963)
- 40 La «trophallaxie» des fourmis étudiée par les radioisotopes. (Dajoz, 1962)
- 44 Etude des échanges de nourriture de la colonie de bourdons au moyen de radioisotopes. (Lecomte, 1963)
- 50 Comparative study on some aspects of the behaviour of *Polyergus rufescens* Latr. and *Raptiformica sanguinea* Latr. (Beck, 1961)
- 271 Royal Jelly of the honeybee. VI. Metabolism of bipterins in the honeybee. (Rembold and Hauser, 1960)
- 458 Marquage radioactif des fourmis dans les plantations d'ananas. (Mortreuil and Brader, 1962)
- 41 Study on the alimentation of radioactively labelled ants by individuals and groups. (Göswald and Klotz, 1963)

I-A-3 POPULATION DYNAMICS

(Dispersal, Flight Range, etc.)

- 63* Андреев, С.В., Воеводин, А.В., Молчанова, В.А., Хотьянович, А.В. НЕКОТОРЫЕ РЕЗУЛЬТАТЫ ПРИМЕНЕНИЯ РАДИОАКТИВНЫХ ИЗОТОПОВ ДЛЯ ЗАЩИТЫ РАСТЕНИЙ. Стр. 322-34 в сб. "Труды Второй Международной Конференции по мирному использованию атомной энергии", т.6 "Получение и применение изотопов" (Доклады советских ученых). М., Атомиздат. 1959.

Andreev, S.V., Voevodin, A.V., Molchanova, V.A., Khotyanovich, A.V. SOME RESULTS OF THE USE OF TRACER TECHNIQUES IN THE STUDY OF PLANT PROTECTION. p.35-92 in "Proceedings of 2nd International Conference on the Peaceful Uses of Atomic Energy" Vol. XXVII Geneva, United Nations, 1958. A/CONF.15/P/2309.

Some of the results of studies carried out at the All-Union Institute of Plant Protection at Leningrad are presented in sections dealing with plant intoxication, insect toxicology, rodent toxicology, herbicides and

insect ecology. The uptake, translocation and accumulation of labelled systemic insecticides were investigated on cotton and cucumber. Parathion and its methyl analogue were studied in detail. The first stage of decomposition of parathion was found to consist of isomerization of the initial preparations with subsequent formation of isomers with anticholinesterase activity. In insect toxicology studies, a contact organosulphur insecticide (S^{35} -labelled) and an intestinally-acting organophosphorus insecticide (P^{32} -labelled) were used on the Asiatic locust, *Locusta migratoria* L. The rate of penetration into the organism, the localization within different organs and tissues, and the kinetics of the preparations within the insect were studied. Microautoradiography was used. - *Eurygaster integriceps* Put. was labelled with C^{14} by dipping in the chloride to which some wetting agent (OP-7) had been added. An activity of $0.37 \mu\text{Ci}$ was thus available, exposing the insect to 720 r over 8 months. The first 3 instars were more conveniently labelled by feeding on P^{32} -labelled wheat shoots. The principal directions of migration and breeding and assembly grounds were studied. The mobility of the insects was clearly connected with their physiological condition as characterized by the fat index.

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Андреев, С.В., Молчанова, В.А., Мартенс, Б.К. ПРИМЕНЕНИЕ РАДИОАКТИВНЫХ ИЗОТОПОВ ДЛЯ МАРКИРОВКИ БАБОЧЕК ЗЕРНОВОЙ СОВКИ. Зоол. Ж. 41, 1 (1962) 84-91.

Andreev, S.V., Molchanova, V.A., Martens, B.K. USE OF RADIOACTIVE ISOTOPES FOR TAGGING *Hadena sordida* Ssk. MOTHS. Zool. Zh. 41, 1 (1962) 84-91; English Translation: Fed. Proc. 22, 5, Pt. II (1963) T825-8.

A combination of photo and chemotaxis was used for trapping, leading to a "self"-labelling of the insects. An electric trap (ESLU-2) was operated with an ordinary bulb or a PRK-4 tube. The light source was surrounded by a wire net consisting of 2 parallel rows of wire maintained at 3000 V. A removable hood with aromatic substances was placed underneath the net. The short circuits caused by the insect on entering the net caused it a shock, the insect then falling into a funnel and thence into a gauze sack. For tagging, the gauze was dipped into melon syrup with a solution of doubly substituted, P^{32} -labelled sodium phosphate. The majority of moths fly relatively short distances in windless weather at $15-25^{\circ}\text{C}$. In fields edged by a forest belt a maximum distance of 100 m was observed, the range dropping sharply beyond it. Forest belts are a considerable hindrance to the migration. In experiments on the maximum range of migration, the highest percentage of moths was found at 0.5-2 km. When studying wind effect on migration range, individuals were found up to 12 km from the release point, a distance greater than could be explained by air currents and wind alone.

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Eddy, G.W., Plapp, F.W., Jr., Roth, A.R. STUDIES ON THE FLIGHT HABITS OF SOME MARKED INSECTS. J. econ. Ent. 55, 5 (1962) 603-7.

Several thousand P^{32} - and fluorescent-marked stable flies (*Stomoxys calcitrans* (L.)), several hundred horn flies (*Haematobia irritans* (L.)), and houseflies (*Musca domestica* L.), and several thousand mosquitoes (*Culex tarsalis* Coquillett, *C. peus* Speiser, and *Aedes dorsalis* (Meigen)) were released in Lake County, Oregon, in September 1961. Efficient labelling was achieved by placing P^{32} in the diet of the insects at the rate of $1 \mu\text{Ci}/\text{ml}$. The percentage of insects that had fed on P^{32} -treated food and the amount of radioactivity were determined by a proportional scaler. Data are tabulated. Both stable flies and horn flies were effectively labelled; the total activity per fly, however, was higher with the stable flies. Both blood and sugar feeding were equally effective. Less success was experienced in labelling mosquitoes. As shown in the results, *Culex peus* reached higher levels of total radioactivity per insect than *C. tarsalis*; the latter were, however, considerably older at the time of labelling. Marked stable, house, and horn flies were recovered 1 and 5 miles from the release site. Activity of mosquitoes was apparently curtailed by low nightly temperatures since none were caught. The stable flies showed the most rapid dispersion, specimens being recovered 5 miles from the release point in slightly less than 2 h.

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Elmore, C.M., Jr., Schoof, H.F. DISPERSAL OF *Aedes taeniorhynchus* Wiedemann NEAR SAVANNAH, GEORGIA. Mosquito News 23, 1 (1963) 1-7.

From the release of approx. 3 million P^{32} -tagged *Aedes taeniorhynchus* near Savannah, Georgia, 415 females and 29 males were recovered in light traps located at distances up to 20 miles from the departure point. Recoveries beyond 4 miles did not occur until the 4th night after release. Female specimens were captured at distances up to 18 miles but more than 75% of the recoveries, exclusive of 1 trap 0.1 mile from the release point, were within 4 miles. The maximum distance at which males were trapped was 2 miles from the departure point. (Summary)

- 67 Féron, M. ÉTUDE DE LA SURVIE HIVERNALE DE DEUX INSECTES SANS DIAPAUSE *Ceratitis capitata* ET *Dacus oleae* (Dipt. Trypetidae) ET LEURS FACTEURS DE PULLULATION. (Résumé) *Ann. Epiphyt.* 13, 4 (1962) 336.

Les méthodes de marquage des imago utilisées ont été: amputation partielle d'une patte, absorption d'une solution colorée (de faible durée) et marquage radioactif (^{32}P).

- 68 Гаджей, Е. Ф. МИГРАЦИИ МУХ В УСЛОВИЯХ ГОРОДА. *Мед. Паразит.* 32, 4 (1963) 465-8.

Gadzhei, E. F. FLY MIGRATION IN URBAN AREAS. *Med. Parazitol.* 32, 4 (1963) 465-8.

A method convenient for the study of fly migrations in urban areas implies using ^{32}P sprayed onto garbage collector walls and refuse as well as put into baits scattered all over apartment houses. Observations were carried out in a city district of the Central Tadzhikistan. Most of the domestic flies migrate from their breeding places (dust and garbage bins) to houses lying at a distance of up to 30 m, but some of them fly to houses as far away as 250 m on the first day. Flies tagged in apartment houses are found on other premises. In the area with several dysentery cases on record, any sizable epidemiological and entomological effect can be achieved only by instituting fly control measures over the entire section under consideration, as well as at the breeding grounds within a zone lying 250 m beyond the boundary of the section. (Auth.)

- 69 Gillies, M. T. MARKING AND RELEASE EXPERIMENTS WITH A TROPICAL MOSQUITO BY THE USE OF RADIOISOTOPES. p. 267-79 in "Radioisotopes in Tropical Medicine, Proceedings of a Symposium, Bangkok, 12-16 December 1960". Vienna, International Atomic Energy Agency, 1962.

Mosquitoes (*Anopheles gambiae*) were reared in the laboratory and labelled by introducing either ^{32}P or S^{35} into the larval breeding pans. Releases were made in series, using the two isotopes in regular alternation. Recaptures were recognized by autoradiography. The particular isotopes present in each specimen (and hence the date of release) were identified by a simple method for discriminating between high and low energy β -particles. Of some 60 000 mosquitoes released 450 were recaptured. The recapture rate of females was 0.5%. Parallel experiments with mosquitoes marked with paint gave similar results. Mosquito movement could be shown to be non-random and related primarily to the distribution of human settlements. Marked females were recaptured up to 23 d after release and, surprisingly, a single male after 30 d. The use of radioisotopes for longevity studies appears to be limited to those species which can be collected in large numbers from natural waters, rather than obtained by artificial breeding.

- 70 Gillies, M. T. STUDIES ON THE DISPERSION AND SURVIVAL OF *Anopheles gambiae* GILES IN EAST AFRICA, BY MEANS OF MARKING AND RELEASE EXPERIMENTS. *Bull. ent. Res.* 52, 1 (1961) 99-127.

Marking and release experiments were carried out in a coastal area of Tanganyika. Laboratory-reared mosquitoes were labelled with ^{32}P or S^{35} , either by topical application or introduction of radioisotopes into the larval breeding pans. Recaptures were recognized by autoradiography. Recaptures were possible up to 2 1/4 miles. Of 132 000 mosquitoes released, 1019 were captured. Mean flight ranges were 0.64 mile for females and 0.52 mile for males; mean range of dispersion (females) 0.98 mile. Both sexes were captured at 2 1/4 miles. Dispersion was non-random and related primarily to the distribution of human settlements. Prevailing winds played a minor role. A relatively high level of mortality appears to be due to the use of laboratory-reared mosquitoes. The corrected sporozoite rate in marked females at time of recapture was 0.8%. The survival of males was only slightly lower than that of females. From the survival curve it appears that the mortality rate remained constant throughout the period in which marked females were recovered.

- 71 Jackson, W. B., Maier, P. P. ADDITIONAL STUDIES OF DISPERSION PATTERNS OF AMERICAN COCKROACHES FROM SEWER MANHOLES IN PHOENIX, ARIZONA. *Ohio J. Sci.* 61, 4 (1961) 220-6.

Periplaneta americana (L.) were trapped, marked by spraying with a ^{32}P -labelled solution, and released in manholes. Attempted recapture by traps indicated little or no movement in a winter experiment, even when 1500 cockroaches from elsewhere were added to 125 already in the manhole. In experiments in late spring, limited movement was recorded from an undisturbed population, but extensive emigration followed the addition of 2000 cockroaches to the 400 already present, marked roaches being recovered in neighbouring yards, blocks of flats, and manholes. About 1/2 the recoveries in yards were made within 50 ft of the manhole into which the extra roaches had been released, but some were up to 200 ft away; 2 were even

recovered from a manhole 475 ft downstream. These results indicate that a sudden increase in population may cause widespread emigration, and that some emigration may normally occur in spring and summer from populations that are readjusting themselves to the carrying capacity of their environment.

- 72 Katiyar, K.P., Valerio, S.J. ESTUDIOS SOBRE LA DISPERSIÓN Y LONGEVIDAD DE LA MOSCA DEL MEDITERRÁNEO *Ceratitis capitata* Wied., MARCADA CON P^{32} . (Studies on the dispersion and length of life of the Mediterranean fruit-fly *C. capitata* labelled with P^{32}). *Turrialba* 13, 3 (1963) 181-84. (In Spanish, with English summary).
Adults from irradiated pupae were labelled by feeding them on a solution containing P^{32} and liberated in a narrow peninsula containing numerous abundantly fruiting trees of *Terminalia catappa* on the Pacific coast of Costa Rica. The flies were recovered for up to 26 d after release; the maximum distance at which recoveries were made was about 1420 yards, and 87.5% of the flies recaptured were collected from traps situated about 220 yards from the release point. In the presence of an abundance of host fruits, dispersion is thus not great.
- 73 Kettlewel, H.B.D., Heard, M.J. ACCIDENTAL RADIOACTIVE LABELLING OF A MIGRATORY MOTH. *Nature*, Lond, 189 (1961) 676-7.
A specimen of *Nomophila noctuella* L. was trapped at Oxford, and 3 others elsewhere in England. A consistent count of 15-20% above background was observed. A particle source was detected in the insect, represented by a perfect 9 μ -sphere, dark brown and typical of particles originating in the high temperature of test explosions, such as carried out in the Sahara desert. There is a high probability that the particle was acquired in Africa. The evidence suggests that the moth was able to cover a distance of approx. 1500 miles in the course of a short life.
- 74* Худалов, Г.Д. К ВОПРОСУ О ПРИМЕНЕНИИ РАДИОАКТИВНОГО ФОСФОРА ПРИ ИЗУЧЕНИИ МИГРАЦИИ МУХ ИЗ ЖИЛЫХ ПОМЕЩЕНИЙ. Стр. 319-24 в сб. "Труды Центрального НИИ дезинфекции", №11. 1959.
Khudakov, G.D. ON THE USE OF RADIOPHOSPHORUS TO STUDY THE MOVEMENT OF FLIES FROM INHABITED PREMISES. p.319-24 in "Transactions of the Central Institute for Scientific Research on Disinfestation", No.11, 1959.
- 75 Lecomte, J. TECHNIQUES D'ÉTUDE DES POPULATIONS D'INSECTES POLLINISATEURS. *Ann. Abeille* 5, 3 (1962) 201-13. (In French, with English summary).
The study of populations of insect pollinators, chiefly the Apidae, requires employment of certain techniques. Those examined in this study are concerned essentially with the measurement of population densities and with the marking by means of radioisotopes of individuals and collections of individuals occurring in these communities.
- 76 Lecomte, J. MÉTHODES D'ÉTUDES SUR LA DYNAMIQUE DES POPULATIONS D'INSECTES, 1962. MÉTHODES D'ÉTUDE DES POPULATIONS D'INSECTES POLLINISATEURS. (Résumé). *Ann. Epiphyt.* 13, 4 (1962) 333.
Voir 75.
- 77 Lee, W.R. THE NONRANDOM DISTRIBUTION OF FORAGING HONEY BEES BETWEEN APIARIES. *J. econ. Ent.* 54, 5 (1961) 928-33.
How distance affects the distribution of foraging honey bees (*Apis mellifera* L.) was studied without having the results confounded by variation in the food supply. In the first experiment colonies were positioned at two locations 1,925 feet apart in a low-bush blueberry (*Vaccinium lamareckii* Camp) field; in the second experiment the colonies were 800 feet apart in an apple orchard. Bees from each apiary were distinguished by either genetic markers or P^{32} . The ratio of bees from one apiary to bees from the other was determined at various distances between the two apiaries. In both experiments the ratio of bees from Apiary A to bees from Apiary B increased significantly as the distance to Apiary A decreased. Regression analysis showed that this was due to both an increase in bees from Apiary A and a decrease in bees from Apiary B. Therefore, bees are not distributed at random in the area between apiaries, but, relative to the food supply, forage in greater numbers close to their hive. (Auth.)

- 78 Levin, M.D. DISTRIBUTION OF FORAGERS FROM HONEY BEE COLONIES PLACED IN THE MIDDLE OF A LARGE FIELD OF ALFALFA. J. econ. Ent. 54, 3 (1961) 431-4.
- An experiment was conducted in northern Utah with colonies of honey bees (*Apis mellifera* L.) mass-marked for identification in the field. Cordovan strains were used for one group and colonies in the 2nd group were tagged with P^{32} . The 1st group, placed in the centre of a large field of alfalfa in bloom, oriented mostly to the field on which they were placed, and retained their dispersion pattern over a 2-week period. The 2nd group, placed in the same location a week later, distributed its foragers in much the same way as the first group but showed a tendency to orient farther afield. (Auth.)
- 79 Lloyd-Jones, C.P., Smith, B.D. THE USE OF RADIOACTIVE PHOSPHORUS TO FOLLOW THE MOVEMENT OF THE BLACK CURRANT GALL MITE. Rep. agric. hort. Res. Sta. Bristol (1960) 133-4. Long Ashton (1961).
- Attempts to label black-currant gall mites (*Cecidophyes ribis* (Westw.)) with P^{32} by standing shoots cut from infested black-currant bushes before bud-burst in a solution of P^{32} -labelled sodium dihydrogen phosphate were unsuccessful. However, when mites from galled buds were dissected 3 d after the radioactive solution had been injected into the buds by hypodermic syringe the mites were found to be radioactive. When labelled buds were attached to uninfested plants, the mites rapidly left them, but could not be detected after dispersal. Plant tissues were digested in nitric acid, the digest made up to a standard volume and its radioactivity determined. It could be shown that the mites tended to move upwards and to congregate in the leaf axils.
- 80* MacLeod, J., Donnelly, J. NATURAL FEATURES AND BLOWFLY MOVEMENT. J. Anim. Ecol. 29 (1960) 85-93.
- P^{32} -labelled *Lucilia caesar* group and *Calliphora erythrocephala* blowflies released beside a 200-yd-wide river were recaptured in numbers on the far side. In 2 late-summer and autumn tests of the barrier effect of a deciduous wood belt 90 yds wide, *Lucilia sericata*, *L. caesar* and *C. erythrocephala* were recovered beyond the wood; *C. vomitoria* was recovered beyond a 50-yd wide stand of conifers. Estimates are given of the density in the test areas of some of the species concerned. The bearing of the observations on dispersal theory is briefly discussed. (Essentially auth. summary).
- 81 MacLeod, J., Donnelly, J. DISPERSAL AND INTERSPERSAL OF BLOWFLY POPULATIONS. J. Anim. Ecol. 32 (1963) 1-32.
- Flies trapped in particular sections of the test area were identified and paint-marked, either in restraint bags or under chill coma; they were subsequently maintained in cages according to section. During the following 2 d flies were radioisotope-tagged by the addition of P^{32} to sucrose solution in their cages. Three experiments are described in which separately marked groups of blowflies were released at different points, and the degree and speed of interchanges assessed by trap recoveries over a period of days. Two types of flight were recognized in the flies dispersing from the initial concentration, viz. dispersal- and interspersal-flying. The dispersal, or exodus, flight from the centres is apparently uni-directional, and either fast or sustained, since considerable distances were covered in short intervals (e.g. 200 yd at 7 mph, or more). Interspersal-type, or random-direction flying, may involve less, or no, net displacement. It is also responsible for a high degree of intermingling of populations from separate major habitats.
- 82 Молчанова, В.А., Мартенс, Б.К., Каменкова, К.В. РАДИОМАРКИРОВКА НАСЕКОМЫХ ДЛЯ ИЗУЧЕНИЯ ИХ МИГРАЦИИ. Стр. 26-8 в сб. "Материалы Симпозиума по применению биофизики в области защиты растений". Л. 1961.
- Molchanova, V.A., Martens, B.K., Kamenkova, K.V. RADIOMARKING OF INSECTS FOR STUDIES ON THEIR MIGRATION. p. 26-8 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961.
- Experiments were carried out in 1958-59 in the Kustanai region of the Soviet Union on the use of radioisotopes for labelling the grain Noctuid [*Hadena sordida* (Bkh.)] and its parasites for studies on their migrations. A method of labelling was used that was not liable to damage the insects. Light-traps were employed to attract the moths, which became labelled by contact with an attractive radioactive solution. They then dispersed, and their movements were observed radiometrically. The parasites *Cnephalia (Isomera) cinerascens* (Rond.) and *Lampronota nitida* (Grav.) (*Meniscus agnatus* (Grav.)) were taken in traps containing a radioactive solution prepared as for the moths. Observations on the moths showed that,

during the period of supplementary feeding and oviposition, they covered distances of 0.5 km in a short time. The males were more active than the females, the distances covered ranging up to 3 and 2 km, respectively. The use of P^{32} to label the parasites showed that *L. nitida*, which parasitizes the larvae, was the more adapted to the moth. The distances covered during the period of mass flight and supplementary feeding were 100-200 m. At the beginning of the period of ear-formation, the moth and parasite moved in large numbers to wild and cultivated grasses and then to early varieties of wheat. While searching for hosts in which to oviposit in wheat fields, the parasites covered distances reaching 700 m. The development of *C. cinerascens* is not synchronised with that of the moth, the adults emerging 2-3 months before hosts in a suitable stage become available in the first half of summer. The adults therefore migrate for considerable distances in search of supplementary hosts, and flights of 18-20 km were recorded. (RAE-A 51: 1963, 523)

- 83 Odum, E.P., Pontin, A.J. POPULATION DENSITY OF THE UNDERGROUND ANT, *Lasius flavus*, AS DETERMINED BY TAGGING WITH P^{32} . *Ecology* 42, 1 (1961) 186-8.

From 400 to 1000 ants in each of 8 colonies were tagged by dipping into a solution of P^{32} (about 1 μ C/ml) and returned to the colonies uninjured. One to 6 d later samples of 100-400 ants were removed and tested for radioactivity with use of a scanning system. Density and variance were calculated from the marking-1 recapture data using the formulas of Bailey (1951). It was found that a good relationship existed between the number of queens produced by a colony and the density of workers. Since queen production was determined in all colonies of a study area, the regression equation was used to calculate worker density in untagged as well as tagged colonies. Individual colonies were estimated to contain from 2000 to 11000 ants. Estimated density for the most favorable area where the competitive species *L. niger* was absent was 1130 workers/m² or a living biomass of 1.36 g/m²; density for the entire 277 m² study area was estimated as 485 workers/m² or 0.6 g/m². (Auth.)

- 84* Ogata, K., Nagai, N., Koshimizu, N., Kato, M., Wada, A. RELEASE STUDIES ON THE DISPERSION OF THE HOUSE FLIES AND BLOW FLIES IN THE SUBURBAN AREA OF KAWASAKI CITY, JAPAN. *Jap. J. sanit. Zool.* 11, 4 (1960) 181-88. (In Japanese, with English summary).

In studies on the dispersion of *Musca domestica vicina* Macq. and *Lucilia* (*Phaenicia*) spp. conducted in the suburbs of Kawasaki city, Japan, in September and October 1959, adults were caught in nets, kept for about 24 h, during which they were given milk labelled with P^{32} , and then released in the evening, when it became too dark for them to migrate. Attempts to recapture them were made for 23 d in houses situated within a radius of about 1100 yards of the release point, by means of fly-tapes or -papers or in cage traps. As the numbers of catching devices were not the same at each collection site, the numbers of labelled flies recovered did not give a true representation of the pattern of dispersal. However, the results indicated that a large number of flies moved within a radius of about 330 ft from the release point. Labelled flies were recaptured only east and west of the release point, and dispersion is thought to have been strongly affected by the presence of a range of hills, some 65-100 ft in height, to the south of the release point, of rice-fields to the north of it, and of a highway running from east to west through it. (From auth. summary)

- 85 Orphanidis, P.S., Soultanopoulos, C.D., Karandinos, M.G. PRELIMINARY EXPERIMENTS WITH RADIOACTIVE PHOSPHORUS (P^{32}) ON THE DISPERSION OF OLIVE FRUIT FLY ADULTS (*Dacus oleae* Gmel.). *Ann. Inst. phytopath. Benaki* 4, 2 (1962) 155-8.

See 86.

- 86 Orphanidis, P.S., Soultanopoulos, C.D., Karandinos, M.G. ESSAI PRÉLIMINAIRE AVEC P^{32} SUR LA DISPERSION DES ADULTES DU *Dacus oleae* Gmel. p. 301-3 in "Radiation and Radiotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.

Le manque de données numériques sur la dispersion de la mouche de l'olive a amené à faire un essai préliminaire avec 2500 adultes élevés dans des cages et marqués, avant leur lâcher, au moyen d'une solution sucrée contenant 20 μ C de P^{32} par centimètre cube. Les mesures ultérieures ont montré une dispersion des adultes marqués jusqu'à une distance de 2 km du point de lâcher pendant les jours ensoleillés d'hiver, dits alcyoniens. (Auth.)

- 87 Pelekassia, C.E.D., Mourikos, P.A., Bantzios, D.N. PRELIMINARY STUDIES ON THE FIELD MOVEMENT OF THE OLIVE FRUIT FLY [*Dacus oleae* (Gmel.)] BY LABELLING A NATURAL POPULATION WITH RADIOACTIVE PHOSPHORUS (P^{32}). Ann. Inst. phytopath. Benaki 4, 2 (1962) 170-9.
- See 86.
- 88 Pelekassia, C.E.D., Mourikos, P.A., Bantzios, D.N. PRELIMINARY STUDIES OF THE FIELD MOVEMENT OF THE OLIVE FRUIT FLY (*Dacus oleae* Gmel.) BY LABELLING A NATURAL POPULATION WITH RADIOACTIVE PHOSPHORUS (P^{32}). p.105-13 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.
- Preliminary trials were conducted in 1961 in the olive-growing area at Rovies, Evvia, Greece, during the autumn when maximum adult fly activity usually occurs. The adult fly population was tagged by painting branches of 30 selected olive trees with bait solution ($H_2P^{32}O_4$ in HCl and hydrolysate protein, Staley No. 7). 500 McPhail traps (with 3% diammonium phosphate lure) were distributed at Rovies and in the adjacent areas (forest and olive groves) up to 10 km from the treated trees; 350 tagged flies were collected. Radioactivity ranged from 258 to 9549 cpm/fly against 8-21 cpm background. Maximum dispersal was 4300 m. A more or less continuous local movement of flies took place from the semi-mountainous grove to the adjacent plains or to the coastal olive groves from north to south. No actual long distance movement (migration) was observed. Pine woods appear to act as a barrier to the movement of adult flies.
- 89 Rakitin, A.A. THE USE OF RADIOISOTOPES IN THE MARKING OF *Eurygaster integriceps* Put. Ent. Rev. 42, 1 (1963) 20-4. Translation from Ent. Obozr. 42, 1 (1963) 39-48.
- Insects were labelled by dipping into a solution of Co^{60} chloride ($\sim 0.37 \mu c$ per insect). A wetting agent, OP-7 (a mixture of monoalkyl and dialkyl phenol ethylene oxide) were added; 0.03 ml of radioactive solution remained on the outer body casing. Insects were released at pre-selected points in checker-board fashion. Radiometric equipment was suitably adapted in the laboratory. Population and distribution of insects could thus be determined. P^{32} was used for tagging larval stages to study vertical and horizontal migrations on wheat and wild cereal grasses, in relation to the stage of development. Horizontal and vertical migrations were a function of nymphal age. Vertical migration varied with temperature, horizontal with the stage of development. - Experiments were carried out with adult insects to determine flight direction when moving to hibernation quarters, over-wintering, the locations of reservations in the forest and the direction of the spring flight from the forest to the field. In 1956, 220 000 and 320 000 tagged insects were released in the forest. A dispersal of up to 15 km was noted. There was scarcely any migration of insects into young belts of forest. In August, when the fat content was high insects flew, actively, from 0.5 - 1 km/d.
- 90 Schnelder, F. DISPERSAL AND MIGRATION. Annu. Rev. Ent. 7 (1962) 223-37.
- Review article. Radioisotopes were employed in some of the studies mentioned but no particular emphasis is given.
- 91* Шура-Бура, Б.Л. К ВОПРОСУ ОБ ИЗУЧЕНИИ МИГРАЦИИ КОМНАТНЫХ МУХ ПРИ ПОМОЩИ РАДИОАКТИВНЫХ ИНДИКАТОРОВ. Стр. 12-22 в сб. "Чтения памяти Холодовского". М., Изд. АН СССР. 1952.
- Shura-Bura, B.L. USE OF RADIOACTIVE TRACERS TO STUDY THE MIGRATION OF HOUSEFLIES. p.12-22 in "A.A. Kholodkovskii Memorial Lectures". Moscow, Izd. AN SSSR. 1952.
- 92* Шура-Бура, Б.Л. ОПЫТ ИЗУЧЕНИЯ МИГРАЦИИ МУХ СО СВАЛКИ МЕТОДОМ МЕЧЕНЫХ АТОМОВ. Гигиена и Санит. 9 (1955) 12-5.
- Shura-Bura, B.L. EXPERIMENTAL INVESTIGATION OF THE MOVEMENT OF FLIES FROM A REFUSE HEAP BY THE LABELLED-ATOM METHOD. Gigiena i Sanit. 9 (1955) 12-15.
- 93 Шура-Бура, Б.Л., Sukhorninova, O.I., Isarova, B.L. RADIOACTIVE TRACERS AS AN AID TO STUDYING THE ABILITY OF SYNANTHROPIC FLIES TO FLY OVER WATER OBSTACLES. Ent. Rev. 41, 1 (1962) 55-60. Translation from Ent. Obozr. 41, 1 (1962) 99-108.

In 1957 (summer), about 30% of all flies on the town rubbish dump were labelled by placing a P^{32} -labelled bait there. Subsequent capture and radiometric examination of 3214 flies captured at 13 points in the town on both sides of the river Volkhov revealed 120 radioactive specimens (3.7% of the total captured). The flies dispersed from the dump primarily in the direction of the poorly constructed part of the town across the river. The dump was one of the main breeding sites for flies in Volkhov. Migration was mainly by flight. The Volkhov, 400-500 m wide near the town, proved no obstacle to fly migration.

- 94 Soenen, A., Proost, M. de, Vanwetswinkel, G. USE OF RADIO-ISOTOPES IN BIOLOGICAL INVESTIGATION OF FRUIT PARASITES. Agricoltura 8 (1960) 259-68.

Out of 800-900 beetles (*Anthrenus pomorum* L.) tagged with P^{32} by feeding, only 15 were located after 12 d. A migration of the beetles is indicated. (13 references). (J. Sci. Food Agric. 12, 6:1961, 1-279)

- 95 Sorla, F., Cléne, J.F. ÉTUDE DU VAGABONDAGE DE *Ceratitis capitata* Wied. EN TUNISIE À L'AIDE DE RADIO-ISOTOPES. Ann. Inst. nat. Rech. agron., Tunisie 32 (1959*) 79-94.

Deux lâchers d'adultes de *C. capitata* marqués à l'aide du ^{32}P ont eu lieu dans les environs de Tunis en novembre 1960 et en juin 1961. Les cératites provenaient d'un élevage de laboratoire, artificiel et continu. Au cours du premier essai, destiné à mettre au point la méthode à utiliser, 70 mouches ont été reprises, dans des gobe-mouches appâtés au phosphate bi-ammonique, sur les 353 cératites mâles et femelles lâchées 3 j auparavant. La distance maximum observée au bout de cette courte période a été de 315 m. Pour le 2e essai, 280 gobe-mouches, dispersés dans un verger long d'un peu plus de 1 km, capturèrent 449 individus sur les 2200 mâles radioactifs qui y furent lâchés. Un mâle a parcouru 460 m en un peu plus d'une journée et 16 autres, se déplaçant plus lentement sur la même distance, se firent prendre le 4e jour. Le plus grand déplacement observé fut effectué par 2 cératites: 610 m en 5 à 7 j. Indépendamment de la distance, le pouvoir de dispersion des cératites s'est révélé comme étant soumis à diverses influences; celles du vent, de l'espèce végétale supportant les gobe-mouches et du temps écoulé depuis le jour du lâcher font objet de diverses observations. (Auth.)

* Compiler's note: Article submitted on 5 July 1961.

- 96 Sorla, F. ÉTUDE DES POPULATIONS ET DE DISPERSION DE *Ceratitis capitata* Wied. (Dipt. Trypetidae) EN TUNISIE À L'AIDE DES RADIOISOTOPES. p.357-61 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency, 1963.

En complément des études écologiques déjà réalisées et des essais préliminaires sur la dispersion, une méthode d'étude des populations a été mise au point, en utilisant des mouches marquées au ^{32}P (1 mc $^{32}PO_4H_3$ pour 100 g d'eau sucrée à 10%) dans un type de boîte de lâcher qui permet de contenir 100-200 mouches à la fois. La valeur de la méthode paraît être confirmée par les résultats donnés par d'autres procédés classiques. L'estimation de population ainsi réalisée a montré qu'il pouvait y avoir de 2 à 8 mâles par hectare à la fin de l'hiver dans différentes plantations.

- 97 Strong, F.E., Bacon, O.G., Russell, J.R. FLIGHT HABITS OF THE ALFALFA SEED CHALCID, *Bruchophagus roddi* Guss. (Hymenoptera: Eurytomidae). Hilgardia 38, 1 (1963) 1-12.

Eurytoma (*Bruchophagus*) *roddi* (Guss.) is an important pest of lucerne grown for seed in the western United States, and information on its flight habits was sought. The following is virtually the authors' abstract of this account of the work. The flight habits of the Eurytomid were studied in natural field populations and by the use of reared insects labelled with P^{32} or ^{35}S . A minimum temperature of 70°F and a minimum light intensity of 0.2 Langley (1 ly = 1 calorie/cm²/min) was found necessary for sustained flight. In a favourable food-plant area, the insects dispersed only a few hundred yards within a few days. Movement in a breeze of less than 5 miles/h was both upwind and downwind. In stronger winds, it was predominantly downwind. The data obtained suggest that when a food-plant area dries up or otherwise becomes unsuitable, the insects fly upwards, where they encounter the stronger winds, and rapidly leave the area. Labelled individuals were recovered 4100 ft downwind of a release point; others were observed to survive 16 d in the field. (RAE-A 52:1964, 187)

- 98 Süs, A., Weigand, G. UNTERSUCHUNGEN ÜBER DIE AUSBREITUNG MARKIERTER RÜSSELKÄFER. (Study on the dispersion of labelled weevils). Atompraxis 7 (1961) 326-7. (In German).

Apion virens Hbst. and *A. seniculus* Kirby, which attack clover, were labelled by shaking them by hand for 10 min in a carrier-free solution of P^{32} , of specific activity 1 mc/ml. The insects were dried on filter

paper, and had an activity of 25 000 to 30 000 cpm. They were then released every 25 m. Following release on May 8, checks were made on May 8, 9, and 13. A distance of 1.85 - 2.67 m was covered by 4 beetles, 7.03 and 7.43 m by 2, and 13.25 m by 1 (i.e. 3 "groups"), the speed of migration increasing after May 8 for the last 2. Direction of migration, total distance covered and final distance from starting point are discussed.

- 99 TernovoI, V.I. A STUDY OF THE MIGRATION OF *Wohlfartia* FLIES BY THE METHOD OF RADIO-LABELLING. p.31 in "Materials of the Symposium on the Use of Biophysics in the Field of Plant Protection". Leningrad, 1961. (In Russian).

Wohlfartia magnifica (Schin.), which infests wounds on domestic animals, is widely distributed in the south of the Soviet Union. The movements of the adults were studied in 1959 by feeding them for 24 h on a sugar solution containing P^{32} , which they were shown, by radiometry and radioautography, to retain for at least 20 d. They were released in the field and recaptured near sheep pens either by a net or by traps baited with meat treated with a 0.02% solution of trichlorophen (chlorofos). Over 1000 were released, and 11 were recaptured, together with 59 unlabelled individuals, at distances ranging from 150 to over 2000 yd from the release point; some were taken near a pound that served as a watering-place for the sheep. Laboratory and field tests indicated that the labelled females transmitted radioactivity to their larval offspring. (RAE-B 51:1963, 212)

- 100 Wharton, R.H., Seow, C.L., Ganapathipillai, A., Jabaratnam, G. HOUSE FLY POPULATIONS AND THEIR DISPERSION IN MALAYA WITH PARTICULAR REFERENCE TO THE FLY PROBLEM IN THE CAMERON HIGHLANDS. *Med. J. Malaya* 17, 2 (1962) 115-31.

Houseflies in Malaya are comparatively scarce in comparison with many other hot countries but they constitute a serious problem on the highlands where they breed in enormous numbers in the coarse organic manures used to fertilize terraced vegetable gardens. Observations on housefly populations at several places on the lowlands and at Cameron Highlands confirmed that flies, mainly *Musca domestica vicina*, were more common on the highlands but that large numbers were sometimes present in markets in lowlands towns and villages. In a mark-release-recapture experiment houseflies and blowflies (*Chrysomya* sp.) which were tagged with P^{32} dispersed rapidly from their breeding grounds on the lowlands but houseflies were caught up to 12 d after release in the vicinity of a market. In a 2nd experiment Cameron Highlands marked flies were found to disperse in large numbers for distances of 0.25 mile and in fairly large numbers up to 0.5 mile. Flies were also carried by lorries from vegetable loading points, many for distances of 3 miles and some for 6 miles. Adult flies were exposed to insecticide deposits of DDT, dieldrin, BHC, diazinon and malathion. Flies on the highlands were knocked down at a slower rate than those from the lowlands, and flies from both areas appeared to be resistant to the 3 chlorinated hydrocarbon insecticides.

- 101 Yerington, A.P., Warner, R.M. FLIGHT DISTANCES OF *Drosophila* DETERMINED WITH RADIOACTIVE PHOSPHORUS. *J. econ. Ent.* 54, 3 (1961) 425-8.

The flight range of *Drosophila* spp. has become increasingly important to the vineyardist and fig grower of the San Joaquin Valley of California due to the increased intermixing of various other fruit and vegetable crops and their attendant cull disposal problem. *Drosophila* were tagged with P^{32} on fermenting fruit paste and released in the field. Several types of bait traps were used to recapture the insects. *D. melanogaster* Meig. was trapped at a distance of at least 4.4 miles upwind from the release point after 24 h. (Auth.)

See also:

- 48 L'abeille et la radioactivité. (Nordau, 1962)
 53 Use of isotopes for investigating the behaviour and ecology of insect pests in some recent studies. (Quraishi, 1963)
 56 The role of radionuclides in insect behavior studies. (Schmidt and Smith, 1963)
 139 Autoradiography as a method of detecting tagged rodents and their ectoparasites in a study of migration problems. (Shura-Bura and Kharlamov, 1961)
 450 Radioactive labelling of lepidopterous larvae: a method of estimating late larval and pupal mortality in the wild. (Cook and Kettlewell, 1960)
 452 Rearing and isotopic labelling of *Fannia canicularis*. (Fay et al., 1963)
 457 The use of radioisotopes for labelling flies. (Mingo-Perez, 1958)
 463 The survival of adults of the white pine weevil, *Pissodes strobi* (Peck), labelled with radioactive cobalt. (Sullivan, 1961)

- 768 The application of nuclear energy to agriculture. (Boroughs, 1962)
- 782 The effect of ionizing radiation on the biology and ecology of Rhodnius prolixus, the principal vector of Schizotrypanum (i.e. Trypanosoma) cruzi in Venezuela. (Gomez et al., 1962)
- 1442 Failure to reduce an isolated blowfly population by the sterile males method. (MacLeod and Donnelly, 1961)
- 1452 Possibilities of eradication of the Mediterranean fruit fly Ceratitis capitata Wied. from Central America by gamma-irradiated males. (Katiyar, 1962)
- 1455 Sterilization of the Mediterranean fruit fly and its application to fly eradication. (Katiyar and Valerio, 1963)
- 1456 The application of nuclear energy to agriculture. (Moh, 1963)
- 1570 Use of radioisotopes and radiation in the control of plant and animal insect pests. (Andreev et al., 1963)
- 1580 Travaux de recherches utilisant les isotopes et les rayonnements nucléaires en entomologie appliquée en France et dans les pays associés. (Pesson, 1962)

I-A-4 INTER-RELATIONS

I-A-4-a INSECT ENVIRONMENT

I-A-4-a-1

Radioactive contaminated systems (including deliberate contamination and fallout). Food chains

- 102 Auerbach, S.I. TRANSFER OF FISSION PRODUCTS THROUGH PLANT TO INSECT FOOD CHAINS. (Abstr. EIA910). p.131-2 in "Research and Development in Progress. Biology and Medicine. Issue No.2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

Current work involves further sampling of plants and insects on White Oak Lake bed to meet 2 objectives: (1) to obtain reliable data on the herbivore-predator transfer of radionuclides, and (2) to detect changes in radionuclide distribution in the ecosystem which might have occurred since the last major sampling in 1958.

- 103 Auerbach, S.I. TERRESTRIAL AND FRESH-WATER ECOLOGY - RADIATION EFFECTS ON Chironomus tentans. (Abstr. EIC905). p.140 in "Research and Development in Progress Biology and Medicine. Issue No.2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

The larvae of C. tentans live in the radioactive sediments of White Oak Creek and the Clinch River. The larvae are exposed to ionizing radiation which is 20-1000 times that of the natural background. The frequency of chromosomal aberrations in salivary gland chromosomes is being compared in irradiated and non-irradiated populations to determine whether there is an effect of increased radiation levels on the genetic constitution of the natural population. Photographs of the chromosomes from a non-irradiated population were taken, to construct cytological maps. Besides facilitating the scoring of chromosomes, these maps are to be compared with the cytological maps of C. tentans from Europe, and used to establish the standard chromosomal arrangement for this area.

- 104 Ball, R.C., Hooper, F.F. TRANSLOCATION OF PHOSPHORUS IN A TROUT STREAM ECOSYSTEM. p.217-28 in "Radioecology. Proceedings of 1st National Symposium on Radioecology. Colorado State University, Fort Collins, 10-15 September 1961". New York, Reinhold Publishing Corp. 1963.

To explore the movement of P in a cold-water stream P^{32} was added. The uptake of P^{32} by aquatic insects and their role in the ecosystem is discussed on p.224, 225, 226 and 228. The summers of 1958, 1959 and 1960 are considered. Concentration curves for consumer organisms within the ecosystem reflected both differences in metabolic turnover rates and food relationships. The gross shape of a concentration curve appears to be characteristic of the animal rather than of the environment. Actual maxima for a given species were more closely related to stream conditions. Curves were similar for closely related species even though living in different microhabitats (e.g. the mayfly Ephemera comuta and E. needhami). Smaller forms (Stimulium sp. and Ephemera) consistently showed higher concentrations than larger forms (Hexagenia limbata, Nigronia sp., Pteronarcys), concentration rising to a rapid peak. Many differences in slope cannot be explained by size differences (relative growth and metabolic turnover) only. Accumulation of P^{32} was much slower for large omnivorous stream insects and for predaceous forms even though they were comparatively small.

- 105 Ball, R.C., Wojtalik, T.A., Hooper, F.F. FISHERIES: UPSTREAM DISPERSION OF RADIOPHOSPHORUS IN A MICHIGAN TROUT STREAM. p.57-64 in "Papers of the Michigan Academy of Science, Arts, and Letters, Vol. 58". 1963. (1962 meeting).

Data on upstream dispersion were collected from an application of ca. 25 mc of P^{32} incorporated into cells of *Escherichia coli* strain 0111. A stonefly (*Isoperla*) had a significant activity at the 400-yard station 36 d after release, and the fishfly, *Nigronia*, at the 400- and 500-yard stations. Of 21 collections, 1 sample of mayfly and 2 samples of the caddis fly, *Brachycentrus*, had significant activity. Predacious species appeared to carry activity more consistently than other forms. Larvae of the snipefly, *Atherix*, nymphs of a stonefly, and the fishfly, *Nigronia*, had activity in a larger percentage of collections than other forms. Various data suggest that radioactivity was taken up by invertebrates at or below the point of release and carried upstream by active migration as well as migratory flights of adults.

- 106 Ball, R.C. STUDY OF PRODUCTIVITY IN A STREAM ECOSYSTEM USING A RADIOACTIVE TRACER. (Abstr. E1C118). p.120-1 in Research and Development in Progress. Biology and Medicine. Issue No.1", TID-4200, Division of Technical Information, AEC. July 1963).

Findings have shown rapid uptake by diatom flora (producers) of the stream and transfer to filter-feeding organisms, *Simulium*, the primary consumers. The isotope is repeatedly recycled, through the producer plants and utilized by primary consumer groups in less time than it takes to reach the detritus feeders. Secondary consumers continue to increase in activity for at least 60 d in spite of the rapid physical transport within the stream. An upstream movement of P^{32} was brought about by the upstream migration of larval aquatic insects. The forthcoming project will make use of As^{74} incorporated in sodium arsenite (herbicide) to follow the pathways of arsenic through a pond ecosystem and establish its relationships to the several trophic levels within the pond and evaluate its potential hazard to man. (From abstr.)

- 107 Chauvin, R., Courtois, G., Anguenot, F. LES FOURMIS (*Formica rufa*) INDICATEURS POSSIBLES DES RETOMBÉES RADIOACTIVES. C.R. Acad. Sci., Paris 256, 2 (1963) 508-11.

Le mécanisme par lequel les fourmis fixent les retombées, paraît en liaison directe avec leur habitude de prélever les excréments sucrés des pucerons des arbres, ou miellat. Les multiples gouttelettes gluantes ainsi exposées à l'air, doivent capter une très grande quantité de poussières atmosphériques et par conséquent, celles des retombées. Il est probable que la résine des confères fixe aussi ces poussières, et que les fourmis en entraînent quelque peu au cours de leurs innombrables marches sur les troncs. D'autre part il y a toute indication que les fourmis ne défont pas à l'intérieur de la fourmilière. L'importance des fourmis comme détecteurs des retombées reste à évaluer du point de vue sensibilité et par rapport aux méthodes traditionnelles. A l'examen γ spectrométrique les auteurs ont décelé dans les fourmis au cours des expériences des pics correspondants au ^{90}Zr , $^{90}(Zr+Nb)$, ^{141}Ce et ^{106}Ru .

- 108* Crossley, D.A., Jr. INSECT FAUNA OF WHITE OAK LAKE BED. "Health Physics Division Annual Progress Report for period ending 31 July 1957". ORNL-2384. 1957.

- 109* Crossley, D.A., Jr. WHITE OAK LAKE BED STUDIES/INSECT STUDIES. "Health Physics Division Annual Progress Report for Period Ending 31 July 1958". ORNL-2590. 1958.

- 110* Crossley, D.A., Jr. WHITE OAK LAKE BED STUDIES/INSECT STUDIES. "Health Physics Division Annual Progress Report for Period Ending 31 July 1959". ORNL-2806. 1959.

- 111* Crossley, D.A., Jr. INSECT STUDIES. "Health Physics Division Annual Progress Report for Period Ending 31 July 1960". ORNL-2994. 24 Oct. 1960.

- 112 Crossley, D.A., Jr., Howden, H.F. INSECT-VEGETATION RELATIONSHIPS IN AN AREA CONTAMINATED BY RADIOACTIVE WASTES. *Ecology* 42, 2 (1961) 302-17.

The development of insect populations on vegetation growing on White Oak Lake bed was followed for 3 years (1956 to 1958), immediately following the draining at White Oak Lake. This lake had served as a final holding basin for Oak Ridge National Laboratory's low-level wastes, and the alluvial terrain exposed upon drainage contained significant concentrations of radioisotopes, including Sr^{90} and Cs^{137} . The insect biomass, estimated by sweep-net and box-trap methods, was about 200 to 300 mg/m². No change could be demonstrated during the seasons, and evidently little change occurred between years. Significant concentrations of both Sr^{90} and Cs^{137} were found in samples of herbivorous insects. Concen-

trations of Sr^{90} were about 25%, and Cs^{137} concentrations about 1% of the soil values. However, the biomass of insects was minute compared to plant and soil masses, and the herbivorous insects contained but a minute fraction of the fission products in the system, since the bulk of these radioisotopes is in the soil. A sizeable fraction of the materials taken up by plants, however, may pass through the herbivorous insects in the system. Insect populations were followed in 2 areas each of smartweed, sedge-rush, and willow vegetation. Each of the vegetation types acquired its own characteristic insects. First-year insect populations tended to be dominated by one or a few species represented by many individuals. The 2nd-year populations showed a reduction in numbers for the dominant species and an influx of additional species, accompanying an increase in plant diversity. No such reduction of the dominant species occurred in the willow areas, presumably because the willows were increasing their coverage each year, and additional species of plants were not invading the willow stands. (Auth.)

- 113 Crossley, D.A., Jr., Corley, C.L., Tietjen, W.L. USE OF RADIOACTIVE TRACERS FOR ANALYSIS OF FOOD CHAINS. p.94-5 in "Health Physics Division Annual Progress Report for Period Ending 30 June 1963". ORNL-3492, Oak Ridge National Lab., Tenn. 30 Sep. 1963.

Use of biological elimination of radioisotopes in insects as indirect measures of metabolism under field conditions was continued with emphasis on the influence of temperature on elimination rates. In geometrid caterpillars the biological half life of Cs^{137} was decreased by one-half for a 10°C rise in temperature. Similar temperature-related trends were found for leaf beetles (*Chrysomela knabii*) and millipedes (*Dixidesmus erasus*).

- 114* Davis, J.J., Foster, R.F. BIOACCUMULATION OF RADIOISOTOPES THROUGH AQUATIC FOOD CHAINS. *Ecology* 39, 3 (1958) 530-45.

The relative concentrations of β -emitters in various Columbia river organisms were determined, amongst them those for caddis fly (*Hydropsyche cockerelli* Banks) larvae and mayfly (Ephemeroptera) nymphs. A graph shows the rate at which caddis fly larvae accumulated radioactive material, mostly P^{32} , when fed filamentous algae (mostly *Spizogyna*) that had been cultured in reactor effluent. The biological half-life was about 16 h. In a flowing stream, the specific activity of a radioisotope will diminish along the food chain. Thus, where the turnover rates of certain isotopes can be measured, inferences can be drawn on feeding habits.

- 115 Davis, J.J. ACCUMULATION OF RADIONUCLIDES BY AQUATIC INSECTS. HW-SA-2848, General Electric Co. Hanford Atomic Products Operation, Richland, Wash. 29 Nov. 1962. 13p.

A survey was made on the accumulation of radionuclides by aquatic insects in the section of the Columbia River that is within the Hanford Reservation in southeastern Washington. More than 60 different radioisotopes have been identified in the aqueous effluents that are continuously discharged into the Columbia River from some of the Hanford Reactors. About 20 of them have been measured in river organisms, among them Chironomid larvae (Hydrobaeninae and Tendipedinae), black fly larvae (Simuliidae), caddis fly larvae (*Hydropsyche*, *Leptocella* and *Glossosoma*), and aquatic moth larvae (*Argyria*). Insects living in the river below the reactor outfalls were found to be many times more radioactive than the water they inhabit. The most abundant radionuclides in insects were P^{32} , Cu^{64} , Cr^{51} , Zn^{65} , and Na^{24} . Interspecies differences in radionuclides accumulation are influenced by ecological and metabolic factors. The most important factors influencing radionuclide accumulation by different species were found to be food habits, biological half-lives of the elements, and seasonal variation in feeding. Typical accumulation factor patterns are presented for a number of immature and adult aquatic insects and also for plankton.

- 116 Hooper, F. ASPECTS OF BIOLOGICAL TRANSPORT OF PHOSPHORUS-32 IN STREAMS. p.247-55 in "Transport of Radionuclides in Fresh Water Systems. A Working Conference, Austin, Texas, 30 January - 1 February 1963". TID-7664, Johns Hopkins Univ. Baltimore, July 1963.

Amongst the aspects considered is the significance of the activity curve for different organisms. Such curves were plotted for a caddis, 2 fish, a mayfly, a fishfly, and filter feeders that live on the rock. The activity curve was characteristic of the species. The movement of this pulse of activity and its possible reflection of the food chain is discussed.

- 117 Howden, H.F., Crossley, D.A., Jr. INSECT SPECIES ON VEGETATION OF THE WHITE OAK LAKE BED, OAK RIDGE, TENN. ORNL-3094, Oak Ridge National Lab., Tenn. 1961. 38p.

Studies on the insects inhabiting this area, which had received low-level radioactive wastes from the Oak Ridge National Laboratory for 12 years prior to draining in 1955, revealed 401 species present during 1956 and 1957. Most numerous were members of the insect orders Hymenoptera, Diptera, and Coleoptera. In the summer of 1956, the first summer following drainage of the lake, there were relatively fewer species of insects represented by large numbers of individuals. In 1957, there were relatively more species but fewer individuals. By the end of 1957, only 2 years after the lake was drained, the vegetation supported a rich and varied insect fauna.

- 118* Krumholz, L.A. AN ECOLOGICAL SURVEY OF THE LIMNOLOGY OF WHITE OAK CREEK AND LAKE. ORO-587 (Vol. II), Tennessee Valley Authority, Norris, Tenn. Feb. 1954, 180p.

Insect fauna and insect radioactivity have been studied in detail over a period of time. Results are tabulated. Percentages of total radioactivity emitted by P^{32} , Sr^{90} , and Cs^{137} were determined for Tendipes and Chaoborus by radiochemical analysis of samples of various invertebrates collected in 1952.

- 119* Krumholz, L.A. AN ECOLOGICAL SURVEY OF THE VERTEBRATE FAUNA OF WHITE OAK LAKE AND ENVIRONS. ORO-587 (Vol. III), Tennessee Valley Authority, Norris, Tenn. Feb. 1954, 208p.

The fish population of White Oak Lake, which receives radioactive waste material from the Oak Ridge National Laboratory, was studied and their food habits analyzed (p.85-98). Samples of Tendipes collected from the lake ranged in radioactive content from 150-2770 cpm/g, whereas those of Chaoborus ranged from 540-1340 cpm/g. None of the samples of stomach contents were analyzed radiochemically. However, (July 1952-) analyses of samples of Chaoborus and Tendipes, which form part of the insect food intake of fish, revealed several radioelements in the following proportions, respectively: P^{32} —25.0, 50.0; rare earths—2.0, 6.0; radioactive Sr —0.5, 6.6; Cs^{137} —1.1, 3.3.

- 120* La Verne, L.C. MIDGE LARVAE AS INDICATORS OF RADIOACTIVE POLLUTION. Engng Bull., Purdue Ext. Ser. 106 (1960) 269-80.

The 4th instar larvae of Tendipes plumosus and T. decorus cannot be used as indicators of pollution due to P^{32} and Fe^{59} because of the low rate of uptake by the larvae as compared to the resulting activity of the hydrosol from the water. Even when the population of larvae/ m^2 (259 larvae) is considered, the total activity of the biota is only about 19.5×10^{-5} $\mu\text{C}/12.9 \text{ g}$. This is considerably less than that of hydrosol estimated to be near 150×10^{-4} $\mu\text{C}/\text{g}$. However, further study should be made of the earlier instars of these benthic forms. Considerable effort will be required to determine whether the 1st instar larvae are planktonic after hatching from the egg and for what period of time. Studies in this laboratory indicate there is a rapid uptake of radionuclides through the larval integument from tap water. Comparable studies regarding all phases of their biology will indicate whether the larvae are capable of assimilating and holding quantities of radionuclides similar to that of the mud. (CA 55: 1961, 27721g)

- 121 Morton, R.J., Ed. RADIATION EFFECTS ON BIOTA. p.58-65 in "Status Report No.1 on Clinch River Study". ORNL-3119, 1961.

The effects of chronic low-level radiation resulting from radioactive wastes on a natural population of Chironomus tentans was investigated by sensitive cytogenetic methods. Salivary glands from larvae originating from a specified site in the Clinch River were studied; approximately 29% of the 48 organisms carried some type of heterozygous inversion in one of the 3 large chromosomes. Implications and future projects are discussed.

- 122 Morton, R.J., Ed. RADIATION EFFECTS ON BIOTA - ESTIMATED RADIATION DOSE RECEIVED BY DIPTERA WITH LIFE STAGES IN BOTTOM SEDIMENTS. p.71-8 in "Status Report No.2 on Clinch River Study". ORNL-3202, 13 Apr. 1962.

The radiation from radionuclides sorbed on the river and creek bottom sediments in the environment of the larvae was 20 to 1000 times that of the natural background. A relatively high frequency of chromosomal aberrations was observed in the salivary gland chromosomes of Chironomus tentans Fabr. larvae collected from White Oak Creek and the Clinch River. While C. tentans normally has 4 pairs of chromosomes, individuals were found with 3 pairs.

- 123 Nelson, D.J., Early, R.C., Griffith, N.A. BIOLOGICAL MOVEMENT AND RESERVOIRS OF Sr^{90} . Health Physics Division Annual Progress Report for Period Ending June 30, 1963. p.109 in ORNL-3492, Oak Ridge National Lab., Tenn. 30 Sep. 1963.

The transport of Sr^{90} from the Clinch River by emerging aquatic midges (Chironomidae) was compared with the accrual of Sr^{90} to the river from weapons-testing fallout. Larval development of the midges occurs in the contaminated river-bottom sediments. Emerging adults were caught in insect light traps operated on the river bank at dusk. Adults in one large, composite sample contained 8.76 times as much Sr^{90} [$(3.55 \pm 1.3) \times 10^{-6}$ μc per gram of dry weight] as did an equal quantity of river-bottom sediment from the same location. Studies elsewhere have shown that $10 \text{ g m}^{-2} \text{ yr}^{-1}$ may be contained in the emergent insect biomass. These emergent insects would transport $(3.55 \pm 1.3) \times 10^{-6} \mu\text{c}$ of $\text{Sr}^{90}/\text{m}^2/\text{year}$ from the river bottom. The average increment of Sr^{90} from fallout in the United States between 1959 and 1960 was 4.2×10^{-3} curie/square mile ($1.62 \times 10^{-3} \mu\text{c}/\text{m}^2$). Thus, fallout entering the river directly would add 45 times as much Sr^{90} as removed by emerging chironomids.

124 Nelson, D.J. ROLE OF BOTTOM ORGANISMS. p.193-201 in "Transport of Radionuclides in Fresh Water Systems. A Working Conference, Austin, Texas, 30 January - 1 February 1963". TID-7664, Johns Hopkins Univ., Baltimore, July 1963.

Of the radioactive material present in sediment, only Sr^{90} , Cs^{137} , and rare earths were confirmed in the insects tested, presumably due to the size of the sample. The possible use of insects as monitors is discussed. (See 123). The dispersal of radioactivity by emerging aquatic insects was thus shown to be of minor importance.

125 Odum, E.P., Kuenzler, E.J. EXPERIMENTAL ISOLATION OF FOOD CHAINS IN AN OLD-FIELD ECOSYSTEM WITH THE USE OF PHOSPHORUS-32. p.113-20 in "Radioecology. Proceedings of 1st National Symposium on Radioecology held at Colorado State University, Fort Collins, 10 - 15 September 1961". New York, Reinhold Publishing Corp. 1963.

Three dominant species of plants, Heterotheca subaxillaris, Rumex acetosella, and Sorghum halepense in an oldfield ecosystem at the U.S. Atomic Energy Commission's Savannah River Plant were labelled by foliar application of P^{32} in separate 100-m quadrats in May 1957, and the subsequent amounts and distribution of tracer in animal populations were determined. When the concentration of the tracer per unit of biomass (mg of wet weight) was plotted against time, a clear graphic separation of certain trophic and habitat groups was evident in all three quadrats. The maximum concentration of P^{32} in major populations occurred as follows: Dorymyrmex, most common ant, and Oecanthus, most common known herbivore, 1-2 weeks; grazing herbivores in general, 2-3 weeks; sedentary spiders, 3-4 weeks; Cryptozoa (ground beetles, crickets, etc.), 4-5 weeks. The trophic position of 2 of the most common species, whose exact food source in nature was previously unknown, was rather clearly established by comparison of their uptake curves with those of species whose food was known. In general, the most common grazing herbivores such as the several orthopteran species fed freely on all 3 species of dominant plants, without marked preference, while some less common species were more selective. (From auth.)

126* Перельский, А.А., Богатырев, И.О. РАССЕИВАНИЕ РАДИОИЗОТОПОВ ВОДНЫМИ НАСЕКОМЫМИ. (Реферат доклада). Бюлл. Моск. Общ. Испыт. Прир., Отд. биол. 64, 2 (1959) 150.

Peredel'skii, A.A., Bogatyrev, I.O. THE SCATTERING OF RADIOISOTOPES BY AQUATIC INSECTS. (Abstr.). Byull. mosk. Obshch. Ispyt. Priр., Ord. biol. 64, 2 (1959) 150.

127* Peredel'skii, A.A., Bogatyrev, I.O. RADIOACTIVE CONTAMINATION OF LAND AREAS BY INSECTS EMERGING FROM CONTAMINATED WATER BODIES. Izv. Akad. Nauk SSSR, Ser. biol., 2 (1959) 186-92. (In Russian). English Translation: IPRS-17812. ♀

Adult winged insect whose larvae have lived at the bottom of water bodies contaminated with radioactive isotopes contain small quantities of radioactivity in their bodies. A quantitative species-specificity was found for various isotopes (Cs^{137} , Sr^{90} , Co^{60} , undiluted mixture of β - and γ -emitters: fission products of a nuclear reactor) and insect species (caddis flies: chiefly Polycentropus flavomaculatus; mayflies Cloeon dipterum, Ephemerella ignita; and midges: chiefly Tendipes) investigated. Increasing specific activity of the water increased the radioactivity of the adult insect. A greater total activity is characteristic of the larger form of insect. The total activity removed from the water body by winged insects can reach high figures over a number of generations, of which each one consists of tens and hundreds of millions of individuals. The accumulation of radioactive insects in adjacent areas and the effective rate of bio-radioecological purification of such water bodies raises extremely grave issues.

- 128* Timofeev-Resovskiy, N.V., Timofeeva-Resovskaya, E.A., Milyutina, G.A., Getsova, A.B. ACCUMULATION COEFFICIENTS OF RADIOACTIVE ISOTOPES OF SIXTEEN ELEMENTS BY FRESH-WATER ORGANISMS AND THE EFFECT OF THE COMPLEX-FORMER ETHYLENEDIAMINE-TETRAACETATE (EDTA), ON SOME OF THEM. Dokl. Akad. Nauk SSSR 132 (1960) 1191-4. (In Russian).

The following concentration coefficients (ratio of concentration of isotope in the organism to its concentration in the medium) were determined for the indicated radioelements: P^{32} 19 species of water plants 1430, 17 species of aquatic organisms (various animals included) 2470; S^{35} 90, 15; Ca^{45} 330, -; Fe^{59} 6860, 510; Co^{60} 4590, 2050; Zn^{65} 7240, 830; Ge^{71} 350, 70; Rb^{86} 950, 180; Sr^{90} 535, 765; Y^{91} 6530, 1080; Zr^{95} 4925, 640; Nb^{95} 7315, 380; Ru^{106} 1800, 545; I^{131} 370, 20; Cs^{137} 520, 265; Ce^{144} 6730, 2045. EDTA lowered the coefficients of Fe, Co, Zn, Y, and Ce considerably; those of Ca, Zr, Nb, Ru, and I were lowered slightly; those of Rb, Sr, and Cs were raised; and others were unchanged. (CA 55: 1961, 36796)

- 129 Тимофеева-Ресовская, Е.А., Тимофеев-Ресовский, Н.В., Гилева, Э.А. О СПЕЦИФИЧЕСКИХ НАКОПИТЕЛЯХ ОТДЕЛЬНЫХ РАДИОИЗОТОПОВ В СРЕДЕ ПРЕСНОВОДНЫХ ОРГАНИЗМОВ. Докл. АН СССР 140, 6 (1961) 1437-40.

Timofeeva-Resovskaya, E.A., Timofeev-Resovskiy, N.V., Gileva, E.A. SPECIFIC ACCUMULATORS OF INDIVIDUAL RADIOISOTOPES IN FRESH-WATER ORGANISMS. Dokl. Akad. Nauk SSSR 140, 6 (1961) 1437-40.

Table of data on accumulation of P^{32} , S^{35} , Ca^{45} , Cr^{51} , Fe^{59} , Co^{60} , Zn^{65} , Ge^{71} , Rb^{86} , Sr^{90} , Y^{91} , Zr^{95} , Nb^{95} , Ru^{106} , Cd^{115} , I^{131} , Cs^{137} , Ce^{144} , and Hg^{203} is presented for a selection of the lower animals and algae and aquatic plants. P, Co, Sr, Y, I, Cs, and Ce are intensively accumulated by some of the animals and all but Ca, Ge, Rb, Nb, I, and Hg are accumulated by at least some of the aquatic plants. Some data were also obtained for the accumulation of radioisotopes (Co^{60} , Cs^{137}) by caddis flies (Trichoptera).

- 130 Timofeeva-Resovskaya, E.A. DISTRIBUTION OF RADIOISOTOPES IN BASIC COMPONENTS OF FRESH-WATER BODIES. Trud. Inst. Biol., Akad. Nauk SSSR Ural'sk. 30 (1963) 1-79. English Translation: JPRS-21816. 1963. 104p.

Results are reported from a series of studies on the distribution of radioactivity from 18 different radioisotopes in surface waters, sediments, and aquatic organisms. Emphasis was placed on the concentration of the various radioisotopes by freshwater organisms. The radioisotopes investigated included P^{32} , S^{35} , Cr^{51} , Fe^{59} , Co^{60} , Zn^{65} , Ge^{71} , Rb^{86} , Sr^{90} , Y^{91} , Zr^{95} , Nb^{95} , Ru^{106} , Cd^{115} , I^{131} , Cs^{137} , Ce^{144} , and Hg^{203} . The following insects were studied: larvae of *Culex pipiens pipiens* L., *Theobaldia alasensis* Ludl., *Halesus interpunctatus* Lett., *Leptocerus* sp., *Phryganea grandis* L., *Aeschna* sp., *Lestes* sp., *Eristalis* sp. and *Tendipes* sp.

See also:

- 154 Accumulation and excretion of Cs^{137} by grasshoppers. (Crossley, 1958)
 157 Movement and accumulation of radiostrontium and radiocesium in insects. (Crossley, 1963)
 165 The accumulation of radioactive isotopes by certain aquatic insects. (Getsova and Volkova, 1962)
 166 The problem of the excretion of radioactive isotopes by various aquatic invertebrates. (Getsova, 1961)
 167 Accumulation and removal of Ruthenium-106, Cerium-144 and Promethium-147 by the fly *Halesus interpunctatus* Zett. (Getsova and Volkova, 1962)
 183 Contributions to the accumulation and excretion of radioactive isotopes of seven chemical elements in dragon fly larvae. (Volkova, 1963)
 184 The build-up factor of the radioisotopes of some chemical elements in aquatic insects. (Volkova, 1963).
 1388 Chromosomal aberrations in a natural population of *Chironomus tentans* exposed to chronic low-level environmental radiation.
 1389 Population genetics and radiation effects studies on *Chironomus tentans*. Health Physics Division Annual Progress Report for Period Ending June 30, 1963. (Blaylock et al., 1963)
 1566 Terrestrial and freshwater radioecology. A selected bibliography. (Klement, 1962)
 1566 Terrestrial and freshwater radioecology. A selected bibliography. (Klement and Schultz, 1963)

- 131 Merker, E. STUDIEN ÜBER UNMITTELBARE UND MITTELBARE VERHÄNGNISVOLLE WIRKUNGEN DER BESTÄNDESDÜNGUNG AUF WALDVERDERBER. (Studies of direct and indirect damaging effects of fertilizers on forest pests). Anz. Schädlingssk. 35, 9 (1962) 133-40. (In German, with English summary).
- Insects depend on the physiological condition of the plants on which they feed. Heat and dryness increases the content of sugar, approximately up to 50%, and other nutrients in the plants. During rainy seasons the proportion of sugar decreases. The osmotic evaluation can be used as indicator of the physiological condition of the plants. The high concentration of sugar stimulates the development of the insects, but they also thrive on plants with high turgor. Young larvae feed only on newly burst open, most turgescient needles and leaves. This is true of the larvae of *Liparis monacha*, *Lymantria dispar*, *Pristiphora abietina* and two *Dreyfusia* on the young needles of the silver fir. Radioactive fertilizers enter the plants and feeding insects. P^{32} is mainly found in the intestines, Ca^{45} is deposited more in the vasa malpighii. It is suggested that fertilizing may over-feed these organs. Observations demonstrate that the physiological condition of the plants in spring and summer has no decisive effect upon the insects. The direct damaging effect of the fertilizers on the larvae is more profound. The adsorbed fertilizers seriously disturb the metabolism of the insects. (From auth. summary)
- 132* Peredel'skiĭ, A.A., Bogatyrev, I.O., Karav'yanskiĭ, N.S. INFLUENCE OF EARTHWORMS (Lumbricidae) AND WIREWORMS (Elateridae) ON THE UPTAKE OF RADIOACTIVE ISOTOPES CALCIUM-45 AND STRONTIUM-90 BY PLANTS FROM THE SOIL. Dokl. Akad. Nauk SSSR 134 (1960) 1450-2. (In Russian)
- Malze (I) and bean (II) plants were grown in soil contaminated with the isotopes, in presence and absence of the animals. The isotopes were concentrated more in the leaves of I in presence of wireworms. Where the isotopes were originally confined to a lower layer of soil the accumulation in the leaves was significantly less than when the isotopes were evenly spread through the soil. The presence of either animal species reduced the uptake of isotopes by the roots of I. In the leaves of II, Sr^{90} accumulated strongly in the presence of earthworms. In the roots of I accumulation of Sr^{90} was markedly reduced by wireworms and earthworms, but in roots of II it was slightly increased by wireworms and much increased by earthworms. Ca^{45} in leaves of I and II was increased strongly by wireworms and weakly by earthworms. In roots of I accumulation of Ca^{45} is greatly repressed by both species; in roots of II the accumulation is strongly increased by wireworms, but unaffected by earthworms. The increased uptake of isotopes in presence of wireworms is probably linked with the damage caused by these animals to the subterranean portions of plants. (CA 55: 1961, 9581e).
- 133* Peredel'skiĭ, A.A., Shaĭn, S.S., Karav'yanskiĭ, N.S., Nikolaev, G.V. SCATTERING OF RADIOISOTOPES IN THE SOIL BY EARTHWORMS (Lumbricidae). Dokl. Akad. Nauk SSSR 135 (1960) 185-8. (In Russian)
- It was shown experimentally that in earthworms living in soil containing Ca^{45} and Sr^{90} the specific radioactivity of the worm rapidly reaches a maximum level which is maintained without much variation afterward; this level may be near that of the contaminated soil. The faeces of earthworms tend to have higher specific radioactivity than found in the soil. Sample calculations are made to estimate the length of time required for a complete spread of radioisotopes over a given volume of soil from one contaminated site by the earthworms. Wireworms (*Agriotes sputator*) are relatively ineffective in spreading radioisotopes by the above mechanism, but the presence of such worms stimulates the intake of radioisotopes by plant roots in the soil. (CA 55: 1961, 11685c)

- 134 Henry, S.M. THE SIGNIFICANCE OF MICROORGANISMS IN THE NUTRITION OF INSECTS. Trans. N.Y. Acad. Sci. 24, 6 (1962) 676-83.

Review article. Studies not only on nutritional but also on other physiological and biochemical relationships between the insect and its associated microorganisms are clearly facilitated by the use of radioisotopes. An attempt (unpublished) is reported, made by the authors, to determine the essential amino acids in Blattella germanica (by the method used in Nature 182 : 1968, 1380 and J. Insect Physiol. 8: 1962, 97). Glucose-U-¹⁴C (25 µc/g) was fed to 4th instar nymphs as a 2% solution with a vitamin mixture. Both xenic and aposymbiotic cockroaches were used. Details of subsequent procedures are given. Results of radiometric analysis are tabulated. The xenic cockroach apparently synthesizes all the amino acids which, according to their level of radioactivity, fall into 2 groups. The quantities detected in xenic and aposymbiotic animals, respectively, differ markedly. The intracellular symbiotes of Blattella clearly have an important function as a significant source of amino acids for their hosts, and they undoubtedly synthesize several growth factors as well. Intestinal microorganisms here, as in many other insects, are apparently of little importance.

* Freed of intra-cellular symbiotes but not intestinal bacteria.

- 135 Martoja, R. ASSIMILATION DE LA CELLULOSE ET MICROORGANISMES INTESTINAUX CHEZ Gryllus bimaculatus DE GEER (Insecte, Orthoptère, Grylloidea). Note. C.R. Acad. Sci., Paris 264, 16 (1962) 3040-2.

Des Grillons normaux, d'autres partiellement privés de leurs germes, et deux Acridoidea dépourvus de segment à bactéries (Locusta migratoria L., Schistocerca gregaria Forskal), tous adultes ont été traités à 20°C, de la façon suivante: on leur a fait ingérer des fragments aussi semblables que possible de cellulose marquée au ¹⁴C et ensuite on a recherché les composés radioactifs dans les tissus. Les faits rapportés démontrent, chez un Gryllide, une possibilité d'assimilation de la cellulose, qui semble être en rapport avec la présence du segment intestinal à microorganismes. Ils permettent de situer des relations entre les germes et l'hôte sur le plan de la symbiose: les bactéries dégradent la cellulose dont les dérivés sont assimilables par l'hôte; inversement, ce dernier apporterait aux germes certains composés, parmi lesquels des composés soufrés ont pu être mis en évidence.

See also:

- 45 A study of termite feeding relationships, using radioisotopes. (McMahon, 1963)
230 The sulfur metabolism of insects. VI. Metabolism of the sulfur amino acids and related compounds in the German cockroach, Blattella germanica (L.). (Henry and Block, 1961)
232 Amino acid synthesis, a rumen-like effect of the intracellular symbiotes of the German cockroach. (Henry and Block, 1962)
373 The role of intestinal symbiotes in the sterol metabolism of Blattella germanica. (Clayton, 1960)

I - A - 4 - c INSECT-ANIMAL

(Including Parasite and Predator Relationships)

- 136 Clark, E.W., Glick, P.A. SOME PREDATORS AND SCAVENGERS FEEDING UPON PINK BOLLWORM MOTHS. J. econ. Ent. 54, 4 (1961) 815-6.

In order to label them with P³², adults of Pectinophora gossypiella (Saund.) were fed on a carbohydrate solution containing radioactive phosphoric acid. They were then released. Traps with lights near the ultra-violet range (3000-4000Å) were used which also caught predators and scavengers, some of them radioactive through feeding on the moths. A list of them is given. Amongst the insects listed was the checkered beetle, Enoclerus quadrisignatus Say, variously reported as of some economic importance as a predator in the Coastal Bend area of Texas, at times causing at least a 20% reduction in the pink bollworm population in cotton blooms. Other radioactive insects, the numbers captured being in brackets, were Achetidae: Acheta sp. (4) Carabidae: Anisotamus nitidipennis Lec. (1) Selenophorus fatuus Lec. (1) Stenomorphus californicus (Men.) (1) Labiduridae: Labidura riparia (Pallas) (Shore earwig) (5) Staphylinidae: Lathrobium sp. (1) Philonthus alumnus Er. (2)

- 137 Dissanaik, A.S. THE USE OF RADIOISOTOPES IN THE STUDY OF HELMINTH LIFE CYCLES. p.323-38 in "Radioisotopes in Tropical Medicine, Proceedings of a Symposium, Bangkok, 12-16 December 1960". Vienna, International Atomic Energy Agency, 1962.
- The infective larval stage of helminths can be "activated" or "labelled" with P^{32} and other suitable isotopes with a view to following them up in the vertebrate host tissues. Various methods have been employed, depending on the type of life cycle involved. Thus, larvae transmitted by invertebrate hosts have been labelled by allowing them to develop in the tissues of previously labelled vectors, e.g. Wuchereria bancrofti in Culex fatigans and Setaria digitata in Amigere obturans. The different methods are described and their possible use in elucidating certain unknown details of the life cycles of helminths of human importance is discussed. A few preliminary observations on γ -emitting, longer-lived radioisotopes, such as Cs^{137} and I^{131} , are discussed.
- 138 Каменкова, К.В., Молчанова, В.А. ПРИМЕНЕНИЕ РАДИОАКТИВНОГО ИЗОТОПА ФОС-ФОРА ДЛЯ МАРКИРОВКИ ЗЕРНОВОЙ СОВКИ И ЕЕ ПАРАЗИТОВ. Стр.111-? в сб. "Вопросы экологии. По материалам четвертой экологической конференции", №11. 1962.
- Kamenkova, K.V., Molchanova, V.A. USE OF THE RADIOISOTOPE OF PHOSPHORUS FOR LABELLING GRAMINIVOROUS NOCTUIDAE AND THEIR PARASITES. p.111-? in "Proceedings of the Fourth Ecological Conference, Voprosy ekologii, No.11, 1962".
- 139 Шура-Бура, Б.Л., Харламов, В.П. РАДИОАВТОГРАФИЯ КАК МЕТОД ВЫЯВЛЕНИЯ МЕЧЕНЫХ ГРЫЗУНОВ И ИХ ЭКТОПАРАЗИТОВ ПРИ ИЗУЧЕНИИ ВОПРОСОВ МИГРАЦИИ. Зоол. Ж. 40, 2 (1961) 258-63.
- Shura-Bura, B.L., Kharlamov, V.P. AUTORADIOGRAPHY AS A METHOD OF DETECTING TAGGED RODENTS AND THEIR ECTOPARASITES IN A STUDY OF MIGRATION PROBLEMS. Zool. Zh. 40, 2 (1961) 258-63.
- Sr^{90} was given to rats (Rattus norvegicus) with bait, and fleas (Xenopsylla cheopis and Ceratophyllus fasciatus) by allowing them to feed on white mice which had been labelled by subcutaneous injection of Sr^{90} . Photographic film or photosensitive ECG paper was used. Radioactivity of skeletal bones could be traced for at least 1.5 months in rats given 0.28 mc/g, in faeces for at least 2 months. Fleas fed on mice given 4 mc/g body weight remained radioactive for at least 2.5 months.
- 140 Свиридов, Г.Г. ПРИМЕНЕНИЕ РАДИОАКТИВНЫХ ИЗОТОПОВ В ИЗУЧЕНИИ НЕКОТОРЫХ ВОПРОСОВ ЭКОЛОГИИ БЛОХ. СООБЩЕНИЕ 2. КОНТАКТ ЗВЕРЬКОВ И ИНТЕНСИВНОСТЬ ОБМЕНА ЭКТОПАРАЗИТАМИ В ПОПУЛЯЦИИ БОЛЬШОЙ ПЕСЧАНКИ. Зоол. Ж. 42, 6 (1963) 947-9.
- Sviridov, G.G. APPLICATION OF RADIOACTIVE ISOTOPES TO THE STUDY OF SOME PROBLEMS OF FLEA ECOLOGY. II. THE CONTACT BETWEEN RODENTS AND THE DEGREE TO WHICH ECTOPARASITES ARE INTERCHANGED IN A POPULATION OF Rhombomys opimus. Zool. Zh. 42, 6 (1963) 947-9. English Translation: JPRS-20864.
- R. opimus and fleas were rendered radioactive by means of S^{35} -labelled methionine. Data are presented on the exchange of parasites, the intensity of infestation, and the range of fleas in a population of rodents (R. opimus) in burrows. The most intensive spread of labelled fleas took place in a radius up to 100 m from the place where they were released.
- 141 Свиридов, Г.Г., Морозова, И.В., Калуженова, З.П., Ильинская, В.Л. ПРИМЕНЕНИЕ РАДИОАКТИВНЫХ ИЗОТОПОВ ПРИ ИЗУЧЕНИИ НЕКОТОРЫХ ВОПРОСОВ ЭКОЛОГИИ БЛОХ. СООБЩЕНИЕ 1. АЛИМЕНТАРНЫЕ СВЯЗИ БЛОХ Xenopsylla С БОЛЬШИМИ ПЕСЧАНКАМИ В ЕСТЕСТВЕННЫХ УСЛОВИЯХ. Зоол. Ж. 42, 4 (1963) 546-50.
- Sviridov, G.G., Morozova, I.V., Kaluzhenova, Z.P., Il'inskaya, V.L. USE OF RADIOACTIVE ISOTOPES FOR THE STUDY OF CERTAIN PROBLEMS OF FLEA ECOLOGY. I. ALIMENTARY RELATIONS OF FLEAS OF THE Xenopsylla WITH Rhombomys opimus Pall. UNDER NATURAL CONDITIONS. Zool. Zh. 42, 4 (1963) 546-50.

Labelling of *Rhombomys opimus* with P^{32} and letting fleas of the genus *Xenopsylla* feed on them revealed that the alimentary activity of the fleas changed relative to the season. It varied in different structural areas of a burrow, due to the microclimatic conditions. In a flea population the females which have a higher feeding activity predominate, indicating their importance in the transmission of diseases. (From auth.)

See also:

- 32 Age characteristics involved in the feeding of *Apanteles glomeratus* L. larvae. (Shapiro and Khotyanovich, 1962)
- 33 Experiments on studying the feeding activity of fleas parasitizing Gerbillinae under natural conditions by means of radioisotopes. (Soldatkin et al., 1962)
- 55 The location of the nests of carpenter ants (*Camponotus* spp., Hymenoptera-Formicidae) by means of a radioactive isotope. (Riordan, 1960)
- 82 Radiomarking of insects for studies on their migration. (Molchanova et al., 1961)
- 158 Determination by radioactive iron (^{59}Fe) of the amount of blood ingested by insects. (De Freitas and Da Silveira Guedes, 1961)
- 159 Some data on the rate of iron elimination in *Triatomids* measured by radioactive iron (^{59}Fe). (De Freitas and Campos, 1961)
- 160 Determinación de la cantidad de sangre ingerida por los insectos por medio del hierro radioactivo (^{59}Fe). (De Freitas and Da Silveira Guedes, 1962)
- 181 Algunos datos sobre la eliminación de hierro en triatomídeos medida con hierro radiactivo (^{59}Fe). (De Freitas and Campos, 1963)
- 448 The use of radioactive isotopes for labelling ticks. (Babenko, 1960)
- 459 Use of radioactive carbon for the labelling of fleas. (Novokreshchenova et al., 1961)
- 586 Systemic action of two insecticides on arthropod parasites of rabbits and cattle. (Adkins, 1961)
- 570 Use of radioisotopes and radiation in the control of plant and animal insect pests. (Andreev, et al., 1963)

I- A - 4 - d INSECT-PLANT

(Including Forest Infestation)

- 142 Auerbach, S.I. ECOLOGICAL CYCLE OF Cs-137 IN A TULIP POPLAR FOREST. (Abstr. E1A899). p.129-30 in "Research and Development in Progress. Biology and Medicine. Issue No.2". TID-4201, Division of Technical Information, AEC. Nov. 1963.

To start the long-range experiments needed for following the redistribution of a tracer isotope in a forest ecosystem, the overstory of a 1/8 acre tulip poplar forest was tagged with 487 mc of Cs^{137} by inoculating 35 trees. Specific objectives and procedures considered for FY 1963 include trapping of foliage insects to relate their activity to that of their food supply, area-collection of insect frass, and measurement of isotope accumulation by invertebrate animals in leaf litter and soil.
- 143 Crossley, D.A., Jr. USE OF RADIOACTIVE TRACERS IN THE STUDY OF INSECT-PLANT RELATIONSHIPS. p.43-53 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.

In both field and laboratory experimentation, insects are allowed to reach steady-state concentrations of radioisotopes through feeding. Then the rate of intake is equal to the rate of elimination of the radioisotope: (rate of ingestion) = (steady-state amount) \times (fractional rate of loss). Measurements of elimination rates (biological half-lives) permit the steady-state concentrations to be translated into intake rate functions. Food consumption studies have been performed for single-insect-species populations and for multiple-species populations. In a single-species investigation, Cs^{137} in a tagged field site was used to estimate the consumption of willow leaves by populations of the beetle *Chrysomela knabi*. Direct measurements of food consumption made in the laboratory showed good agreement with field estimates of feeding rates based on the radioisotope techniques. Biological half-lives differed for the larval stages and these had to be considered separately. Radioisotopes provided a means of separating overwintering adults from newly emerged ones; through the more rapid elimination of caesium from overwintering adults.

In multiple-species work, the relationship between size of insect and elimination rate was used to derive an average biological half-life for Cs^{137} elimination from herbivorous insects in a field site tagged with Cs^{137} . This average rate, used in conjunction with data on plant and insect biomasses and concentrations of radiocaesium, permitted an evaluation of plant consumption by an entire insect community. Similarly, the utilization of insects as food by predaceous arthropods was estimated from steady-state concentrations of radiocaesium in predators and prey, biomasses, and an average elimination rate. (From auth.)

- 144 Delattre, R. NOTE PRÉLIMINAIRE SUR L'UTILISATION DES RADIOISOTOPES DANS L'ÉTUDE DES PARASITES DU COTONNIER EN AFRIQUE. p.85-92 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1962". Vienna, International Atomic Energy Agency, 1963.

Le chenille de Diparopsis watsoni Roth est nuisible au cotonnier en détruisant fleurs et capsules. Cette noctuelle, pratiquement monophage, passe l'inter-saison, soit dans le sol sous forme de chrysalides en diapause à partir du 10 novembre, soit par des générations continues (polyvoltines) sur les plants non arrachés. Des études de laboratoire ont permis d'élucider les principaux mécanismes déclenchant la diapause et y mettant fin. Des expériences préliminaires ont eu lieu à Tikem (République du Tchad) en vue de déterminer des techniques de marquage simples. Dans un premier essai, ^{32}P a été appliqué en pulvérisation aqueuse directe sur le feuillage de cotonniers jeunes. Malgré la pluie, l'absorption fut de 10% environ par la plante en quelques heures. Diverses chenilles phyllophages (Sylepta derogata, Prodenia litura) ne retiennent pas de radioactivité, mais les chenilles qui se nourrissent d'organes fructifères (Heliothis armigera, Earias insulana, Diparopsis watsoni, etc.) sont facilement détectable 3 mois après l'application. Dans un deuxième essai, ^{32}P et ^{35}S ont été appliqués sur des cotonniers âgés, juste avant la période de mise en diapause naturelle de Diparopsis. Les résultats d'ensemble laissent espérer que l'on pourra sans trop de difficultés distinguer, parmi les populations de chrysalides prélevées dans le sol, celles nourries sur le cotonnier avant qu'il ne soit marqué, donc qui auront subi une diapause. Une contre-expérience sera ensuite nécessaire; elle consistera à marquer, en cours de saison, les cotonniers d'un champ ayant déjà porté la même culture l'année précédente, les chrysalides sans diapause étant cette fois marquées. Des observations annexes sont également en cours sur divers autres parasites du cotonnier. (From auth.)

See also:

- 14 Consumption of vegetation by insects. (Crossley, 1963)
24 Die Wirkung of Aphidenstichen auf pflanzliche Zellen. (Effects on plant cells of aphid punctures). (Marek, 1961)
59 Problems of practical importance in honeydew research. (Kloft, 1963)

I - A - 4 - e POLLINATION

See:

- 76 Méthodes d'études sur la dynamique des populations d'insectes, 1962. Méthodes d'étude des populations d'insectes pollinisateurs. (Rés.). (Lecomte, 1962)
75 Techniques d'étude des populations d'insectes pollinisateurs. (Lecomte, 1962)

I - B Insect Physiology and Biochemistry

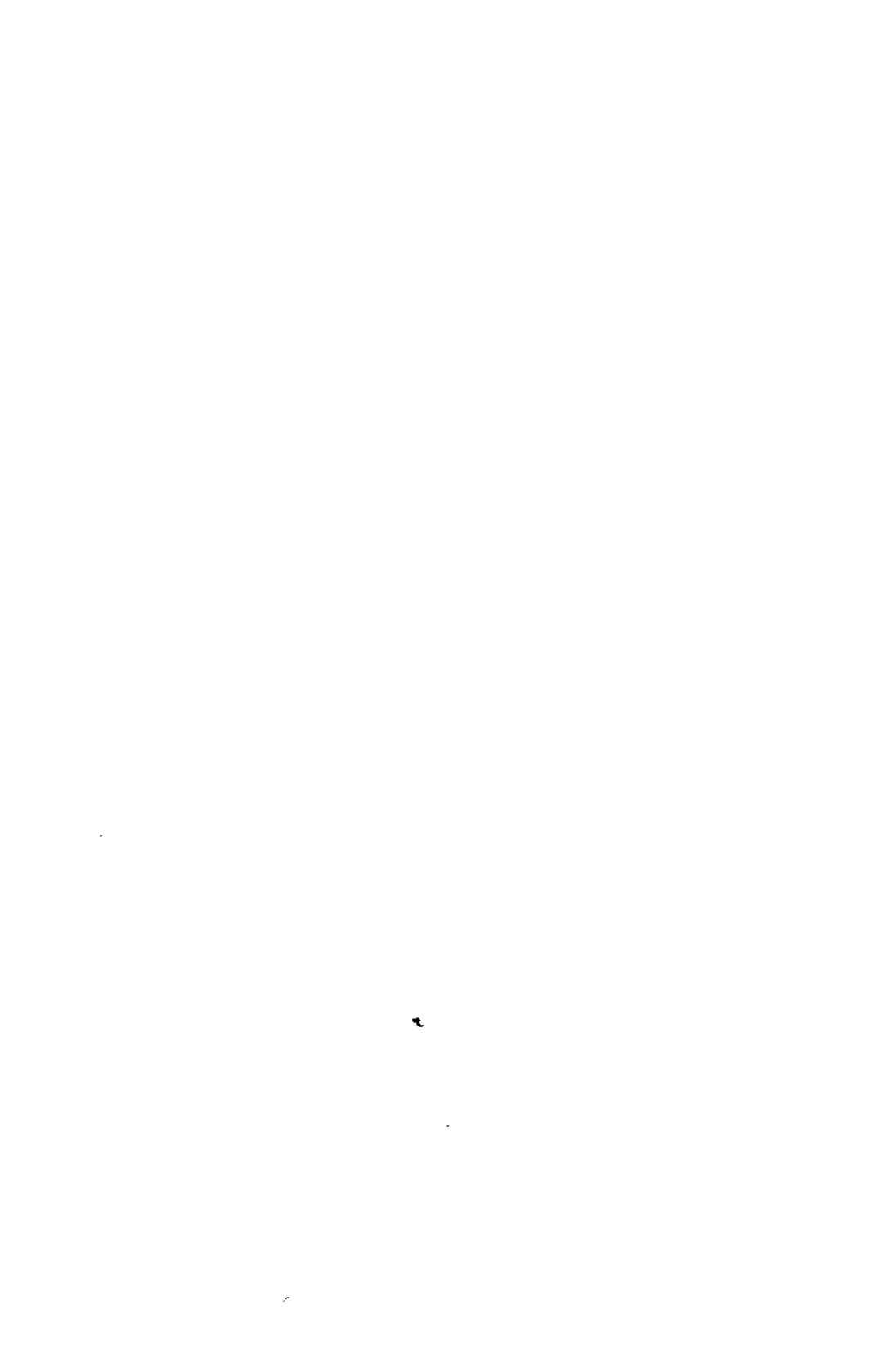
I - B - 1 GENERAL ARTICLES. SURVEYS

- 145* Андреев, С.В., Мартенс, Б.К., Молчанова, В.А., Шкарлат, Г.М. ИЗУЧЕНИЕ БИОЛОГИИ МАССОВОГО ВРЕДИТЕЛЯ ХЛЕБОВ.....МЕТОДОМ РАДИОМАРКИРОВКИ. Стр.107 в сб. "Тезисы докладов Научной конференции по применению радиоактивных и стабильных изотопов и излучений в сельском хозяйстве". М., Всесоюз. Акад. с.-х. Наук им. Ленина. 1958.

Andreev, S.V., Martens, B.K., Molchanova, V.A., Shkarlat, G.M. USE OF THE RADIO-LABELLING METHOD TO INVESTIGATE THE BIOLOGY OF ECONOMICALLY IMPORTANT GRAIN PESTS. p.107 in "Papers presented to the Scientific Conference on the Use of Radioactive and Stable Isotopes and Radiation in Agriculture". Moscow, Lenin All-Union Academy of Agricultural Science, 1958.



- 158 De Freitas, J.R., Da Silveira Guedes, A. DETERMINATION BY RADIOACTIVE IRON (^{59}Fe) OF THE AMOUNT OF BLOOD INGESTED BY INSECTS. Bull. World Hlth Org. 25, 2 (1961) 271-3.
- Three days after the injection into a fowl 4 months old of 1.5 ml solution of sterile iron citrate containing sufficient Fe^{59} to give 44.5 μc , the haemoglobin of the blood of the fowl already contained radioactive iron. Starved 5th-instar nymphs and adults of Triatoma infestans (Klug) and 1st-instar nymphs of Panstrongylus megistus (Burm.) were allowed to feed for 1 h on the labelled fowl, and females of Culex pipiens fatigans Wied, were given access to the bird overnight. The amount of blood ingested was calculated from the ratio of the radioactivity of the insect after feeding to that of 1 mm^3 of the blood, and the results were compared with those obtained when the insects were weighed before and after the blood-meal. With the Triatomines, results from both methods agreed when radioactivity was measured immediately after feeding. A few hours after the blood-meal, the Panstrongylus nymphs had eliminated 43% of the liquid ingested. The average amount of blood taken by Culex was found to be 3.3 mg by the gravimetric and 10.2 mm^3 by the isotopic method; about 70% of the liquid ingested was eliminated in < 12 h. The advantages of the Fe^{59} technique are a conveniently long half-life, a high degree of conversion to labelled haemoglobin, and persistence for several months in the blood of the vertebrate; and its easy detection, suitability for Fe-metabolism studies in several phases of insect life-cycle and the tracing of labelled insects.
- 159 De Freitas, J.R., Campos, M. SOME DATA ON THE RATE OF IRON ELIMINATION IN Triatomids MEASURED BY RADIOACTIVE IRON (^{59}Fe). Bull. World Hlth Org. 25, 2 (1961) 274-8.
- Studies on the elimination and assimilation of Fe^{59} by 5th-instar nymphs and adults of Triatoma infestans (Klug) and 1st-instar nymphs of Panstrongylus megistus (Burm.) are described. The bugs were allowed to feed overnight on the fowl with labelled blood, and the radioactivity of the insects and of their excreta was determined at intervals during the next 77-87 d, in the course of which the bugs were given two unlabelled feeds. The elimination of Fe^{59} was insignificant up to the 6th day after feeding. After 36 d, it was lowest in the 1st-instar nymphs and highest in the adults. At the end of the observations, the percentages of the ingested Fe^{59} assimilated by the 1st- and 5th-instar nymphs and the adults were 2, 19 and 5, respectively. The average retention time (the interval, in days, between the blood-meal and the time when 50% of the ingested Fe had been eliminated) was 40 d for the 1st-instar nymphs, 31 for the 5th-instar nymphs and 16 for the adults. Ways in which retention time may affect transmission of Trypanosoma cruzi by the Triatomines are suggested.
- 160 De Freitas, J.R., Da Silveira, Guedes, A. DETERMINACIÓN DE LA CANTIDAD DE SANGRE INGERIDA POR LOS INSECTOS POR MEDIO DEL HIERRO RADIATIVO (^{59}Fe). Bol. Ofic. sanit. pan-amer. 53, 5 (1962) 428-9.
- See 158.
- 161 De Freitas, J.R., Campos, M. ALGUNOS DATOS SOBRE LA ELIMINACIÓN DE HIERRO EN TRIATOMI-MEDIDA CON HIERRO RADIATIVO (^{59}Fe). Bol. Ofic. sanit. pan-amer. 54, 1 (1963) 61-3.
- See 159.
- 162* Faludi, B. Csukás-Szatóczky, L., Széplaky, K. TRANSFER TO THE NEW GENERATION OF THE P^{32} , INCORPORATED BY THE PARENTS IN Drosophila melanogaster IMAGES. Ann. Univ. Budapest, Sect. Biol. 3 (1960) 171-8. (In English).
- Organisms were grown at 26° on Belgowsky's medium containing P^{32} as inorganic phosphate. Under these conditions a generation develops in 200-40 h. Fractionations were obtained for 4-d old larvae, young pupae, and male and female imagoes. There was a marked increase in acid-soluble P just prior to the pupal stage. Beyond the pupal stage there was an increase in lipid P. Experiments on mating of radioactive adults with non-radioactive mates showed that the egg contributed 50 times as much P to the offspring as did the spermatozoa (calculation corrected for weight differences). The medium and the egg provided nearly the same amount of P to the alkali soluble and alcohol-soluble fractions of the larva. Spermatozoa and medium provided vastly different amounts of P to the various fractions, e.g. the sperm contributed much more P to the lipid fraction than did the medium. As expected, the P contribution of the medium to deoxyribonucleic acid was smaller than that of the spermatozoa. (CA 55: 1861, 19037g)



the level of the original "tag" and (in aquatic environments) on the physico-chemical nature of the environment, and (2) an assimilated pool which is distributed throughout the tissues of the body with some concentration in digestive organs and gonads and which is excreted much more slowly at a rate more directly related to metabolic processes. Biological half-life ($T_{1/2}$) of the assimilated pool varied from as long as 250 d in inactive adults kept at low temperatures to 20 d in active egg-laying *Oncopeltus* females or rapidly growing *Tenebrio* larvae. Young adult *Tenebrio* kept for 30 d at 10°, 20°, and 30°C averaged 163, 40, 23 d $T_{1/2}$, respectively, which is roughly inversely proportional to expected metabolic rate at these temperatures. $T_{1/2}$ of 5 adult *Oncopeltus* which had been confined to small bottles in the laboratory decreased 5-fold (125-25 d) when released for 10 d in an outdoor habitat, indicating much greater activity in the field. It is concluded that the rate of loss from the assimilated pool provides a "metabolic clock" for comparing laboratory and field rates of energy flow in arthropod populations.

- 175 Ofstedal, P. STUDIES WITH RADIOACTIVE YTTRIUM IN FLIES. I. RETENTION AND DISTRIBUTION IN *Drosophila* AFTER INJECTION. *Int. J. Rad. Biol.* 3, 2 (1961) 211-21.

After injection into *Drosophila melanogaster* males, Y^{91} citrate is completely retained. The pattern of distribution is shown to depend upon the injection site, and - with regard to the wings - upon the age of the fly at the time of injection. Microscopically, it is shown that two alternative patterns of distribution occur: The radioactivity is concentrated either in the pericardial cells and the thoracic nephrocytes, or in the haemocytes. The mechanism deciding which of these patterns will obtain is discussed. It is presumed that it depends upon the type of aggregate formed when the Y^{91} citrate is prepared from the solution of $Y^{91}Cl_3$. The findings are discussed, but no definitive explanation can be given. (Auth.)

- 176 Ofstedal, P. STUDIES WITH RADIOACTIVE YTTRIUM IN FLIES. II. RETENTION AND DISTRIBUTION IN *Drosophila* AND IN *Musca* AFTER INGESTION. *Int. J. Rad. Biol.* 3, 2 (1961) 222-30.

After ingestion, retention of Y^{91} citrate falls to a few per cent after 2-3 d in *Drosophila*, a week in *Musca*. This retained radioactivity forms a tail on the retention curve. The retention site in *Drosophila* - after 4 d - is shown to be a narrow band of cells in the endodermal mid-gut immediately anterior to the transition to the ectodermal hind-gut (pyloric region). In some flies, there is also a more diffuse and somewhat wider zone containing radioactivity in the middle mid-gut. There is no activity in the pericardial cells, or in the Malpighian tubules. In *Musca* - after a week - there is no activity in the pyloric region, but most of the activity is found in a region in the middle mid-gut. This zone is situated about one-third anterior from the pyloric region, and covers 10-25% of the total mid-gut length. Also, the pericardial structures contain some 5-15% of the total activity. The findings are discussed. (Auth.)

- 177 Ökay, M., Sengün, A. INCORPORATION OF IRON-59 INTO THE CELLS OF DIFFERENT TISSUES OF *Chironomus plumosus*. *Nature, Lond.* 197, 4867 (1963) 613-4.

Larvae of *C. plumosus* were exposed to tap water containing $Fe^{59}Cl_3$ solution (specific activity 100 mc Fe^{59} /g Fe). Differences in concentration and immersion period did not affect the result. Preparations were made from salivary glands, mid-gut, Malpighian tubules and rectum (squash preparations, stained with aceto-orcein, covered with Kodak Ar 10 stripping film and exposed 7-90 d. Great variability of localization in tissues and of association with cellular components makes results difficult to interpret (it is suggested that some Fe^{59} molecules are not bound to the chromosomes but are localized in the nucleoplasm). Similar results were obtained with *Drosophila melanogaster*.

- 178* Семенова, Л.М. ИЗУЧЕНИЕ ПРОНИЦАЕМОСТИ ПОКРОВОВ ПОЧВЕННЫХ НАСЕКОМЫХ ДЛЯ СОЛЕЙ МЕТОДОМ МЕЧЕННЫХ АТОМОВ НА ПРИМЕРЕ ЛИЧИНОК *Tipula paludosa*. *Зоол. Ж.* 36 (1957) 1826-30.

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 *Tipula paludosa*. *Zool. Zh.* 36 (1957) 1826-30.

Solutions of $Na_2H^{42}PO_4$ 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: 1958, 12247d)

- 179* 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". Minneapolis, Univ. of Minnesota, 1960.

Host caterpillars of Ephesia kühniella were injected orally with several concentrations of Ca^{45} . Virgin female Habrobracon juglandis were then allowed to oviposit on them. High concentrations of Ca^{45} were lethal to developing larvae. In some studies on metal deficiencies, Sr was found to be able to substitute to a certain degree for Ca and to prevent spontaneous chromosome breakage. The experiments have indicated that both Ca^{45} and Sr^{90} are incorporated into the sperm of Habrobracon and that the sperm nucleus retains both of these isotopes up to the fusion of the haploid male and female nuclei. As yet it has not been determined whether the isotopes are retained after DNA synthesis, that is, in the 1- and 2-cell embryo of Habrobracon.

- 180 Sutcliffe, D.W. STUDIES ON SALT AND WATER BALANCE IN CADDIS LARVAE (Trichoptera): I. OSMOTIC AND IONIC REGULATION OF BODY FLUIDS IN Limnephilus affinis Curtis. J. exp. Biol. 38 (1961) 501-9.

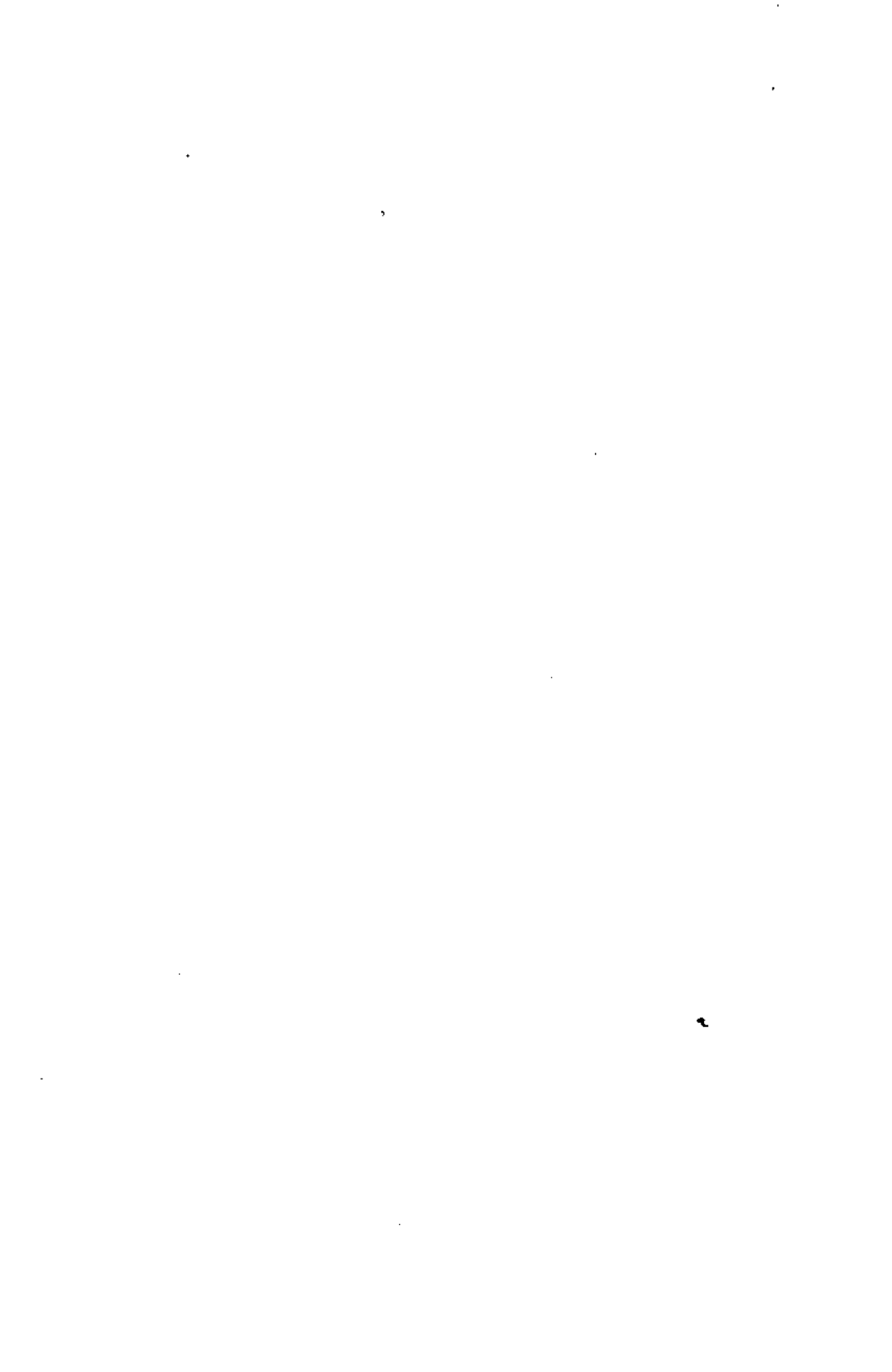
Larvae of L. affinis occur in both fresh- and brackish-water habitats in North West Europe. They were found to tolerate external salt concentrations up to at least 410 mM/l NaCl (~75% sea water) and survive for short periods in 460 mM/l NaCl (~85% sea water). The permeability of the body wall to Na ions was investigated by measuring Na^{24} influx from sea-water media. From these results the quantity of water imbibed through the mouth could also be estimated. The technique is described in detail. Larvae were removed from radioactive media at > 100-h intervals, and the radioactivity of a known volume (2-5 μ l) of haemolymph was assessed. In each experiment the standard deviation of counts on 6-8 samples from one pipette was < $\pm 3\%$. Decay of Na, measured for various periods up to 60 h always resulted in a half-life of 15.1 h. The body wall is highly permeable to water, but relatively impermeable to Na and chloride. Most of the Na and chloride uptake from salt water occurs via the mouth. The Na and chloride levels in the haemolymph are powerfully regulated. Both are maintained strongly hypotonic against large external concentration gradients. The Malpighian tubule-rectal system is very sensitive to changes in the haemolymph chloride level. The chloride level in the rectal fluid can be at least 3 times higher than in haemolymph. The rectal fluid is hyperosmotic to the haemolymph and to the medium at high external salt concentration. At external concentrations > ~200 mM/l NaCl, water balance is maintained by regulating the haemolymph roughly iso-osmotic with the medium.

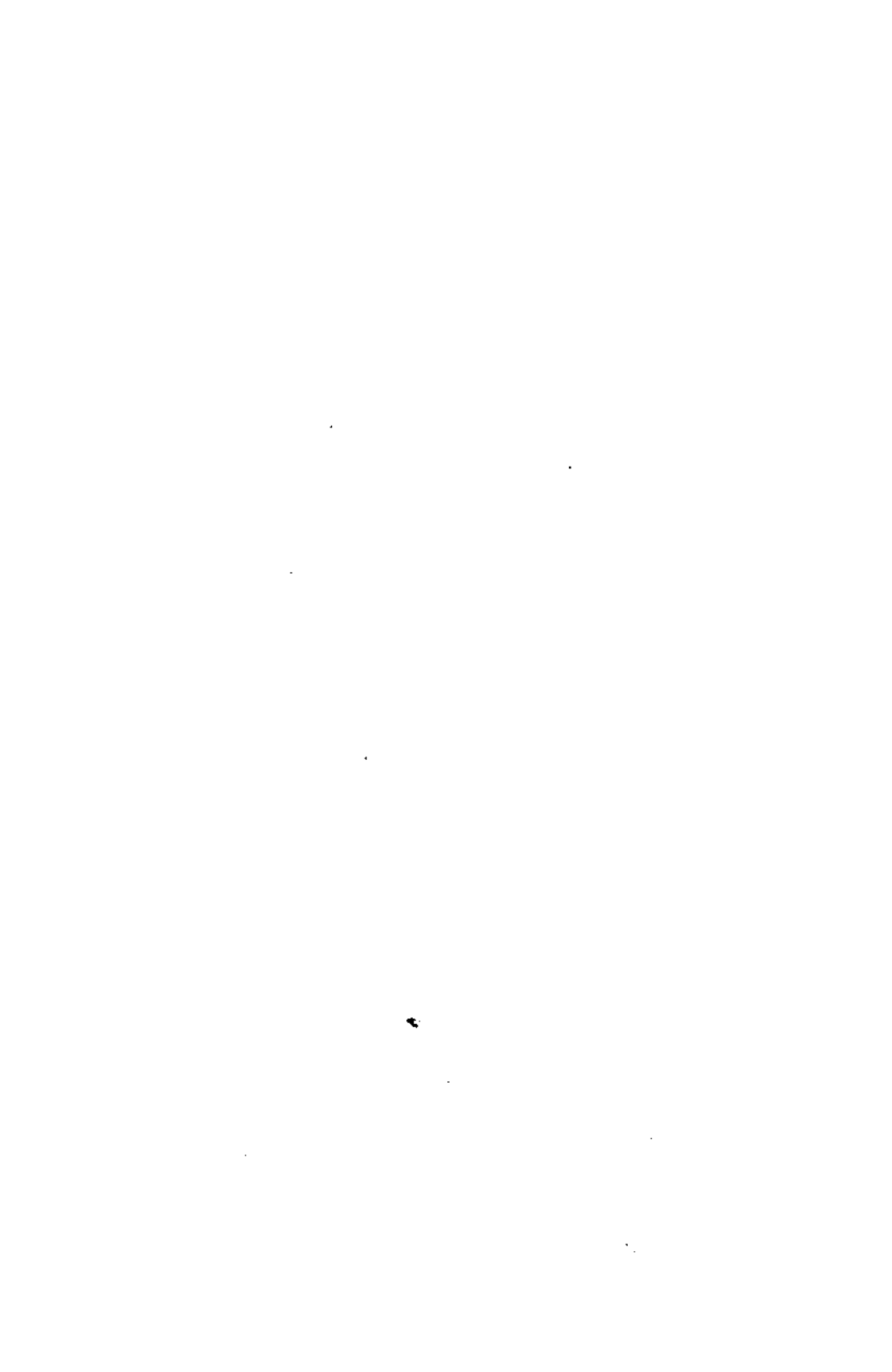
- 181 Sutcliffe, D.W. STUDIES ON SALT AND WATER BALANCE IN CADDIS LARVAE (Trichoptera). II. OSMOTIC AND IONIC REGULATION OF BODY FLUIDS IN Limnephilus stigma Curtis AND Anabolia nervosa Leach. J. exp. Biol. 38 (1961) 521-30.

Survival and regulation in sea-water media was studied in the fresh-water caddises L. stigma and A. nervosa. The majority of larvae did not survive for more than a few days at external salt concentrations > ~60 mM/l NaCl. In sea-water media the haemolymph osmotic pressure increased to remain slightly hyper-osmotic to the medium. The haemolymph Na level also increased to remain slightly hypertonic to the medium, but the chloride level was maintained hypotonic until just prior to death of the larvae. When the haemolymph chloride concentration was raised above the normal level, the Malpighian tubulorectal system elaborated fluid in which the chloride concentration was hypertonic to the haemolymph. The system is highly sensitive to changes in the haemolymph chloride level. The regulation of body-fluid composition in the fresh-water caddises is compared with that found previously in the euryhaline larvae of L. affinis. It is suggested that the maintenance of a low haemolymph Na concentration in L. affinis is an important part of adaptation for survival in salt water. Na^{24} was used. (Essentially auth. summary).

- 182 Sutcliffe, D.W. STUDIES ON SALT AND WATER BALANCE IN CADDIS LARVAE (Trichoptera). III. DRINKING AND EXCRETION. J. exp. Biol. 39 (1962) 141-60.

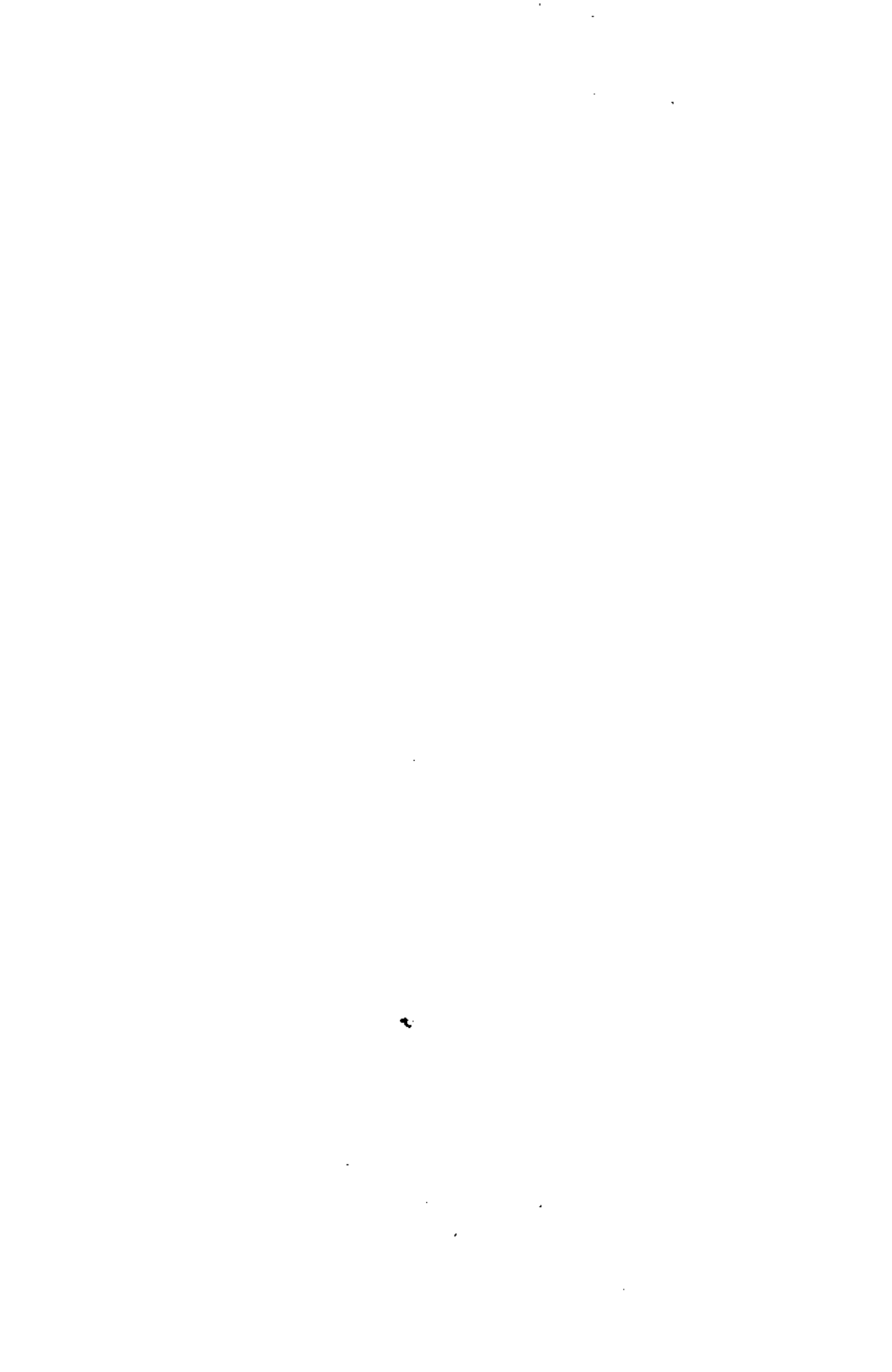
Na^{24} was used in these experiments. The fresh-water caddis larvae, Limnephilus stigma and Anabolia nervosa, drink and regurgitate large quantities of salt water at frequent intervals. Drinking is not controlled, and larvae may drink an amount equivalent to 50% of the body weight/d. The gut wall is adversely affected by salt water and exosmosis occurs across the gut wall. L. affinis larvae drink only small quantities of salt water. Drinking is strictly controlled, and the intake is roughly equivalent to 3-7% of the body weight/d over a wide range of external salt concentrations. The gut wall is not affected by high salt concentrations; regurgitation and exosmosis do not normally occur. In the fresh-water caddises the rate of rectal fluid production is approximately equivalent to 7% of the body weight/d. Rectal fluid is not produced at high external salt concentrations. L. affinis larvae continue to produce rectal fluid at





- 188 Bade, M.L. METABOLIC CONVERSIONS DURING PUPATION OF THE CECROPIA SILKWORM. 2. TESTS FOR THE OPERATION OF THE GLYOXYLATE CYCLE. Biochem. J. **83** (1962) 478-82.
- The possible operation of the glyoxylate cycle in tissues of the pupating cecropia silkworm has been assayed by incubating the tissues with [2- C^{14}]acetate and comparing the incorporation of radioactivity in the presence of various substrates and of malonate into component acids of the citric acid cycle. There is a decrease of radioactivity in malate when glyoxylate is not an efficient remover of active acetate. Very little C^{14} is incorporated into malate in the presence of malonate, suggesting that the major route of malate synthesis is via the citric acid cycle. Tissues obtained from feeding larvae and early pupae show qualitatively the same incorporation pattern; enzymic activity/mg of protein diminishes greatly in the order: larva, prepupa, pupa. These results are consistent with the operation of the citric acid cycle as a major pathway of acetate metabolism in the stages of silkworm development investigated and fail to support appreciable activity by the glyoxylate-cycle enzymes in any of them. (Auth. summary)
- 189 Candy, D.J., Kilby, B.A. THE BIOSYNTHESIS OF TREHALOSE IN THE LOCUST FAT BODY. Biochem. J. **78** (1961) 531-6.
- Generally labelled D-[C^{14}] glucose was used throughout the study. An extract prepared from the fat body of Schistocerca gregaria catalyses the formation of trehalose from glucose and uridine diphosphate glucose. Glucose 6-phosphate and trehalose phosphate were indicated as intermediates in this reaction. The extract hydrolyses trehalose phosphate at a greater rate than any other sugar phosphate tested. The presence was shown of phosphoglucomutase, nucleoside diphosphate-kinase and uridine diphosphoglucose-pyrophosphorylase activities in the fat body. A scheme for the biosynthesis of trehalose from glucose in the fat body of Schistocerca is presented. (Essentially auth. summary)
- 190 Clegg, J.S., Evans, D.R. BLOOD TREHALOSE AND FLIGHT METABOLISM IN THE BLOWFLY. Science **134** (1961) 54-5.
- The concentration of trehalose in the blood of Phormia regina was found to determine the rate of energy expenditure during flight as reflected in measurements of the wing-beat frequency. Fat body was found to be the source of blood trehalose; either endogenous or exogenous substrates are used for its synthesis. Synthesis of trehalose by the fat body from exogenous glucose and its release into the medium was demonstrated by incubating intact fat body with glucose-U- C^{14} (specific activity 2820 cpm/ μ M). Trehalose isolated from the medium after 30 min of incubation had a specific activity of 822 cpm/ μ M, i.e. 93% of the total counts, other than glucose, found in the medium.
- 191 Clegg, J.S., Evans, D.R. THE PHYSIOLOGY OF BLOOD TREHALOSE AND ITS FUNCTION DURING FLIGHT IN THE BLOWFLY. J. exp. Biol. **38** (1961) 771-92.
- The finding of earlier workers that glucose and trehalose are the normal blood sugars in Phormia regina was confirmed. Most of the flight energy is derived from the oxidation of trehalose and, to a lesser extent, of other sugars in the blood. The concentration of blood trehalose normally regulates the rate at which energy is expended by the flight muscles. Exhaustion results when trehalose cannot be supplied at the necessary rate. Fat body is the chief source of blood trehalose; endogenous and exogenous substrates are used for the synthesis. The rate of blood synthesis can be very rapid, almost compensating for the rate of utilization during flight. The intensity of flight is determined largely by the interaction of rate of trehalose utilization and that of trehalose synthesis. Blood volume was estimated from dilution of injected C^{14} -inulin to be 6-7 μ l. (CA 58: 1963, 1750c)
- 192 Gordon, H.T., Robbins, D.A. METABOLISM OF GLUCOSE AND D-ARABINOSAMINE IN THE GERMAN COCK-ROACH. (Abstr.80). Bull. ent. Soc. Amer. **9**, 3 (1963) 184.
- Male B. germanica oxidize injected D-glucose-U- C^{14} slowly and D-arabinose-1- C^{14} rapidly to expired CO_2 , by independent pathways. Both sugars are cleared from the blood within 1 h but persist in tissues for many hours. Several metabolites of each sugar have been tentatively identified.
- 193 Hines, W.J.W., Smith, M.J.H. SOME ASPECTS OF INTERMEDIARY METABOLISM IN THE DESERT LOCUST (Schistocerca gregaria Forskal.). J. Insect Physiol. **9**, 4 (1963) 463-8.
- The incorporation and distribution of radioactivity from [C^{14}]glucose, [2- C^{14}]acetate, and [1-4- C^{14}]succinate into the soluble metabolic intermediates of homogenates of the fat-body, head, and leg muscle of S. gregaria have been studied. The tissue homogenates were found to utilize the labelled substrates, but the patterns of incorporation of the radioactivity from each substrate varied with the tissue. (Auth.)

- 194 Kubista, V., Foustka, M. INORGANIC PHOSPHATE AND THE RATE OF GLYCOLYSIS IN INSECT MUSCLE. Nature, Lond, **195** (1962) 702-3.
- Changes in the acid-soluble phosphorus compounds were followed during anaerobiosis and in subsequent recovery in O_2 in preparations of the intact metathoracic musculature of the cockroach *Periplaneta americana*. Phosphorus compounds were labelled by injecting P^{32} a week prior to the experiment, by which time practically uniform labelling of all soluble P compounds had been achieved. Evidence is presented to show that the level of inorganic phosphate is rate-limiting for anaerobic glycolysis in the tissue.
- 195* Lasker, R., Giese, A.C. CELLULOSE DIGESTION BY THE SILVERFISH, *Ctenolepisma lineata*. J. exp. Biol. **33**, 3 (1955) 542-53.
- Silverfish fed cellulose uniformly labelled with C^{14} respire $C^{14}O_2$. The insects may gain weight temporarily on a diet of cellulose alone but the diet is not satisfactory for prolonged feeding. Utilization efficiency for cellulose is comparable to that of the dairy cow. None of the bacteria from the guts, grown in favorable culture media, are capable of digesting cellulose. A few molds do, though they are never seen growing in the gut and are presumably developed from spores grazed from wood by the silverfish. Bacteria-free insects were obtained by washing eggs in a solution of $HgCl_2$ and $EtOH$ and raising the nymphs on rolled oats and vitamins under aseptic conditions. These insects also respired $C^{14}O_2$ when fed labelled cellulose. A cellulase, cellobiase, and an amylase were present in extracts of the midgut. (CA 51: 1957, 3852a)
- 196 Lipke, H., Grainger, M. MUCOPOLYSACCHARIDES OF THE COCKROACH DURING MOLTING. (Abstr.) Fed. Proc. **21**, 2 (1962) 170.
- The principal bound carbohydrates of the plasma are mannose, galactose and glucosamine, with glucose, arabinose, xylose and galactosamine as lesser entities. During molting, characteristic changes in the protein and acid fuchsin-positive components of the plasma are evident (Siakotos, J. gen. Physiol. **43**: 1960, 1015) which are accompanied by a redistribution of bound sugars into mannose-rich and galactosamine-rich glycoproteins. Mole ratios of bound carbohydrates vary throughout the entire molting cycle and continue after shedding of the old cuticle. Incorporation of glucose-U- C^{14} into plasma glycoprotein was measured essentially as described by Spiro (JBC **234**: 1959, 742) before, during and after ecdysis. Between molts, amino acids of the protein moiety acquired the most label by a factor of 7 over the pre-molt period. Significant incorporation occurred in 24 h. Two-fold increases were observed in cpm/ μM bound hexose during this period while hexosamine increased 5-fold. Amino sugars incorporation achieved a maximum rate considerably faster than neutral sugars. The rates of incorporation and composition of the protein-bound sugars of other tissues will be described.
- 197 Lipke, H., Graves, B., Leto, S. POLYSACCHARIDE AND GLYCOPROTEIN FORMATION IN THE COCKROACH. (Abstr. 2962). Fed. Proc. **22**, 2 (1963) 658.
- Cuticle freed of hypoderm contains 0.5% by weight of bound carbohydrate other than Gm, identified as Glu, Gal, Man, Ar, and Xyl. These sugars occur in all the strata, indicating a function other than connectives. During the molt cycle the rate C^{14} incorporation from injected Glu- C^{14} differs for each of the hexoses of the cuticles and for Gm and N-Ac of chitin. Autonomy of the integument with respect to synthesis of polysaccharide and glycoprotein is suggested since specific activity of bound carbohydrate and polypeptide exceeds that of corresponding plasma or fat body materials, and no pentose can be detected in fat body. The chitin N-Ac does not follow a product-precursor relation with lipid, specific activity is 1% of chitin Gm. Amino acid analysis of cuticle shows aspartic and tyrosine to be deficient in strata first formed, with label from Glu- C^{14} in all amino acids after 24 h.
- 198 Saito, S. TREHALOSE IN THE BODY FLUID OF THE SILKWORM, *Bombyx mori* L. J. Insect Physiol. **9**, 4 (1963) 509-19.
- The rate of metabolism of "blood sugar" (trehalose) was studied using 5th instar larvae of the silkworm, *Bombyx mori*. Glycogen in the fat body decreased on starvation while body fluid trehalose remained approximately at the initial value during the first few hours of starvation. Experiments on the rate of turnover of body fluid trehalose were carried out by injecting radioactive sugars into the larvae. Values of 6 h and 10.6 h were obtained for the half-life of body fluid trehalose under feeding and starvation, respectively. When a large volume of saline was injected into starved larvae, the concentration of "blood sugar" fell temporarily, and after a while it regained its initial level. On the other hand, when a large amount of trehalose was injected, the level of "blood sugar" was elevated markedly followed by a fall to



The enzyme assays were conducted in 10 ml Erlenmeyer flasks at 37°C with mechanical shaking. Unless otherwise stated, the atmosphere was air. Glass beads (200 mg) were placed in the flasks, followed by 20 μ moles of C^{14} -DDT in acetone (specific activity 12000 cpm/ μ mole).

208 Deleted.

209 Bier, K. AUTORADIOGRAPHISCHE UNTERSUCHUNGEN ZUR DOTTERBILDUNG. (Autoradiographic studies on yolk formation). *Naturwissenschaften* 49, 14 (1962) 332-3. (In German)

Protein synthesis in the ovary of *Calliphora erythrocephala* Meig. was investigated by injecting H^3 -L-histidine. After 1-15 min, radioactivity was found in the cytoplasm of nurse and follicle cells; 40 min later, however, the pattern changed, increasing radioactivity being noted in the peripheral ooplasm where it formed a very pronounced border region after 80 min. Round complexes appeared in the yolk interior. Amino acids would appear to penetrate into the follicle by two pathways. At first, the H^3 -histidine largely accounts for the radioactivity; it reaches the cytoplasm as free amino acid where it is incorporated to replace or take part in the formation of protein molecules. Protein synthesis takes place mostly in the cytoplasm of nurse cells. The change in pattern is to be interpreted as due to the supply of free labelled amino acid being largely exhausted, and labelled protein molecules also reaching the oocyte in increasing amounts. The steps preceding yolk formation are initiated by the follicular epithelium.

210 Block, R.J., Henry, S.M. METABOLISM OF THE SULPHUR AMINO ACIDS AND OF SULPHATE IN *Blattella germanica*. *Nature*, Lond. 191 (1961) 392-3.

B. germanica is able to utilize sulphate-S for the synthesis of methionine and cystine, but also to satisfy its sulphur requirements with homocysteine, methionine sulfoxide, cysteic acid, taurine, and β -hydroxyethanesulphonic acid. 1-5 μ c of the S^{35} -compound were injected, and the subsequent procedure is described. Results indicate that methionine and cystine are converted in the cockroach to sulphate by at least two pathways: (a) methionine sulfoxide \rightarrow methionine \rightarrow (homocysteine) \rightarrow (cystathionine) \rightarrow cysteine \rightarrow (cysteinesulphinic acid) \rightarrow β -sulphinyl pyruvic acid \rightarrow sulphite \rightarrow sulphate; or (b) methionine \rightarrow (homocysteine) \rightarrow (cystathionine) \rightarrow cysteine \rightarrow (cysteinesulphinic acid) \rightarrow (2-aminoethane sulphinic acid) \rightarrow taurine \rightarrow \rightarrow sulphate. Pathway (a) for the oxidation of cysteine is characteristic of most organisms and is probably the principal method of sulphate production in the cockroach. The results obtained with the aposymbiotic cockroaches were not due to traces of aureomycin carried over from the maternal diet. The hypothesis that the intracellular symbionts are responsible for converting sulphate-S into methionine-S-cysteine-S could be substantiated in an experiment involving the destruction of the gut micro-flora while retaining the intra-cellular symbionts. The effect of temperature on sulphate utilization in xenic cockroaches was also studied.

211* Brenner-Holzach, O., Leuthardt, F. UNTERSUCHUNGEN ZUR BIOSYNTHESE DER PTERINE BEI *Drosophila melanogaster*. (Study on the biosynthesis of pterins in *Drosophila melanogaster*). *Helv. chim. Acta* 42, 6 (1959) 2254-7. (In German).

Larvae of *D. melanogaster* (wild type and mutant *Sepia*) were fed with C^{14} -labelled glycine, formate and glucose and the specific radioactivity in uric acid and pterines of the flies was measured. These experiments showed that C atoms of glucose are specifically incorporated in the pterines but not in the purines. Possible pathways are discussed. (Essentially auth. summary)

212 Brenner-Holzach, O., Leuthardt, F. BIOGENESIS OF PTERINS WITH *Drosophila melanogaster*. *Helv. chim. Acta* 44 (1961) 1480-95. (In German).

Larvae of the wild type of *D. melanogaster* and of 2 mutants (*rosy* and *sepia*) were fed labelled glycine- $U-C^{14}$, formate- $1-C^{14}$, glucose- $6-C^{14}$, and the specific radioactivity in isoxanthopterin, drosopterin, sepiapterin, and uric acid of the flies determined after isolation by paper chromatography. C-6 and -7 of the pteridine ring were isolated as oxalic acid after degradation with Cl followed by acid hydrolysis, the pyrimidine ring being unattacked. The method was tested by the degradation of the synthetic isoxanthopterin- $6-C^{14}$ and - $4a-C^{14}$. The experiments with glucose- $U-C^{14}$ and glucose- $1-C^{14}$ proved that C atoms of the glucose were specifically used to build up the pyrazine ring of the pteridines. They furnished C-6 and 7 of the pteridine skeleton. After feeding glucose- $6-C^{14}$, drosopterin, a pterin with a C_3 side chain, had much higher activity than isoxanthopterin. The synthesis of pterins was discussed. It was suggested that a pterin with side chain was the primary product of pteridine synthesis. (CA 56: 1962, 7815e)

- 213* Brictaux-Grégoire, S., Dewandre, A., Florkin, M., Verly, W.G. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XI. UTILISATION DU CARBONE DU FORMIATE POUR LA BIOSYNTHESE DES ACIDES AMINÉS DE LA FIBROÏNE DE LA SOIE. *Arch. Int. Physiol. Biochim.* 67, 4 (1959) 687-92.
- Quand du formiate- ^{14}C est introduit dans l'hémocoel à la fin de la période d'alimentation, le ^{14}C incorporé à la fibroïne de la soie apparaît principalement dans le C-3 de la sérine et de l'alanine isolées à partir de cette protéine. Une certaine activité apparaît toutefois dans tous les carbones de la glycine, de la sérine et de l'alanine. La participation du pyruvate au cycle de Krebs est invoquée pour expliquer cette observation. D'autre part l'activité qui apparaît dans le C-1 de la glycine et de la sérine est supérieure à l'activité du C-2 de ces mêmes acides aminés. Pour expliquer ces constatations, des hypothèses supplémentaires sont formulées. La fraction du formiate injecté incorporée dans la glycine, l'alanine et la sérine de la fibroïne de la soie est de l'ordre de quelques unités pour cent. (Conclusions)
- 214* Brictaux-Grégoire, S., Dewandre, A., Florkin, M. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XVI. CONVERSION DE LA THRÉONINE EN GLYCINE, SÉRINE ET ALANINE DE LA FIBROÏNE DE LA SOIE. *Arch. Int. Physiol. Biochim.* 68, 2 (1960) 281-4.
- Chaque larve d'un groupe de 20 individus au 5^e âge, pris juste avant la dernière défécation, a reçu une injection de 34 μg de L-thréonine- ^{14}C marquée uniformément. L'activité spécifique du produit étant de 7 mc/mM, chaque larve a reçu 2 μc . Toutes les larves sauf une ont filé leur cocon normalement. Les cocons ont été coupés et débarrassés des nymphes 7 j après l'injection. Le ver à soie, comme le rat, est capable de transformer la thréonine en glycine. L'activité spécifique de la sérine étant intermédiaire entre celle de la glycine et celle de l'alanine, il est vraisemblable que la sérine est un intermédiaire entre la glycine et l'alanine. La conversion de glycine en sérine a été démontrée chez le ver à soie (Nature 182: 1958, 1515). 6% seulement de la thréonine injectée ont été transformés en glycine de la fibroïne.
- 215 Brictaux-Grégoire, S., Dewandre, A., Florkin, M. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XVIII. UTILISATION DES ACIDES GLUTAMIQUE ET ASPARTIQUE POUR LA SYNTHÈSE DES ACIDES AMINÉS DE LA FIBROÏNE DE LA SOIE. *Biochem. Z.* 333 (1960) 370-6.
- De l'acide aspartique-3- ^{14}C (d'une activité spécifique de 0,88 mc/mM) et de deux variétés d'acide glutamique (acide glutamique-3,4- ^{14}C , d'activité spécifique 2,3 mc/mM et acide glutamique-2- ^{14}C , d'activité spécifique 0,61 mc/mM) ont été injectés à des vers à soie après la fin de la période d'alimentation (juste avant la dernière défécation). Les résultats indiquent une utilisation intense de ces acides pour la synthèse des acides aminés de la fibroïne de la soie, en particulier pour celle de l'alanine. Il apparaît que l'alanine de la fibroïne trouve son origine majeure dans les acides aspartique et glutamique, qui sont les acides aminés quantitativement les plus importants de la feuille de mûrier. La localisation du ^{14}C permet de discuter les relations métaboliques des acides aspartique et glutamique avec les acides aminés de la fibroïne.
- 216 Brictaux-Grégoire, S., Florkin, M. CONTRIBUTIONS À LA BIOCHIMIE DU VER À SOIE. XXVI. UTILISATION DU GLUCOSE POUR LA SYNTHÈSE DE LA FIBROÏNE DE *Bombyx mori* L. *Arch. Int. Physiol. Biochim.* 70, 5 (1962) 711-7.
- Trois variétés de glucose marqué (glucose-1- ^{14}C , glucose-2- ^{14}C , glucose-6- ^{14}C) ont été injectées à des vers à soie. Une grande partie de l'activité injectée (15-33%) se trouve dans l'alanine, la sérine, la glycine, l'acide glutamique et l'acide aspartique. La tyrosine de la fibroïne n'a incorporé aucune activité. Les résultats obtenus cadrent avec la notion selon laquelle la glande séricigène peut synthétiser à partir du pyruvate ou des substances fournissant du pyruvate les acides aminés de la fibroïne, à l'exclusion de la tyrosine.
- 217 Brunet, P.C.J. SYNTHESIS OF AN AROMATIC RING IN INSECTS. *Nature, Lond.* 199 (1963) 492-3.
- In view of the importance of 3,4-dihydroxyphenol to insects a preliminary attempt was made to discover the metabolic pathway to protocatechuic acid (I). These experiments involved injecting substances labelled with C^{14} suspected of being precursors of I and assaying egg capsules and colleterial gland for radioactive I and its precursors. Uniformly labelled tyrosine (0,4 μc) and glucose-1- C^{14} (1 μc) were used. In the female cockroach (*Periplaneta americana*) the evidence showed that I could be synthesized either from tyrosine or from glucose, but that different metabolic pathways appear to be followed.

- 218 Candy, D.J., Kilby, B.A. STUDIES ON CHITIN SYNTHESIS IN THE DESERT LOCUST*. J. exp. Biol. 39 (1962) 128-40.
- The chitin content of locust cuticle (from leg, thorax, abdomen and wing) increases rapidly after the final molt to the adult form and reaches maximum ca. 300 h after moult. C^{14} -glucose injected into the haemolymph gives rise to labelled chitin. Cell-free extracts of adult wing can convert glucose into uridine diphosphate N-acetylglucosamine (UDPG) by a pathway involving hexokinase, phosphohexose isomerase, glutamine transaminase, phosphoglucosamine transacetylase, acetyl coenzyme-A synthetase, phosphoacetylglucosamine mutase and UDPG-pyrophosphorylase. The utilisation of UDPG in chitin biosynthesis could not be demonstrated in vitro. (Auth.)
- * Schistocerca gregaria (Forsk.)
- 219 Cline, R.E., Pearce, G.W. UNIQUE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE METABOLISM OF FORMATE AND PROLINE IN THE HOUSEFLY. Biochemistry 2, 4 (1963) 857-62.
- Insecticide-treated and control flies were injected with C^{14} -labelled biochemicals, and 3 h later the soluble radiometabolites were extracted for identification and assay by paper chromatography and radiometric techniques. Of the injected compounds, DDT was found to interfere most with the metabolism of formate, glycine, and proline. Thus after injection of formate- C^{14} , more uric acid and allantoin, and less proline were recovered as radiometabolites from flies treated with DDT and related chlorinated hydrocarbon insecticides than from flies untreated or treated with non-toxic analogues. However, insecticides of other types such as pyrethrum, organic phosphates, and phosphonates and a carbamate failed to show a significant effect on formate metabolism, providing additional evidence for a different mode of action. (Auth.)
- 220 Corrigan, J.J., Srinivasan, N.G., Meister, A. STUDIES ON THE ORIGIN OF D-SERINE IN THE JAPANESE SILKWORM. (Abstr. 78). Bull. ent. Soc. Amer. 9, 3 (1963) 164.
- To investigate the source of the D-serine previously found (J. Biol. Chem. 237: 1962, PC3844) in Bombyx mori C^{14} glucose and C^{14} -L-serine were injected into late last-instar larvae. Evidence for conversion to D-serine was obtained in these experiments and also in studies with tissue homogenates.
- 221 Corrigan, J.J., Keams, C.W. AMINO ACID METABOLISM IN DDT-POISONED AMERICAN COCK-ROACHES. J. Insect Physiol. 9, 1 (1963) 1-12.
- Amino acids were quantitatively compared in haemolymph from DDT-poisoned and DDT-treated, but symptom-free, Periplaneta americana. Symptoms were induced by holding insects at a lower temperature in accordance with the negative temperature coefficient of DDT action. While most amino acids were unchanged, proline was depleted in paralysed insects. As the duration of paralysis increased, proline progressively decreased to $\frac{1}{2}$ the normal blood concentration. Relief of symptoms resulted in restoration of proline to the normal concentration. Identical effects were observed with TDE-poisoned cockroaches and tobacco hornworms, but other insecticides failed to produce this reversible depletion. Injection of C^{14} -L-proline (U) into cockroaches followed by induction of DDT symptoms revealed that three times as much oxidation of proline carbon to CO_2 occurred in insects with symptoms as in the controls. An increase in C^{14} -glutamine was observed in the blood and central nerve of poisoned insects. It was postulated that symptoms of DDT shift the demand for oxidizable carbon to proline. This could result from the inhibition of one or more oxidative enzymes above the level of alpha-ketoglutaric acid. (Auth.)
- 222 Devi, A., Lindsay, P., Sarkar, N.K. SYNTHESIS AND BREAKDOWN OF PROTEINS AND RIBONUCLEIC ACID IN Tribolium confusum. Experientia 19, 7 (1963) 344-5.
- The incorporation of leucine- C^{14} into proteins and of uridine- C^{14} into RNA was determined at various stages of the insect life. The rate of incorporation into proteins increases slowly but regularly in the initial stages of growth, but during the latter part of the larval period (8-12 d) the rate increases sharply; during 13-16 d the specific activity of the labelled protein does not significantly change. At the pupal stage (17-20 d) the specific activity drops and then rises slowly thereafter. The drop occurs while the insect does not take food. The curve for RNA is similar but the rises occur sooner. Maximum incorporation occurs between 4-10 d. RNA synthesis precedes protein synthesis and the protein synthesis can be considered an index of growth of the insect. (CA 59: 1963, 5546d).

- 223 Fox, A.S., Kang, S.H. AMINO ACID INCORPORATION INTO PROTEIN BY CELL-FREE PREPARATIONS OF *Drosophila melanogaster*. p.201 in "XVI International Congress of Zoology, Washington, August 20-27, 1963, Vol. II". Moore, J.A., Ed. Washington D.C., XVI International Congress of Zoology. (See 224)
- 224 Fox, A.S., Kang, S.H. AMINO ACID INCORPORATION INTO PROTEIN BY CELL-FREE PREPARATIONS OF *Drosophila melanogaster*. (Abstr.850). Fed. Proc. 22, 2 (1963) 303.
- C^{14} - or H^3 -leucine is incorporated into protein in cell-free preparations from *D. melanogaster*. Mitochondria are not required and are removed from homogenates of adults or larvae by centrifugation at 15000 X g. Microsomes are sedimented at 125000 X g. SRNA and pH5 fraction are prepared from the supernatant by the phenol method and precipitation respectively. Incorporation requires microsomes, pH5 fraction or SRNA, 20 amino acids, ATP and generating system, GTP, and Mg^{++} . Total TCA precipitable counts, hot TCA insoluble counts (protein-bound), and hot TCA soluble counts (nucleotide-bound) all increase linearly for 25 min and reach a plateau after 40 min of incubation at 37°C, indicating a possible requirement for replacement of mRNA. Rate of incorporation with excess pH 5 fraction is linear with microsome concentration; with excess microsomes it is linear with pH 5 fraction. (From abstr.)
- 225 Friedman, S. RATE OF EQUILIBRATION OF THE CONTENTS OF THE GUT OF *Anopheles quadrimaculatus* LARVAE WITH THE SURROUNDING MEDIUM. Nature, Lond. 200 (1963) 605-6.
- A marked improvement in the growth rate of culicine larvae had been reported when protein in suspension replaced protein in solution in the medium. In order to determine the rate of equilibration of a small, highly soluble molecule between the surrounding medium and the gut of the 4th instar larvae of *A. quadrimaculatus* Say, larvae were exposed for varying periods to solutions of sodium acetate-1- C^{14} (25 μ C/ml) and their guts homogenized, plated out and counted. The present study indicates that soluble protein enters the gut at the same rate as any particulate matter, passing the peritrophic membrane to fill the entire lumen, experimentally estimated at 0.07 μ l. A 2% solution of soluble protein could be shown to provide, at any given time, ~19% of the amount of protein, both available and unavailable, which might be present in the gut due to ingestion of bacteria, but only 4% of this amount in a suspension of pure protein.
- 226* Frontali, N. GLUTAMIC ACID CARBOXYLASE IN THE NERVOUS TISSUE OF INSECTS. Boll. Soc. Ital. Biol. sper. 35 (1959) 2154-5.
- Homogenized cephalic ganglia of bees is incubated with C^{14} -labelled glutamic acid in an atmosphere of N for 1 h. The mixture is deproteinized, chromatographed bidimensionally, and the spots detected by radioactivity. Rf value and confirmatory tests show that one of the spots is glutamic acid carboxylase. Further quantitative radioactivity measurements show that the enzyme present in bees is 80% of that found in the brain of mice. Other tests using Warburg's CO_2 method on homogenized heads of *Musca domestica* and the brain of mice proved inconclusive. (CA 57: 1962, 11679b)
- 227 Fukuda, T., Kameyama, T. BIOCHEMICAL STUDIES ON THE FORMATION OF SILK PROTEIN. XIII. THE SYNTHESIS OF GLYCINE FROM GLYCOLIC ACID IN THE SILKWORM LARVA. Nippon Sanahigaku Zasshi 30 (1961) 437-41.
- The glycine-isolated from the fibroin produced by the silkworms that consumed the glycolic acid-1- C^{14} had a comparatively higher concentration of C^{14} and all the radioactivity was located in the carboxyl C atom of glycine. A comparatively higher concentration of the C^{14} appeared in the glyoxylic acid isolated from the body fluid of the silkworms that consumed glycolic acid-1- C^{14} . These facts seem to suggest that glycolic acid is used for formation of glycine via glyoxylic acid, and that this reaction plays an important role in the glycine synthesis in silkworm larva. (CA 60: 1964, 897f)
- 228* Fuzeau-Braesch, S. BIOLOGICAL AND BIOCHEMICAL STUDIES OF PIGMENTATION OF SOME INSECTS. *Gryllus bimaculatus*. Bull. Biol. 94 (1960) 526-527. (In French).
- A genetic variability was observed which permitted the selection of bright and dark strains. The population density determines the threshold; beyond the genotype, only the dark phenotype is formed. The hypodermal pigment is onmochrome, established as melanin by means of tryptophan- C^{14} and tyrosine incorporation, as well as by chemical analysis. A yellow and black pigment arises from tyrosine, apparently through the action of a cuticle phenolase complex on intermediary products. (From CA 60: 1964, 14892d)

Fuzeau-Braesch, S. ÉTUDE DE LA PIGMENTATION TÉGUMENTAIRE DES INSECTES A L'AIDE DE RADIO-ÉLÉMENTS. p. 289-96 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.

Les substances suivantes ont été utilisées: (1) L-tyrosine, marquée uniformément au ^{14}C , (2) tryptophane marqué au ^{14}C , 1 $^{\text{er}}$ atome de la chaîne, (3) sulfate de sodium marqué au ^{35}S , (4) dl-méthionine marqué au ^{35}S , et (5) dl-cystine marqué au ^{35}S . Les insectes hétérométaboles suivants ont été injectés: Gryllus bimaculatus de Geer avec les substances 1-5, Locusta migratoria avec la substance 1. L'élément choisi est injecté à différents moments du cycle de mue: avant la sécrétion des protéines cuticulaires, la cuticule étant alors au repos; au moment du dépôt de ces protéines; à l'instant où commence le processus de sclérification de ces protéines. Après un laps de temps adéquat la cuticule est prélevée, traitée de façon appropriée et autoradiographiée in toto. La comparaison photographique des résultats permet de conclure à l'utilisation ou non de l'élément choisi dans la formation pigmentaire, compte tenu des processus chimiques antérieurs relatifs à l'élément. Les pigments cuticulaires sont tous issus du métabolisme de la tyrosine, confirmant le terme de «mélaniques» qui leur était jusqu'à présent attribué sans preuve directe. Le tryptophane, exceptionnellement intégré dans la cuticule, constitue le substrat des pigments noirs et rouges omochromiques de l'hypoderme. Le soufre inorganique ne joue pas de rôle spécifique régulier dans la formation des pigments cuticulaires, contrairement à ce que laissent supposer différentes hypothèses sur le rôle des groupements sulfhydryles. Du point de vue de la biochimie comparée, les mélanines semblent être chez les insectes exclusivement cuticulaires, les granulaires étant réservées aux vertébrés. Quant aux granules hypodermiques sombres, ils sont, chez les insectes, de nature omochromique, dérivés du tryptophane et non mélaniques.

- 230 Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. VI. METABOLISM OF THE SULFUR AMINO ACIDS AND RELATED COMPOUNDS IN THE GERMAN COCKROACH, Blattella germanica (L.) Contr. Boyce Thompson Inst. 21 2 (1961) 129-45.

The metabolism of S^{35} -labelled cystine, cysteine, cysteine-sulfonic acid, taurine, methionine, methionine sulfoxide, methionine sulfone, and C^{14} -labelled serine was studied in the German cockroach, Blattella germanica (L.). Neither cysteine-sulfonic acid nor cysteic acid was used for the synthesis of cysteine. Taurine was partially utilized only after degradation to sulfate by intestinal microorganisms. C^{14} -labelled cysteine was produced by cockroaches injected with serine- C^{14} together with sulfate, sulfite, or thiosulfate. These data indicate that the synthesis of cysteine in the cockroach proceeds via condensation of either sulfide or thiosulfate with serine. Cysteine was found to undergo the following reactions in the cockroach: incorporation into protein, transulfuration to methionine when intracellular symbionts are present, and degradation to taurine and sulfate by pathways conforming with those known to occur in other organisms. Methionine and methionine sulfoxide were found to be interconvertible. Demethylation, incorporation into protein, conversion to cysteine, and degradation to sulfate and other compounds were observed. Methionine sulfone was not metabolized. (Auth.)

- 231 Henry, S.M., Block, R.J. THE SULFUR METABOLISM OF INSECTS. VII. THE METABOLISM OF THE SULFUR AMINO ACIDS AND OF SULFATE IN THE BLOWFLY, Phormia regina (Meig.). Contr. Boyce Thompson Inst. 21, 7 (1962) 447-52.

The interrelationships of sulfate, cystine, and methionine in Phormia regina (Meig.) were investigated using S^{35} -labelled metabolites. The blowfly was unable to use sulfate for synthesis of the sulfur-containing amino acids. Methionine-S was converted to cystine-S and glutathione-S and was incorporated into protein. Cysteine and cystine were incorporated into protein and were degraded to taurine and sulfate but were not used in the synthesis of methionine. Sulfur metabolism in this insect, therefore, resembles that of most other insects and higher animals. Failure to synthesize methionine from cystine or sulfate is considered indicative of a dietary requirement for either methionine or a suitable thiomethyl precursor. (Auth.)

- 232 Henry, S.M., Block, R.J. AMINO ACID SYNTHESIS, A RUMEN-LIKE EFFECT OF THE INTRACELLULAR SYMBIONTS OF THE GERMAN COCKROACH. (Abstr.) Fed. Proc. 21, 2 (1962) 9.

Glucose- U^{14}C was fed as a 2% solution with a vitamin mixture consisting of choline, folic acid, nicotinamide, pantothenic acid, pyridoxal, thiamin, and riboflavin to xenic Blattella germanica (L.) and to aposymbiotic B. germanica obtained by feeding the parents aureomycin. After grinding and extracting with 80% ethanol, the proteinaceous residue was hydrolyzed in acid. The amino acid areas were eluted from 2-dimensional chromatograms and the radioactivity was measured with a glass flow counter. The

amino acids of the xenic cockroach, listed in order of decreasing radioactivity, were glutamic acid, alanine, aspartic acid, tyrosine, serine, proline, glycine, lysine, histidine, phenylalanine, threonine, isoleucine, valine, and arginine. Aposymbiotic cockroaches failed to synthesize tyrosine, phenylalanine, isoleucine, valine, arginine, and probably threonine from glucose. The necessity for symbionts for the synthesis of cystine and methionine from inorganic sulfate has been demonstrated previously (Henry & Block, *Contrib. Boyce Thompson Inst.*, 20, 317, 1960). The data thus indicate that the symbionts perform biochemical functions similar to those of rumen microorganisms. Impairment of tyrosine synthesis may be partially responsible for the light color of symbiont-free cockroaches.

- 233 Henry, S.M., Cook, T.W. METABOLISM OF CYSTATHIONINE IN *Blattella germanica* (L.). (Abstr. 79) *Bull. ent. Soc. Amer.* 9, 3 (1963) 164.

Cystathionine- S^{35} , injected into xenic and aposymbiotic German cockroaches, was cleaved rapidly to cysteine. Some conversion to methionine, presumably via homocysteine, also occurred. The latter is surprising inasmuch as only plants and some microorganisms are known to be able to effect this conversion.

- 234 Hopkins, T.L. OXIDATIVE METABOLISM OF ADENINE IN THE MADEIRA COCKROACH. (Abstr. 76). *Bull. ent. Soc. Amer.* 9, 3 (1963) 164.

Adenine-8- C^{14} injected into adult female *Leucophaea modesta* was rapidly oxidized to uric acid and stored in the fat body. Minor amounts were excreted in the feces in 12 d and about 3% as $C^{14}O_2$ in 12 h. Adenine-2- C^{14} was also oxidized to $C^{14}O_2$ in the early interval.

- 235 Jacobs, M.E., Brubaker, K.K. BETA-ALANINE UTILIZATION OF EBONY AND NON-EBONY *Drosophila melanogaster*. *Science* 139, 3561 (1963) 1282-3.

C^{14} -labelled β -alanine was injected into newly formed *D. melanogaster* female pupae. Homozygous ebony deposited less C^{14} in pupal sheaths, deposited more C^{14} in adult body extracts and wings, and decarboxylated and oxidized β -alanine to excrete $C^{14}O_2$ faster than did non-ebony homozygotes. Heterozygotes were intermediate in all these activities. (Auth.)

- 236 Japan, Sericultural Experiment Station, Tokyo. STUDIES BY CARBON-14 ON THE FORMATION OF THE SILK PROTEIN. (Abstr.). *Nucl. Sci. Abstr.*, Japan 1 3/4 (1962) 170. (In English).

Sodium glycolate-1- C^{14} was used to discover a precursor of glyoxylic acid synthesis. Amino acids (glycine, serine, etc.) were isolated from fibroin produced by silkworm which had consumed 0.5 μ Ci/head of the glycolate on the 4th day of the 5th instar. Radioactivities of the amino acids and the hydrazones isolated were measured. Location and concentration of C^{14} suggest that that glycolic acid is used for glycine formation via glyoxylic acid, and that this reaction plays an important role in the glycine synthesis in silkworm larvae.

- 237 Japan, Sericultural Experiment Station, Tokyo. METABOLIC PATHWAY OF AMINO ACIDS IN SILK-WORM LARVAE IN RELATION TO SILK PRODUCTION. *Nucl. Sci. Abstr.*, Japan 2, 2 (1963) 130-1. (In English).

Silkworms (Nichi 124 x Shi 124) which consumed 0.5 μ Ci/worm of citric acid-1,5- C^{14} (1.1 mCi/mM) on the 4th day of the 5th stage were reared on mulberry leaves until cocoons were produced. The fibroin protein was isolated from the radioactive cocoon fibre and the glycine as a salt of 5-nitronaphthalene-1-sulfonate from the fibroin hydrolysate (Stein and Moore procedure). The glycine was then separated from the salt. The amino acid isolated was recrystallized until the specific activity became constant. The chemical purity of the amino acid was established by paper chromatography. The amino acid was also degraded by procedures described by Vernon *et al.* to determine the distribution of C^{14} in the glycine molecule. In another experiment, glyoxylic acid was isolated as its 2,4-dinitrophenylhydrazone from the body fluid of silkworms which had consumed labelled citric acid on 3rd day of the 5th stage. A higher radioactivity was found in isolated glycine; all the C^{14} appeared at the carbon of the carboxyl group in glycine. A comparatively high radioactivity was also recognized in the hydrazone of glyoxylic acid. The results suggest that glyoxylic acid, a precursor of glycine synthesis, is synthesized from citric acid via the glyoxylate cycle.

- 238 Jaworski, E., Wang, L., Marco, G. SYNTHESIS OF CHITIN IN CELL-FREE EXTRACTS OF *Prodenia eridania*. *Nature, Lond.* 198, 4882 (1963) 790.

The results of a preliminary investigation on the biosynthesis of chitin in the southern army worm, *P. eridania*, are reported. There are indications that chitin synthetase is present in cell-free extracts. The 6th instar, pre-pupal and pupal stages were used, and the enzyme was obtained by the procedure of Glaser and Brown (J. Biol. Chem. 228: 1957, 729). The total reaction mixture of 1.5 ml consisted of 6×10^{-4} M C^{14} -uridine diphospho-N-acetylglucosamine (3.08×10^4 dpm), 1.12×10^{-2} M N-acetylglucosamine, 5 mg chitodextrin and 1 ml of enzyme preparation. The pellet was labelled with C^{14} which indicated the presence of chitin synthetase: peaking of enzymatic activity occurred at the pre-pupal (or late 6th instar) stage of development, which is about the time when the insect is beginning to form its pupal casing. Results appear consistent with those of Candy and Kilby (218) on the desert locust.

- 239 Jenny, E., Hicklin, A., Leuthardt, F. IN-VITRO-EINBAU RADIOAKTIVER AMINOSÄUREN IN DIE PROTEINE VON *Drosophila*-PUPPEN. (In vitro incorporation of radioactive amino acids into proteins of *Drosophila* pupae). *Helv. chim. Acta* 45, 6 (1962) 2014-20. (In German, with English summary).

The incorporation of radioactive amino acids into microsomes from *D. melanogaster* (pupae) is described. Enzymatic incorporation can only be demonstrated after the inhibition (by phenylthiourea) of a very active tyrosinase, which is present in the microsomal fraction. C^{14} -labelled leucine was used. The system has the following properties: (1) It requires ATP, Mg^{++} , an ATP regenerating system, but not GTP. (2) Sucrose-washed microsomes with and without addition of pH 5 enzymes incorporate to the same extent. (3) Microsomes treated with deoxycholate or 0.05 M KCl incorporate less than the untreated ones, the former being nevertheless stimulated by addition of pH 5 enzymes or the pH 5 precipitate of the KCl extract. (4) Rat liver microsomes or pH 5 enzymes can be exchanged with the corresponding fraction from *Drosophila*. (From auth. summary).

- 240* Karlson, P. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. III. ÜBER DEN EINBAU VON TYROSIN-UMWANDLUNGSPRODUKTEN IN DAS PUPPENTÖNNCHEN DER SCHMEISSFLIEGE *Calliphora erythrocephala*. (Tyrosine metabolism in insects. III. The incorporation of tyrosine metabolites in the puparium of the blowfly *Calliphora erythrocephala*). *Hoppe-Seyl. Z.* 318 (1960) 194-200. (In German, with English summary).

The last larval cuticle is transformed into the puparium by the incorporation into it of tyrosine metabolites. It has been demonstrated, with uniformly labelled tyrosine, that about 80% of the free tyrosine enters the cuticle. In ligated animals, puparium formation and tyrosine incorporation occur only after injection of ecdysone. Besides uniformly labelled tyrosine, tyrosine- $[\beta-C^{14}]$ and 3, 4-dihydroxy-phenylalanine- $[\beta-C^{14}]$ are incorporated but not hydroquinone- $[2, 3, 5, 6-C^{14}]$. Contrary to the hypothesis of Dennell, it is concluded that the sclerotization is due to the action of o -quinones, and that the elimination of the side chain plays only a minor part in the reaction sequence. (Auth. summary)

- 241 Karlson, P., Sekeris, C.E., Sekeris, K.E. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. VI. IDENTIFIZIERUNG VON N-ACETYL-3, 4-DIHYDROXY- β -PHENÄTHYLAMIN (N-ACETYL-DOPAMIN) ALS TYROSINMETABOLIT. (Tyrosine metabolism of insects. VI. Identification of N-acetyl-3, 4-dihydroxy- β -phenethylamine (N-acetyl-dopamine) as a tyrosine metabolite). *Hoppe-Seyl. Z.* 327 (1962) 86-94. (In German, with English summary).

A new metabolite, N-acetyl-dopamine, has been isolated from larvae of the blowfly, *Calliphora erythrocephala*. This compound was hitherto unknown, and was also synthesized for comparison from dopamine. N-acetyl-tyramine and the 4-O- β -glucoside of N-acetyl-dopamine were also found in the extracts. The incorporation of $[\alpha-C^{14}]$ N-acetyl-dopamine and generally labelled N-acetyl-tyramine (their preparation is described) into the cuticle was studied. In a comparative incorporation experiment, N-acetyl-dopamine and dopamine were the most efficient precursors of the sclerotization material. It is concluded that N-acetyl-dopamine is the phenolic precursor of the sclerotizing quinones. (Auth.)

- 242 Karlson, P., Schlossberger-Raecke, I. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. VIII. DIE SKLEROTISIERUNG DER CUTICULA BEI DER WILDFORM UND DER ALBINOMUTANTE VON *Schistocerca gregaria* Forsk. (Tyrosine metabolism of insects. VIII. Cuticle sclerotization in the wild form and the albino mutant of *Schistocerca gregaria* Forsk.) *J. Insect. Physiol.* 8 (1962) 441-52. (In German).

The albino strain of *Schistocerca* differs from the wild type in having no melanin while the sclerotization of the cuticle is virtually unaltered. A preliminary survey of the tyrosine metabolism of the two strains revealed that there are no qualitative but only minor quantitative differences in tyrosine content, phenoloxidase activity, and incorporation of radioactive precursors into the sclerotin of the cuticle. It is concluded

that the mutation to albino influences only processes in melanized parts of the cuticle, and that the main pathway of tyrosine metabolism, i.e. sclerotization and tanning of the cuticle, is not affected. Some observations on the incorporation of metabolites into the ecdysial membrane are reported and discussed. Experiments were carried out with radioactive preparations: generally labelled L-tyrosine (specific activity 9 mc/mM), DL-tyrosine- α -C¹⁴ (0.5 mc/mM) DL-dihydroxyphenylalanine (DOPA)- α -C¹⁴ (0.5 mc/mM). Depending on activity the dose/animal was 4-33 μ g. The solutions were injected as shortly as possible before moulting. Animals were killed at intervals after moulting, the cuticles were prepared and the radioactivity of the ashes determined.

- 243 Karlson, P., Sekeris, C.E. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. IX. KONTROLLE DES TYROSINSTOFFWECHSELS DURCH ECDYSON. (Tyrosine metabolism of insects. IX. Control of tyrosine metabolism by ecdysone). *Biochim. biophys. Acta* 63 (1962) 489-95. (In German, with English summary).

Changes in tyrosine metabolism have been observed during development of *Calliphora erythrocephala* larvae. In younger larvae (early 3rd-instar), tyrosine is mainly transaminated, while in older larvae conversion to 3,4-dihydroxyphenylalanine and decarboxylation to 3,4-dihydroxyphenylethylamine is predominant. This metabolic shift is prevented by ligation (elimination of the ecdysone-producing ring gland). In ligated abdomens as well as in intact animals, decarboxylase activity is enhanced by injection of ecdysone. It is concluded that one of the characteristic biochemical effects of ecdysone is the induction of the decarboxylating enzyme, possibly by interaction with the genetic material. Generally labelled preparations, L-[C¹⁴] tyrosine and L-[2'-C¹⁴] DOPA, were used and were obtained from the Radiochemical Centre Amersham and the California Corporation for Biochemical Research.

- 244 Karlson, P., Ammon, H. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. XI. BIOGENESE UND SCHICKSAL DER ACETYLGRUPPE DES N-ACETYLDOPAMINS. (Tyrosine metabolism of insects. XI. Biogenesis and fate of the acetyl group of N-acetyldopamines). *Hoppe-Seyl. Z.* 330 (1963) 161-8. (In German, with English summary).

An acetyl coenzyme A-transacetylase, which acetylates tyramine and dopamine, was demonstrated in blowfly larvae (*Calliphora erythrocephala*). This transacetylase system reacted with histamine and serotonin, but not with glucosamine, tyrosine, dopa, or amino acids. Its activity was unaffected by ecdysone. No significant change was seen due to age of the insect. The C¹⁴-labelled acetyl grouping was incorporated into the cuticle during sclerotization. The incorporation was also followed by radioautography. Sclerotization could be inhibited by ultraviolet irradiation. The following, generally labelled, radioactive preparations were used: [C¹⁴]-L-tyrosine, [α -C¹⁴] DL-dopa, [α -C¹⁴] dopamine, [α -C¹⁴] tyramine, and [1-C¹⁴] acetanhydride. [For XII., See 279]

- 245 Karlson, P., Sekeris, C.E. N-ACETYL-DOPAMINE AS SCLEROTIZING AGENT OF THE INSECT CUTICLE. *Nature, Lond.* 196 (1962) 183-4.

Evidence is presented for the identification of N-acetyl-dopamine (a metabolite of tyrosine in blowfly - *Calliphora erythrocephala* - larvae) as the tanning agent in puparium formation. Some data had been obtained by means of radioactive N-acetyl-dopamine labelled at the β -C-atom, which is readily incorporated into the cuticle. The incorporation is as high as that of tyrosine, within experimental error. If only the acetyl group of N-acetyl-dopamine is labelled, the radioactivity is, furthermore, found mainly in the cuticle. Hence it could be concluded that N-acetyl-dopamine is incorporated as a whole molecule.

- 246 Karlson, P., Hoffmeister, H. ZUR BIOGENESE DES ECDYSONS. I. UMWANDLUNG VON CHOLESTERIN IN ECDYSON. (An investigation of the biogenesis of ecdysone. I. Transformation of cholesterol into ecdysone). *Hoppe-Seyl. Z.* 331 (1963) 298-300. (In German, with English summary).

H³-labelled cholesterol (50 mg in an aqueous suspension, with a total activity of 25 mc) was injected into (1000) larvae of *Calliphora erythrocephala*. The larvae were killed 36 h later, extracted with methanol, followed by the technique described by Karlson et al., in *Liebigs Ann. Chem.* 682: 1963, 1. Extraction and purification gave a crude radioactive ecdysone. CocrySTALLIZATION with unlabelled ecdysone yielded pure ecdysone with constant specific activity (0.97×10^3 cpm/mg). It is concluded that cholesterol is the precursor of ecdysone.

- 247 Kasting, R., McGinnis, A.J. NUTRITION OF THE PALE WESTERN CUTWORM, *Agrotis orthogonia* Morr. IV. AMINO ACID REQUIREMENTS DETERMINED WITH GLUCOSE-U-C¹⁴. *J. Insect Physiol.* 8, 1 (1962) 97-103.
- An indirect method using glucose-U-C¹⁴ to determine amino acid requirements was applied to 5th instar larvae of the pale western cutworm, *Agrotis orthogonia* Morr. C¹⁴O₂ was produced after glucose-U-C¹⁴ was injected, indicating that the substrate was metabolized. The amino acids, alanine, aspartic acid, glutamic acid, proline, serine, and cysteine acid, isolated from the larvae contained relatively large quantities of radioactivity and were classed as nutritionally non-essential. Phenylalanine, arginine, lysine, histidine, leucine, isoleucine, and cystine contained little radioactivity and were classed as nutritionally essential. Methionine is probably essential also. The requirement for threonine remains in doubt. Tyrosine was not synthesized appreciably from glucose-U-C¹⁴ but was readily formed from phenylalanine. (Auth.)
- 248 Kasting, R., Davis, G.R.F., McGinnis, A.J. NUTRITIONALLY ESSENTIAL AND NON-ESSENTIAL AMINO ACIDS FOR THE PRAIRIE GRAIN WIREWORM, *Ctenicera destructor* Brown, DETERMINED WITH GLUCOSE-U-C¹⁴. *J. Insect Physiol.* 8, 11/12 (1962) 589-96.
- Valine, lysine, phenylalanine, arginine, histidine, threonine, leucine, isoleucine, and tyrosine were not readily synthesized from glucose-U-C¹⁴ by the prairie grain wireworm and, except for tyrosine, are classed as nutritionally essential. Tyrosine was readily formed from phenylalanine. Although methionine and glutamic acid were synthesized to a limited extent, they are considered to be nutritionally essential also. In contrast, proline, alanine, aspartic acid, serine, and glycine were readily synthesized from glucose-U-C¹⁴ and are classed as nutritionally non-essential. A peptide containing leucine, glycine, and glutamic acid was demonstrated and may be of nutritional significance. The relative quantities of the common amino acids found in this insect are presented. (Auth.)
- 249 Kirsten, E., Kirsten, R., Arese, P. DAS VERHALTEN VON FREIEN AMINOSÄUREN, ENERGIEREICHEN PHOSPHORSÄURE-VERBINDUNGEN UND EINIGEN GLYKOLYSE- UND TRICARBONSÄURECYCLUS-SUBSTRATEN IN MUSKELN VON *Locusta migratoria* BEI DER ARBEIT. (The behaviour of free amino acids, high energy phosphoric acid compounds and some glycolytic and tricarboxylic acid cycle substrates in the muscles of *Locusta migratoria* at work). *Biochem. Z.* 337, 2 (1963) 167-78. (In German, with English summary).
- Characteristic shifts of the levels of some free amino acids take place in flight muscle of *Locusta migratoria* during flight. Glutamate shows a decrease of ~ 3 µM/gm fresh weight (fw) proline one of ~ 7 µM/gm fw, while aspartate increases by ~ 1 µM/gm fw and free amides (glu-NH₂, asp-NH₂) show an increase of ~ 3 µMol/gm fw. The shifts of glutamate and aspartate are already detectable after 20 sec of flight, while proline and amide begin changing only in later phases of flight. The flight muscle (which is known to perform an intensive aerobic metabolism during flight) shows in anaerobiosis (the animal put into a N₂-atmosphere for 3 min) a significant decrease of glutamate, proline, and aspartate content. Glutamate-U-C¹⁴ was incorporated to a high rate into aspartate during flight. Alanine rises only in the first phase of flight as well as in anaerobiosis of the flight muscle. Alanine also increases in the jumping muscles during muscular activity (the jumping muscles of *Locusta migratoria* are known to perform a mainly anaerobic metabolism in the active state). The shifts of alanine show the same direction as those of pyruvate. The free amide content of jumping muscles also shows an increase of ~ 2 µM/gm fw after 10-15 jumps, while besides alanine no further changes of free amino acid levels are to be observed in the active state. While in the flight muscle of the locust the phosphagen (phosphoryl arginine) content amounts to 6 µM/gm fw in rest and decreases to approximately one half of this value during activity, the leg muscle phosphoryl arginine amounts to 24 µM/gm fw in rest and decreases by ~ 18 µM/gm fw during muscular activity. The corresponding changes within the adenosine triphosphate (ATP) adenosinediphosphate (ADP)-system are comparatively small: ~ 6 µM/gm fw in flight as well as in jumping muscle during rest decrease by 0.4 - 0.5 µM/gm fw during activity. (Auth.)
- 250 Kondo, Y. THE CYSTATHIONINE PATHWAY IN THE SILKWORM LARVA. *J. Biochem.*, Tokyo 51 (1962) 183-92.
- Cystathionine was found to be commonly present in the larval haemolymph of silkworm, including 5 races with white and one with yellow blood, but not in other Lepidopterous insects. The content of cystathionine (I) in haemolymph of *Bombyx mori* is detected only after hatching, and is increased to about 130 mg % by feeding mulberry leaves. Following an injection of DL-methionine (II)-S³⁵ only L-S³⁵ is found in the blood, but no S³⁵-labelled metabolites of I are detected. II-S³⁵ is metabolized in *Antheraea pernyi* to S³⁵-labelled

cystine, taurine, and sulfate, but $I-S^{35}$ is not detected. B. mori appears to have no cystathionase or of only very low activity while A. pernyi appears to have a different pathway of II metabolism.

- 251 Kroeger, H., Jacob, J., Sirlin, J.L. THE MOVEMENT OF NUCLEAR PROTEIN FROM THE CYTOPLASM TO THE NUCLEUS OF SALIVARY CELLS. Exp. Cell Res. **31** (1963) 416-23.

Salivary glands from middle to late larvae of Chironomus thummi were incubated in their own haemolymph, either with DL- H^3 -lysine monohydrochloride or H^3 -guanosine (specific activities of 22 and 400 mc/mM) to a final concentration of 50-100 μ Ci/ml. Protein-labelled chromosomes and nucleoli from salivary cells were implanted into the cytoplasm of unlabelled salivary cells. Autoradiographs showed the label to move preferentially into the host nucleus. From comparison with the pattern of uptake of free lysine in controls the transfer of label is considered to take place in protein. This would indicate the presence in the nucleus of protein with nucleotropic affinity.

- 252 Lewis, S.E., Fowler, K.S. IN VITRO SYNTHESIS OF PHOSPHOARGININE BY BLOWFLY MUSCLE. Nature, Lond. **194** (1962) 1178-9.

The in vitro effect of arginine on the O_2 uptake by suspensions of thoracic muscle of Calliphora erythrocephala was examined. Addition of adenosine diphosphate, or arginine, HCl to the incubation mixture increased the rate of O_2 uptake, measured with a vibrating Pt electrode. Radiometric scanning of chromatograms of the supernatant from the incubation mixture precipitated with EtOH after incubation with arginine and $P^{32}O_4^{3-}$ showed that about 67% of the incubated P^{32} coincided with phosphoarginine detected chemical. This P^{32} -labelled compound was hydrolyzed in situ, eluted, and rechromatographed. Two compounds were identified, arginine and P^{32} as inorganic phosphate. Preliminary examination of suspensions of thoracic muscle had shown that on incubation with arginine and adenosine triphosphate, the amount of phospho-arginine produced by the soluble fraction is about 10-fold that produced by the sarcosomes. (CA 57: 1962. 11881g)

- 253* Lu, K.H., Li, W.Y. THE USE OF LABELED ACETIC ACID IN THE SYNTHESIS OF SILK PROTEIN. Shih Yen Sheng Hsueh Pao **6**, 4 (1959) 263-75.

$HOAc-C^{14}$ was injected into an adult caterpillar (Attacus ricini). The label disappeared rapidly from the haemolymph and CO_2 , while the lipids and proteins remained labelled. The radioactivity of silk protein kept increasing until an equilibrium between them and proteins of the body was established. The protein of the silk cocoon contained approximately 9.2% of the introduced radioactivity, wherein the activity of fibroin and of sericin was almost equal. In the hydrolysis of labelled fibroin, the content of alanine was found to be high. In addition, there were found the following: glycine, leucine, phenylalanine, valine, tyrosine, glutamic and aspartic acids, threonine, serine, arginine, lysine and histidine. Maximum introduction of C^{14} was into alanine, aspartic and glutamic acids, serine, glycine, valine and tyrosine; threonine, leucine and histidine did not contain it. In 5 d, the protein content of silk in each gland increased from 3 mg during the 1st d up to 115.4 mg on the 5th, while ribonucleic acid increased from 380 mg up to 2995.2 mg then decreased in parallel with the disappearance of protein. (CA 58:1963,19661b)

- 254 Lu, C.-H., Wang, P.-Y. FIBROIN BIOSYNTHESIS IN Samia ricini. Shih Yen Sheng Wu Hsueh Pao **8**, 3/4 (1963) 301-22. (In Chinese).

This work was undertaken to det. which cellular structure in S. ricini synthesizes the fibroin, to study the turnover rate of silk protein, and to correlate protein synthesis with ribonucleic acid (RNA) metabolism. S. ricini at 5th instar was employed. Glycine- C^{14} was used in this work. The distribution of C^{14} in the cellular fractions was detected. The posterior silk glands were homogenized and fractionated by centrifugation at various forces into crude (cG), large (lG) and medium sized (mG) granules. The supernatant was treated with M HOAc to pH 5, and precipitation resulted. The precipitate (sG) was separated from the solution (s). Thirty min after glycine- C^{14} was used, most of the C^{14} was present in lG, some in mG, and very little in sG and s. Because mG had a very high specific activity, mG might be the site of the fibroin synthesis. At 8 h C^{14} was found in RNA from the coagulated fibroin. P^{32} was found in RNA, when it was used instead of C^{14} . Both RNA- C^{14} and RNA- P^{32} gave the same biological half-life. This demonstrates that the turnover rate of silk protein is very fast. The kind of RNA in connection with the fibroin synthesis was not given. (CA 61: 1964, 4758h)

- 255 McGinnis, A.J., Kasting, R. NUTRITION OF THE PALE WESTERN CUTWORM, *Agrotis orthogonia* Morr. (LEPIDOPTERA: NOCTUIDAE). V. UTILIZATION OF PROTEIN LABELED WITH CARBON-14. *J. Nutr.* **76**, 4 (1962) 333-40.

A diet containing algal protein-U- C^{14} provided a convenient means of studying *in vivo* protein utilization by larvae of the pale western cutworm, *Agrotis orthogonia* Morr. Utilization of dietary protein in both 1st- and 5th-instar larvae was found to be quantitatively significant. This technique avoids the difficulty of enzyme extraction artifacts and has particular application to organisms that are too small to permit investigation by classical methods. (Auth.)

- 256 Miura, Y., Ito, H., Tanaka, S., Momose, K., Sunaga, K., Moriyama, A. THE PROTEIN SYNTHESIS IN SILK GLANDS. I. TRANSFER OF RADIOACTIVITY FROM PRELABELED CELL DEBRIS TO PARTICULATE FRACTIONS IN THE CELL-FREE SYSTEMS OF THE POSTERIOR SILK GLAND. *J. Biochem.*, Tokyo **50** (1961) 458-66.

Glycine-2- C^{14} was injected in *Bombyx mori* or was incubated with silk gland mince in 0.4 M sucrose at pH 7.4-7.6, 37°C. The silk gland or its mince was homogenized and subjected to differential centrifugations at 700, 14,000, and 8500 (pH 6.1) and 8500 g (pH 4.9) to separate cell debris (CD), large particles (LP), small particles (SP), incorporating enzyme (I), and amino acid-activating enzyme (II) fractions, respectively. Carbon-14 transfer from C^{14} -labelled CD to other fractions was examined by the cell-free system containing adenosine and guanosine triphosphates, phosphocreatine, creatine kinase, $MgCl_2$, KCl, sucrose, amino acids, all the gland fractions, and C^{14} -labelled CD at pH 7.4-7.6. Carbon-14 of CD was dominantly transferred to the protein and polypeptide moieties of LP, and to a lesser extent, to these compounds, in SP. II was unnecessary and could be omitted from the above cell-free system. *In vivo* incorporation of glycine-2- C^{14} was $CD > LP \gg SP \gg I \gg II$; C^{14} was predominant in the protein part of CD, LP, and SP and was very low (< 0.6% of the protein) in the lipid or phosphatido-peptide parts. (CA 56: 1962, 10721e)

- 257 Miura, Y., Ito, H., Tanaka, S., Momose, K., Sunaga, K., Moriyama, A. THE PROTEIN SYNTHESIS IN SILK GLANDS. II. EFFECTS OF INHIBITORS ON TRANSFER OF RADIOACTIVITY AND ROLE OF LIPID FRACTION IN PROTEIN SYNTHESIS. *J. Biochem.*, Tokyo **50** (1961) 526-32.

The C^{14} -transferring potency of the cell-free system (cf. preceding abstr.) was inactivated by ribonuclease and deoxyribonuclease digestion, and water of deoxycholate washing, but it was not affected by 10^{-4} M chloramphenicol, 2,4-dinitrophenol, or 10^{-5} M N mustard. The inactivation treatments did not change C^{14} radioactivity of the protein fraction of CD, except for the case of demineralized water-washing. It is concluded that: the C^{14} -precursor(s) in CD is not an integral part of CD-protein, but may be peptidolike substances attached to CD consisting of nuclear debris and cell membrane fragments as demonstrated microscopically: the lipid fraction is not associated with the precursor(s), but simply mediates the transfer reaction. (CA 57: 1962, 103699g)

- 258 Miura, Y., Ito, H., Tanaka, S., Momose, K., Sunaga, K., Araki, E. PROTEIN SYNTHESIS IN SILK GLANDS. III. RADIOACTIVE SUBSTANCES IN CELL DEBRIS. *J. Biochem.*, Tokyo **51** (1962) 267-73.

Incorporation of glycine-2- C^{14} (I) into the cell debris fraction (II) of silk gland is catalyzed by the enzyme fraction, E_{2+3} (cf. loc. cit.), which is accelerated by the simultaneous addition of 18 natural amino acids. A partial hydrolysis of C^{14} -labelled II yields C^{14} -peptide-nucleic acid complex (III), containing I as a sole C^{14} -substance. Neither phospholipid nor phosphatidoprotein of II is enriched by C^{14} . The particulate fraction of the silk gland cell (cf. loc. cit.) mediates effectively C^{14} incorporation to the protein fraction of II from III- C^{14} . A slight yield of protein- C^{14} from I occurring in II is processed by the particulate enzyme(s) adhered to the cell membrane contaminated in II. III is very likely a precursor of I in incorporation to protein. (CA 57: 1962, 103699f)

- 259 Miura, Y., Ito, H., Momose, K., Sunaga, K., Ikeda, K. STUDIES ON THE PROTEIN SYNTHESIS IN SILKGLANDS. IV. INCORPORATION OF LABELED GLYCINE INTO THE VESICULAR PROTEIN BY POSTERIOR SILKGLANDS. *J. Biochem.*, Tokyo **52**, 5 (1962) 333-42. (In English).

Posterior silk glands from *Bombyx mori* L. (obtained on the 6th or 7th day of the 5th instar) were incubated with glycine-2- C^{14} , minced and subjected to density gradient fractionation. Mitochondria were effectively separated from the particle fraction which actively incorporates amino acids into protein. The amino-acid-incorporating particles were found to have high lipid but relatively low RNA content. Electron microscopy showed the particles to consist mainly of smooth-surfaced endoplasmic reticulum. The possibility that the particle might be a secretory granule of fibroin is considered. The supply of energy from oxidative

phosphorylations is assumed to be of primary importance for fibroin synthesis. Oxidative phosphorylation of the particles with succinate and glycine-2- C^{14} incorporation into the particle proteins were inhibited by 10^{-4} M 2,4-dinitrophenol, but not by chloramphenicol or gramicidin-S. The role of nuclei in fibroin synthesis and fibroin secretion in the posterior silk glands is discussed.

- 280 Momose, K. STUDIES ON THE INCORPORATION OF LABELED GLYCINE INTO THE PROTEIN OF THE MITOCHONDRIA-LIKE PARTICLES BY POSTERIOR SILK GLANDS. Seikagaku Zasshi **34** (1982) 199-204. (In Japanese).

Slices of posterior silk glands incubated with glycine-2- C^{14} (**1**) at 37° (0.4M sucrose buffer, pH 7.8) were homogenized by a Waring blender and the resulting homogenates were separated by a density gradient centrifugation. Incorporation of **1** was highest in large particles precipitated at 14000 g at 30 min) containing mitochondria. But among 5 fractions of these large particles, a fraction highest in the specific radioactivity was lowest in ribonucleic acid content and low in succinic dehydrogenase activity, indicating the site of fibroin protein at "secretion particles" in glands. 2,4-Dinitrophenol strongly inhibited the incorporation of **1** into the large particles. Thus, the synthesis of fibroin protein requires the supply of energy by oxidative phosphorylation. Chloramphenicol and gramicidin-S stimulated the incorporation of **1** into the large particles. (CA 57: 1982, 6453h)
- 261 Muramatsu, M., Shimura, K., Nagayama, H. STUDIES ON THE BIOSYNTHESIS OF GLYCINE IN THE SILKWORM. I. FORMATION OF GLYCINE FROM SERINE. J. Biochem., Tokyo **49** (1961) 55-8.

Serine-1- C^{14} injected to *Bombyx mori* at 5th instar stage was incorporated into glycine of body fluid and in a later stage, into glycine of the protein of posterior silk gland. A direct conversion of serine to glycine is suggested from an exclusive labelling of carboxyl C of glycine. (CA 55: 1961, 13689d)
- 262 Muramatsu, M., Shimura, K. STUDIES ON THE BIOSYNTHESIS OF GLYCINE IN THE SILKWORM. II. CONVERSION OF GLYOXYLIC ACID TO GLYCINE IN THE INTACT SILKWORM. J. Biochem., Tokyo **52**, 4 (1982) 297-301.

Following the injection of glyoxylic acid-1,2- C^{14} the C^{14} -radioactivity was predominantly recovered in the glycine and serine residues of the protein synthesized in posterior silk gland. A minor part of C^{14} was detected in respiratory CO_2 . When C^{14} -glycine was administered any appreciable amount of C^{14} was recovered in glyoxylic acid of body fluid or respiratory CO_2 . (BA 43: 1963, 21239)
- 263 Nigon, V., Nonnenmacher, J. THE INCORPORATION OF TRITIATED THYMIDINE IN THE COURSE OF OVOGENESIS IN *Drosophila*. Dev Biol. **3** (1961) 210-24.

3-d-old *Drosophila* were injected in the abdomen with 0.3 - 0.6 μ c of tritiated thymidine. Ovaries were collected 1 h later and distribution of radioactivity observed. Maximum incorporation of radioactivity corresponded to the most actively growing period of the oöcyst. Thymidine uptake occurred in structures sensitive to the action of deoxyribonuclease and ribonuclease. As a possible explanation of the data the existence of a metabolically active deoxyribonucleic acid fraction was discussed. (CA 56: 1962, 1849c)
- 264 Okamoto, S., Okada, T., Kyo, S. THE MECHANISM OF FIBROIN BIOSYNTHESIS BASED ON ITS CHEMICAL STRUCTURE. I. THE PARTIAL HYDROLYZATES OF C^{14} -LABELLED FIBROIN. Nippon Kagaku Kaishi **37**, 3 (1963) 163-6. (In Japanese).

The present work was carried out to clarify whether fibroin biosynthesis in the silkworm's posterior silk glands proceeds by a stepwise mechanism or by simultaneous conjugation of component amino acids. Labelled fibroin was prepared by injecting 1 μ c glycine-1- C^{14} . 2 h after the injection fibroin- C^{14} was separated from the posterior gland, and partially hydrolyzed with concentrated HCl at 40° for 18 h. From the hydrolyzate, 17 peptides were isolated by repeated paper chromatographic procedures. Their specific radioactivities were counted, and their amino acid components were identified by paper chromatography. The peptides differed widely in their specific radioactivities. Autoradiography was applied to the paper chromatograms of hydrolyzates of each peptide. Some peptides containing glycine or serine residues had high radioactivity, but others displayed no activity. Fibroin is probably labelled nonuniformly, and fibroin biosynthesis in silk glands occurs by a stepwise mechanism. (From EM 17, 1: 1964, abstr. 329)
- 265 Okamoto, S., Okada, T. THE MECHANISM OF FIBROIN BIOSYNTHESIS BASED ON ITS CHEMICAL STRUCTURE. II. THE FORMATION OF CRYSTALLINE AND NONCRYSTALLINE PARTS OF FIBROIN. Nippon Kagaku Kaishi **37**, 3 (1963) 167-71. (In Japanese).

C^{14} labelled fibroin was prepared by injecting or dosing glycine-1- C^{14} to silkworms. Crystalline and non-crystalline fractions were separated by protease such as trypsin or pancreatin from the labelled fibroin solution. Specific radioactivity of each fraction was counted for various time intervals after the injection. That of the N- and non-N-terminal amino acids of the 2 fractions was also measured. The crystalline fraction had higher radioactivity generally, but lower at its N-terminal residue as compared with the non-crystalline fraction. This difference appeared most distinctly at 2 h after the injection. The crystalline fraction, so far as ascertained in the present experimental conditions, is synthesized first, and then the formation of the non-crystalline fraction follows it. There was no doubt about the non-uniform mode of labelling of each fraction of fibroin, judging from the values of radioactivity of the N- and non-N-terminal residues. (From EM II 17, 1: 1964, abstr.330)

- 266 Price, G.M. SOME ASPECTS OF AMINO ACID METABOLISM IN THE ADULT HOUSEFLY, Musca domestica. Biochem. J. 80 (1961) 420-8.

Extracts from whole flies, heads and haemolymph were analysed, following injection of [2- C^{14}] acetate into 5-6 d old Musca domestica L. The experimental procedures are described. Location of amino acids was studied by a) chemical, b) radiometric, and c) radioautographic methods. Aspartic acid and glutamic acid were concentrated in the tissues of the fly and hardly detectable in the haemolymph. γ -Aminobutyric acid was detectable only in the head extracts. After injection of the fly with [2- C^{14}]acetate, α -alanine, aspartic acid, γ -aminobutyric acid, glutamic acid, glutamine and proline became labelled. Labelled α -alanine, aspartic acid, glutamic acid and proline were identified in a protein hydrolysate from 'labelled' flies. Glutamic-alanine- and glutamic-aspartic acid-transaminase activity was demonstrated in sarco-somes isolated from flight-muscle, but these two enzyme systems were not detectable in haemolymph. - Other amino acids identified were β -alanine, arginine, glycine, leucine, lysine, methionine sulphoxide, phenylalanine, serine, taurine, tyrosine and valine.

- 267 Price, G.M., Moriya, S. EFFECTS OF ANOXIA ON THE METABOLISM OF AMINO ACIDS BY THE ADULT HOUSEFLY (Musca domestica) IN VIVO. Biochem. J. 84 (1962) 98P.

4- d-old houseflies were injected with [2- C^{14}]acetate and left in air for 1 h. One group was killed immediately in liquid nitrogen (zero-time control), a second (aerobic) after being left in air for another 2 h, and a third group (anoxic) after 2 h in O_2 - free nitrogen. At least 8 C^{14} -labelled intermediates, other than free amino acids, were detectable in the ethanol extracts of anoxic flies (amongst them glutathione, fumarate, lactate, malate and succinate, the largest amount of C^{14} -activity being found in succinate). Specific radioactivity measurements of the protein amino acids showed that in the aerobic flies free C^{14} -amino acids had been incorporated into protein over the 2-h-period, whereas in the anoxic flies there had not been any incorporation.

- 268 Price, G.M. THE EFFECTS OF ANOXIA ON METABOLISM IN THE ADULT HOUSEFLY Musca domestica. Biochem. J. 86 (1963) 372-8.

Houseflies were injected with [2- C^{14}] acetate and were left in air for 1 h. Some were men killed, some were left in air for a further 1 h or 2 h, and others were put into oxygen-free N_2 for 1 h or 2 h. In the aerobic flies C^{14} -labelled α -alanine, aspartate, glutamate, glutamine, proline, γ -amino-butyrate, fumarate, malate, α -oxoglutarate, pyruvate, succinate, and glutathione were present. In the anoxic flies all the above intermediates were present as well as C^{14} -labelled lactate and 3 other unidentified C^{14} -labelled intermediates. In the anoxic flies there was an increase in the concentration of α -alanine, but there was a fall in the concentrations of aspartate and of glutamine. The concentration of pyruvate rose during the first 30 min of anoxia but later returned to its original value. There was a rise in the C^{14} activity of lactate, of succinate and of γ -aminobutyrate. In the aerobic flies the specific activity of the protein amino acids increased whereas in the anoxic flies their specific activity either decreased or remained the same. (Auth.)

- 269* Rabinovitch, M., Vugman, I. AUTORADIOGRAPHIC OBSERVATIONS ON THE SILK GLANDS OF Bombyx mori. J. biophys. biochem. Cytol. 6 (1959) 293-4.

Glycine-1- C^{14} was administered to B. mori larvae (5th instar) 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. summary)

- 270 Раменская, Г.П. АВТОРАДИОГРАФИЧЕСКОЕ ИССЛЕДОВАНИЕ БИОСИНТЕЗА БЕЛКА В КЛЕТКАХ ФИБРОИНОВОГО ОТДЕЛА ШЕЛКОТДЕЛИТЕЛЬНОЙ ЖЕЛЕЗЫ ТУТОВОГО ШЕЛКОПРЯДА (*Bombyx mori*). Ж. общ. Биол. 23, 5 (1962) 391-3.
- Ramenskaya, G.P. AN AUTORADIOGRAPHIC STUDY OF PROTEIN SYNTHESIS IN THE CELLS OF THE FIBROIN PORTION OF THE SILK GLAND IN *Bombyx mori*. Zh. obshch. Biol. 23, 5 (1962) 391-3.
- Radioautography of transverse sections of the silk gland, 5 min - 48 h after injection of 0.07 - 0.33 μC of glycine- C^{14} into the haemolymph of larvae on the 6th day of the 5th stage, showed that during the 1st hour the radioactivity is incorporated mainly into the cytoplasm, with increasing amounts in the nuclei and a gradual concentration of radioactivity in the internal membrane of the gland. After 2 h radioactivity also appeared in the secretion, increasing with time up to 9 h and accumulating in the glandular lumen. After 2 d little radioactivity remained. The results indicate that fibroin or its precursors are first synthesized in the cytoplasm. The subsequent appearance of radioactivity in the nuclei may be due either to simultaneous fibroin synthesis in the nuclei, or to penetration of secreted material from the cytoplasm. (From BA 42: 1963, 3906)
- 271* Rembold, H., Hanser, G. ROYAL JELLY OF THE HONEYBEE. VI. METABOLISM OF BIOPTERINS IN THE HONEYBEE. Hoppe-Seyl. Z. 319 (1960) 213-3.
- A synthesis of bioplerin-2- C^{14} is described. The labelled compound with a specific activity of 2 mc/mmM was fed to 2-d-old queen bee larvae in the hive and to corresponding worker larvae in a thermostat. In both cases most of the radioactivity was excreted before pupation, and the remainder was present in equal concentrations in the pupa and imago. The absorbed bioplerin can be demonstrated unchanged in all stages of development and undergoes no significant conversion to other fluorescent compounds. In the excrement other fluorescent materials are presented besides bioplerin. Small amounts of other *Crithidia* growth substances, together with bioplerin, were found when extracts of both queen and worker larvae were separated by paper chromatography. (CA 55: 1961, 11687d)
- 272* Rizki, M.T.M., Rizki, R.M. FUNCTIONAL SIGNIFICANCE OF THE CRYSTAL CELLS IN THE LARVA OF *Drosophila melanogaster*. J. biophys. biochem. Cytol. 5 (1959) 235-40.
- Larvae fed tyrosine- C^{14} showed that in the crystal cells radioactivity was restricted to the crystal inclusions and was significantly higher than that found in other types of haemocytes. When samples of blood cells were incubated with 3-(3,4-dihydroxyphenyl) alanine, the extra-crystalline cytoplasm became blackened while the crystals remained colorless. These observations are consistent with the hypothesis that the substrate is localized in the crystal inclusions, whereas the enzyme is found in the surrounding cytoplasm. (CA 53: 1959, 16401h)
- 273 Russo-Cafa, S. FAT BODY INSECTS. AUTORADIOGRAPHIC OBSERVATIONS ON INCORPORATION OF ADENINE- C^{14} AND OROTIC ACID- C^{14} IN LARVAL TROPHOCYTES OF *Musca domestica*. R.C. Ist. Sci. Camerino 4,3 (1963) 210-28. (In Italian).
- Nuclei of fat-body cells are labelled 10 min after injection of title compounds. Two hours later labelling is more evident mainly in nucleus; 6 h later several cytoplasmic tracks are evident. Radioactivity is related to ribonucleoproteins identified in fat-body cells with Pyronine-methyl green, and toluidine blue. Radioactivity disappears after ribonuclease and perchloric acid treatment. Results suggest occurrence of synthesis of ribonucleic acid and its transfer from nucleus to cytoplasm in fat-body cells of larvae. (CA 60: 1964, 18255e)
- 274 Самарина, О.П. ВКЛЮЧЕНИЕ ГЛИЦИНА-1- C^{14} В БЕЛКИ ФРАКЦИЙ ГОМОГЕНАТА ШЕЛКОТДЕЛИТЕЛЬНОЙ ЖЕЛЕЗЫ ТУТОВОГО ШЕЛКОПРЯДА *Bombyx mori* L. Биохимия 27, 5 (1962) 814-21.
- Samarina, O.P. GLYCINE-1- C^{14} INCORPORATION INTO THE PROTEINS OF FRACTIONS OF SILK GLAND HOMOGENATE OF *Bombyx mori* L. Biokhimiya 27, 5 (1962) 814-21. Available in English in Biochemistry (Translation of Biokhimiya) 27, 5 (1963) 690-5.
- The homogenate of the silk gland of silk worm larvae in 5th instar was divided by differential centrifugation into 5 fractions. The particulate fractions contained large amounts of RNA. The highest concentration of RNA was found in the 4th fraction, sedimented at 100 000 g. Nuclear material sedimented almost completely in the 1st fraction. In vivo as well as in vitro glycine- C^{14} incorporates in a very short time into

the proteins of the 1st 3, especially of the 2nd and the 3rd fractions. In chase experiments with non-radioactive glycine after preliminary incubation *in vivo* or *in vitro* with glycine- C^{14} radioactive label was transferred to the protein of the 4th and 5th fractions. Incorporation of glycine was inhibited to almost the same extent in each fraction by RNase, chloramphenicol and to a lesser extent - by DNase or protamin. The results obtained are discussed in connection with the participation of various cell structures in protein biosynthesis in the silk gland. (Auth.: BA 43, 1963, 8280)

- 275 Schmfalek, P. FORMATION OF JUVENILE HORMONES IN WILD SILK SPINNERS. *Z. Naturf.* 18b, 6 (1963) 462-6.

The juvenile hormone (CA 57, 7751f) in combined MeOH and C_6H_6 extracts of *Samia cynthia* was identical in its thin-layer chromatography properties to farnesol (I) and farnesal (II). Mevalonate-2- C^{14} was incorporated by live insects into substances characterized by chromatography as I, II, and neuroliodol. Isolated I and II injected into *Tenebrio* species insects produced allaturn-hormone activity. (CA 59: 1963, 10504c)

- 276 Seifichi, S., Shimura, K. ELECTRON MICROSCOPIC AND SOME BIOCHEMICAL STUDIES ON THE CELL FRACTIONS OF SILK GLANDS. *Tohoku J. agric. Res.* 12 (1961) 253-60.

The highest specific activities of acid phosphatase and acid ribonuclease in homogenates of silkworm silk glands were found in the large microsomal fraction while similar total activities but lower specific activities of both enzymes were found in the mitochondrial fraction. Electron micrographs revealed microsomal structures in all particulate fractions including the cell debris fraction. The large microsomal fraction also contained electron-dense granules thought to be indicative of the lysosomal nature of this fraction. The small microsomal fraction consisted of small microsomal vesicles and free Palade particles. Subfractionation of each cell fraction with Na deoxycholate following incubation with glycine-1- C^{14} (I) showed that I was incorporated predominantly into the insoluble proteins. These proteins contained most of the ribonucleic acid of each subfraction and more glycine than either the whole fraction or the soluble subfraction. It is suggested that fibroinlike materials exist, perhaps in the intracisternal areas like the intracisternal granules of exocrine cells of pancreas, which become insoluble during the subfractionation process analogous to the coagulation of fibroin. (CA 56: 1962, 12097c)

- 277 Seifichi, S., Shimura, K. BIOSYNTHESIS OF SILK FIBROIN. III. IN VIVO INCORPORATION OF GLYCINE- C^{14} INTO PROTEINS OF POSTERIOR SILK GLAND FRACTIONS. *J. Biochem.*, Tokyo 49 (1961) 69-75.

The homogenate of posterior silk gland with 0.36 M sucrose was fractionated to R (residue), M (mitochondrion), L (large microsomal granules), S (small microsomal granules), and soluble supernatant by differential centrifugations at 1000, 3900, 15 000 and 105 000 \times g. successively. Ribonucleic acid (RNA)-containing microsomes were released from R by deoxycholate treatment. RNA was highest in S, and lower in M and L, but not present in soluble fraction. M and L fractions were rich in phospholipides. R contained a large amount of fibroin. The 4 sedimenting fractions were examined for C^{14} following the injection of glycine-1- C^{14} . R showed an initial, temporary rise of C^{14} incorporation, presumably to its microsomal moiety, and later incorporation of C^{14} to fibroin of R proceeded when C^{14} radioactivity of L, M, and S fractions were decaying. Microsomes in heterogeneous states in R, M, L, and S fractions play a role in taking up glycine for protein synthesis. (CA 55: 1961, 12669f)

- 278 Sekeris, C.E., Karlson, P. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. VII. DER KATABOLISCHE ABBAU DES TYROSINS UND DIE BIOGENESE DER SKLEROTISIERUNGSSUBSTANZ, N-ACETYL-DOPAMIN. (Tyrosine metabolism of insects. VII. The catabolic degradation of tyrosine and the biogenesis of the sclerotizing agent N-acetyldopamine). *Biochem. biophys. Acta* 62 (1962) 103-13. (In German, with English summary).

In early 3rd-instar *Calliphora* larvae, tyrosine is transaminated to p-hydroxyphenylpyruvic acid and further metabolized to p-hydroxyphenylpropionic acid. The transaminase is a pyridoxal phosphate-dependent enzyme and can transfer the amino group to α -ketoglutarate. In the late 3rd instar (just before pupation), tyrosine is hydroxylated to DOPA. The action of a DOPA decarboxylase was further demonstrated; *in vivo*, the dopamine formed is rapidly acetylated to N-acetyldopamine. This metabolite serves as sclerotizing agent in puparium formation. The findings are discussed in connection with the mode of action of the metamorphosis hormone, ecdysone. The following radioactive preparations were used: generally labelled L-[C^{14}]tyrosine, DL-[2- C^{14}]DOPA, [2- C^{14}]tyramine, and [3- C^{14}]dopamine.

- 279 Sekeris, C.E. ZUM TYROSINSTOFFWECHSEL DER INSEKTEN. XII. REINIGUNG, EIGENSCHAFTEN UND SUBSTRATSPEZIFITÄT DER DOPA-DECARBOXYLASE. (Tyrosine metabolism in insects. XII. The purification, properties, and substrate specificity of Dopa-decarboxylase). Hoppe-Seyl. Z. 332 (1963) 70-8. (In German, with English summary)
- Determination of enzyme activity by a radiochemical method is not only more specific but at least 5 times as sensitive as manometric measurements. A C^{14} -labelled substrate was used. A 360 fold purification of the Dopa-decarboxylase from Calliphora erythrocephala larvae was achieved by fractionation with ammonium sulphate and chromatography on DEAE-cellulose. The purified enzyme is very labile and requires pyridoxal phosphate and Fe ions. Carbonyl reagents and amines, particularly N-acetyl-dopamine, inhibit the decarboxylation. Dopa is more readily decarboxylated than 5-hydroxy-tryptophan or 5,6-dihydroxy-tryptophan. Phenylalanine, tyrosine, tryptophan and histidine are not attacked. The enzyme can be regarded as a specific Dopa-decarboxylase.
- 280 Sekeris, C.E. TYROSINE METABOLISM IN THE BLOWFLY, Calliphora erythrocephala. p.281-7 in "Radiation and Radioisotopes Applied to Insects of Agricultural Importance. Proceedings of a Symposium, Athens, 22-26 April 1963". Vienna, International Atomic Energy Agency. 1963.
- Sclerotization is due to interaction of α -quinones with cuticle proteins. It has been shown by means of C^{14} -labelled amino acids that N-acetyldopamine is the immediate precursor of the sclerotizing quinones in Calliphora erythrocephala. The intermediate steps in the biosynthesis of N-acetyldopamine are hydroxylation of tyrosine to dopa, decarboxylation of dopa to dopamine and N-acetylation of dopamine to N-acetyldopamine. This metabolic pathway of tyrosine is followed only in the final-instar larvae; early 3rd-instar larvae catabolize tyrosine by transamination to p-hydroxyphenylpyruvic acid and reduction to p-hydroxyphenyllactic and -propionic acid. The metabolic shift from transamination to hydroxylation and decarboxylation is brought about by the hormone of the prothoracic gland, ecdysone, and can be inhibited by ligation or destruction of the ring gland. Injection of ecdysone into the ligated animals leads to activation of the dopadecarboxylase within 10-14 h. The first action of the hormone produces the puffing phenomenon in chromosomes. The working hypothesis is that the hormone interacting with the genetic material leads to stimulation of the synthesis of specific (messenger-) RNA which is transferred to the cytoplasm and produces enzyme proteins. (Essentially auth.)
- 281* Shigematsu, A. INCORPORATION OF C^{14} -AMINO ACIDS INTO PROTEIN AND LIPID FRACTIONS OF SILKWORMS. Seikagaku Zasshi 32 (1960) 519-24.
- Shortly after the injection of C^{14} -labelled amino acids into Bombyx mori, radioactivity was incorporated into protein fractions of silk gland, then fibroin became radioactive. At about the same time lipoproteins (I) of the silk gland became radioactive. The rate of incorporation of leucine, phenylalanine, and tryptophan into I was ~20% of that incorporated into protein, and there was a proportional relation between the incorporation of amino acids into these 2 fractions. Amino acids were incorporated into the fat body of silkworms, and also into the lipid-soluble fraction of this organ, but the pattern was markedly different from that into the silk gland. Incorporation of glycine- C^{14} into the fat body was low, whereas that of leucine was high. (CA 60: 1964, 4507h)
- 282 Shigematsu, H., Koyasako, T. KINETICS OF SYNTHESIS OF FIBROIN IN THE POSTERIOR DIVISION OF THE SILKGAND OF THE SILKWORM, Bombyx mori. Nature, Lond. 195 (1962) 501-2.
- The synthesis of fibroin and secretion in the posterior division of the silk gland can be divided into 3 phases: the absorption of amino acids, the synthesis of fibroin, and its secretion. An attempt was made to show that the complex reaction is effected by an enzyme system by studying the incorporation of C^{14} -labelled glycine into fibroin *in vitro*. The co-existence of amino acids other than glycine showed alanine to have no marked effect on the incorporation of C^{14} -labelled glycine into fibroin, serine to retard the reaction and tyrosine to accelerate it. (CA 57: 1962, 10369i)
- 283 Shigematsu, H. SILKWORM DEVELOPMENT AND SILK PRODUCTION unpublished (cited on p.296 in Annu. Rev. Ent. 8 (1963)). --- "Found that 59% of given C^{14} -glycine enters fibroin in 8 h, 32% of which passes through fatty tissues and the alimentary canal".
- 284* Shimura, K., Fukai, H., Saito, J., Saeki, R. NONUNIFORM LABELING OF THE SILK FIBROIN SYNTHESIZED IN VIVO. J. Biochem., Tokyo 43 (1956) 101-2.