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MOSQUITOES OF MIDDLE AMERICA

8th ANNUAL PROGRESS REPORT

For the period 1 Oct 1970 – 31 Dec 1971

by

John N. Belkin, Ph.D.

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13. ABSTRACT

During the 15 months covered by this report, 1 Oct 1970 to 31 Dec 1971, extensive field work by members of the staff and cooperators was carried out in the Dominican Republic and Costa Rica and brief surveys were made in Mexico, Nicaragua, Guadeloupe, Martinique and Belem, Brazil. Much of this material was reared in the Los Angeles laboratory. Nearly 1,600 collections were processed, with the preparation of about 8,900 slides of individual rearings, 830 slides of male genitalia, 580 slides of whole larvae, and more than 19,000 mounts of adults. Material from about 1,350 collections, consisting primarily of individually reared specimens, was identified and classified for current and projected taxonomic revisions. Sixty-nine plates of final illustrations were prepared and 221 preliminary drawings were made. A revision of the container-breeding *Aedes* was finished and the manuscript nearly completed. A manuscript on the *Aedes varipalpus* group was in the process of revision. Preliminary studies on *Haemagogus, Trichoprosopon, Anopheles (Kerteszia), Culex (Carrollia)* and the subgenera of *Culex* with short-palped males were begun. Six papers were published during the period, 3 of them of major scope: Revision of the genus *Deinocerites*; Topotypic species from Brazil; Biology of *Culex tarsalis*.

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ABSTRACT

The project "Mosquitoes of Middle America", a cooperative enterprise of the University of California, Los Angeles, the U.S. Army Medical Research and Development Command and the National Institutes of Health, is concerned with detailed studies on the systematics, bionomics, distribution and vector potential of the mosquitoes of Central America, West Indies and adjacent portions of North America and South America. Its principal objective is to provide basic biological data needed for the rational control of mosquito-borne disease in these areas.

During the 15 months covered by this report, 1 Oct 1970 to 31 Dec 1971, extensive field work by members of the staff and cooperators was carried out in the Dominican Republic and Costa Rica and brief surveys were made in Mexico, Nicaragua, Guadeloupe, Martinique and Belem, Brazil. Much of this material was reared in the Los Angeles laboratory. Nearly 1,600 collections were processed, with the preparation of about 8,900 slides of individual rearings, 830 slides of male genitalia, 580 slides of whole larvae, and more than 19,000 mounts of adults. Material from about 1,350 collections, consisting primarily of individually reared specimens, was identified and classified for current and projected taxonomic revisions. Sixty-nine plates of final illustrations were prepared and 221 preliminary drawings were made. A revision of the container-breeding *Aedes* was finished and the manuscript nearly completed. A manuscript on the *Aedes varipalpus* group was in the process of revision. Preliminary studies on *Haemagogus*, *Trichoprosopon*, *Anopheles (Kerteszia)*, *Culex (Carrollia)* and the subgenera of *Culex* with short-palped males were begun. Six papers were published during the period, 3 of them of major scope: Revision of the genus *Deinocerites*; Topotypic species from Brazil; Biology of *Culex tarsalis*.

INTRODUCTION

TECHNICAL OBJECTIVE

The overall objective of the project is to obtain detailed data on the systematics, bionomics, distribution and vector potential of the bloodsucking mosquitoes in Middle America, the subtropical and tropical area extending from the southern United States to the edge of the Amazon basin. The ultimate goal is to produce a monograph of several volumes containing the basic biological information needed for the rational control of mosquito-borne diseases in the area, including the United States.

The specific aims of the project and its general methodology are:

(1) To undertake and publish comparative studies of various natural groups of mosquitoes as sufficient topotypic material becomes available. Every species treated will be described and illustrated in every available stage in as great detail as the material will allow. Data on bionomics and distribution will be summarized from standard collecting forms and from the literature, and from these data the disease vector potential of every species will be evaluated. Keys will be provided for adults, male genitalia, larvae and pupae. Emphasis will be given to the study of species groups of importance as disease vectors.

(2) To undertake and publish interim regional faunal studies for critical portions of the area.

(3) To carry out additional field collections, observations and rearings (individual, progeny, mass) to obtain topotypic material in areas not adequately surveyed in the past and for groups requiring additional information. Special emphasis will be given to progeny rearings and to rearings from field-collected eggs for species seldom encountered in the larval stage.

GOALS SET FOR THE CURRENT PERIOD

A radical reorganization of our plans had to be made for the current period owing to the reduction in the level of support from NIH which eliminated a professional staff position and secretary. Accordingly, the specific goals set for the current period were limited to the following:

Taxonomic Studies

(1) Completion of the study on the mosquitoes originally described from Brazil.
(2) Completion of the study on the container-breeding *Aedes* of the New World.
(3) Continuation of the study on *Culex (Carrollia).*
(4) Continuation of the revision of the subgenera of *Culex* with short-palped males.

Identification and Classification

(5) Identification and classification of material previously collected in Puerto Rico, Virgin Islands, the Lesser Antilles and elsewhere.

Illustration

(6) Preparation of final drawings of container-breeding *Aedes.*
(7) Preparation of preliminary drawings of *Anopheles (Kerteszia), Culex (Carrollia)* and *Trichoprosopon.*

Collection and Rearing

(8) Collection and rearing of topotypic and other species in Florida.

(9) Initiation of a cooperative topotypic survey in Costa Rica.

Processing

(10) Processing of material obtained in the field.

Documentation

(11) Preparation of manuscripts for publication.
(12) Completion of taxonomic, reprint and map files.

PERSONNEL

STAFF

The following staff at the laboratory in the Department of Zoology, University of California, Los Angeles, includes full-time and part-time personnel supported by both the contract with the U.S. Army Medical R & D Command and the grant from NIH during this period:

John N. Belkin, Principal Investigator (50% time)
Thomas J. Zavortink, Asst. Res. Zool. II (100%)
William A. Powder, Staff Res. Assoc. III (100%)
Sandra J. Heinemann, Staff Res. Assoc. I (100%)
L. Margaret Kowalczyk, Scientific Illustrator (100%)
Nobuko Kitamura, Scientific Illustrator (100%)
Nancy E. Tometich, Typist-Clerk (100%; to 14 Jan 1971)
Claire M. Price, Typist-Clerk (100%; 1 Feb to 20 May 1971)
Caryle L. Stallard, Edit. Asst. II (100%; from 7 June 1971)
Michael J. Nelson, Res. Asst. (50%; to 31 Dec 1970)
Eugene F. Drake, Res. Asst. (100%; July through Sept 1971)
Thomas E. Rogers, Res. Asst. (100%; July through Sept 1971)
Michael I. Faran, David K.H. Kwan, Donald G. Manley, Wan Hin Ooi and Richard R. Walker, Lab. Assts. (all 50%; Oct through Dec 1971)

COOPERATORS

The project continued to benefit greatly from the cooperation of numerous individuals to whom we are greatly indebted for their contributions.

J. Hal Arnell, who received his Ph.D. in Biology from the University of Utah in Aug 1971, with J.N. Belkin as external member of advisory committee, was appointed to a Postdoctoral Traineeship (NIH) on 1 Sept 1971 to work under the supervision of J.N. Belkin. He undertook the revision of his dissertation and began studies on the genus *Haemagogus*, both of which will be published by the project.

Michael J. Nelson obtained his Ph.D. in Zoology in March 1971 under the supervision of J.N. Belkin and prepared his dissertation on the biology of *Culex tarsalis* for publication by the project.

Jose D. Valencia, graduate student under the supervision of J.N. Belkin, continued studies on the subgenus *Carrollia* of *Culex* for his dissertation which will be published by the project.

Eugene F. Drake, graduate student under the supervision of J.N. Belkin since April 1971, began studies on the group *Arribalzagia* of *Anopheles* for his dissertation which will be published by the project.

Thomas F. Rogers, graduate student, transferred to the University of Delaware in Oct. where he will complete a review of the genus *Limatus* for his M.S. degree, with J.N. Belkin as a member of his advisory committee, to be published by the project.

Abdiel J. Adames, who received his Ph.D. in Aug 1970 under the supervision of J.N. Belkin, and Pedro Galindo, both of the Gorgas Memorial Laboratory, continued studies on the subgenus *Melanoconion* of *Culex* which will be illustrated and published by the project.

Samuel G. Breeland, Central America Malaria Research Station, El Salvador, agreed to undertake a cooperative study on the anophelines of Central America.

Lewis T. Nielsen, Department of Biology, University of Utah, continued cooperative collections in the southwestern U.S.A. and Mexico.

J.M. Alvarez V., G. Batista del Villar and C. Lopez Dominguez of the Departamento de Investigaciones Cientificas, Universidad Autonoma de Santo Domingo provided facilities, transportation and an assistant (J. Gomez) for a topotypic survey of the Dominican Republic.

M. Vargas of the Faculdad de Microbiologia, Universidad de Costa Rica, provided facilities and an assistant (A. Berrios), V.M. Villarejos and F. Granados of the ICMRT-LSU transportation, and J.R. Campabadal, OTS, facilities and transportation for a topotypic survey of Costa Rica.

L. Bahnson and D.W. Heinemann cooperated in the topotypic survey of Costa Rica from 9 July to 31 Aug 1971.

D.A. Schroeder cooperated in topotypic surveys in Costa Rica and Nicaragua from 1 July to 31 Dec 1971.

T.H.G. Aitken of the Rockefeller Foundation cooperated in a topotypic survey in Belem, Brazil, in Oct and Nov 1970.

C.J. Marinkelle, Universidad de Los Andes, Bogota, continued collections for the project in Colombia.

H. Floch, Institut Pasteur, Guadeloupe, provided transportation for a brief survey which was continued for the project by G. Cornely.

M. Gout, Institut Pasteur, Martinique, provided transportation and an assistant (F. Pamphile), and J.M. Fize, Bureau Municipal d'Hygiene, invaluable advice, in a brief topotypic survey of the island which is expected to be continued as a cooperative project in the future.

C.G. Moore, University of Puerto Rico, Mayaguez, continued the cooperative survey of the island.

TRAVEL

Members of the staff undertook the following travel in connection with field work during this period:

J.N. Belkin, 19 June to 4 Aug 1971, to organize and conduct topotypic and general cooperative surveys in the Dominican Republic, Guadeloupe, Martinique, Panama, Costa Rica, El Salvador, Guatemala and Mexico.

J.N. Belkin, 30 Oct to 7 Nov 1971, to El Salvador to attend the Inter-American Malaria Research Symposium, at the invitation of the organizing committee, and to collect topotypic species.

T.J. Zavortink, 3-13 June 1971, to collect in western Mexico with cooperator L.T. Nielsen.

S.J. Heinemann, 9 July to 31 Aug 1971, to conduct a topotypic survey in Costa Rica.

E.F. Drake, 15 June to 11 Aug 1971, and T.E. Rogers, 19 June to 14 Sept 1971, to collect in the Dominican Republic.

FACILITIES

The inadequate forced-air circulation system in the laboratories and offices in Los Angeles make it extremely difficult to work during periods of hot as well as cold weather. No funds are available in the Department to improve the system and air-condition the quarters. It is estimated that $6,000 are needed to alleviate this situation.

ACCOMPLISHMENTS

Nearly all the goals set for the period were met:

Taxonomic Studies

(1) J.N. Belkin finished the study on the mosquitoes originally described from Brazil (404 sp.). Lectotypes for 30 species and restricted type localities for 42 species were designated in the resultant publication with co-authors, R.X. Schick and S.J. Heinemann, who participated in the preliminary drafts of the manuscript. This work provides the background necessary to obtain, with the aid of cooperators, topotypic associated reared material of Brazilian species that is necessary for interpreting the taxonomic status of numerous Middle American species of medical importance. Except for a few corrections and additions, data on the types of all the species described from the New World have now been published.

(2) T.J. Zavortink completed the taxonomic work on a revision of the species of *Aedes* of the New World breeding in containers, other than members of the subgenus *Howardina* and the *terrens* group which were previously revised. The manuscript is nearly completed and will be ready for publication in the first quarter of 1972. This study is very likely to provide a framework and model for a complete revision of the *Ochlerotatus-Finlaya* complex of subgenera of *Aedes*. Whereas the majority of the previously described species treated in this study was placed primarily in the subgenera *Finlaya* and *Ochlerotatus*, the 27 forms now recognized (including 6 new species and 4 poorly known unnamed forms) are assigned to 6 distinct subgenera of *Aedes* (*Protomacleaya, Gymnometopa, Kompia, Abraedes, Ochlerotatus* and a new subgenus) and the subgenus *Conopostegus* of *Haemagogus*. Included among these are several proven or suspected medically important species such as members of the *triseriatus* group, *fluviatilis* group, *leucocelaenus* group and possibly *atropalpus* group. With the completion of this work there remain to be studied in the genus *Aedes* only the numerous ground-pool breeders of the subgenus *Ochlerotatus* (in the broad sense), *Aedes (Aedimorphus) vexans* and *Aedes (A.) cinereus*. Preliminary studies were also started on *Trichoprosopon, Anopheles (Kerteszia)* and *Toxorhynchites*.

(3) Graduate student J. Valencia completed the preliminary taxonomic work on 15 species of the subgenus *Carrollia* of *Culex*. Unfortunately no material of 2 Brazilian species has been available for this study and 3 other South American species are poorly represented. It is expected that this study will be finished by the end of the second quarter of 1972.

(4) Little progress was made by J.N. Belkin on the completion of the revision of the subgenera of *Culex* with short-palped males. The problem is much more complex than anticipated and requires the reclassification of the entire group of subgenera of the *Melanoconion* complex. It may be possible to complete the study by the end of 1972.

Identification and Classification

(5) S.J. Heinemann identified and classified material from about 1,350 collections, consisting primarily of individually reared specimens from Puerto Rico, Virgin Islands, the Lesser Antilles,

Dominican Republic and Costa Rica. This involved the preparation of some 450 additional genitalia slides for current and projected taxonomic revisions. Nearly 1,500 specimens were identified for C.J. Marinkelle.

Illustration

(6) L.M. Kowalczyk prepared 59 plates of final illustrations for the taxonomic revision of the container-breeding *Aedes*, including the larvae, pupae and male genitalia of 25 species and the complete morphology of adults of 7 species representing distinct species groups. N. Kitamura and L.M. Kowalczyk prepared 10 plates of final illustrations for the revision of the *varipalpus* group of *Aedes*.

(7) N. Kitamura and L.M. Kowalczyk prepared the following preliminary drawings: 8 drawings of larvae and pupae of *Anopheles (Kerteszia)*; 50 drawings of larvae, pupae, male and female genitalia, and buccopharyngeal armature of *Culex (Carrollia)*; 60 drawings of larvae, pupae and male genitalia of *Trichoprosopon*; 100 drawings of larvae, pupae and male genitalia of species from Puerto Rico, Virgin Islands and Lesser Antilles; and 3 drawings of larvae and pupae for cooperators A.J. Adames and P. Galindo.

Collection and Rearing

(8) Plans for field work in Florida were abandoned owing to the drought and fires. A topotypic survey was carried out instead by J.N. Belkin, E.F. Drake, T.E. Rogers and cooperators in the Dominican Republic where 274 collections were made and all but 2 of the 19 topotypic species and a total of 46 species were obtained. Many of these collections were reared in the Los Angeles laboratory. This material is critical for the study of the mosquitoes of the West Indies as no significant collections have been made on the island of Hispaniola since the first survey in 1905. A more intensive survey of the Dominican Republic may be undertaken by cooperator J. Maldonado-Capriles in 1972.

(9) An intensive survey was conducted in Costa Rica by J.N. Belkin, S.J. Heinemann and 4 cooperators. Approximately 135 species, including 30 of the 37 topotypic nominal species, were obtained in 325 collections. A brief survey of the Bluefields area of Nicaragua was also made from the base in Costa Rica by cooperator D.A. Schroeder with a total of 56 collections. Many of the collections from both Costa Rica and Nicaragua were reared by the staff in the Los Angeles laboratory. This material is critical for the determination of the taxonomic status of a number of nominal species from Central America currently synonymized with widespread species which appear to be actually composed of complexes of closely related forms.

(9a) A few additional collections of topotypic species or material needed for current studies were made by J.N. Belkin in Guadeloupe (2), Martinique (10) and El Salvador.

Processing

(10) W.A. Powder, with the assistance of part-time personnel and S.J. Heinemann, processed nearly 1,600 collections. This involved the preparation of about 8,900 slides of individual rearings, 830 slides of male genitalia, 580 slides of whole larvae, and more than 19,000 mounts of adults. Several thousand slides and adult mounts were provided with permanent labels. A great deal of time was also spent by W.A. Powder in assembling and preparing supplies and equipment for field work.

Documentation

(11) C.M. Price prepared the final copy for lithoprinting of the paper on "Mosquitoes originally described from Brazil." C.L. Stallard edited and prepared the final copy for the paper on

the "Winter biology of *Culex tarsalis* in Imperial Valley, California", typed the rough draft of part of the manuscript on the container-breeding *Aedes*, and finished a rough manuscript draft on data for the collections from the Lesser Antilles, which was started by N.E. Tometich.

(12) C.L. Stallard reorganized and completed the taxonomic file which contains the original descriptions and type data for all the species described from the Americas. The map file was brought up to date and work was begun also in completing the reprint file of all primary taxonomic works on the mosquitoes of the Americas.

PUBLICATIONS

The following papers appeared during the period:

Adames, A.J. 1971. Mosquito Studies (Diptera, Culicidae). XXIV. A revision of the crabhole mosquitoes of the genus *Deinocerites*. Am. Entomol. Inst., Contrib. 7(2). 154 p.

Belkin, J.N. 1971. Type locality restriction for *Wyeomyia schnusei*. Mosq. Syst. Newsl. 3:26.

Belkin, J.N. 1971. Mosquito types in East Germany. Mosq. Syst. Newsl. 3:31.

Belkin, J.N. and S.J. Heinemann. 1971. *Aedes vexans* in Guatemala. Mosq. Syst. Newsl. 3:27.

Belkin, J.N., R.X. Schick and S.J. Heinemann. 1971. Mosquito Studies (Diptera, Culicidae). XXV. Mosquitoes originally described from Brazil. Am. Entomol. Inst., Contrib. 7(5). 64 p.

Nelson, M.J. 1971. Mosquito Studies (Diptera, Culicidae). XXVI. Winter biology of *Culex tarsalis* in Imperial Valley, California. Am. Entomol. Inst., Contrib. 7(6). 56 p.

SIGNIFICANCE

The relevance of our studies to health problems is illustrated in the recent epidemic of Venezuelan equine encephalomyelitis (VEE). The crabhole mosquitoes of the genus *Deinocerites* were strictly of academic biological interest when J.N. Belkin and C.L. Hogue reviewed the genus in 1959. Shortly after the beginning of the project, in late Nov 1963, J.N. Belkin pointed out to P. Galindo of the Gorgas Memorial Laboratory that members of this genus might be good candidate vectors of encephalitides because of the maintenance of relatively constant populations throughout the year, probable feeding on birds and other vertebrates around their mangrove breeding sites and the records of the feeding of some species on horses and occasionally on man. After the first recovery of an arbovirus (St. Louis encephalitis) from *D. pseudes* in 1967 from a pool collected in Panama in 1964, A.J. Adames undertook a thorough revision of the genus at the suggestion of P. Galindo. Subsequently, VEE was recovered from pools in Central America and the laboratory transmission of this virus by the same species was demonstrated. The data on the distribution of *pseudes* (Ecuador to Texas) presented in the recently published revision of the genus by A.J. Adames are highly suggestive that this species played a significant, if not the principal, role in the spread of the epidemic of VEE from Ecuador through Colombia, Panama, Central America and Mexico to Texas, and that it may be the primary endemic reservoir vector of VEE on the Pacific coast of the New World tropics.

DISCUSSION AND RECOMMENDATIONS

Owing to the reduction in the professional staff, less emphasis could be placed during the period on taxonomic studies than originally planned. However, taxonomic studies were completed for about 32 additional species, bringing the total studied to date to about 200, 176 in considerable detail and 34 synoptically. This total is probably about 15-20% of the overall number of species of the subfamily Culicinae that will be necessary to study to complete the project. Although, with the restoration of the professional position it is anticipated that more taxonomic studies can be accomplished in the future, it is probable that the project cannot be completed in less than 10 additional years.

The completion of the series of papers dealing with the data on the types of all the nominal species described from the Americas (except for corrections and a few additions) and the completion of the taxonomic, reprint and map files should expedite taxonomic revisions considerably in the future for the staff as well as cooperators. Having completed this arduous task, the principal investigator may be able to devote more time to taxonomic studies if administrative duties permit it.

Field work continues to be an important phase of the project as individually reared associated material of about 50% of the 752 nominal species previously described from the area (excluding the U.S.A.) is still lacking, primarily from Panama, Guatemala, Mexico, Colombia, Venezuela, the Guianas, Cuba and the Bahamas. In addition such material is almost nonexistent for nearly 900 nominal species described from South America and the United States. Many of these species are necessary for determining the taxonomic status of Middle American species. Field work during this period was particularly successful in obtaining a large percentage of topotypic species in the Dominican Republic, Costa Rica and Martinique. Additional field work is absolutely essential to obtain critical material for taxonomic revisions and will have to be continued at about the same level as in the past for at least 6 years.

Although considerable inroad was made the last quarter of 1971 in processing and labelling accumulated material, thanks to additional funds, much work remains to be done to make the research collection more accessible for taxonomic studies. Preliminary identifications and classification into groups are still needed for many collections but cannot be made until the material of all stages is processed and male genitalia slides are prepared. Considerable time will have to be devoted to this phase of the project in 1972 to expedite taxonomic studies.