ECTOPARASITES OF PANAMA

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RUPERT L. WENZEL
VERNON J. TIPTON
Editors

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ERRATA

ECTOPARASITES OF PANAMA

p. x, line 28	for "authorized" read: "authored"
p. 200, line 28	for "singe" read: "single"
p. 420, line 7	for "posterior" read: "proximal (anterior)"
" " 10	" "anterior" " "distal (posterior)"
" " 14	" " " " "
" " 30–31	" "posterior" " "proximal (anterior)"
p. 436, line 12	for "116" read: "96"
" " 13	" "43" " "22"
p. 518, line 8	for "Almirante" read: "Changuinola"
p. 528, " 9 of text	" "setae in *dunni*" read: "setae. *In dunni*"
p. 570, line 7	for "Playo" read: "Playa"
p. 575, line 16	" " " "
p. 598, line 8	for "1" read: "6"
p. 602, line 19	add: "Paratypes deposited in the collections listed on p. 410."
p. 609, line 5	for "Guanote" read: "Guanota"
" " 39	add: "Paratypes deposited in the collections of Field Museum of Natural History, the United States National Museum, Universidad Central de Venezuela, and the Environmental Health Branch, USAFSC, at Corozal (Canal Zone)."
p. 620, last line	delete: "11 (1 bat) Juan Mina (Canal Zone), 28 July 1960"
p. 622, line 30	add: "Paratypes deposited in the collections listed on p. 410."
p. 622, last line	delete: " . From *Artibeus lituratus*"
p. 623, line 1	for "2 August" read: "30 August"
p. 698, lines 13, 14	for "50" and "±300" read: "40" and "±200"
p. 709, lines 24, 25	for "III" and "IV", read: "IV and "III"
p. 716, line 40	for "50" and "±300" read: "40" and "±200"
p. 734, line 39	" " " " " " " "
p. 797, line 21	for "Coleopterg" read: "Coleoptera"

Foreword

The well-known difficulties presented by malaria and yellow fever during the construction of the Panama Canal served to focus the interest of medical entomologists upon this area of the world. The continuing presence of these and other arthropod-borne diseases has maintained this interest at a high level in the years following the completion of the canal. Much of the work in this interim period has been concerned with those aspects of tropical diseases that are directly associated with the attempts of humans to establish and maintain a healthy environment in the tropics for themselves and their domestic animals. As more information is obtained concerning the natural ecology of arthropod-borne human and animal diseases in tropical areas, however, the need for a more complete understanding of host-parasite relationships becomes more apparent and the potential importance of both vertebrates and invertebrates as vectors or reservoirs of disease is appreciated more fully. The geographical location of the Panamanian Isthmus has made it a region of interchange between the fauna of North and South America as well as being a part of the area in which the autochthenous fauna of Middle America has developed. The climate, geological history, and varied physiography of Panama have combined to produce varied environments having a rather rich ectoparasite fauna in which unique and complex host-parasite relationships have developed. It is with these that the investigations reported here are concerned.

This volume presents the results of rather extensive studies concerning ectoparasites of the vertebrate fauna of Panama, and to a lesser degree, their hosts. While the results of these studies have indicated the variety of ectoparasites to be found in this rather limited geographical area and something of the complexities of the host-parasite relationships that occur there, it is recognized that the information available for some of the groups is meager and incomplete. There still are remote areas of Panama in which the ectoparasite fauna remains virtually unstudied and it is quite certain that future work will result in additions being made to the species now known to be present. It is the authors' hope that this publication will be useful to those concerned with tropical environments and will stimulate other investigators to continue to work toward a more complete understanding of the many problems still remaining in these areas.

Harold D. Newson

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Preface

This volume deals with major groups of ectoparasites of vertebrates, primarily those of mammals, in Panama. The Mallophaga of birds, the Analgesidae, and the smaller families of mites—such as the Myobiidae, Sarcoptidae, and Listrophoridae are not included. The Spelaeorhynchidae (bat mites) and Polyctenidae (bat bugs), although not treated in separate papers, have been identified to genus and included under their hosts in the comprehensive host parasite list near the end of the volume. Records that have been published for these in the past have also been included in the list.

The contributors are aware that many described and undescribed species in the groups treated are yet to be collected in Panama and that many taxonomic problems are yet to be solved. This work should not be considered as a definitive treatise on the groups discussed, but rather as a starting point for the study of the complex taxonomic, biological, and epidemiological problems that are encountered in this important area of the world.

In editing the book, a number of unique problems arose, chiefly because of the diverse subject material and differing taxonomic formats used by the various contributors, the use made of a complete volume as contrasted with that of reprints, and because some of the papers had been prepared before the decision was made to incorporate them in one volume. Thus, consistency of treatment was not always possible.

Acknowledgments

The preparation of this volume has required the active participation and cooperation of so many agencies and individuals that it would be difficult to list them all here or to acknowledge and assess their individual contributions. The role played by many of them is acknowledged by Dr. Fairchild and others in the Introduction and elsewhere.

The field investigations and study of the material collected were effected through the close collaboration of personnel of various federal agencies in Panama, notably the Gorgas Memorial Laboratory, the Middle America Research Unit (National Institutes of Health), the United States Army, and the Smithsonian Institution. The Army Transportation Corps provided much of the transportation for collecting trips, some of them to remote and virtually inaccessible areas. Some of the collaborating specialists not associated with the above agencies also participated in field investigations. Special acknowledgment is due Mr. Charles M. Keenan of the Environmental Health Branch, United States Army Caribbean, and Dr. Charles O. Handley, of the Smithsonian Institution, whose knowledge, field experience, and energies contributed greatly to the success of the field program; and Mr. Pedro Galindo of the Gorgas Memorial Laboratory whose assistance in expediting the field surveys was invaluable. The collaboration of Dr. Handley, who has concurrently been preparing a monograph on the mammals of Panama, was indispensable to many phases of the project.

The encouragement and support of Colonel Robert Traub, Medical Service Corps (Retired)—formerly Chief, Entomology Research Section, United States Army Medical Research and Development Command, Office of the Surgeon General, Department of the Army—and of his successor, Lieutenant Colonel Harold D. Newson, Medical Service Corps, played a major role in the realization of the volume.

Much of the field work of Lt. Col. Vernon J. Tipton, Charles M. Keenan, and Charles O. Handley was made possible through a research grant to Lt. Col. Tipton by the United States Army Medical Research and Development Command. Publication costs were assisted by similar grants to the Chicago Natural History Museum, with Rupert L. Wenzel as Principal Investigator and Lt. Col. Tipton as Principal Professional Assistant.

The editorial work, too, required the active cooperation of many individuals. Grateful acknowledgment is given the following:

Dr. Graham B. Fairchild, who reviewed most of the manuscripts before submitting them to be prepared for publication; various of the staff of the Division of Insects, Chicago Natural History Museum, including Miss Ella Fojtik, former secretary, who retyped major parts of the manuscripts submitted for publication; Mary Ryan Wenzel, who typed the index and all of the manuscripts authorized jointly by the editors; and Alicja Kiewlicz Myszkowski, technician, who carefully and painstakingly did a large part of the indexing; and especially Christina Johnson Fowler who was responsible for much of the editing, proofreading, and make-up, and for the typographic design of the book. She also assisted in other phases of the work, including the compilation of the comprehensive host-parasite list, a complex and difficult task.

RUPERT L. WENZEL
VERNON J. TIPTON

Editors

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Introduction

GRAHAM B. FAIRCHILD[1]

Study of the ectoparasites of vertebrates has been greatly intensified since World War II, chiefly because of an increased interest in zoonoses, diseases of animals communicable to man. Particular emphasis has been placed on the underdeveloped areas of the world, including large parts of tropical America, whose ectoparasite fauna is still poorly known. The experience of medical entomologists has shown that taxonomic and ecological studies of animal reservoirs and vectors are essential to investigating the epidemiology of arthropod-borne diseases and must precede any organized effort to control them. The importance of ectoparasites in the epidemiology of such diseases is aptly illustrated by the role of fleas in the transmission of plague, of trombiculid mites in scrub typhus, of ticks in Rocky Mountain spotted fever.

The attention of medical entomologists was first focused on Panama by the classical work with yellow fever and malaria during the building of the Canal. Through the control of these and other diseases, a safe and sanitary environment was rapidly established in the Canal Zone, and shortly thereafter in Panama. This enabled trained personnel to reside in the area for long periods of time and to conduct extended field and laboratory investigations of other arthropod-borne diseases and of the natural history and resources of Panama.

The providing of adequate facilities and of an atmosphere congenial to research at the Board of Health Laboratory at Ancón, under the leadership of research-minded Samuel Taylor Darling, directed the interest of several persons toward medical entomology. Notable among them was Lawrence H. Dunn, who produced the first work of any consequence on the ectoparasites of Panama (1916, et seq.).

The initiation of biological surveys of the Canal Zone under the auspices of the Smithsonian Institution further stimulated interest in the

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[1] Gorgas Memorial Laboratory, Panamá, Panamá.

area and led to the publication of Goldman's *Mammals of Panama* in 1910 and Standley's *Flora of the Panama Canal Zone* in 1928. In this period, too, the volumes by Meek and Hildebrand on the fishes of Panama, both fresh water and marine, were published by the Field Museum (now the Chicago Natural History Museum). In 1924, the opening of the field laboratory on Barro Colorado Island provided much-needed facilities for work in the area. Many of the scientists who worked on the island collected ectoparasites.

In 1929, the Gorgas Memorial Laboratory was established as a research institute for tropical medicine. From its beginning, it was a center for studies in medical entomology; staff members published papers on ectoparasites and furnished material for specialists elsewhere. In 1943, Fairchild listed most of the then-known ectoparasites of Panama (excluding the Mallophaga and the pupiparous Diptera), a total of 63 species and subspecies belonging to 21 genera. He also gave a partial bibliography of relevant publications.

In 1956, a systematic survey of the ectoparasite fauna of Panama was initiated by Major (now Lt. Colonel) Robert M. Altman. By 1959 a considerable backlog of information and unworked material relating to Panamanian ectoparasites had accumulated, both in Panama and in various collections elsewhere. The fortuitous circumstances which brought together Drs. Conrad E. Yunker and James M. Brennan at the Middle America Research Unit, Major Vernon J. Tipton with the Army Environmental Health Branch, and Dr. Phyllis T. Johnson, Mr. Eustorgio Méndez, and Dr. Graham B. Fairchild at the Gorgas Memorial Laboratory, all interested in ectoparasites, proved mutually stimulating. These workers continued the project begun by Major Altman.

Field work by Dr. Alexander Wetmore on the birds of Panama and by Dr. Charles O. Handley on the mammals, together with field investigations of arthropod-borne virus diseases that were being carried out by Mr. Pedro Galindo of the Gorgas Memorial Laboratory, offered unrivaled opportunities to make extensive collections in remote areas that would have otherwise been difficult to reach. Thus, the ectoparasites of Panama have been more thoroughly collected than those of any other area of comparable size in tropical America.

In the course of this survey, over 360 species of blood-sucking ectoparasites, representing more than 120 genera were collected. Of these, 15 genera and more than 115 species were new. As a consequence it became necessary to enlist the aid of other specialists to study and report on the material collected.

Because of the difficulties encountered in identifying the numerous species in diverse groups and the widely scattered literature on the subject, Major Vernon J. Tipton and Dr. Rupert L. Wenzel suggested the desirability of bringing together the papers resulting from these studies and, thus, to incorporate in one volume most of what is known about the ectoparasites of a single area. It seemed particularly appropriate that this should be done for Panama because of its significance in the history of medical entomology. The enthusiastic cooperation of the participating specialists, the officials of the Chicago Natural History Museum, and the United States Army (Medical Research and Development Command, Office of the Surgeon General) made this possible.

The fauna of Panama is of special interest, because the isthmian region is the only dry-land bridge between North and South America. Knowledge of the present Panama fauna is of great importance in understanding the movements and distribution of the animals of both continents. Furthermore, the relatively small land area, with its great diversity of habitats and climatic zones, contains an unusually rich fauna of manageable size. It is believed, therefore, that the following papers, although primarily taxonomic in purpose, will prove of basic usefulness not only to those engaged in studies of zoonoses in this area, but also those with broader zoological interests.

The Republic of Panama occupies the isthmus between North and South America. It is a roughly S-shaped area with its long axis running approximately east and west. It lies between 7° 09′ and 9° 37′ North latitude, and 77° 09′ and 85° 01′ West longitude, hence wholly within the tropics and about 1200 miles directly south of Miami, Florida. It is bounded on the west by the Republic of Costa Rica, on the north by the Caribbean sea, on the east by the Republic of Colombia, and on the south by the Pacific Ocean. It has a maximum east-west extension of about 475 miles, and a north-south extension of about 225 miles, but because of its shape no straight east-west line passes wholly over land and no point within the country is much more than 30 miles from salt water. The exact area is not known; published figures vary from 28,000 to 33,000 square miles.

Physically the country is dominated by a backbone range of mountains, the continental divide, consisting largely of igneous rocks and including a number of now extinct volcanos. This range is highest in western Panama; elevations of over 11,000 feet are reached, the highest point being El Barú (Volcán Chiriquí), at 11,410 feet. Eastward, the divide drops to lower elevations; the low point of 316 feet is reached at the Canal Zone, whence the range continues at around 2500 feet to near the Colombian border, where elevations of over 5000 feet are reached. For the most part the continental divide is closer to the Caribbean coast than to the Pacific, with the result that most of the agriculturally developed land is on the Pacific side, as are all but one of the major rivers.

Geologically the underlying structure is complex, reflecting a history of repeated changes, although at the present time the land is comparatively stable, and no serious earthquakes have occurred in recent times. Sedimentary rocks of tertiary age alternate with igneous intrusions and flows of lava and beds of ash. There is much folding and faulting. The soils are in general rather acid clays of low fertility, although areas with comparatively good soils do exist, especially in Chiriquí Province and the lowlands of Darién and Bocas del Toro Provinces. There are no large bodies of fresh water except for the artificial Gatún and Madden Lakes in the Canal Zone. Except for the lower reaches of the Tuira in Darién Province, rivers are rapid and shallow and not navigable except by dugout canoe and similar craft. There are extensive freshwater and tidal coastal swamps on both coasts, especially at the mouths of the numerous rivers. On the Pacific coast, notably within the Gulf of Panamá, the tidal range is great, reaching 18 feet or more, while on the Caribbean coast it is barely two feet. Much of the coast line is rocky and precipitous or fringed with mangrove swamp and mud flats, though sand beaches occur in favorable localities on both coasts.

Originally most of the country was covered with forest, except for some drier areas along the Pacific coast which appear to have been grassland since prehistoric times. Man's agricultural activities in the past few centuries have changed much of this, especially on the more densely populated Pacific coastal plain, so that forest in this area is reduced to scrub on steep hillsides and narrow gallery forest along streams. The predominant and somewhat primitive agricultural practice consists of cutting and burning forest in the dry season to plant a crop in the ashes. A new patch of forest is destroyed each year, so that virgin forest in all accessible areas is rapidly disappearing. Repeated burnings prevent reforestation. This results in increasing areas of grassland, unsuitable for further agricultural use and with very depauperate fauna.

Panama has a hot, tropical climate which is somewhat tempered by the proximity of the sea. Temperatures at sea level in the Canal Zone area seldom go below 70°F. or above 90°F. though extremes of about 60° and 96° are sometimes encountered. Information is scanty for many areas, but in general extremes are slightly greater on the drier Pacific coast than on the Caribbean, and lower temperatures prevail at higher elevations. The diurnal temperature range is not great, seldom more than 10°F. Hot nights are rare. The year is divided into two climatic seasons, wet and dry, which are much more pronounced on the Pacific side than on the Atlantic. The wet or rainy season, known locally as *invierno*, or winter, generally extends from about the middle of April to the middle of December, although it varies greatly in duration and intensity locally and from year to year. During the rainy season, rain is to be expected on any day, most often in the afternoon and generally in the form of heavy local thunderstorms. Occasionally there are widespread rains of long duration, especially from October to December. Rainfall may be exceedingly heavy, up to 2.48 inches in 5 minutes and over 10 inches in a single 24-hour period.

Annual average rainfall varies from year to year and place to place, but it is generally heaviest along the Caribbean coast on the mountain slopes and least along the Pacific coast west of the Canal Zone. As much as 247 inches in a single year have been recorded from Porto Bello on the Caribbean and as little as 25 inches at Naos Island at the Pacific entrance of the Canal. Greater rainfall probably occurs in some mountain areas. Relative humidity is generally high, seldom below 60 percent during the day and almost always above 90 percent at night. During the dry season, the local *verano* or summer, there may be no rain, at least on the Pacific side, for as much as four months, and seldom is more than an inch a month recorded for the months from January through March. The Caribbean slope and mountains usually receive occasional showers, and in the wetter areas there is no real dry season.

Winds are seldom strong, and windspeeds of over 30 m.p.h. are exceptional. Panama is outside the hurricane belt. During the rainy season light and variable winds from the south are common or on occasion there may be strong winds of short duration, accompanying thunderstorms. During the dry season, the North East tradewinds may blow fairly steadily from January through March.

Politically the country is divided into nine provinces and the Intendencia of San Blas. Of these, Bocas del Toro, Colón, and San Blas lie wholly on the Caribbean coast; Veraguas fronts on both coasts, and the remaining provinces are wholly on the Pacific side of the continental divide. The Canal Zone is a strip about 10 miles wide from coast to coast dividing Colón and Panamá provinces.

Detailed delineation of life zones in Panama has hardly begun. Goldman in his *Mammals of Panama* (1920) discusses the problem and gives a provisional map. Standley in his *Flora of the Panama Canal Zone* (1928) devotes several pages to general descriptions of the plant associations in the Canal Zone. Holdridge and Budowski in a recent report (1955) discuss life zones in more detail, giving a map showing four life zones: *Tropical,* up to 600 meters altitude on the Atlantic coast, to 700 meters on the Pacific; *Subtropical,* from 600 or 700 to 1500 meters; *Lower Montane,* up to 2600 meters and *Montane,* over 2600 meters. These zones are further divided into dry, wet, and transition divisions. In general, the Tropical zone comprises 76 percent of the republic, the Subtropical about 18 percent, the Lower Montane and Montane together about 5 percent, the last occurring only on the highest mountains in Chiriquí Province. The classification is based largely on considerations of temperature, precipitation and forest associations. The mountainous nature of much of the country results in limited areas of high rainfall with associated rain shadows. This, coupled with edaphic and underlying geological features of circumscribed extent, cause abrupt changes in the vegetation cover over relatively short distances and render general statements subject to numerous exceptions. Thus, relatively low hills within a few miles of each other may have quite different vegetation and associated faunas. The same mountain may be clothed in grass and xerophytic scrub on its leeward side and dense fog forest on the windward side with practically no zone of transition.

For present purposes, and until much more detailed information is available, the country may be divided into three zones: below 1000 feet; from 1000 to 5000 feet; and over 5000 feet. These correspond very roughly to the Tropical, Subtropical and combined Submontane and Montane zones of Holdridge and Budowski. The collections reported in this group of papers have come very largely from elevations below 5000 feet, with some representation from areas in Chiriquí Province from above 10,000 ft. The accompanying map indicates these three zones.

A few collecting localities that are representative of these zones are described below.

Cerro Punta (Chiriquí) is a small village located on the slopes of Volcán Barú at an elevation of about 6000 feet. Extensive collections of mammals and ectoparasites were made in this vicinity (Bambito, Finca Lara, Casa

Tilley, Finca Martinz) at elevations of from 4800 feet to over 8000 feet. Rainfall is moderately heavy, and the dry season is distinct though not intense. The heavy forest is representative of the humid upper Tropical Zone, with oaks and bamboo occurring at the higher levels. The area is rapidly being cleared for coffee and vegetable crops.

Finca Lerida (Chiriquí) is a coffee farm between Boquete and Cerro Punta on the slopes of Volcán Barú at an elevation of between 5000 and 6000 feet. An area of virgin forest near the farm was preserved until 1955, but most of the adjacent area is now used for coffee and vegetable crops and for pasture. The former owner and his wife, Mr. and Mrs. T. B. Monniche, were interested in natural history, collected birds, and were hosts to many visiting naturalists, a number of whom collected ectoparasites.

Almirante (Bocas del Toro) is the headquarters town for large banana and cacao plantations operated by the Chiriqui Land Company. Extensive collections were made from August 1951 through May 1953 at a camp established about 12 miles southwest of the town for the study of sylvan yellow fever. From 1959 to 1962, collections were made at several other localities within a few miles of the town. All collecting localities are below 500 feet, and most are lower. They include virgin forest as well as swamp forest, second growth, and land under cacao and banana cultivation. Precipitation is high throughout the area. There is no pronounced dry season and no month regularly has less than three inches of rainfall. The town is situated on the Chiriquí Lagoon. Isla Bastimentos and Cayo Agua (Water Key) are islands in the Lagoon.

Río Changena, lower camp (Bocas del Toro) was a temporary camp on an eastern tributary of the Río Changuinola, about 20 miles inland, at an elevation of 2400 feet. The area is one of heavy tropical forest with continuous high rainfall throughout the year. Collections were made during September 1961, within a radius of two miles of the camp, and up to elevations of 3000 feet. Rain fell on more than half the days during this time. The ground was continuously wet, in degrees ranging from moist to saturated.

Río Changena, upper camp, or **Rancho Mojica** (Bocas del Toro), a small coffee farm, is located about 10 miles from the continental divide on the Atlantic side, at an elevation of 4800 feet. The collecting area is a tropical rain forest surrounding a four or five acre plot, once cleared but now supporting some secondary growth. A stream runs near the lower fringe of the clearing. Collections were made along the stream and along a trail on a high ridge ranging in elevation from 5000 to 5650 feet. The climate during the collecting period seemed drier than that at the lower camp.

Cerro Hoya (Los Santos) is a mountain area behind Las Palmitas. The higher elevations are heavily forested and appear to have abundant rainfall. Mammal and ectoparasite collections were made here from 11 January 1962 to 2 March 1962 at elevations between about 1000 and 3000 feet.

Las Palmitas (Los Santos) is a small settlement at the foot of Cerro Hoya, near the Pacific coast. The area is relatively dry, with an intense dry season. The land has been long under cultivation and little of the original vegetation remains.

Canal Zone. Numerous collections, all at low elevations, have been made on both sides of the isthmus in the Zone. Because of restrictions on agricultural use of land within the Zone, there are many areas of nearly undisturbed forest. On the Caribbean coast, in the Camp Piña and Mohinga Swamp areas, there are patches of virgin rain forest. Barro Colorado Island and Madden Forest provide successively drier habitats. In general, the rainfall pattern in this area is modified by the low elevation. The Caribbean coast is somewhat drier than adjacent areas and the Pacific coast has a less intense dry season than areas farther west. Considerable trapping was done in and about townsites and military installations, in small patches of second growth forest, scrub and grassland. Many collections have come from animals found dead on highways and from bats taken in abandoned buildings, road culverts, and old mine tunnels.

Cerro Pirre or upper **Rio Seteganti** (Darién) is the location of a temporary camp, used during January and February 1961. It was situated on the western edge of a sloping valley or plateau, between the Cerro Pirre range and Cerro Setetule, one mile south of the Río Setegantí and 26 air miles to the south of El Real. The elevation of this camp was about 1500 feet, in an area of tropical rain forest broken by occasional marshy meadows and fields of wild cane. Collections were made in the valley itself and along a long, narrow, gently sloping spur, perpendicular to the Cerro Pirre range, up to an elevation of 3500 feet. Except for occasional trails of rubber collectors leading toward the nearby Colombian border, there is no evidence of human habitation of this area since the nearby Cana mines were closed about 45 years ago.

Weather data for this area is fragmentary. Judging from the dearth of deciduous trees and the abundance of surface water noted during the dry season, this area is more like the modified rain forest of the Atlantic Coast than the tropical wet and dry or Savanna Forest of the Pacific slopes.

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Gazetteer of Collecting Localities in Panama

GRAHAM B. FAIRCHILD [1] and CHARLES O. HANDLEY, JR.[2]

The Panamanian collecting localities mentioned in this volume are indexed in this gazetteer. Section I is an index to province of all collecting localities. In Section II, the localities are arranged by province and have been identified as precisely as possible, usually to the nearest minute of latitude and longitude.[3] However, it should be realized that the exact collecting sites in many instances may be miles away from the center of the town, or summit of the mountain, or bank of the stream indexed. Names of mountains, rivers, ranches, forts, islands, etc., are to be found under the specific name. For example, Cerro Malí will be found under Malí, Cerro, and Río Chágres under Chágres, Río.

Elevations in feet above sea level have been given for all collecting sites above 1000 feet. In this instance the figures relate as nearly as possible to the elevation of actual collecting sites rather than to the elevation of the town or mountain indexed.

To facilitate rapid discovery of the general position of collecting localities, all localities have been related to 50 key localities which are identified by number in the gazetteer and on the accompanying map. This map and the gazetteer should be used in conjunction with more detailed maps, preferably the one used as a basis for determining the coordinates (see footnote) or the *Millionth Map of Hispanic America* (American Geographical Society, Publication No. 5). The *Road Map of Canal Zone and Vicinity*, prepared by the Engineer Service (Corozal, Canal Zone), United States Army Caribbean, is also very useful, though much less detailed.

The gazetteer was compiled after most other portions of the volume were in galley proof. Consequently it is possible that some of the errors in spelling or altitude that existed in the systematic reports may not have been corrected. If any are discovered, or if additional localities can be more precisely identified, information on them will be received with thanks by the compilers and the editors.

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[1] Gorgas Memorial Laboratory, Panamá, Panamá.

[2] Smithsonian Institution, Washington, D. C.

[3] The three part map of the Republic of Panama, scale 1:500,000, produced by USARCARIB, was used as a base for the determination of all coordinates.

Section I. Index of Localities to Province [4]

[4] Section I is an index to province of all collecting localities. In Section II, the localities are arranged by province.

Colón, Colón
Colón, Isla, Bocas del Toro
Colorado, Río, Chiriquí
Concepción (6), Chiriquí
Corozal, Canal Zone
Corte Culebra Road, Canal Zone
Cotito, Río, Chiriquí
Coto Region, Chiriquí
Cristóbal, Canal Zone
Culebra, Canal Zone
Curundu, Canal Zone
Cylindro, Bocas del Toro

Davalá, Chiriquí
David (7), Chiriquí
Davis, Fort, Canal Zone
Divalá, Chiriquí
Divisa, Herrera
Donoso, Colón

El Banco, Chiriquí
El Barú, Chiriquí
El Copé, Coclé
El Hato del Volcán, Chiriquí
El Limón, Colón
El Potrero, Coclé
El Real (43), Darién
El Valle (18), Coclé
El Vijía, Canal Zone
El Volcán, Chiriquí
Emperador, Canal Zone
Empire, Canal Zone
Escobal (30), Colón
Escudo de Veraguas, Isla (1), Bocas del Toro
Esnápe, Río (48), Darién

Farfan, Canal Zone
France Field, Canal Zone
Frijoles, Canal Zone
Frijolito, Río, Colón

Galeta Island, Canal Zone
Galeta Point, Canal Zone
Gamboa (28), Canal Zone
Gariché, Río, Chiriquí
Gatún, Canal Zone
Gobernadora, Isla, Veraguas
Goofy Lake, Panamá
Guánico, Los Santos
Guayabalito, Colón
Guayabito, Panamá
Guayabo, Darién
Gulick, Fort (33), Canal Zone

Howard Field, Canal Zone
Hoya, Cerro (12), Los Santos
Huile, Panamá

Indio, Río, Canal Zone
Insólita, Isla, Chiriquí

Jaqué (47), Darién
Jefe, Cerro, Panamá
Jesucito, Río, Darién
Juan Díaz, Panamá
Juan Mina, Canal Zone

Kobbe, Fort (22), Canal Zone
K-9 Road, Canal Zone
K-10 Road, Canal Zone

La Boca, Canal Zone
La Chorrera (20), Panamá
La Concepción, Chiriquí
La Laguna, Darién
La Palma, Darién
La Vaca, Río de, Chiriquí
La Zumbadora, Panamá
Lagartera, Canal Zone
Lara, Finca, Chiriquí
Las Cáscadas, Canal Zone
Las Cruces, Canal Zone
Las Cruces Trail, Canal Zone
Las Cumbres, Panamá
Las Palmitas, Los Santos
Lava Flow, Chiriquí
Lerida, Finca, Chiriquí
Lewis, Casa, Chiriquí
Limón, Río, Darién
Lion Hill, Canal Zone
Llano Verde, Chiriquí

Madden Airstrip, Panamá
Madden Dam (27), Canal Zone
Madden Forest (25), Canal Zone
Madden Road, Canal Zone
Madden Wye, Canal Zone
Majé, Río, Panamá
Malí, Cerro, Darién
Mamoní, Río, Panamá
Mandinga (38), San Blas
Mandinga, Río, Canal Zone
Margarita, Canal Zone
Mariato, Río, Veraguas
Marragantí, Darién
Martinz, Finca, Chiriquí
Martinz Dairy, Chiriquí
Maxon Ranch, Panamá
Miraflores, Canal Zone
Mohinga Valley, Canal Zone
Moja Polla, Río, Panamá
Mojica, Rancho, Bocas del Toro
Mojinga, Río, Canal Zone
Mono, Río, Darién
Monte Obscuro, Panamá
Mount Hope, Canal Zone

Nueva Colonia, Chiriquí
Nueva Gorgona, Panamá
Nuevo Emperador, Panamá [4]
Nuevo Limón (34), Colón

Orchid Island, Canal Zone

Pacheca, Isla, Panamá
Pacora (39), Panamá
Paitilla, Punta, Panamá
Paja, Panamá
Palenque, Colón
Palo Santo, Chiriquí
Panamá (23), Panamá
Panamá Viejo, Panamá
Pando, Cerro, Chiriquí
Paracoté, Veraguas
Paraíso, Canal Zone
Parida, Isla, Chiriquí
Parita (14), Herrera
Paya, Boca de Río (44), Darién
Paya Village, Darién
Pearl Islands (41), Panamá
Pedasí (13), Los Santos
Pedregal, Chiriquí
Pedro Gonzáles, Isla, Panamá
Pedro Miguel, Canal Zone
Pelado, Cerro, Canal Zone
Pelisa, Darién
Peluca, Río, Panamá
Peña, Punta de, Bocas del Toro
Penonomé (16), Coclé
Pequeni, Río (36), Panamá
Perlas, Archipielago de las (41), Panamá
Pesé, Herrera
Piña (31), Colón
Piña, Camp, Canal Zone
Piña, Punta, Darién
Pinogana, Darién
Pirre, Cerro, Darién
Pital, Camp (6a), Chiriquí
Pito, Río, San Blas
Porcada, Isla, Chiriquí
Portobelo (or Porto Bello) (35), Colón
Potuga, Herrera
Prominente, Cerro, Panamá
Pucro, Río, Darién
Pueblo Nuevo, Chiriquí
Pueblo Nuevo, Panamá
Puente, Río, Panamá
Puerto Limón, Colón
Puerto Obaldía, San Blas
Puma Island, Canal Zone
Punusa, Boca de Río, Darién

Quarry Heights, Canal Zone

Randolph, Fort, Canal Zone
Real de Santa Maria, Darién
Red Tank, Canal Zone
Remédios (8), Chiriquí
Represo, Canal Zone
Rey, Isla del, Panamá
Río Abajo, Panamá
Río Chico Hydrographic Station, Panamá
Río Hato (17), Coclé
Risco, Boca de Río, Bocas del Toro
Rodman Naval Station, Canal Zone

Sabanas, Panamá
Saboga, Isla, Panamá
Salamanca Hydrographic Station, Canal Zone
Salto de Madroño, Panamá
Salud, Colón
San Félix, Chiriquí
San Francisco de la Caleta, Panamá
San José, Isla, Panamá
San Juan, Canal Zone
San Lorenzo, Fort, Canal Zone
San Miguel, Panamá
San Miguel, Isla, Panamá
San Pablo, Canal Zone
Santa Clara, Chiriquí
Santa Clara, Coclé
Santa Clara, Quebrada, Chiriquí
Santa Clara, Río, Chiriquí
Santa Cruz de Cana, Darién
Santa Fé (11), Veraguas
Santa Rosa, Colón
Santiago (10), Veraguas
Sapo, Cerro, Darién
Sereno, Chiriquí
Setegantí, Río (46), Darién
Sevilla, Isla, Chiriquí
Sherman, Fort (32), Canal Zone
Sibube, Bocas del Toro
Siolo (or Siola), Chiriquí
Soná, Veraguas
Summit, Canal Zone

Tabernilla, Canal Zone
Taboga, Isla (21), Panamá
Taboguilla, Isla, Panamá

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[4] Brennan and Yunker (see *The Chiggers of Panama*, elsewhere in this volume) refer collections from Nuevo Emperador to the Canal Zone. These collections were made in the Canal Zone near Nuevo Emperador.

Tacarcuna, Cerro, Darién
Tacarcuna Casita, Darién
Tacarcuna Laguna, Darién
Tacarcuna Village (45), Darién
Tacarcuna Yellow Fever Station, Darién
Tapalisa, Darién
Tapia, Panamá
Terebé, Río, Bocas del Toro
Teribe, Río, Bocas del Toro
Tigre, Cerro, Canal Zone
Tilley, Casa, Chiriquí
Timi de Boa, Río Teribe, Bocas del Toro
Timishik, upper Río Teribe, Bocas del Toro
Tocumen, Panamá

Trinidad, Río, Panamá
Tuira, Río, Darién

Venado Beach, Canal Zone
Vieja, Punta, Bocas del Toro
Viejo, Cerro, Veraguas
Viejo, Río, Veraguas
Vijía, Canal Zone
Villa Rosario, Panamá
Vique, Punta, Panamá

Wald, Chiriquí

Yaviza, Darién

Section II. Index to Localities by Province

Bocas Del Toro

Agua, Cayo, 9°10′N-82°02′W (near Almirante–2)
Almirante (2), 9°18′N-82°24′W
Bastimentos, Isla, 9°19′N-82°08′W (near Almirante–2)
Boca del Drago, 9°26′N-82°20′W (near Almirante–2)
Caballero, Rancho, near 9°02′N-82°41′W (near Río Changena–3), 5000 feet
Changena, Río (3), 9°06′N-82°34′W, 2300-2600 feet
Changuinola, 9°27′N-82°31′W (near Almirante–2)
Changuinola, Río, 9°22′N-82°31′W (near Almirante–2)
Chiriquicito, 8°57′N-82°10′W (near Almirante–2)
Colón, Isla, 9°24′N-82°16′W (near Almirante–2)
Cylindro (NE of Boquete on upper Caribbean slope, near Boquete–5), above 4000 feet
Escudo de Veraguas, Isla (1), 9°06′N-81°33′W
Mojica, Rancho, near 9°02′N-82°41′W (near Río Changena–3), 4800-5600 feet
Peña, Punta de (a point on Laguna de Chiriquí?)
Risco, Boca de Río, 9°16′N-82°28′W (near Almirante–2)
Sibube, 9°36′N-82°47′W (near Almirante–2)
Terebé, Río (See: Río Teribe)
Teribe, Río (=Río Terebé), 9°24′N-82°33′W (near Almirante–2)
Timi de Boa, Río Teribe (near Almirante–2)
Timishik, Upper Río Teribe (near Almirante–2)
Vieja, Punta (=Punta Patiño, 9°18′N-82°04′W, or a point on Laguna de Chiriquí?)

Canal Zone

Albrook Field, 8°59′N-79°34′W (near Fort Clayton–24)
Alhajuela, 9°11′N-79°38′W (old hydrographic station between highway bridge and Madden Dam–27)
Amador, Fort, 8°55′N-79°33′W (near Panamá–23)
Ancón, 8°57′N-79°34′W (near Panamá–23)
Balboa, 8°57′N-79°35′W (near Panamá–23)
Barro Colorado Island (29), 9°09′N-79°51′W
Bas Obispo, 9°06′N-79°42′W (old village, now abandoned, on Panama Railroad, near Gamboa–28)
Bohio, 9°10′N-79°51′W (old station on Panama Railroad, now under water, near Barro Colorado Island–29)
Boracho, Loma, 9°17′N-79°56′W (near Fort Sherman–32)

Borinquen Road (=K-2 Road), west bank, Pacific Side (near Fort Kobbe–22)
Cacao Plantation, 9°06′N-79°41′W (near Gamboa–28)
Cardenas, 8°59′N-79°35′W (near Fort Clayton–24)
Casaya, Río, 9°06′N-79°41′W (near Gamboa–28)
Chágres, Camp, 9°13′N-79°37′W (near Madden Dam–27; records of 20–30 years ago may refer to a locality within Fort Sherman–32)
Chágres, Río, 9°08′N-79°41′W (near Gamboa–28)
Chico (probably Río Chico Hydrographic Station, Panamá, near Calzada Larga–26)
Chiva Chiva, 9°01′N-79°35′W (near Fort Clayton–24)
Clayton, Fort (24), 8°59′N-79°36′W
Coco Solo, 9°21′N-79°54′W (near Fort Gulick–33)
Cocoli, 8°58′N-79°36′W (near Fort Kobbe–22)
Corozal, 8°58′N-79°35′W (near Fort Clayton–24)
Corte Culebra Road
Cristóbal, 9°20′N-79°55′W (near Fort Gulick–33)
Culebra, 9°03′N-79°40′W (near Gamboa–28)
Curundu, 8°59′N-79°33′W (near Fort Clayton–24)
Davis, Fort, 9°15′N-79°56′W (near Fort Gulick–33)
El Vijía (=Vijía), 9°12′N-79°36′W (village, now under water, near Madden Dam–27)
Emperador (See: Empire)
Empire (= Emperador), 9°03′N-79°41′W (old administrative center of Canal, on west bank, about halfway between Paraíso and Gamboa–28)
Farfan, 8°55′N-79°36′W (Near Fort Kobbe–22)
France Field, 9°21′N-79°53′W (near Fort Gulick–33)
Frijoles, 9°10′N-79°49′W (near Barro Colorado Island–29)
Galeta Island, 9°23′N-79°53′W (near Fort Gulick–33)
Galeta Point, 9°23′N-79°52′W (near Fort Gulick–33)
Gamboa (28), 9°06′N-79°42′W
Gatún, 9°15′N-79°56′W (near Fort Gulick–33)
Gulick, Fort (33), 9°18′N-79°53′W
Howard Field, 8°54′N-79°37′W (near Fort Kobbe–22)
Indio, Río, 9°15′N-79°59′W (near Fort Sherman–32)
Juan Mina, 9°09′N-79°40′W (near Gamboa–28)
Kobbe, Fort (22), 8°54′N-79°36′W
K-9 Road (parallels south bank of Río Cocoli for 3.3 mi. between K-2 and K-6 roads; near Fort Kobbe–22)
K-10 Road (extends 6.6 mi. NW from Arraiján to head of Río Mandinga; near Fort Kobbe–22)
La Boca, 8°56′N-79°34′W (near Panamá–23)
Lagartera, 9°07′N-79°58′W (village, now under water, near Escobal–30)
Las Cáscadas, 9°05′N-79°42′W (near Gamboa–28)
Las Cruces, 9°07′N-79°41′W (village, now under water, near Gamboa–28)
Las Cruces Trail (extends from Río Chágres, above mouth of Río Casaya, through Madden Forest, Chiva Chiva, Cardenas, and Curundu to Panamá)
Lion Hill, 9°13′N-79°54′W (now an island in Gatun Lake, near Barro Colorado Island–29)
Madden Dam (27), 9°13′N-79°38′W
Madden Forest (25), 9°05′N-79°38′W
Madden Road (=C-25 Road, extending between Paraíso and Madden Dam, and passing through Madden Forest)
Madden Wye, 9°03′N-79°39′W (near Madden Forest–25)
Mandinga, Río, 9°05′N-79°42′W (near Gamboa–28)
Margarita, 9°18′N-79°54′W (near Fort Gulick–33)
Miraflores, 8°59′N-79°36′W (near Fort Clayton–24)
Mohinga Valley (=Río Mojinga), 9°18′N-79°59′W (near Fort Sherman–32)
Mojinga, Río (See: Mohinga Valley)
Mount Hope, 9°19′N-79°54′W (near Fort Gulick–33)
Orchid Island, 9°10′N-79°52′W (near Barro Colorado Island–29)

Paraíso, 9°02′N-79°39′W (near Madden Forest–25)
Pedro Miguel, 9°01′N-79°37′W (near Fort Clayton–24)
Pelado, Cerro, 9°07′N-79°43′W (near Gamboa–28)
Piña, Camp, 9°16′N-80°00′W (near Fort Sherman–32)
Puma Island, 9°13′N-79°55′W (near Barro Colorado Island–29)
Quarry Heights, 8°57′N-79°34′W (near Panamá–23)
Randolph, Fort, 9°22′N-79°54′W (near Fort Gulick–33)
Red Tank, 9°00′N-79°36′W (near Fort Clayton–24)
Represo (near Barro Colorado Island–29)
Rodman Naval Station, 8°56′N-79°35′W (near Fort Kobbe–22)
Salamanca Hydrographic Station, 9°17′N-79°36′W (near Río Pequeni–36)
San Juan, 9°15′N-79°36′W (village, now under water, near Madden Dam–27)
San Lorenzo, Fort, 9°18′N-80°01′W (near Fort Sherman–32)
San Lorenzo Caves (See: Fort San Lorenzo)
San Pablo, 9°06′N-79°48′W (old station on Panama Railroad, now under water, near Barro Colorado Island–29)
Sherman, Fort (32), 9°21′N-79°57′W
Summit, 9°03′N-79°40′W (near Madden Forest–25)
Tabernilla, 9°07′N-79°49′W (old station on Panama Railroad, now under water, near Barro Colorado Island–29)
Tigre, Cerro, 9°04′N-79°39′W (near Madden Forest–25)
Venado Beach, 8°53′N-79°37′W (near Fort Kobbe–22)
Vijía (See: El Vijía)

CHIRIQUÍ

Almijas, Isla, 8°16′N-82°24′W (near David–7)
Bambito, 8°15′N-82°37′W (near Cerro Punta–4), 5000-6000 feet
Barú, Cerro (See: Volcán de Chiriquí)
Bogavo (See: Bugaba)
Boquerón, 8°31′N-82°34′W (near Concepción–6)
Boquete (5), 8°47′N-82°25′W, 2000-7500 feet
Boquete-Volcan Trail (near Boquete–5), above 6500 feet
Brava, Isla, 8°12′N-82°16′W (near David–7)
Bugaba (=Bogavo), 8°29′N-82°37′W (near Concepción–6)
Burica, Punta, 8°02′N-82°52′W (near Camp Pital–6a)
Butz, Finca, 8°50′N-82°37′W (near Cerro Punta–4), 5000 feet
Candela, Río, 8°51′N-82°49′W (near Cerro Punta–4), above 3500 feet
Casita Alta (See: Finca Lerida)
Cerro Punta (4), 8°53′N-82°34′W, 5000-7800 feet
Cerro Punta-Boquete Trail (between Cerro Punta–4 and Boquete–5), 6800–7800 feet
Chiriquí, Volcán de (=Cerro Barú and El Barú), 8°49′N-82°32′W (near Cerro Punta–4), 6000-11,400 feet
Chiriquí Viejo, Río, 8°49′N-82°40′W (near Cerro Punta–4), above 3000 feet
Colorado, Río, 8°51′N-82°44′W (near Cerro Punta–4), 4000 feet
Concepción (=La Concepción–6), 8°31′N-82°37′W
Cotito, Río, 8°51′N-82°45′W (near Cerro Punta–4), 4900 feet
Coto Region (=Río de la Vaca, base of Burica Peninsula, near Concepción–6)
Davalá (See: Divalá)
David (7), 8°26′N-82°26′W
Divalá (=Davalá), 8°25′N-82°43′W (near Concepción–6)
El Banco, 8°42′N-82°31′W (near Boquete–5), near 3500 feet
El Barú (See: Volcán de Chiriquí)
El Hato del Volcán (See: El Volcán)
El Volcán (=El Hato del Volcán and Lava Flow), 8°47′N-82°38′W (near Cerro Punta–4), 4000-6000 feet
Gariché, Río, 8°44′N-82°41′W (near Cerro Punta–4), 3200-5300 feet

Insólita, Isla (=Isla Porcada), 8°08′N-81°44′W (near Remédios–8)
La Concepción (See: Concepción)
La Vaca, Río (See: Coto Region)
Lara, Finca, 8°51′N-82°36′W (near Cerro Punta–4), 5600-5800 feet
Lava Flow (See: El Volcán)
Lerida, Finca (=Casita Alta), 8°49′N-82°29′W (near Boquete–5), 5000-7400 feet
Lewis, Casa, 8°52′N-82°36′W (near Cerro Punta–4), 5600-5700 feet
Llano Verde, 8°48′N-82°37′W (near Cerro Punta–4), 5000 feet
Martinz, Finca (=Martinz Dairy), 8°52′N-82°34′W (near Cerro Punta–4), 6500-6800 feet
Martinz Dairy (See: Finca Martinz)
Nueva Colonia
Palo Santo, 8°49′N-82°40′W (near Cerro Punta–4), 4200 feet
Pando, Cerro, 8°55′N-82°43′W (near Cerro Punta–4), 3800-5600 feet
Parida, Isla, 8°07′N-82°19′W (near David–7)
Pedregal, 8°22′N-82°26′W (near David–7)
Pital, Camp (between Puerto Armuelles and Costa Rican Boundary–6a)
Porcada, Isla (See: Isla Insólita)
Pueblo Nuevo, 8°06′N-81°42′W (near Remédios–8)
Remédios (8), 8°14′N-81°50′W
San Félix, 8°19′N-81°52′W (near Remédios–8)
Santa Clara (=Quebrada Santa Clara and Río Santa Clara), 8°51′N-82°46′W (near Cerro Punta–4), 3600-4200 feet
Santa Clara, Quebrada (See: Santa Clara)
Santa Clara, Río (See: Santa Clara)
Sereno, 8°51′N-82°51′W (near Cerro Punta–4), 3600-3700 feet
Sevilla, Isla, 8°14′N-82°23′W (near David–7)
Siolo (or Siola), 8°51′N-82°44′W (near Cerro Punta–4), 4100-4300 feet
Tilley, Casa, 8°51′N-82°36′W (near Cerro Punta–4), 5300-5600 feet
Wald (Río Chiriquí Viejo, near Cerro Punta–4), 3800 feet

Coclé

Aguadulce (15), 8°14′N-80°33′W
Antón, 8°24′N-80°16′W (near Río Hato–17)
El Copé, 8°37′N-80°35′W (near Penonomé–16), 1500 feet
El Potrero, 8°32′N-80°33′W (near Penonomé–16)
El Valle (18), 8°36′N-80°08′W, 2000-3000 feet
Penonomé (16), 8°31′N-80°22′W
Río Hato (17), 8°22′N-80°11′W
Santa Clara, 8°22′N-80°07′W (near Río Hato–17)

Colón

Achiote, 9°12′N-80°01′W (near Piña–31)
Aspinwall (See: Colón)
Bonita, Quebrada (on Transisthmian Highway; near Madden Dam–27)
Bruja, Cerro, 9°29′N-79°34′W (near Portobelo-35), 1000-2000 feet
Buena Vista, 9°16′N-79°42′W (near Madden Dam–27)
Cativá (or Cativálˊ), 9°21′N-79°51′W (near Fort Gulick–33)
Cement Plant, 9°15′N-79°40′W (near Madden Dam–27)
Colón (=Aspinwall), 9°21′N-79°55′W (near Fort Gulick–33)
Donoso, 9°09′N-80°19′W (near Piña–31)
El Limón (See: Nuevo Limón)
Escobal (30), 9°08′N-79°58′W
Frijolito, Río, 9°12′N-79°46′W (near Nuevo Limón–34)
Guayabalito, 9°11′N-79°40′W (near Madden Dam–27)

Nuevo Limón (=El Limón and Puerto Limón) (34), 9°14′N-79°49′W
Palenque, 9°42′N-79°22′W (near Portobelo–35)
Piña (31), 9°16′N-80°03′W
Portobelo (or Porto Bello) (35), 9°41′N-79°41′W
Puerto Limón (See: Nuevo Limón)
Salud, 9°12′N-80°08′W (near Piña–31)
Santa Rosa, 9°10′N-79°40′W (near Madden Dam–27)

Darién

Amagal, 7°24′N-78°02′W (near Jaqué–47), 1000 feet
Aruza, 8°02′N-77°39′W (near El Real–43)
Boca de Cupe, 8°02′N-77°36′W (near El Real–43)
Camogantí, 8°08′N-77°54′W (near El Real–43)
Cana (=Santa Cruz de Cana), 7°47′N-77°42′W (near Río Seteganti–46), 1800-3500 feet
Cana, Loma (near Cerro Pirre and Río Setegantí–46), 4900 feet
Capetí, 8°04′N-77°33′W (near El Real–43)
Casita (=Tacarcuna Casita), 8°01′N-77°22′W (near Tacarcuna Village–45), 1500 feet
Chepigana, 8°17′N-78°04′W (near El Real–43)
Chucunaque, Río, 8°23′N-77°49′W (near El Real–43)
Cituro, 8°00′N-77°36′W (near Boca de Río Paya–44)
El Real (=Real de Santa Maria) (43), 8°06′N-77°45′W
Esnápe, Río (48), 8°05′N-78°13′W
Guayabo, 7°23′N-78°02′W (near Jaqué–47)
Jaqué (47) and Río Jaqué, 7°31′N-78°10′W
Jesucito, Río, 8°02′N-78°18′W (near Río Esnápe–48)
La Laguna (=Tacarcuna Laguna), 8°04′N-77°19′W (near Tacarcuna Village–45), 3200 feet
La Palma, 8°24′N-78°09′W (near El Real–43)
Limón, Río (between Cana and Cerro Pirre, near Río Setegantí–46), 5100 feet
Malí, Cerro, 8°07′N-77°14′W (near Tacarcuna Village–45), 4100-4800 feet
Marragantí, 8°08′N-77°44′W (near El Real–43)
Mono, Río, 7°43′N-77°33′W (near Boca de Río Paya–44)
Paya, Boca de Río (44), 7°55′N-77°31′W
Paya Village, 7°53′N-77°24′W (near Boca de Río Paya–44)
Pelisa (on Río Pavarando?)
Piña, Punta (or Piña Point), 7°34′N-78°13′W (near Jaqué–47)
Pinogana, 8°07′N-77°41′W (near El Real–43)
Pirre, Cerro (or Mount Pirre), 7°51′N-77°44′W (near Río Setegantí–46), 4500-5300 feet
Pucro, Río, 7°59′N-77°34′W (near Boca de Río Paya–44)
Punusa, Boca de Río, 7°48′N-77°32′W (near Boca de Río Paya–44)
Real de Santa Maria (See: El Real)
Santa Cruz de Cana (See: Cana)
Sapo, Cerro (or Mount Sapo), 7°58′N-78°22′W (near Río Esnápe–48), 1000-3000 feet
Setegantí, Río (46), 7°46′N-77°40′W, 1600-3000 feet
Tacarcuna, Cerro, 8°10′N-77°18′W (near Tacarcuna Village–45), 4100-4800 feet (Note: the "Mount Tacarcuna" of Anthony, Bull. American Mus. Nat. Hist., **35**:357–376, 1916, and Goldman, Smithsonian Misc. Coll., **69**, no. 5, 1920, is Cerro Malí)
Tacarcuna Casita (See: Casita)
Tacarcuna Laguna (See: La Laguna)
Tacarcuna Village (=Tacarcuna Yellow Fever Station) (45), 8°05′N-77°17′W, 1800-3000 feet
Tacarcuna Yellow Fever Station (See: Tacarcuna Village)
Tapalisa (and Río Tapalisa), 7°59′N-77°26′W (near Boca de Río Paya–44)
Tuira, Río (or Río Tuyra), 8°08′N-77°45′W (near El Real–43)
Yaviza (or Yavisa), 8°09′N-77°42′W (near El Real–43)

Herrera

Azuero, Peninsula de (Herrera and Los Santos and part of Veraguas provinces)
Capina, 7°53'N-80°33'W (near Parita–14)
Divisa, 8°07'N-80°42'W (near Parita–14)
Parita (14), 7°59'N-80°32'W
Pesé, 7°54'N-80°38'W (near Parita–14)
Potuga, 8°04'N-80°38'W (near Parita–14)

Los Santos

Azuero, Peninsula de (Herrera and Los Santos and part of Veraguas provinces)
Guánico (=Guánico Arriba and Las Palmitas), 7°20'N-80°30'W (near Cerro Hoya–12)
Hoya, Cerro (12), 7°18'N-80°42'W, 1500-3200 feet
Las Palmitas (See: Guánico)
Pedasí (13), 7°32'N-80°03'W

Panamá

Aguas Buenas, 9°07'N-79°37'W (near Madden Forest–25)
Arraiján, 8°57'N-79°41'W (near Fort Kobbe–22)
Avaso, Río (probably a misprint for Rio Abajo)
Azul, Cerro (37) (See: Cerro Prominente, Goofy Lake, and La Zumbadora)
Bayano, Río, 9°06'N-79°05'W (near Chepo–40)
Bejuco, 8°36'N-79°54'W (near Chame–19)
Cabima, near 9°08'N-79°34'W (near Calzada Larga–26)
Calidonia, 8°57'N-79°32'W (near Panamá–23)
Calzada Larga (=Casa Larga) (26), 9°10'N-79°34'W
Campana, Cerro, 8°41'N-79°56'W (near Chame–19)
Candelaria Hydrographic Station, 9°22'N-79°32'W (near Río Pequeni–36)
Capira, 8°45'N-79°53'W (near La Chorrera–20)
Carasquilla (probably La Carasquilla, a suburb of Panama City)
Casa Larga (See: Calzada Larga)
Cativo, 9°10'N-78°50'W (near Chepo–40)
Chame (19), 8°34'N-79°54'W
Chapera, Isla, 8°34'N-79°03'W (Archipielago de las Perlas–41)
Charco del Toro (head of Río Majé; near Chimán–42)
Chepo (40), 9°10'N-79°06'W
Chilibre, 9°08'N-79°38'W (near Madden Dam–27)
Chilibrillo Caves (near Chilibre on Transisthmian Highway; near Madden Dam–27)
Chimán (42), 8°43'N-78°37'W
Cocos, Punta, 8°12'N-78°55'W (Archipielago de las Perlas–41)
Goofy Lake (="Cerro Azul" of Environmental Health Branch, U. S. Army), 9°09'N-79°26'W (Cerro Azul–37), 750-2000 feet
Guayabito (probably a locality near Chorrera, formerly Los Guayabitos)
Huile, 9°01'N-79°46'W (near La Chorrera–20)
Jefe, Cerro (See: La Zumbadora)
Juan Díaz, 9°02'N-79°28'W (near Panamá–23)
La Chorrera (20), 8°52'N-79°48'W
La Zumbadora (="Cerro Azul" of Gorgas Memorial Laboratory and C. O. Handley, Jr.; including Cerro Jefe), 9°14'N-79°21'W (Cerro Azul–37), 850-3200 feet
Las Cumbres, 9°05'N-79°33'W (near Panamá–23)
Madden Airstrip, 9°10'N-79°34'W (near Calzada Larga–26)
Majé, Río, 8°40'N-78°32'W (near Chimán–42)
Mamoní, Río (See: Salto de Madroño)
Maxon Ranch (See: Río Trinidad)

Moja Polla, Río (Quebrada), 9°11′N-79°39′W (near Madden Dam–27)
Monte Obscuro (suburb of Panamá–23)
Nueva Gorgona, 8°33′N-79°53′W (near Chame–19)
Nuevo Emperador (=Paja), 9°00′N-79°45′W (near La Chorrera–20)
Pacheca, Isla, 8°39′N-79°04′W (Archipielago de las Perlas–41)
Pacora (39), 9°04′N-79°18′W
Paitilla, 8°57′N-79°32′W (suburb of Panamá–23)
Paja (See: Nuevo Emperador)
Panamá (=Panama City) (23), 8°58′N-79°32′W
Panamá Viejo, 8°59′N-79°30′W (near Panamá–23)
Pearl Islands (See: Archipielago de las Perlas)
Pedro Gonzáles, Isla, 8°22′N-79°07′W (Archipielago de las Perlas–41)
Peluca, Río, 9°22′N-79°34′W
Pequeni, Río (36), 9°22′N-79°32′W
Perlas, Archipielago de las (=Pearl Islands) (41), 8°21′N-79°00′W
Prominente, Cerro (="Cerro Azul" of E. A. Goldman), 9°13′N-79°18′W (Cerro Azul–37), 500–2950 feet
Pueblo Nuevo, 9°01′N-79°31′W (near Panamá–23)
Puente, Río, 9°11′N-79°34′W (near Calzada Larga–26)
Rey, Isla del (=Isla San Miguel), 8°23′N-78°56′W (Archipielago de las Perlas–41)
Río Abajo, 9°01′N-79°31′W (near Panamá–23)
Río Chico Hydrographic Station, 9°15′N-79°31′W (near Calzada Larga–26)
Sabanas (suburb of Panamá–23)
Saboga, Isla, 8°36′N-79°05′W (Archipielago de las Perlas–41)
Salto de Madroño, Río Mamoní (near Chepo–40)
San Francisco de la Caleta, 8°59′N-79°30′W (near Panamá–23)
San José, Isla, 8°15′N-79°08′W (Archipielago de las Perlas–41)
San Miguel, 8°26′N-78°57′W (Archipielago de las Perlas–41)
San Miguel, Isla (See: Isla del Rey)
Taboga, Isla (21), 8°47′N-79°35′W
Taboguilla, Isla, 8°47′N-79°32′W (near Isla Taboga–21)
Tapia, 9°01′N-79°28′W (near Panamá–23)
Tocumen, 9°04′N-79°24′W (near Pacora–39)
Trinidad, Río (=Maxon Ranch), 8°57′N-80°00′W (near Escobal–30)
Villa Rosario, 8°46′N-79°53′W (near La Chorrera–20)
Vique, Punta, 8°52′N-79°40′W (near Fort Kobbe–22)

San Blas

Armila (49) 8°40′N-77°27′W
Cangandí, Río, 9°26′N-79°07′W (near Mandinga–38)
Mandinga (38), 9°29′N-79°05′W
Pito, Río, 8°42′N-77°32′W (near Armila–49)
Puerto Obaldía, 8°40′N-77°26′W (near Armila–49)

Veraguas

Afuera, Isla (See: Isla Canal de Afuera)
Altos Cacao, 7°39′N-80°49′W (near Cerro Hoya–12) 1400 feet
Azuero, Peninsula de (Herrera and Los Santos and part of Veraguas provinces)
Bubí, Río, 8°00′N-81°32′W (near Remédios–8)
Calobré, 8°19′N-80°51′W (near Santiago–10)
Calovébora, 8°48′N-81°12′W (near Santa Fé–11)
Canal de Afuera, Isla (=Isla Afuera), 7°41′N-81°37′W (near Isla Coiba–9)
Cébaco, Isla, 7°31′N-81°11′W (near Isla Coiba–9)
Coiba, Isla (9), 7°26′N-81°45′W
Gobernadora, Isla, 7°33′N-81°12′W (near Isla Coiba–9)

Mariato, Río, 7°40'N-89°54'W (near Cerro Hoya–12)
Paracoté, 7°40'N-81°01'W (near Cerro Hoya–12)
Santa Fé (11), 8°31'N-81°04'W
Santiago (10), 8°05'N-80°59'W
Soná, 8°00'N-81°19'W (near Santiago–10)
Viejo, Cerro, 7°38'N-80°47'W (near Cerro Hoya–12), 2000–3300 feet
Viejo, Río, 8°03'N-81°34'W (near Remédios–8)

Mites of the Subfamily Laelaptinae in Panama
(Acarina: Laelaptidae)

VERNON J. TIPTON [1], ROBERT M. ALTMAN [2], AND CHARLES M. KEENAN [3]

During the past few years we have collected several hundred small mammals in Panama. The ectoparasites removed from these animals form a most interesting collection, of which the Acarina are by far the most numerous. The present study is limited to mites of the subfamily Laelaptinae, since the vast majority of the mesostigmatid mites collected belong to eight genera of this subfamily. Of these, *Laelaps* Koch, *Gigantolaelaps* Fonseca, *Eubrachylaelaps* Ewing, *Echinolaelaps* Ewing and *Mysolaelaps* Fonseca, are most commonly associated with myomorph rodents; *Tur* Baker and Wharton with hystricomorph rodents; *Steptolaelaps* Furman with sciuromorph rodents, and *Haemolaelaps* Berlese with both rodents and marsupials.

As Furman and Tipton (1961) point out, "The study of neotropical parasitic mites is of importance because they may fill key roles in epidemiological patterns which for the moment are confusing." Because they are numerous and widespread, it is possible that mites may figure prominently in the solution of some of our more perplexing epidemiological problems in the tropics.

We wish to acknowledge with gratitude the assistance given us by Captain Wallace P. Murdoch and Major Gordon Field and their staff of illustrators at the 406th Medical General Laboratory in Tokyo, Japan. All of our illustrations were prepared by this group. Dr. Charles O. Handley, Smithsonian Institution, identified the host animals. Dr. Flavio da Fonseca, Instituto Butantan, São Paulo, Brazil, as always, has been very kind in assisting us with information about species of the Laelaptinae in South

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[1] Lieutenant Colonel, Medical Service Corps, United States Army. The senior author assumes complete responsibility for the descriptions of new species in this paper. For purposes of citation in subsequent publications, authorship of species described herein should be attributed to him alone.

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America. We are especially indebted to Dr. Deane P. Furman, University of California at Berkeley, as our format and some of our keys essentially follow those of Furman and Tipton (1961).

KEY TO THE PANAMANIAN GENERA OF LAELAPTINAE

FEMALES; FROM FURMAN AND TIPTON, 1961

1. Genito-ventral plate with one pair of setae 2
   Genito-ventral plate with more than one pair of setae 4
2. Peritremalia produced posterior to stigmata; posterior seta of coxa II similar to setae of other coxae 3
   Peritremalia not produced posterior to stigmata; posterior seta of coxa II longer than setae of other coxae ....*Gigantolaelaps* Fonseca
3. Spine-like seta on posterior margin of coxa III; elongate setae on dorsal apices of femur and genu I; tectum with three apical lobes ....*Eubrachylaelaps* Ewing
   Coxa III without spine-like seta; femur and genu I without elongate setae; tectum a single rounded lobe ....*Haemolaelaps* Berlese
4. Genito-ventral plate with three pairs of setae ....*Steptolaelaps* Furman
   Genito-ventral plate with four pairs of setae 5
5. Central setae of dorsal plate minute; coxae without spiniform setae ....*Mysolaelaps* Fonseca
   Central setae of dorsal plate not minute; at least one pair of coxae with spiniform setae 6
6. Large mites, over 1 mm. long; sternal plate as long or longer than wide ....*Echinolaelaps* Ewing
   Medium sized mites, less than 1 mm. long; sternal plate never as long as wide 7
7. Peritremal plate broad; epigynial and anal plates fused or in juxtaposition ....*Tur* Baker and Wharton
   Peritremal plate narrow; epigynial and anal plates not fused or in juxtaposition ....*Laelaps* Koch

We prefer to summarize the morphological characteristics of the genera in a tabular form (table 1) rather than treat each genus separately, since Tipton (1960) and Furman and Tipton (1961) have recently discussed this group of genera.

Some of the characters listed in table 1 are variable in occurrence in certain genera. Thus, coarse dorsal setae occur consistently in species of *Echinolaelaps, Steptolaelaps* and *Tur,* but only in some species of *Eubrachylaelaps, Gigantolaelaps* and *Laelaps.* There are numerous setae on the unarmed portion of the venter in some species of *Haemolaelaps* but not in others. The value of the tectum as a generic character has not been fully investigated. In *Tur anomalus* n. sp., the tectum is very difficult to see, but appears to be a single lobe; it is trilobed in *T. uniscutatus.*

Genus **Echinolaelaps** Ewing

Macrolaelaps Ewing, 1929, Man. Ext. Parasites, p. 185.
Echinolaelaps Ewing, 1929, loc. cit., pp. 185–186.
Type-species: *Laelaps echidninus* Berlese, 1887.

This genus is represented in Panama by two species, one of them (*E. lowei* n. sp.) known only from Panama.

Echinolaelaps echidninus (Berlese)

Laelaps echidninus Berlese, 1887, Acari, Myriap. Scorp. Italia, pt. 39, p. 157.
Echinolaelaps echidninus Ewing, 1929, Man. Ext. Parasites, p. 185.

MATERIAL EXAMINED: 9 females from *Rattus rattus*, Arraiján (Panama), 5 April 1961, collected by C. M. Keenan and V. J. Tipton.

REMARKS: Our Panamanian material differs very little from specimens in our collections from other parts of the world. We have collected hundreds of specimens of both *R. rattus* and *R. norvegicus* but have found only a single rat infested with *E. echidninus*. However, *Laelaps nuttalli* was very abundant.

TABLE 1. COMPARATIVE CHART OF PANAMANIAN GENERA OF LAELAPTINAE (FEMALES)

Character	*Echinolaelaps*	*Eubrachylaelaps*	*Gigantolaelaps*	*Haemolaelaps*	*Laelaps*	*Mysolaelaps*	*Steptolaelaps*	*Tur*
Idiosoma over 1 mm.	+	0	+	0	0	+	0	0
Pairs of setae on G-V plate	4	1	1	1	4	4	3	4
Number of lobes in tectum*	4	3	1	1	3	3	1	3
At least 1 robust coxal seta	+	+	+	0	+	0	+	+
Pilosity of venter sparse	+	0	+	+	+	+	+	+
Sternal plate as long as wide	+	0	0	0	0	0	0	0
Dorsal setae coarse	+	0	0	0	+	0	+	+

*Refers only to Panamanian species

Echinolaelaps lowei Tipton, new species. Plate 1.

DIAGNOSIS: Like *E. boultoni* Furman and Tipton, *E. lowei* n. sp., has epigynial and anal plates which are not in juxtaposition. *E. boultoni* has bulbous setae on coxa I; these setae are piliform to setiform in *E. lowei*.

DESCRIPTION: *Idiosoma.*—1040 μ long, 697 μ wide (width measured at level of coxae IV).

Dorsum.—Dorsal plate elliptical, with 37 pairs setae; 936 μ long, 614 μ wide; covers almost entire dorsum, leaving only narrow, postero-lateral band of soft integument bearing 14 pairs setae; posterior margin with three pairs longer than medial setae; penultimate setae about one-half length of last pair.

Venter.—Tritosternum bifurcate near base, pilose; sternal plate coarsely reticulate; 198 μ long, 161 μ wide; with three pairs setae approximately same length; one pair slit-like pores just caudad of first pair setae. Endapodal plates well defined; with setae smaller than sternal setae. Metapodal plates small, elongate. Epigynial plate expanded; with prominent transverse lines; with four pairs setae, distance between first pair 130 μ, second pair 198 μ, third pair 151 μ, fourth pair 73 μ; anal plate widely separated from epigynial plate; 146 μ long, 114 μ wide; distance between anterior margin of plate and anus much greater than length of anus; adanal setae 52 μ long; postanal seta 104 μ long.

Legs.—Legs long and slender except for leg II, which is more robust. Setae of coxa I piliform to setiform; a short, bulbous seta on coxa III. Dorsal apices of femur and genu I with setae less robust than sternal setae.

Gnathosoma.—Deutosternum with seven rows of two to five teeth per row. Gnathosomal setae about one-half length of medial hypostomal setae. Chelae robust, both digits toothed; fixed digit bearing long, bent seta. Hypopharyngeal processes prominent, fimbriate epipharynx sublanceolate, covered with denticles. Tectum not apparent.

TYPE MATERIAL: Holotype female from *Nectomys alfari* (host no. 4082), Cerro Azul (Panamá), 2 February 1958, collected by R. M. Altman and C. M. Keenan. In the collection of the United States National Museum. A paratype female, same data and repository as the holotype.

REMARKS: This species is named for Mr. Wilbur Lowe, a remarkable technician and a tireless worker.

Genus **Eubrachylaelaps** Ewing

Eubrachylaelaps Ewing, 1929, Man. Ext. Parasites, p. 186. Furman, 1955a, Ann. Ent. Soc. Amer., 48, (1–2), pp. 51–59 (revision and key).
Cyclolaelaps Ewing, 1933, Proc. U.S. Nat. Mus., 82, (30), p. 5.

Type-species: *Laelaps hollisteri* Ewing, 1925.

Only one species of this genus is recorded from Panama. It would be unusual, however, if *E. rotundus* Fonseca is not collected in Panama in the future; it occurs in nearby Venezuela.

Eubrachylaelaps jamesoni Furman. Plate 2.

Eubrachylaelaps jamesoni Furman, 1955a, Ann. Ent. Soc. Amer., 48, (1–2), pp. 52–54, figs. 1–4.

MATERIAL EXAMINED: 153 females from *Peromyscus nudipes*, Cerro Punta; 83 females from *P. nudipes* from Rancho Mojica; 2 females from *Oryzomys fulvescens*, Cerro Punta and Rancho Mojica; 1 female from *Reithrodontomys creper;* 1 female from *Heteromys desmarestianus*, Cerro Punta; and hundreds of specimens in alcohol from both localities, mostly from *P. nudipes;* January 1960 to March 1962, collected by C. O. Handley, C. M. Keenan, V. J. Tipton, and C. E. Yunker.

REMARKS: Our measurements of the dorsal and sternal plates of Panama specimens are roughly comparable to those given by Furman (1955a) for type material from Mexico. Specimens from Rancho Mojica are slightly smaller (average length of dorsal plate for 10 specimens, 590 μ), less heavily sclerotized with the setae of the venter apparently a little more delicate than specimens from Cerro Punta (average length of dorsal plate for 10 specimens, 626 μ). The average ratio of length to width of sternal plate is 2 to 1 for Rancho Mojica specimens and 2.1 to 1 for Cerro Punta specimens.

We must add that different mounting techniques were used for specimens from these two localities. Additional recently collected specimens from Cerro Punta were treated in much the same manner (using heat as a part of the mounting technique) as the Rancho Mojica specimens and the morphological differences were then not nearly as apparent.

Genus **Gigantolaelaps** Fonseca

Gigantolaelaps Fonseca, 1939a, Mem. Inst. Butantan, 12: 12 (transl., p. 61).
Type-species: *Gigantolaelaps vitzthumi* Fonseca, 1939.

The genus *Gigantolaelaps* Fonseca is well represented in Panama, both by species and individuals. We have tentatively associated our Panamanian specimens with five described species.

KEY TO THE PANAMANIAN SPECIES OF *GIGANTOLAELAPS*

FEMALES

1. Sternal plate with two to six (usually three) accessory setae .... *G. oudemansi* Fonseca
   Sternal plate with no accessory setae 2
2. Proximal seta of coxa I longer than distal seta; both setae spiniform .... *G. goyanensis* Fonseca
   Proximal seta of coxa I not longer than distal seta; distal seta always piliform, proximal seta usually piliform 3
3. Dorsal plate bearing approximately 400 setae; a relatively small species with dorsal plate not over 1100 μ long .... *G. inca* Fonseca
   Dorsal plate bearing 86 setae; a relatively large species with dorsal plate over 1400 μ long 4
4. Antero-median projection of sternal plate scarcely produced beyond insertion of first pair of setae. Small paired setae of posterior margin of dorsal plate reach beyond margin for not more than one-fourth of their length.... *G. gilmorei* Fonseca
   Antero-median projection of sternal plate produced far beyond insertion of first pair of setae as a pronounced lobe. Small paired setae of posterior margin of dorsal plate reach beyond margin for more than one-fourth of their length.... .... *G. wolffsohni* (Oudemans)

Gigantolaelaps gilmorei Fonseca. Plates 3 (figs. 4, 8), 4.

Gigantolaelaps gilmorei Fonseca, 1939a, Mem. Inst. Butantan, 12: 22 (transl., p. 71), figs. 6–10 (Goyaz State, Brazil). Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), pp. 175, 177, pls. 2 (fig. 9), 3 (figs. 1, 2), 4 (fig. 6), 5 (fig. 2), 6 (fig. 2).

MATERIAL EXAMINED: A total of 206 females and 1 male as follows: 179 females and 1 male from (35) *Oryzomys capito;* 27 females from (5) *O. alfaroi;* 13 females from (2) *O. bombycinus;* 3 females from (1) *O. caliginosus;* 4 females from (1) *Nectomys alfari;* 3 females from (1) *Sigmodon hispidus;* 1 female from (1) *Reithrodontomys sumichrasti;* 1 female from (1) *Zygodontomys microtinus;* 1 female from (1) *Proechimys semispinosus.*

Most specimens from *O. capito* and *O. alfaroi* were collected at Cerro Hoya (Los Santos) by C. O. Handley, February 1962. Most others were collected at Cerro Azul (Panamá) and Canal Zone, July 1956 to January 1962, by Robert M. Altman, C. M. Keenan and V. J. Tipton.

REMARKS: *G. gilmorei* Fonseca is a large species (idiosoma well over 2000 μ in length), distinct from others of the genus in possessing the following combination of characters: the bases of the first pair of sternal setae are on or very near the anterior margin of the sternal plate; both setae of coxa I are piliform; and the epigynial setae do not extend to the caudal margin of the epigynial plate.

The majority of our specimens were collected from a group of closely related species of the genus *Oryzomys* at localities of 2000-3000 feet elevation. They conform rather closely to the description and figures given by Fonseca (1939a) except that the epigynial setae are shorter, the setae of the venter are somewhat more sparse, and the anal and epigynial setae slightly more delicate than indicated by Fonseca.

Gigantolaelaps goyanensis Fonseca. Plates 3 (figs. 1, 6), 5.

Gigantolaelaps goyanensis Fonseca, 1939a, Mem. Inst. Butantan, 12: 32 (transl., p. 81), figs. 15–18 (Brazil). Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), p. 177, pls. 3 (fig. 3), 4 (fig. 5), 5 (fig. 8), 6 (fig. 3).

MATERIAL EXAMINED: 22 females and 2 males from (1) *Zygodontomys microtinus,* Cerro Azul (Panamá), 16 August 1956, collected by R. M. Altman and C. M. Keenan.

REMARKS: *G. goyanensis* Fonseca is the only species of the genus thus far recorded from Panama in which both setae of coxa I are robust and the proximal seta is longer than the distal seta. A rather anomalous situation exists with respect to this species in that we have collected it only once although we have examined 74 specimens of *Zygodontomys microtinus.*

Gigantolaelaps inca Fonseca. Plate 6.

Gigantolaelaps inca Fonseca, 1960, Acarologia, 2, (1), pp. 11–14, figs. 1, 2 (Peru). Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), pp. 182–184, pls. 2 (fig. 7), 3 (figs. 7, 8), 4 (fig. 4), 5 (fig. 7), 6 (fig. 6).

MATERIAL EXAMINED: A total of 655 females and 2 males as follows: 568 females and 2 males from (25) *Oryzomys albigularis;* 63 females from (8) *Oryzomys alfaroi;* 11 females from (1) *Peromyscus flavidus;* 9 females from (1) *Didelphis marsupialis;* 4 females from (1) *Peromyscus nudipes;* all collected above 5000 feet elevation near Cerro Punta (Chiriquí) or Rancho Mojica (Bocas del Toro) during January, February, and May, 1960, September 1961 and March 1962 by C. O. Handley, C. M. Keenan and V. J. Tipton.

REMARKS: In Panama, *G. inca* Fonseca apparently occurs only at elevations above 5000 feet. Like *G. oudemansi* Fonseca, it is a small species but it lacks the accessory setae on the sternal plate and it has very dense setae on the dorsal plate. Our specimens are not markedly different from those in our collection from Venezuela nor from figures and description given by Fonseca (1960) and Furman and Tipton (1961). The dorsal plates of our specimens appear to cover a greater area in relation to the entire specimen than do those from Venezuela and those from Peru as figured by Fonseca. However, measurements of the dorsal plates conform closely to those given by Fonseca and Furman and Tipton.

Gigantolaelaps oudemansi Fonseca. Plates 3 (figs. 2, 7), 7.

Gigantolaelaps oudemansi Fonseca, 1939a, Mem. Inst. Butantan, 12: 15 (transl., p. 64), figs. 1–5 (Goyaz State, Brazil). Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), pp. 173, 175, pls. 3 (figs. 5, 6), 4 (fig. 3), 5 (fig. 6), 6 (fig. 5).

MATERIAL EXAMINED: A total of 960 females and 7 males as follows: 791 females and 6 males from (48) *Oryzomys capito;* 73 females from (6) *O. alfaroi;* 35 females from (2) *O. bombycinus;* 24 females from (2) *O. caliginosus;* 7 females from (1) *O. bicolor;* 1 female from (1) *O. fulvescens;* 22 females from (1) *Nectomys alfari;* 4 females, 1 male from (1) *Sigmodon hispidus;* 1 female from (1) *Zygodontomys microtinus;* 1 female from (1) *Peromyscus flavidus;* 1 female from (1) *Didelphis marsupialis;* from all of our collecting localities that were below 5000 feet elevation, July 1956 to February 1962, collected by R. M. Altman, C. O. Handley, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: *G. oudemansi* Fonseca is the only known species of the genus that has accessory setae on the sternal plate. We have collected *G. oudemansi* from a number of species of hosts. There are some morphological characters which vary according to host. Generally, there are three accessory setae on the sternal plate but in several specimens from *O. capito* there were four or five accessory setae. Other measurable differences are presented in table 2, based on the same criteria used by Furman and Tipton (1961). Thus, populations from different hosts and different geographic locations may be compared.

Gigantolaelaps wolffsohni (Oudemans). Plates 3 (figs. 3, 5, 9, 10), 8–11.

Laelaps wolffsohni Oudemans, 1910, Rev. Chilena Hist. Nat., 14: 147 (Chile).

Gigantolaelaps wolffsohni Morlan, 1951, Jour. Parasit., 37, (3), p. 273. Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), pp. 179–181; pls. 3 (figs. 4, 9), 4 (figs. 1, 2), 5 (figs. 1, 3–5), 6 (figs. 1, 4).

Macrolaelaps peruvianus Ewing, 1933, Proc. U. S. Nat. Mus., 82, (30), p. 7 (Lima, Peru).

Gigantolaelaps peruvianus Fonseca, 1939a, Mem. Inst. Butantan, 12: 11 (transl., p. 60).

MATERIAL EXAMINED: 140 females from hosts and localities mentioned below, collected from July 1956 to September 1961 by R. M. Altman, C. O. Handley, C. M. Keenan and V. J. Tipton.

REMARKS: Furman and Tipton (1961) have discussed the morphological variation in 75 Venezuelan specimens of *G. wolffsohni,* the majority of which were from eight identified host species. We have 140 Panamanian specimens from six host species from six localities.

Specimens taken from *Oryzomys fulvescens* at Rancho Mojica (pl. 11) are obviously quite different from those taken from *O. caliginosus* at Cerro Campana (pl. 8). On the basis of size alone they would seem to represent two distinct species, but in addition, the Cerro Campana specimens have robust setae on coxa I, and shorter penultimate setae on the dorsal plate. However, specimens from other hosts and other localities intergrade between these two extremes and in spite of vast differences in total size, the ratio between plate sizes is essentially the same in all specimens. We have tended to disregard differences in length of setae because they may be broken off or may extend at an angle through a deep focal plane, rendering measurements unreliable and bringing the factor of distortion into an already confused picture.

TABLE 2. MEASUREMENTS OF *GIGANTOLAELAPS OUDEMANSI*, BY HOST SPECIES OF *ORYZOMYS*.
(in microns)

Character		*O. alfaroi* (6)	*O. bombycinus* (10)	*O. caliginosus* (6)	*O. capito*			
					Venezuela (4)	Los Santos (7)	Canal Zone (10)	Cerro Azul (10)
Length of Posterior Setae of Coxae II	Range	190–229	156–177	198–229		200–220	187–208	187–270
	Mean	211	174	215		210	203	224
Length of Genito-Ventral Plate*	Range	245–260	229–260	239–260	194–207	239–281	229–260	229–260
	Mean	256	244	244	203	260	248	250
Distance between Genital Setae	Range	150–160	125–156	140–160	110–121	146–187	135–156	125–177
	Mean	155	145	149	115	160	148	156
Length of Genital Setae	Range	177–208	177–218	166–198	169–181	150–208	166–198	177–208
	Mean	193	190	181	175	190	178	189
Length of Accessory Setae of Sternal Plate	Range	85–104	95–125	83–94	94–97	83–108	52–114	73–114
	Mean	92	109	86	96	94	82	98
Length of 1st pair Sternal Setae	Range	232–281	250–312	250–302	220–234	218–281	208–270	260–322
	Mean	256	266	276	228	262	251	270
Distance between 1st Pair Sternal Setae	Range	135	114–146	135–146	114–120	140–166	135–156	114–156
	Mean	147	133	140	117	150	145	142

Numbers in parentheses indicate number of specimens measured.
*Measured from level of genital setae insertions.

Our specimens fall into four groups designated A, B, C, and D. GROUP A (pl. 8), with 100 specimens from *Oryzomys caliginosus*, 2 specimens from *Nectomys alfari*, 1 specimen from *Zygodontomys microtinus*, from Cerro Azul, Cerro Campana, El Valle, and Bocas del Toro, is the largest of the four groups. The length of the dorsal plate ranges from a minimum of 1612 μ in the Bocas del Toro specimens to a maximum of 1956 μ in the Cerro Campana specimens. The length of the sternal plate ranges from a minimum of 374 μ in the Cerro Azul and Bocas del Toro specimens to a maximum of 455 μ in the Cerro Campana specimens. The setae of coxa I are more robust, the venter is more setose, and the epigynial plate is expanded somewhat more than in Group B. Group A resembles Fonseca's *G. vitzthumi.*

GROUP B (pl. 9), 12 specimens from *Oryzomys capito* and 2 specimens from *O. fulvescens* from El Valle, is characterized as follows: the length of the dorsal plate varies from 1612 to 1664 μ and the sternal plate ranges from 270 to 312 μ in length; the anterior margin of the sternal plate is not projected forward as radically as in Group A; the setae of coxa I are setiform, and the setation of the venter is somewhat more sparse than in Group A.

GROUP C (pl. 10), 12 specimens from *Sigmodon hispidus* from Bocas del Toro, differs little from the previous group except that the coxal setae are very short and somewhat spiniform. The orientation of the coxae may account for this seeming difference. Also, the venter is more setose than in Group B.

GROUP D (pl. 11), 8 specimens from *O. fulvescens* from Cerro Punta (Chiriquí) and 13 specimens from *O. fulvescens* from Rancho Mojica (Bocas del Toro), differs from the other groups in the following characters: size is small, the length of the dorsal plate varying from 1404 to 1580 μ and that of the sternal plate from 281 to 292 μ; the setae of coxa I, especially the distal seta, are piliform; the penultimate setae of the dorsal plate extend beyond the margin of the plate for more than one-half of their length and the epigynial plate is expanded only slightly. This group appears to be Fonseca's *G. wolffsohni, s. str.*

We have not overlooked the possibility that these four groups may represent four distinct species, but because of the gradation in size, shown in table 3, we prefer to refer all of our specimens to one species, *G. wolffsohni.* A detailed study of specimens from its entire range will be necessary before the composition of this particular taxon is understood. However, for the moment we may say that *G. wolffsohni, s. lat.*, is a highly variable species which has both a wide geographical and ecological range.

Comments on the Genus *Gigantolaelaps*

Furman and Tipton (1961) have pointed out that the unusually high degree of apparent variation in *Gigantolaelaps* "may be linked in part to the evolutionary status of the host genera" as well as to a certain amount of distortion associated with the mounting technique used. We have several long series each, from single host animals. The adults in these series apparently are not all the same age; in addition, it appears that not all have fed as adults. It would be interesting and profitable to investigate the changes in total size

TABLE 3. MEASUREMENTS OF *GIGANTOLAELAPS WOLFFSOHNI* (SENSU LATO).
(in microns)

		A				B	C	D	
		Oryzomys caliginosus			*Nectomys alfari*	*Oryzomys capito*	*Sigmodon hispidus*	*Oryzomys fulvescens*	
Character		Bocas del Toro	Cerro Azul	Cerro Campana	Cerro Azul	El Valle	Bocas del Toro	Rancho Mojica	Cerro Punta
Length of Sternal Plate	Range	374–406	385–426	416–455	374–385	270–312	302–312	281–292	281–291
	Mean	392	413	438	379	293	308	289	286
Length of 1st pair of Sternal Setae	Range	312–385	364	374–416	332	322–343	281–343	291–332	302–332
	Mean	349	364	392	332	334	312	310	315
Distance between 1st pair of Sternal Setae	Range	198–228	185–192	192–210	160–172	135–161	148–161	132–145	135–146
	Mean	207	190	203	166	146	158	138	142
Length of Distal Seta, Coxa I	Range	88–109	100–114	109–120	73	130–146	52–62	104–125	104–130
	Mean	101	107	113	73	139	55	110	120
Length of Proximal Seta, Coxa I	Range	68–109	104	110–114	73–83	99–108	52–62	85–104	78–104
	Mean	94	104	112	78	102	50	95	91
Length of Genital Plate	Range	302–332	281–302	312–332	322	265–281	312–343	250–270	228–270
	Mean	316	289	318	322	271	322	257	254
Length of Genital Setae	Range	291–312	281–343	312–332	312	290–343	281–332	312–332	322–343
	Mean	300	312	326	312	316	300	318	334
Distance between Genital Setae	Range	239–291	245–275	265–286	200–250	224–235	204–239	200–239	213–225
	Mean	272	257	280	235	228	231	216	218
Length of Penultimate Setae of Dorsal Plate	Range	114–130	93–104	104–114	88–94	99–114	83–104	120–145	110–172
	Mean	119	99	109	91	106	99	132	141
Length of Dorsal Plate	Range	1612–1768	1747–1924	1820–1956	1745–1820	1612–1664	1643–1716	1404–1456	1404–1580
	Mean	1695	1841	1895	1780	1624	1666	1414	1497

and degree of sclerotization over the life span of adult mites of this genus. It may be that plates and setae only appear to increase in size because of changes in sclerotization as a result of aging.

Genus **Haemolaelaps** Berlese

Haemolaelaps Berlese, 1910, Redia, **6**: 261.
Atricholaelaps Ewing, 1929, Man. Ext. Parasites, p. 186.
Ischnolaelaps Fonseca, 1935, Mem. Inst. Butantan, **10**: 19.

Type-species: *Haemolaelaps marsupialis* Berlese, 1910.

We have obtained specimens of this genus from nearly every species of rodent we have collected, as well as from several marsupials. It appears that almost all host species have a distinct population of *Haemolaelaps* and further, that each host species has distinctive populations in each collecting locality. Either host specificity is very marked, with little individual variation in a population, or else host specificity is almost entirely lacking and variation is much greater than is known for other laelaptine genera. If the latter is true, then it may be that variation is inversely proportional to host specificity.

The shape of the pilus dentilis frequently has been used as a specific character. Allred (1958) has suggested that it would be better employed to separate groups of species. This structure is delicate and is susceptible to distortion which renders it of questionable taxonomic value. We have a series in which the pilus dentilis is inflated in some specimens while in others it appears to have burst during the mounting process. In another series from *Nyctomys sumichrasti* (pl. 13), the apical as well as the proximal portion is swollen. Some of the specimens from *Metachirus nudicaudatus* are similar to those from *Nyctomys,* while others have the pilus dentilis inflated proximally only, as figured in plate 18.

Other characters too are variable within a series from a single host animal. Degree of sclerotization, length and number of setae (the latter may be due in part to orientation of the mite on the slide), and shape and size of the anal plate vary considerably. On the other hand some characters are remarkably constant, e.g., the shape of the sternal plate, the shape and length of the setae of coxa I, and the relative length of the gnathosomal and hypostomal setae.

We are referring most of our specimens to a single species, *Haemolaelaps glasgowi* (Ewing), although it is evident that there are some extreme differences among our specimens. Specimens collected from *Peromyscus nudipes* and *Reithrodontomys sumichrasti* at high elevations conform more closely to the figures and description given by Strandtmann (1949) than do those collected at low elevations. Plates 12 to 23 show the range of variation.

Haemolaelaps glasgowi (Ewing). Plates 12-23.

Laelaps glasgowi Ewing, 1925, Proc. Ent. Soc. Wash., **27**: 1–7 (Illinois, U.S.A.).
Haemolaelaps glasgowi Strandtmann, 1949, Jour. Parasit., 35, (3), pp. 325–352.

MATERIAL EXAMINED: 102 females from *Peromyscus nudipes,* 41 females from *Oryzomys fulvescens,* 19 females from *O. albigularis,* 14 females from *Reithrodontomys mexicanus,* 12 females from *R. sumichrasti,* 17 females and 1 male from *R. creper,* 1 female from *Scotinomys teguina,* and 19 females from *S. xerampelinus,* from Rancho Mojica, Cerro Punta or Boquete Trail; 49 females from *Sigmodon hispidus,* 14 females and 1 male from *Oryzomys capito,* 1 female from *O. fulvescens,* 4 females from *O. caliginosus,* 6 females from *O. alfaroi,* 1 female from *O. bombycinus,* 1 female from *Tylomys panamensis,* 11 females from *Nectomys alfari,* 4 females from *Nyctomys sumichrasti,* 3 females from *Liomys adspersus,* 4 females and 1 male from *Hoplomys gymnurus,* 7 females from *Rattus rattus,* 9 females from *Proechimys semispinosus,* 3 females from *Heteromys desmarestianus,* 2 females from *H. australis,* 2 females from *Zygodontomys microtinus,* 26 females from *Sciurus granatensis,* 47 females from *Metachirus nudicaudatus,* 8 females from *Philander opossum,* and 3 females from *Didelphis marsupialis,* mostly from Cerro Azul (Panamá) and Canal Zone.

REMARKS: Specimens from Rancho Mojica and Cerro Punta are more nearly like figures and description given by Strandtmann (1949) than those from Cerro Azul and the Canal Zone. Those from *Hoplomys gymnurus* are the largest (dorsal plate over 800 μ in length) and those from *Sigmodon hispidus* the smallest (dorsal plate 572 μ in length). The setae of the dorsal plate are robust and uniform in size in specimens from marsupials (pl. 18), while in specimens from oryzomine rodents (pl. 13), the setae of the dorsal plate are smaller and not uniform in size.

The pilosity of unarmed areas in specimens from *Nyctomys sumichrasti* (pl. 13) is sparse whereas it is much denser in specimens from *Metachirus nudicaudatus.* In considering these differences, especially the extremes in the range of variation, it seemed advisable to describe several new species. However, it was impossible to find a well delineated group of specimens that did not merge into the next group.

The genus *Haemolaelaps* is badly in need of revision. For the Neotropical Region it will be necessary to study long series from many localities in order to understand variation and geographical distribution. To describe new species now would only add confusion to a problem which becomes even more complex as additional material becomes available.

Genus **Laelaps** Koch

Laelaps Koch, 1836, Deutschl. Crust. Myriap. Arach., pt. 4, p. 19. Tipton, 1960, Univ. Calif. Publ. Ent., 16, (6), pp. 260–262 (generic revision).

Type-species: *Laelaps agilis* Koch, 1836.

Several South American representatives of *Laelaps* occur in Panama. This is not surprising since several of the host genera occur throughout Central and South America.

KEY TO THE PANAMANIAN SPECIES OF *LAELAPS*

Females

1. Gnathosomal setae at least twice as long as distal seta of coxa I .... *L. dearmasi* Furman and Tipton
   Gnathosomal setae not twice as long as distal seta of coxa I 2

2. Distance between fourth pair of genito-ventral setae approximately the same as distance between first pair of genito-ventral setae .... *L. nuttalli* Hirst
Distance between fourth pair of genito-ventral setae much less than the distance between first pair of genito-ventral setae 3
3. Distance between second pair of genito-ventral setae approximately four times greater than distance between fourth pair of genito-ventral setae .... *L. paulistanensis* Fonseca
Distance between second pair of genito-ventral setae not more than three times greater than distance between fourth pair of genito-ventral setae 4
4. Proximal seta of coxa I at least three times as wide as distal seta 5
Proximal seta of coxa I less than three times as wide as distal seta ... *L. thori* Fonseca
5. Medial setae of the dorsal plate about 30 μ in length .... *L. pilifer* n. sp.
Medial setae of the dorsal plate about 52 μ in length .... *L. castroi* Fonseca

Laelaps castroi Fonseca. Plate 24.

Laelaps castroi Fonseca, 1958, Mem. Inst. Butantan, 28: 116 (Pernambuco, Brazil).

MATERIAL EXAMINED: 64 females from *O. alfaroi* and 30 females from *O. fulvescens* from Cerro Punta (Chiriquí); 13 females from *O. fulvescens* and 1 female from *Peromyscus nudipes* from Rancho Mojica (Bocas del Toro), January 1960 to March 1962, collected by C. O. Handley, C. M. Keenan and V. J. Tipton.

REMARKS: *L. castroi* may be distinguished from other species of the genus in Panama by the following combination of characters: short, robust proximal seta and a longer piliform seta on coxa I, fairly robust setae on the dorsal plate, and gnathosomal setae almost as long as the medial hypostomal setae.

Our specimens are much smaller than those from Venezuela and are not as heavily sclerotized. The length of the idiosoma as recorded by Fonseca is 670 μ, while our specimens are only 560 μ. The size and shape of the setae of coxa I vary somewhat from the figures given by Fonseca but are of the same general configuration.

Laelaps dearmasi Furman and Tipton. Plates 25, 26, 30 (figs. 4, 6, 7, 9).

Laelaps dearmasi Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle, 21, (60), pp. 187–191, pls. 8, 9.

MATERIAL EXAMINED: A total of 191 females and 7 males as follows: 139 females, 5 males from *Zygodontomys microtinus,* 20 females from *Proechimys semispinosus,* 6 females and 1 male from *Oryzomys capito,* 1 female from *O. caliginosus,* 5 females from *Rattus rattus,* 19 females and 1 male from *Sigmodon hispidus* and 1 female from "rat"; all from Canal Zone (except 16 females from Cerro Azul), July 1956 to September 1960, collected by R. M. Altman, C. M. Keenan and V. J. Tipton.

REMARKS: *L. dearmasi* is the only Panamanian species of *Laelaps* that has long, robust gnathosomal setae which extend beyond the posterior margin of the gnathosoma. Panamanian specimens differ little from Venezuelan material. The distal seta of coxa I is somewhat more robust in our specimens.

Laelaps nuttalli Hirst

Laelaps nuttalli Hirst, 1915, Bull. Ent. Res., 6: 183 (Colombo, Ceylon).
Laelaps hawaiiensis Ewing, 1924, Bull. B. P. Bishop Mus. Honolulu, 98: 118.
Haemolaelaps nuttalli Turk, 1950, Parasitology, 40, (1–2), p. 67.

MATERIAL EXAMINED: 11 females from *Rattus norvegicus*, 6 females from *Proechimys semispinosus*, plus hundreds of specimens in alcohol from *Rattus rattus;* Canal Zone, July 1959 to December 1961, collected by C. M. Keenan and V. J. Tipton.

REMARKS: *L. nuttalli* has a short, spiniform distal seta and a longer piliform proximal seta on coxa I. The distance between the first pair of epigynial setae is about the same as the distance between the fourth pair. Specimens from Panama fall within the range of intra-specific variation for this species and are very similar to specimens from the United States.

Laelaps paulistanensis Fonseca. Plate 27.

Laelaps paulistanensis Fonseca, 1935, XII Int. Congr. Zool., p. 1610.

MATERIAL EXAMINED: 6 females from *Oryzomys alfaroi* from Cerro Punta (Chiriquí), January and February 1960, collected by C. M. Keenan and V. J. Tipton.

REMARKS: *L. paulistanensis* is the largest of the Panamanian species and as in *L. dearmasi,* its epigynial plate is greatly expanded so that the distance between the second pair of setae is at least twice as great as the distance between the fourth pair.

Our specimens are smaller (936 μ compared with 1030 μ recorded by Fonseca), the anterior setae of the dorsal plate are longer, the anal plate is broader in outline, and the anterior margin straighter than is described and figured by Fonseca (1936). However, the measurements of the ventral plates and setae and the coxal seate conform quite closely to Fonseca's description.

Laelaps pilifer Tipton, new species. Plates 28, 30 (figs. 5, 11).

DIAGNOSIS: *L. pilifer* n. sp., belongs to a species complex which includes *L. paulistanensis* Fonseca, *L. differens* Fonseca, *L. castroi* Fonseca, *L. oryzomydis* Pratt and Lane, and *L. manguinhosi* Fonseca. *L. paulistanensis* and *L. pilifer* have short delicate setae on the dorsal plate, a robust proximal seta and a piliform distal seta on coxa I. *L. paulistanensis* is a larger species (idiosoma over 1000 μ compared with 510 μ) and the distance between the second pair of epigynial setae is four times the distance between the fourth pair, while it is approximately three times in *L. pilifer*. In the latter species the distal seta of coxa I is much more delicate and the proximal seta shorter than in *L. paulistanensis.*

DESCRIPTION: *Idiosoma.*—510 μ long, by 322 μ wide.

Dorsum.—Dorsal plate elliptical, with prominent shoulders; 477 μ long by 292 μ wide; covers almost entire dorsum leaving only narrow, latero-posterior band of soft integument. Setae of dorsal plate rather delicate, not reaching to bases of setae in next row; 35 pairs; penultimate pair much smaller than medial setae; last pair longer than others; one pair of round pores adjacent to penultimate setae, an additional pair cephalad and laterad of these.

Venter.—Tritosternum bifurcate, pilose. Sternal plate 108 μ wide by 86 μ long with three pairs setae of about same length; two pairs slit-like pores. Endapodal plates rather well defined; setae about same size as sternal setae. Epigynial plate expanded, with four pairs setae; distance between first pair 80 μ, second pair 145 μ, third pair 88 μ, fourth pair 52 μ; surface of plate with transverse lines. Metapodal plates discrete. Anal plate shield-like; 77 μ wide by 58 μ long (measured to base of postanal seta); adanal setae originate cephalad of posterior margin of anus; 31 μ long. Postanal seta 40 μ long. Approximately 10 pairs setae on unarmed venter. Peritreme reaches beyond middle of coxa II; extends posterior of stigma.

Legs.—Robust, with claws and caruncles. Leg IV longest, leg III shortest. Coxae I, III with spiniform setae; proximal seta of coxa I short, spiniform; distal seta very delicate, shorter than proximal seta. Dorsal apices of femur and genu I with setae no stronger than dorsal setae.

Gnathosoma.—Deutosternum with seven rows of two to five teeth per row. Gnathosomal setae slightly more than one-half length of medial hypostomal setae. Epipharynx long, apex rounded. Hypostome bipartite, fimbriate. Chelae well developed, toothed; fixed digit with long, slightly inflated seta. Tectum single, membranous flap; apex rounded.

TYPE MATERIAL: Holotype female from *Oryzomys capito* (field no. 7104), Río Seteganti (Darién), 5 February 1961, collected by C. M. Keenan, V. J. Tipton and C. E. Yunker. In the collection of the United States National Museum. Paratypes: 80 females from *O. capito*, 2 females from *O. caliginosus* and 1 female from *O. bombycinus*, Cerro Azul; 57 females from *O. capito*, 9 females from *Proechimys semispinosus* and 1 female from *Didelphis marsupialis*, Camp Piña (Canal Zone); 10 females from *O. capito*, Río Seteganti (Darién); 8 females from *O. capito*, Cerro Hoya (Los Santos); July 1956 to February 1962, collected by R. M. Altman, C. O. Handley, C. M. Keenan and V. J. Tipton. In the collections of the Environmental Health Branch, Canal Zone, and V. J. Tipton.

Laelaps thori Fonseca. Plates 29, 30 (figs. 1, 8).

Laelaps thori Fonseca, 1939b, Mem. Inst. Butantan, 12: 111 (transl., p. 133), fig. 5.

MATERIAL EXAMINED: 14 females from *Oryzomys albigularis* and 2 females from *Peromyscus flavidus*, Rancho Mojica (Bocas del Toro), September 1961, collected by V. J. Tipton; 3 females from *O. albigularis*, Cerro Punta (Chiriquí), February 1960, collected by C. M. Keenan and V. J. Tipton; 2 females from *O. capito*, Cerro Azul, July 1956, collected by R. M. Altman and C. M. Keenan.

REMARKS: *L. thori* has delicate dorsal setae and the proximal seta of coxa I is stout but not spiniform. A comparison of our specimens with figures given by Fonseca reveals some differences which may constitute specific characters. In our specimens the venter is more setose, the anal plate appears to be wider, and the dorsal setae are shorter and more delicate. In spite of these differences we are referring our specimens to this species.

In specimens from Cerro Azul (pl. 29) the proximal seta is shorter and thicker than in those from Rancho Mojica, and there are two or three more setae on the venter. Specimens from Cerro Punta are closer to Fonseca's figures than those from Rancho Mojica and the Rancho Mojica specimens are closer than those from Cerro Azul. This entire series is probably conspecific and may even be an extension of the *L. pilifer-castroi* complex.

Laelaps species. Plate 30 (figs. 2, 10).

MATERIAL EXAMINED: A single female from *Oryzomys bicolor,* Camp Piña (Canal Zone), 29 August 1956, collected by R. M. Altman and C. M. Keenan.

REMARKS: This specimen differs markedly from *L. pilifer* n. sp. in that the gnathosomal setae are minute, the proximal seta of coxa I is setiform, not spiniform and the pilus dentilis is inflated as in *Haemolaelaps.* Although it probably represents an undescribed species of *Laelaps,* we shall await further material before making a decision as to its disposition.

Comments on the Genus Laelaps

We are not satisfied with this arrangement of the *Laelaps* species. It is only tentative. We lack basic biological information—e.g., on host specificity, ecological and geographical patterns, and morphological changes in relation to age—essential to an understanding of the systematics of a taxon. Apparently the species of this genus have a wide geographic range.

Within a large group of specimens, the *castroi-pilifer-thori* complex, there are several more or less distinct subgroups. The characters which separate the species of the complex are not clearly defined and there is extreme variation within a long series from the same host specimen. Characters thought to be constant in this genus, e.g., shape and size of coxal setae, plate size and shape and details of the chelicerae, are variable even on the same specimen. If one could obtain specimens from enough localities a few miles apart, it is possible that one would find clines of characters throughout Central and South America. Many species now regarded as distinct might prove to represent population differences along these clines.

Genus **Mysolaelaps** Fonseca

Mysolaelaps Fonseca, 1935, Mem. Inst. Butantan, **10**: 17.

Type-species: *Mysolaelaps parvispinosus* Fonseca, 1935.

We have collected only one species of *Mysolaelaps* although a second is probably present. *Mysolaelaps heteronychus* Fonseca occurs on a species of *Rhipidomys* in Venezuela. We have been unable to collect this host in Panama, although one species is represented in the fauna.

Mysolaelaps parvispinosus Fonseca. Plate 31.

Mysolaelaps parvispinosus Fonseca, 1936, Mem. Inst. Butantan, **10**: 17. (São Paulo, Brazil).

MATERIAL EXAMINED: 2 females from *Oryzomys capito,* El Valle, 27 March 1957, and 3 females from *O. fulvescens,* Cerro Jeffe, 7 February 1958, collected by R. M. Altman and C. M. Keenan.

REMARKS: *Mysolaelaps parvispinosus* is readily separated from the other two neotropical species of *Mysolaelaps.* The genito-ventral setae of *M. heteronychus* are minute and approximately equal in size, while in *M. parvispinosus* the first pair of genito-ventral setae are much smaller than the last three pairs. The sternal setae of *M. microspinosus* are small and approximately equal in size whereas the first pair of sternal setae of *M. parvispinosus* are small, the second and third pairs are more robust and are more than twice as long as the first pair.

The first pair of epigynial setae measure 68 to 80 μ long whereas they were only 57 μ long in specimens from Brazil and Venezuela. The fourth pair of epigynial setae are more widely separated in our specimens (169-198 μ; mean of five specimens, 175 μ) than in Venezuelan specimens (130 to 156 μ; mean of five specimens, 151 μ). Although our series is small there appears to be considerable variation in this species.

Genus **Steptolaelaps** Furman

Steptolaelaps Furman, 1955b, Jour. Parasit., 41, (5), p. 519.

Type-species: *Neolaelaps heteromys* Fox.

Only one species of this genus has been collected in Panama.

Steptolaelaps heteromys (Fox). Plates 32, 33.

Neolaelaps heteromys Fox, 1947, Zoologica, 32, (3), pp. 117–119 (Venezuela).
Steptolaelaps heteromydis Furman, 1955b, Jour. Parasit., 41, (5), p. 521.
Steptolaelaps heteromys Furman and Tipton, 1961, Mem. Soc. Cienc. Nat. La Salle; 21, (60), p. 195.

MATERIAL EXAMINED: 7 males and 43 females from *Heteromys desmarestianus;* 23 males, 71 females and 2 nymphs from *H. australis;* 4 females from *Liomys adspersus;* 2 females from *Oryzomys* sp.; 1 female from *Tylomys panamensis;* from the Canal Zone, Río Seteganti, Cerro Azul, and El Valle; March 1957, January and February 1958, January and October 1960, collected by R. M. Altman, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: *S. heteromys* is distinct from the only other species of the genus, *S. liomydis,* in having long and tapering (rather than short) gnathosomal setae and in details of the female chelicerae (Furman, 1955b). The adanal setae in our specimens appear to be slightly longer than in those figured by Furman (1955b). Otherwise, our specimens are remarkable for their lack of variation.

These mites are most commonly associated with heteromyid rodents and have been collected most frequently at elevations below 3000 feet. We have collected 76 specimens of *Heteromys desmarestianus* at elevations above 3000 feet. None of them harbored *S. heteromys.*

Genus **Tur** Baker and Wharton

Protonyssus Turk, 1946, Ann. Mag. Nat. Hist., (11), 13: 347.
Tur Baker and Wharton, 1952, Introd. Acar., p. 85 (new name for *Protonyssus* Turk, not *Protonyssus* Trouessart, 1915). Furman and Tipton, 1958, Jour. Parasit., 44, (5), pp. 541–7 (redescription of genus).

Type-species: by original designation and monotypy, *Protonyssus uniscutatus* Turk.

A new species, described below, possesses characteristics of both *Laelaps* and *Tur.* This has raised serious doubts as to the validity of the genus *Tur.* However, we choose to recognize it for the time being.

Tur anomalus Tipton, new species. Plates 30 (figs. 3, 12), 34.

DIAGNOSIS: *Tur anomalus* n. sp., runs to *T. lativentralis* (Fonseca) in the key provided by Furman and Tipton (1961). It is similar to that species in that the anal plate is separate from the epigynial plate and the gnathosomal and hypostomal setae are reduced in both species. However, *T. anomalus* is only 525 μ long whereas *T. lativentralis* is more than 1000 μ. In addition, the setae of coxa I are very short and robust and the adanal setae do not reach the base of the postanal seta in *T. anomalus*, while the setae of coxa I are at least half the length of the coxa and the adanal setae reach beyond the base of the postanal seta in *T. lativentralis*.

DESCRIPTION: *Idiosoma.*—525 μ long by 309 μ wide.

Dorsum.—Dorsal plate strongly elliptical, with prominent shoulders; 504 μ long by 260 μ wide; does not cover entire dorsum, with narrow postero-lateral band of soft integument. Setae of dorsal plate in definite pattern; 39 pairs setae; some reticulation adjacent to bases of setae.

Venter.—Tritosternum pilose. Sternal plate 128 μ wide by 109 μ long. Anterior margin straight, posterior margin slightly convex; three pairs sternal setae of approximately same length; two pairs slit-like pores. Endapodal plates fairly well defined; setae slightly longer than sternal setae. Metapodal plates elliptical. Epigynial plate expanded; with four pairs of setae; distance between first pair of setae 62 μ, second pair 108 μ, third pair 126 μ, fourth pair 92 μ; posterior margin truncate, in juxtaposition with anal plate. Anal plate broadly triangular with straight anterior margin; 92 μ wide by 71 μ long (measured to base of postanal seta); adanal setae with bases cephalad of posterior margin of anus; 24 μ long; postanal seta 28 μ long. Approximately nine pairs of setae on unarmed portion of venter. Peritremalia posterior to stigmata broad, lying in juxtaposition with parapodal plates which partially encircle coxae IV; peritremes sinuate, reaching to anterior margin of coxae II.

Legs.—Coxa I with two stout, striated, spiniform setae; proximal seta longer than distal seta; spiniform setae on coxae II and III; femur I with strong spiniform seta on ventral surface, two strong setae on dorsal surface. Legs I and II more robust than other legs; leg IV longest, leg III shortest.

Gnathosoma.—Deutosternum with usual rows of teeth. Gnathosomal setae slightly coarser than medial hypostomal setae. Epipharynx tongue-like, with medial groove. Details of the chelicerae not readily discernible but long seta at base of chela; chelae toothed; pilus dentilis apparently absent.

TYPE MATERIAL: Holotype female from *Hoplomys gymnurus* (field no. 4038), Cerro Azul (Panama), 29 January 1958, collected by R. M. Altman and C. M. Keenan. In the collection of the United States National Museum. Eleven paratype females, same data and repository as the holotype.

REMARKS: *T. anomalus* exhibits even more characteristics of *Laelaps* than does *T. lativentralis.* The gnathosomal and hypostomal setae are reduced. The posterior margin of the sternal plate is not deeply invaginated and the setae of the dorsal plate as well as of the venter are not robust as in other species of the genus. The broad peritremalia, the anal plate lying in juxtaposition with the epigynial plate and the details of the female chelicerae, though not clearly visible, show some affinities with other species of *Tur.* The discovery of this species emphasizes again (Furman and Tipton, 1961) that the differences between *Tur* and *Laelaps* are not as marked as was first supposed.

Tur uniscutatus (Turk). Plates 35, 36.

Protonyssus uniscutatus Turk, 1946, Ann. Mag. Nat. Hist., (11), 13: 347.
Tur uniscutatus Baker and Wharton, 1952, Introd. Acar., p. 85. Furman and Tipton, 1958, Jour. Parasit., 44 (5), pp. 541–547.

MATERIAL EXAMINED: 1228 females and 43 males from *Proechimys semispinosus* from the Canal Zone; 303 females from *P. semispinosus* from Almirante (Bocas del Toro) and 21 females and 1 male from *P. semispinosus* from Cerro Azul; 16 females from *Didelphis marsupialis,* 3 females from *Marmosa robinsoni,* 1 female from *Philander opossum* and 1 female from *Heteromys desmarestianus,* Camp Piña (Canal Zone); 13 females from *Nasua nasua,* Gamboa (Canal Zone); 6 females from *Hoplomys gymnurus,* Cerro Azul and Almirante; 13 females from "rat", Barro Colorado Island; collected from July 1956 to July 1960 by R. M. Altman, C. O. Handley, C. M. Keenan and V. J. Tipton.

REMARKS: More than 95 percent of our 1649 specimens are from *Proechimys semispinosus.* Although this represents a long series, the range of variation is not as great as in species of other neotropical genera. Plates 35 and 36 show the extremes in variation, mostly differences in the diameter of the gnathosomal setae, size and number of setae on the venter, and minor differences in the details of the female chelicerae. Figures of Panamanian specimens given by Furman and Tipton (1958) differ slightly from our illustrations in these same characters. A study of all the specimens from which the drawings were made reveals that the differences are not as great as the illustrations indicate. However, specimens from Bocas del Toro do have heavier body setae and the female holoventral plate is slightly more expanded than in specimens from other localities.

HOST-PARASITE LIST

Class Mammalia

Order Marsupialia
Family Didelphidae

Marmosa robinsoni
Tur uniscutatus (Turk)

Didelphis marsupialis
Gigantolaelaps inca Fonseca
" *oudemansi* Fonseca
Laelaps pilifer n. sp.
Tur uniscutatus (Turk)
Haemolaelaps glasgowi (Ewing)

Philander opossum
Tur uniscutatus (Turk)
Haemolaelaps glasgowi (Ewing)

Metachirus nudicaudatus
Haemolaelaps glasgowi (Ewing)

Order Rodentia
Suborder Sciuromorpha
Family Sciuridae

Sciurus granatensis
Haemolaelaps glasgowi (Ewing)

Family Heteromyidae

Heteromys australis
Steptolaelaps heteromys (Fox)
Haemolaelaps glasgowi (Ewing)

Heteromys desmarestianus
Steptolaelaps heteromys (Fox)
Eubrachylaelaps jamesoni Furman
Tur uniscutatus (Turk)
Haemolaelaps glasgowi (Ewing)

Liomys adspersus
Steptolaelaps heteromys (Fox)
Haemolaelaps glasgowi (Ewing)

Suborder Myomorpha
Family Cricetidae

Oryzomys albigularis
Gigantolaelaps inca Fonseca
Laelaps thori Fonseca

Oryzomys alfaroi
Gigantolaelaps gilmorei Fonseca
" *inca* Fonseca
" *oudemansi* Fonseca
Laelaps castroi Fonseca
" *paulistanensis* Fonseca
Haemolaelaps glasgowi (Ewing)

Oryzomys bicolor
Gigantolaelaps oudemansi Fonseca
Laelaps sp.

Oryzomys bombycinus
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
Laelaps pilifer n. sp.
Haemolaelaps glasgowi (Ewing)

Oryzomys caliginosus
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Laelaps dearmasi Furman and Tipton
" *pilifer* n. sp.
Haemolaelaps glasgowi (Ewing)

Oryzomys capito
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman and Tipton
" *pilifer* n. sp.
" *thori* Fonseca
Mysolaelaps parvispinosus Fonseca

Oryzomys fulvescens
Gigantolaelaps oudemansi Fonseca
" *wolffsohni* (Oudemans)
Eubrachylaelaps jamesoni Furman
Laelaps castroi Fonseca
Mysolaelaps parvispinosus Fonseca
Haemolaelaps glasgowi (Ewing)

Oryzomys sp.
Steptolaelaps heteromys (Fox)

Nectomys alfari
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Echinolaelaps lowei n. sp.
Haemolaelaps glasgowi (Ewing)

Tylomys panamensis
Steptolaelaps heteromys (Fox)
Haemolaelaps glasgowi (Ewing)

Nyctomys sumichrasti
Haemolaelaps glasgowi (Ewing)

Reithrodontomys creper
Eubrachylaelaps jamesoni Furman
Haemolaelaps glasgowi (Ewing)

Reithrodontomys mexicanus
Haemolaelaps glasgowi (Ewing)

Reithrodontomys sumichrasti
Gigantolaelaps gilmorei Fonseca
Haemolaelaps glasgowi (Ewing)

Peromyscus flavidus
Gigantolaelaps inca Fonseca
" *oudemansi* Fonseca
Laelaps thori Fonseca

Peromyscus nudipes
Eubrachylaelaps jamesoni Furman
Gigantolaelaps inca Fonseca
Laelaps castroi Fonseca
Haemolaelaps glasgowi (Ewing)

Zygodontomys microtinus
Gigantolaelaps gilmorei Fonseca
" *goyanensis* Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Laelaps dearmasi Furman and Tipton
Haemolaelaps glasgowi (Ewing)

Scotinomys teguina
Haemolaelaps glasgowi (Ewing)

Scotinomys xerampelinus
Haemolaelaps glasgowi (Ewing)

Sigmodon hispidus
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Laelaps dearmasi Furman and Tipton
Haemolaelaps glasgowi (Ewing)

Family Muridae

Rattus norvegicus
Laelaps nuttalli Hirst

Rattus rattus
Echinolaelaps echidninus (Berlese)
Laelaps dearmasi Furman and Tipton
" *nuttalli* Hirst
Haemolaelaps glasgowi (Ewing)

Suborder Hystricomorpha
Family Echimyidae

Proechimys semispinosus
Tur uniscutatus (Turk)
Gigantolaelaps gilmorei Fonseca
Laelaps dearmasi Furman and Tipton
" *nuttalli* Hirst
" *pilifer* n. sp.
Haemolaelaps glasgowi (Ewing)

Hoplomys gymnurus
Tur uniscutatus (Turk)
" *anomalus* n. sp.
Haemolaelaps glasgowi (Ewing)

Order Carnivora
Family Procyonidae

Nasua nasua
Tur uniscutatus (Turk)

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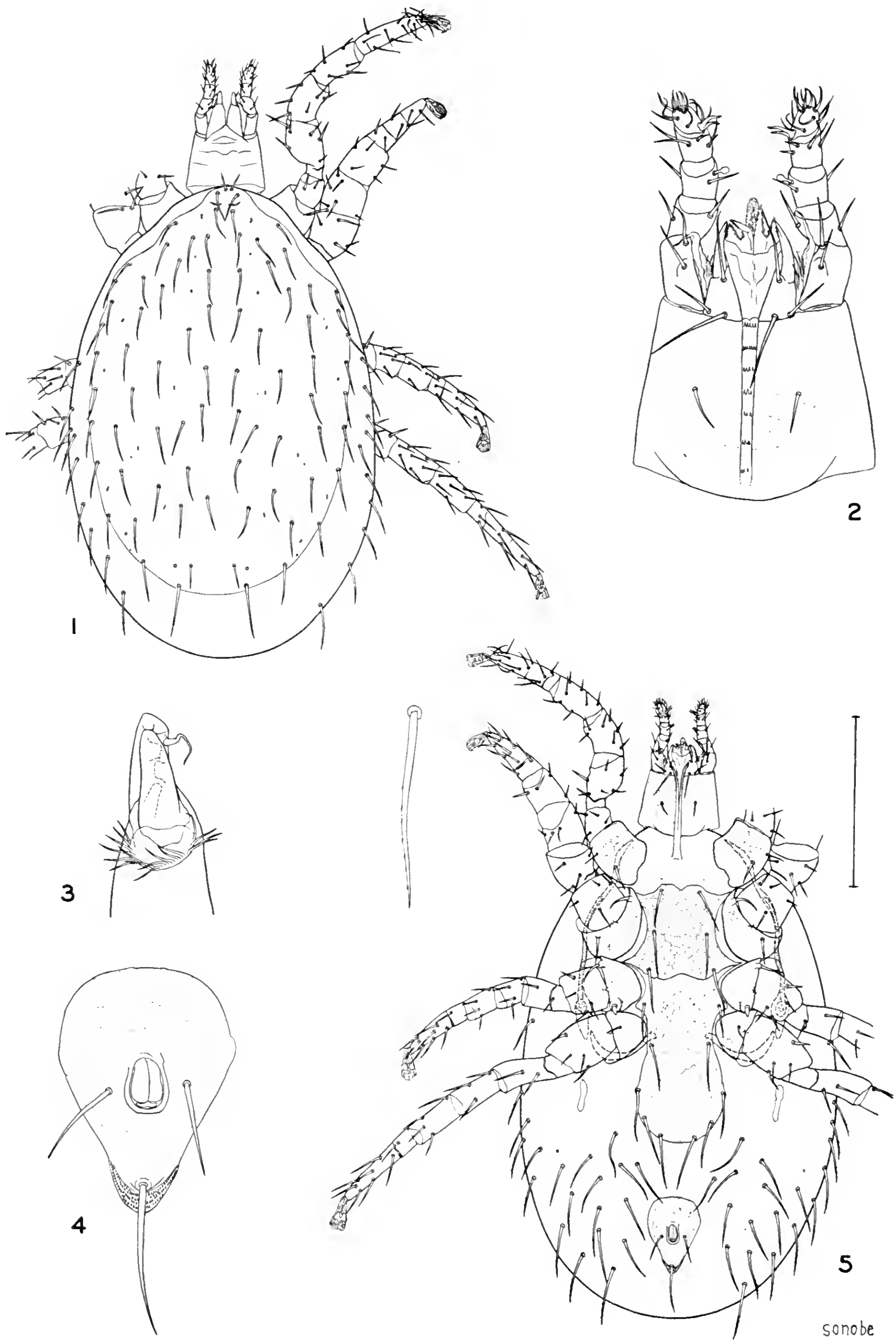
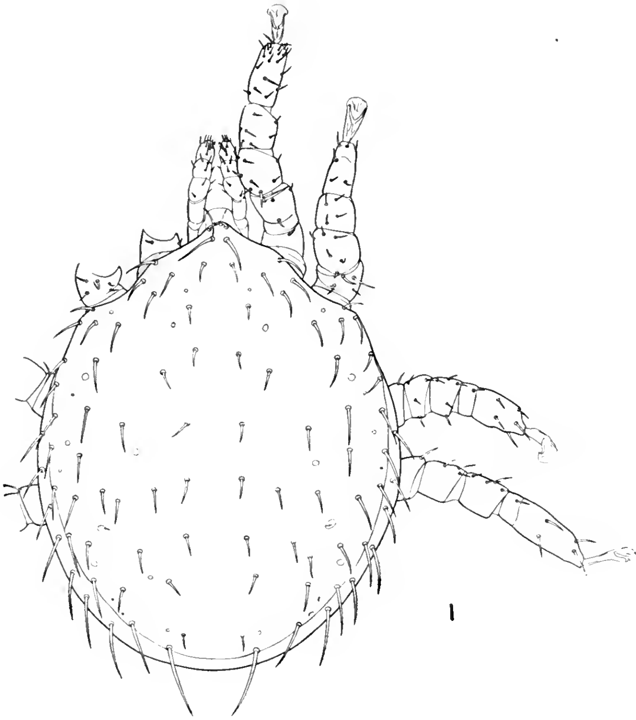


Echinolaelaps lowei Tipton, new species, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



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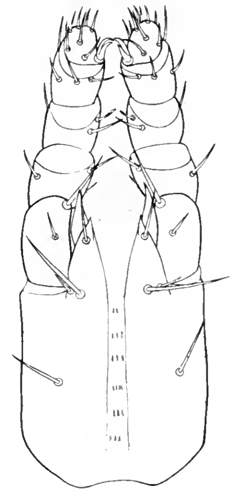

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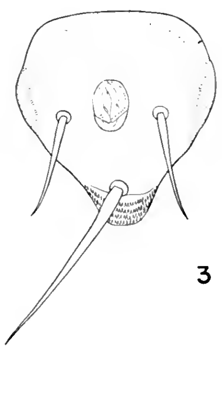

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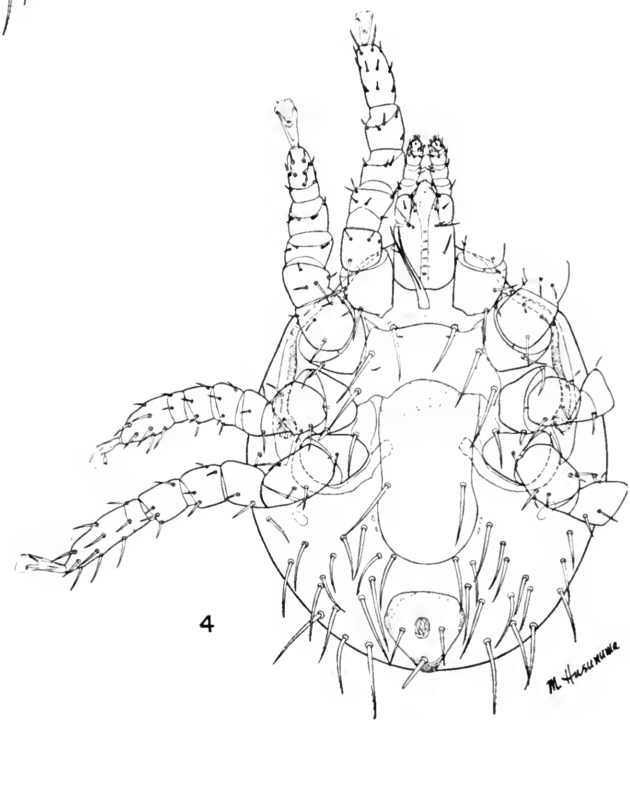

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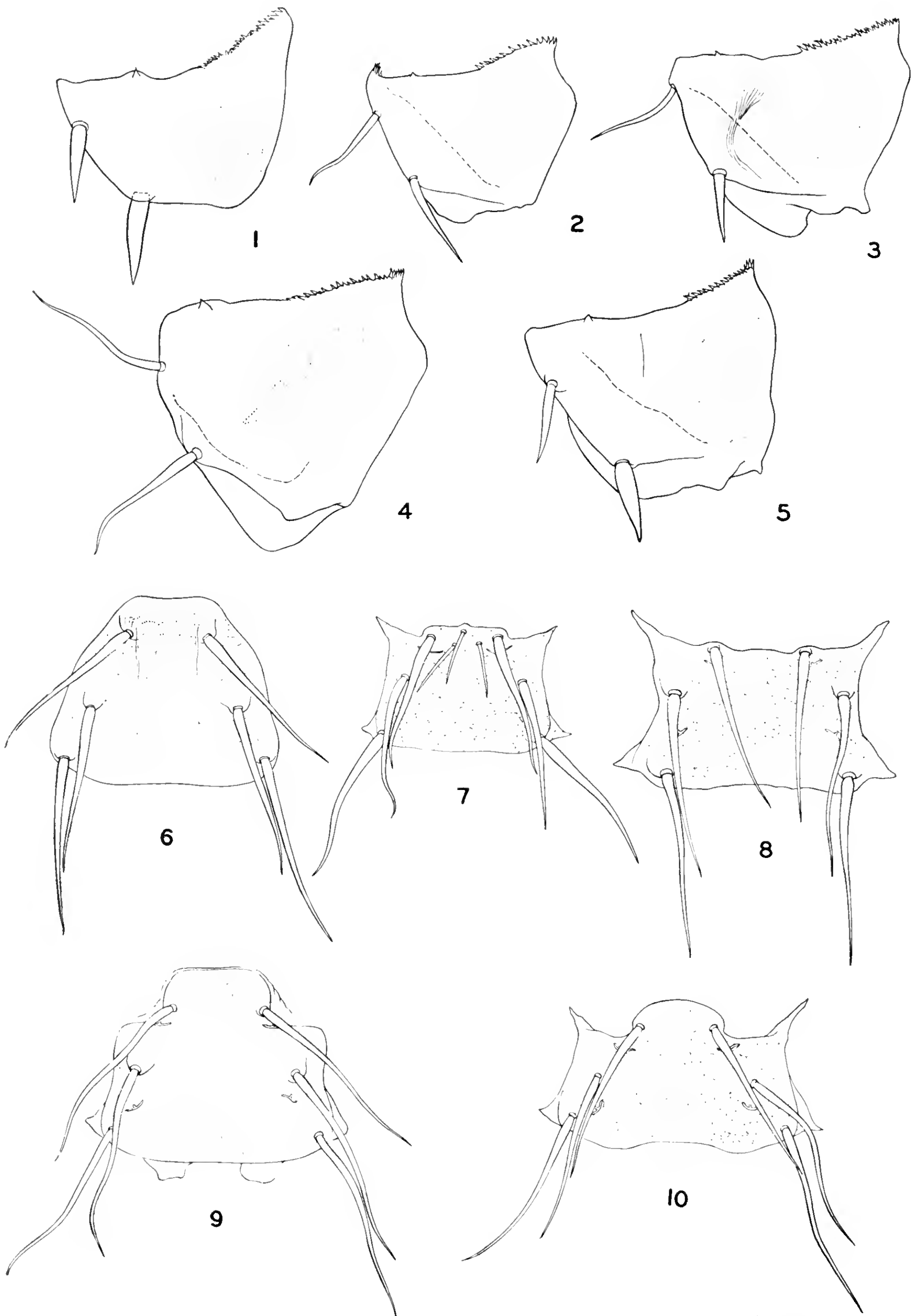
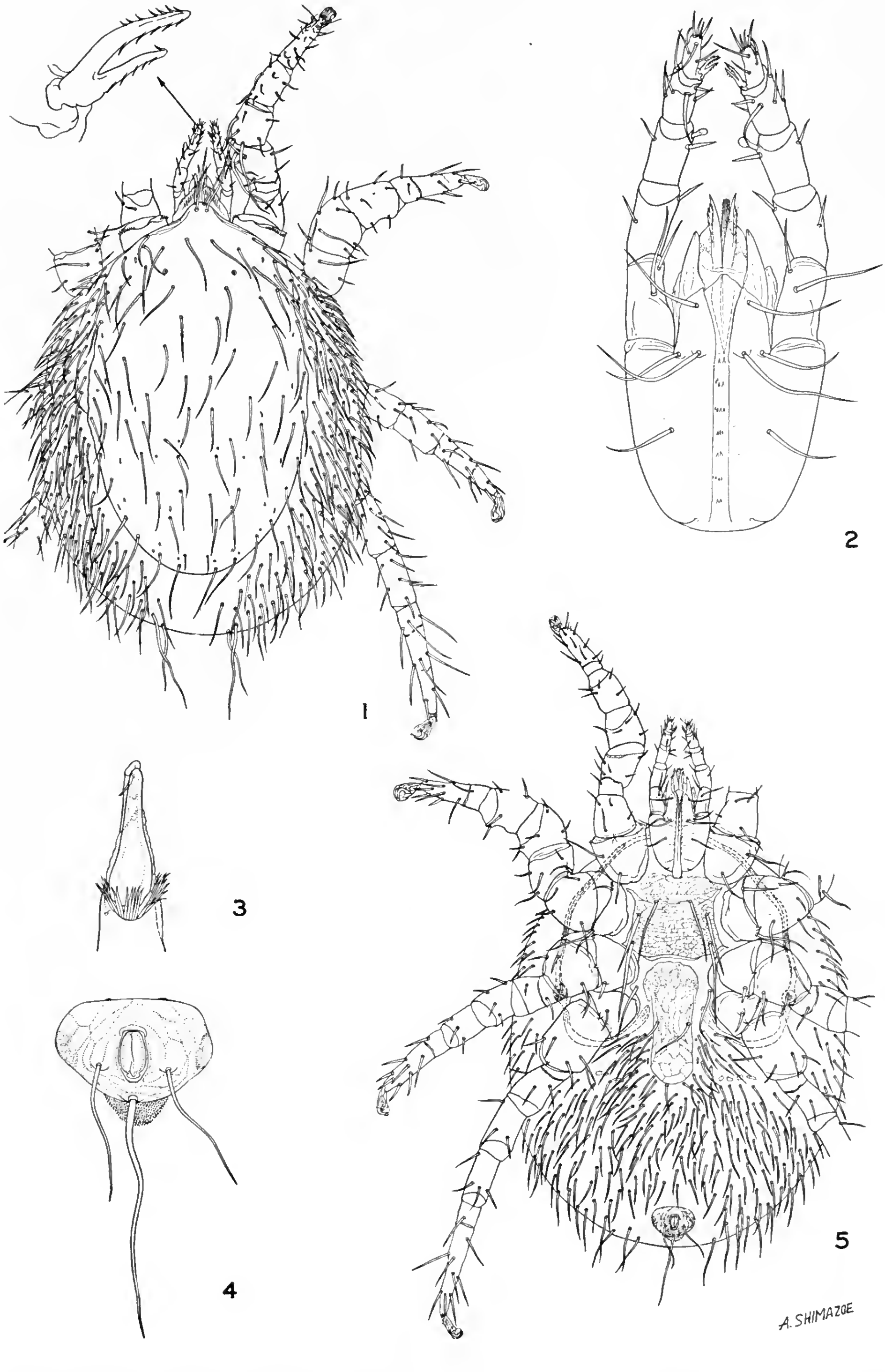
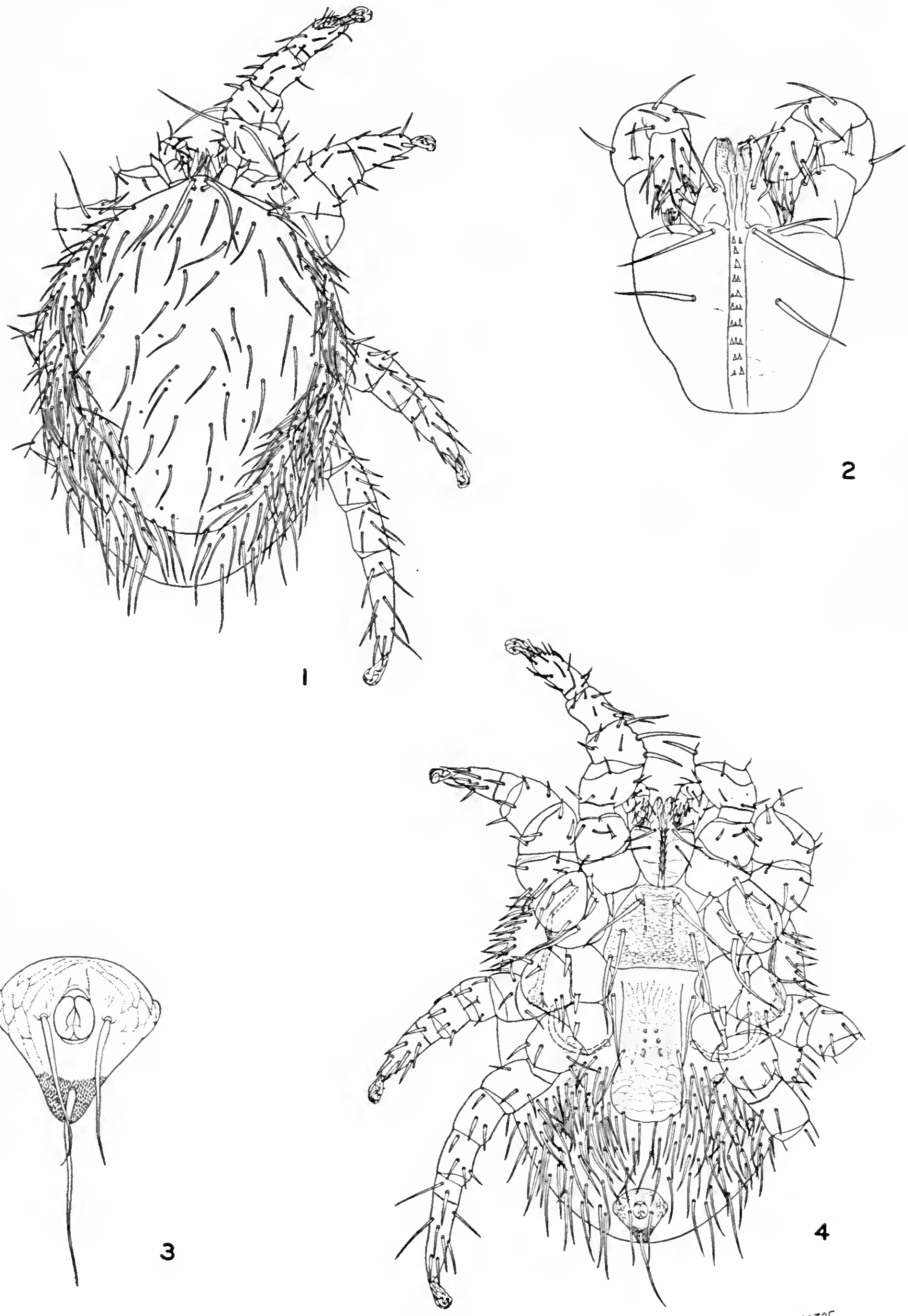
Eubrachylaelaps jamesoni Furman, female. 1, dorsal view. 2, gnathosoma. 3, anal plate. 4, ventral view.



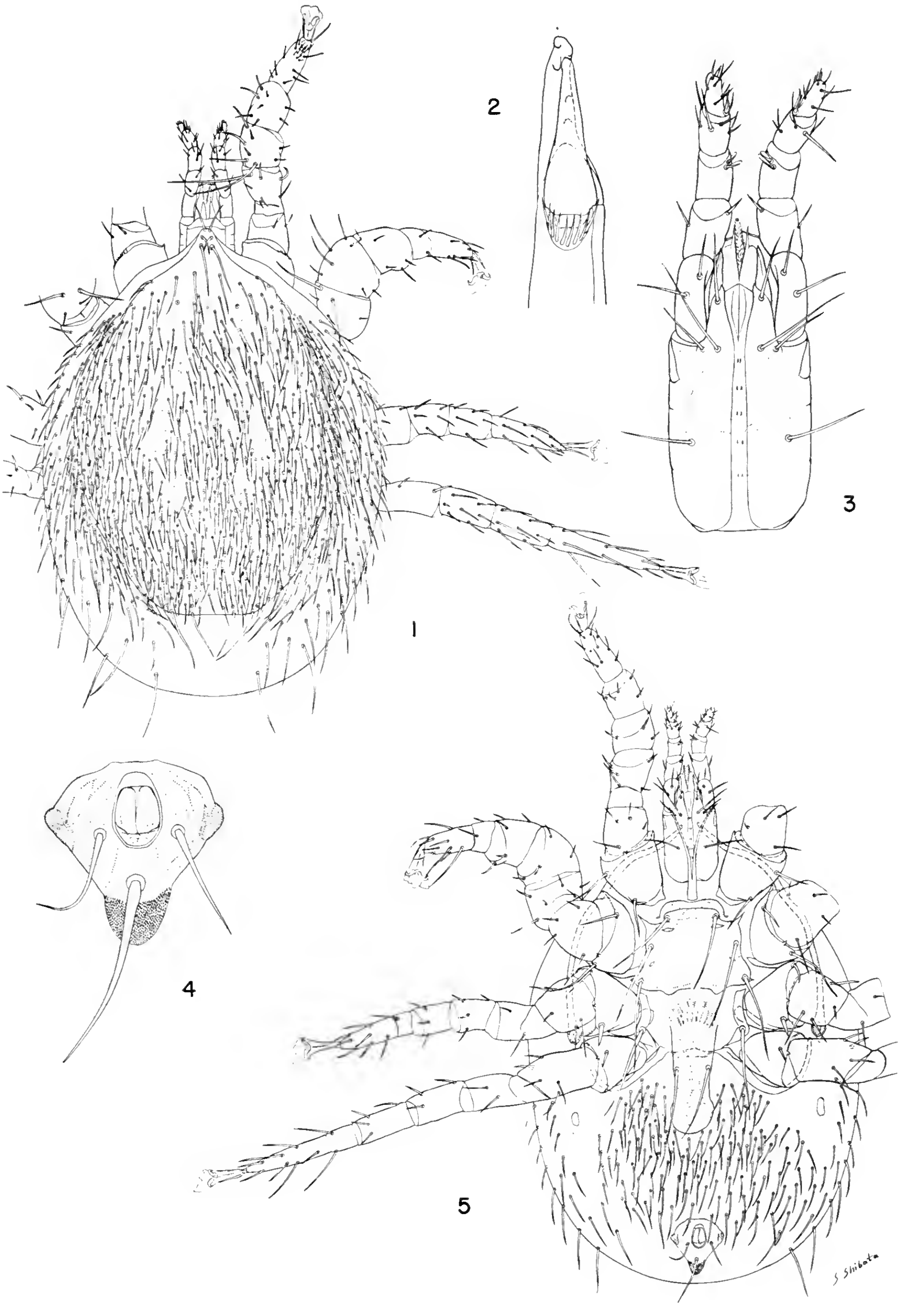
Coxa I and sternal plates. *Gigantolaelaps gilmorei* Fonesca (figs. 4, 8). *G. goyanensis* Fonseca (figs. 1, 6). *G. oudemansi* Fonseca (figs. 2, 7). *G. wolffsohni* (Oudemans) (figs. 3, 5, 9, 10).



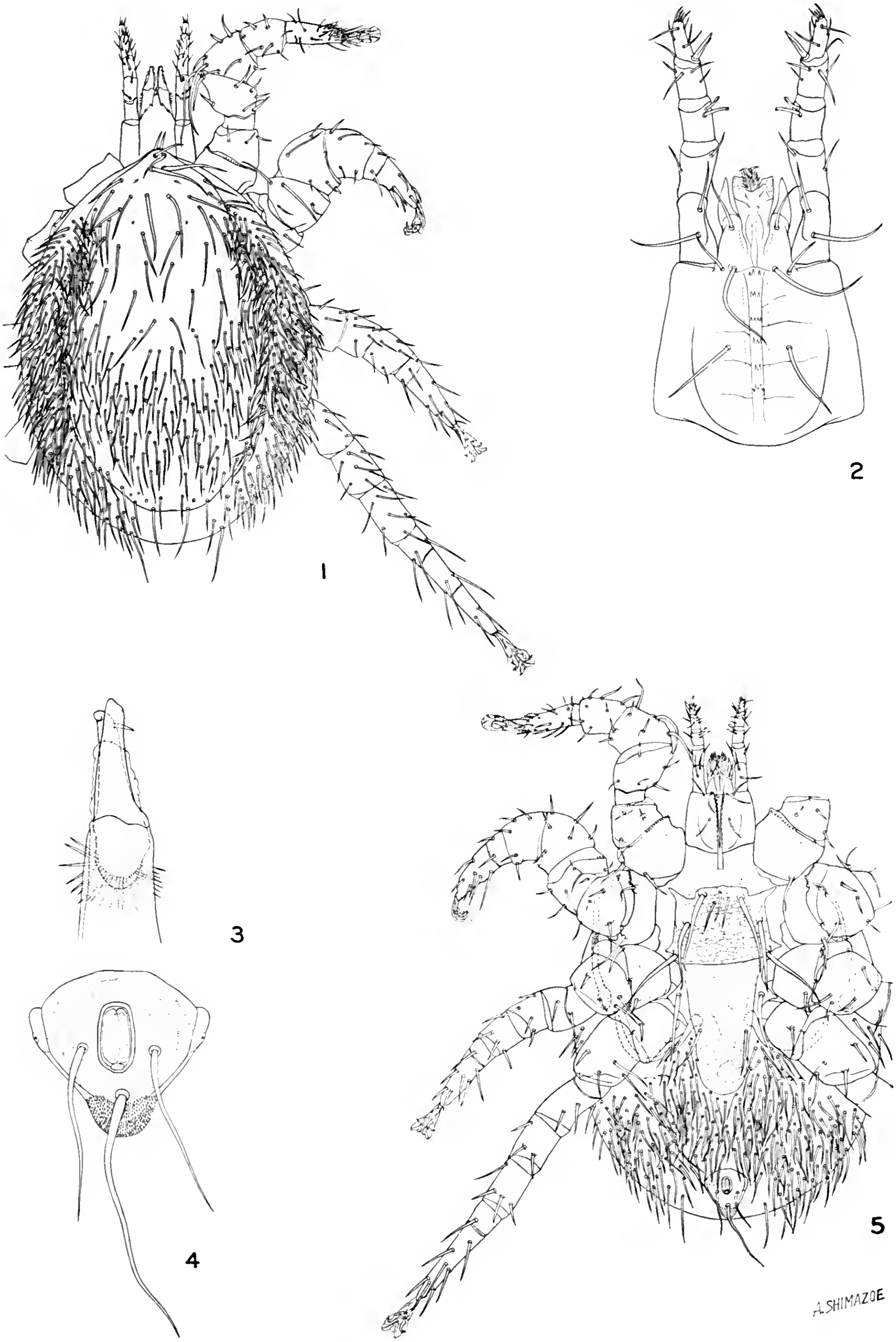
Gigantolaelaps gilmorei Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



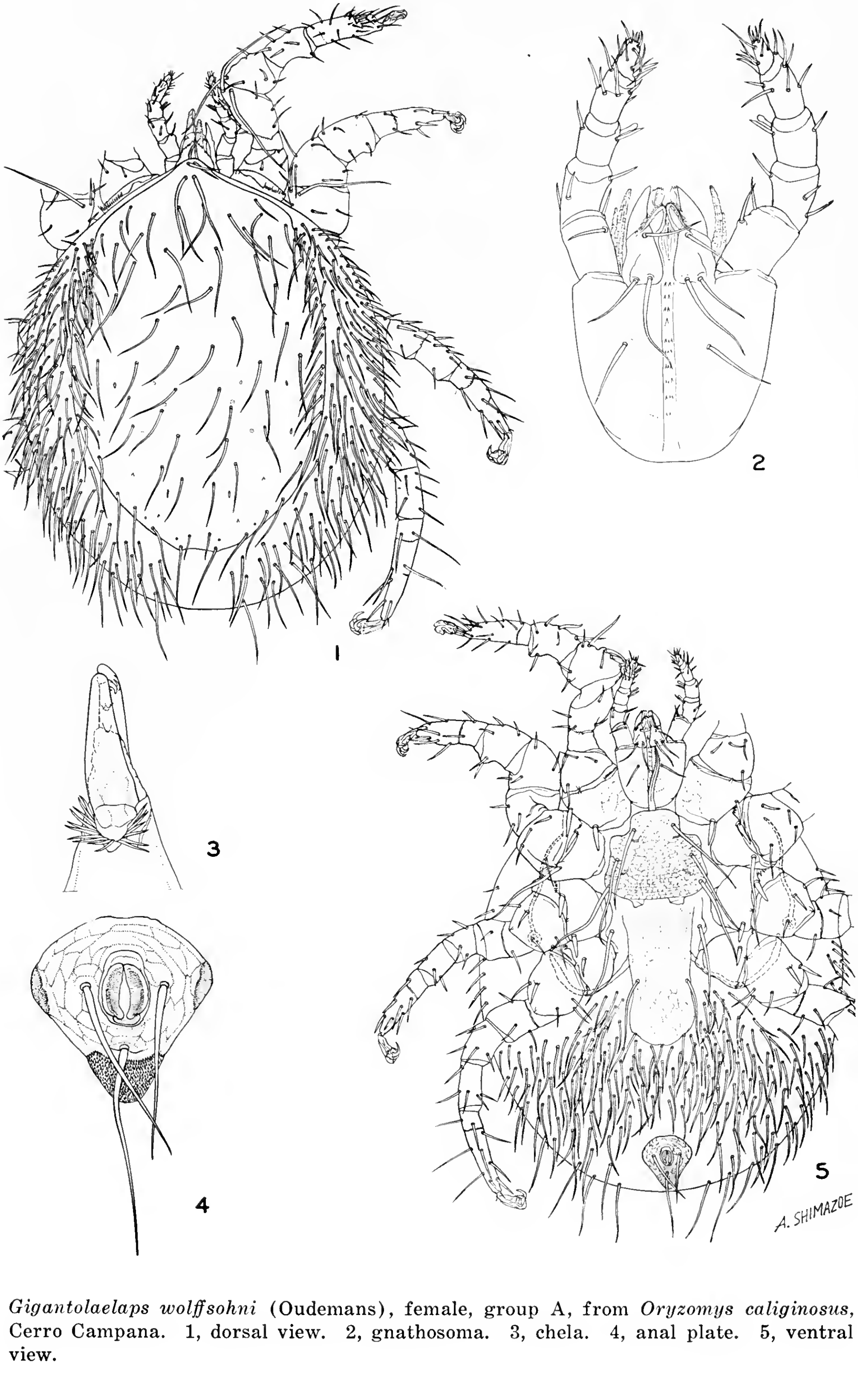
Gigantolaelaps goyanensis Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, anal plate. 4, ventral view.



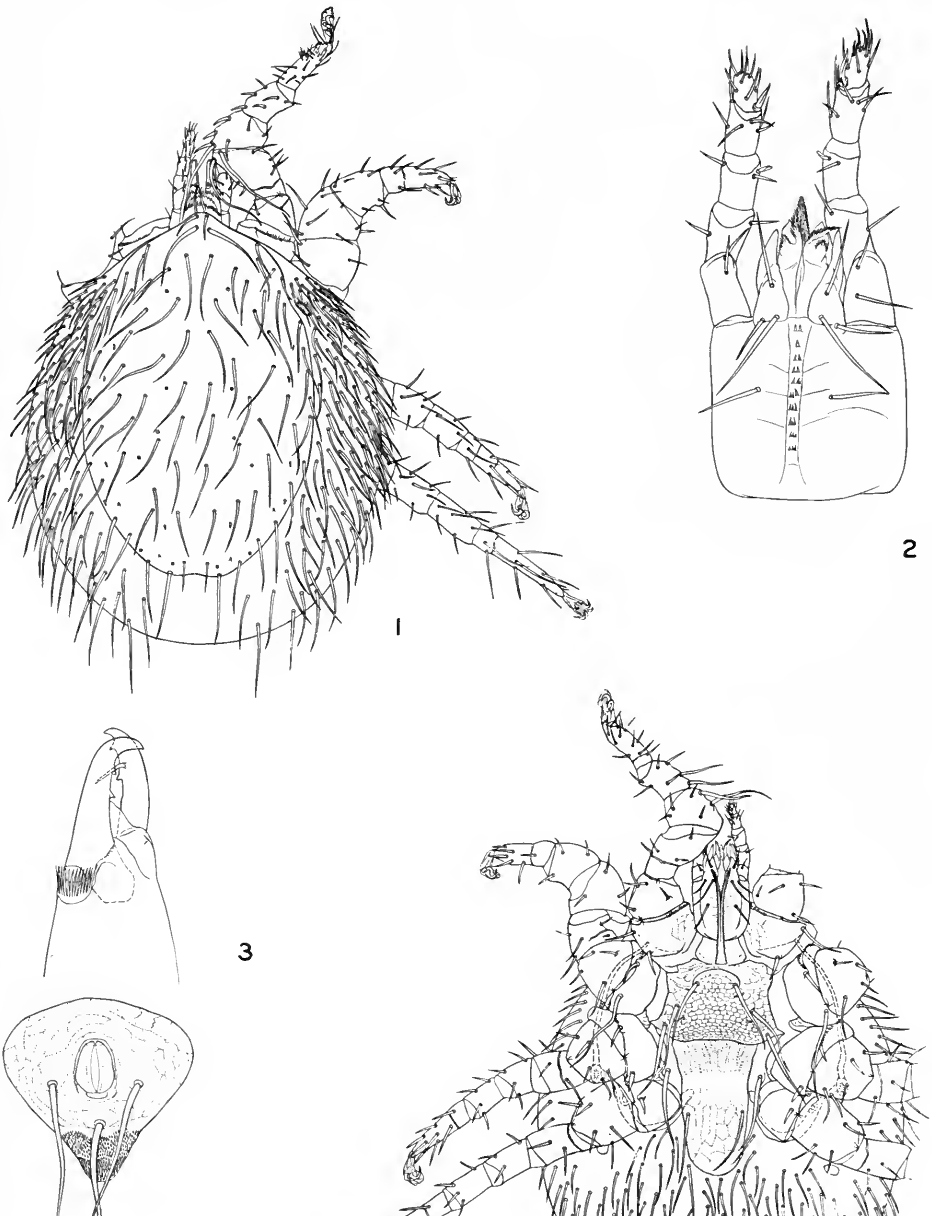
Gigantolaelaps inca Fonseca, female. 1, dorsal view. 2, chela. 3, gnathosoma. 4, anal plate. 5, ventral view.



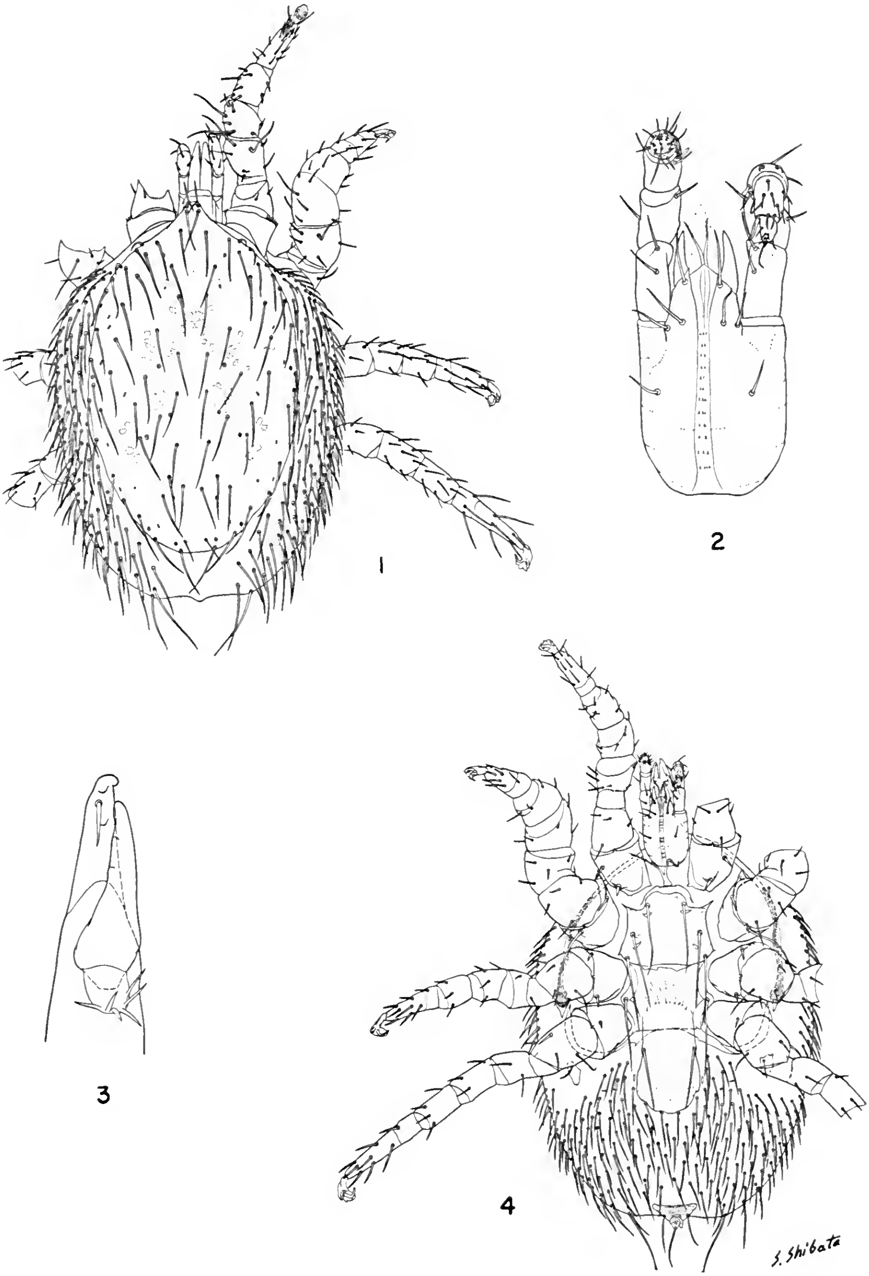
Gigantolaelaps oudemansi Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



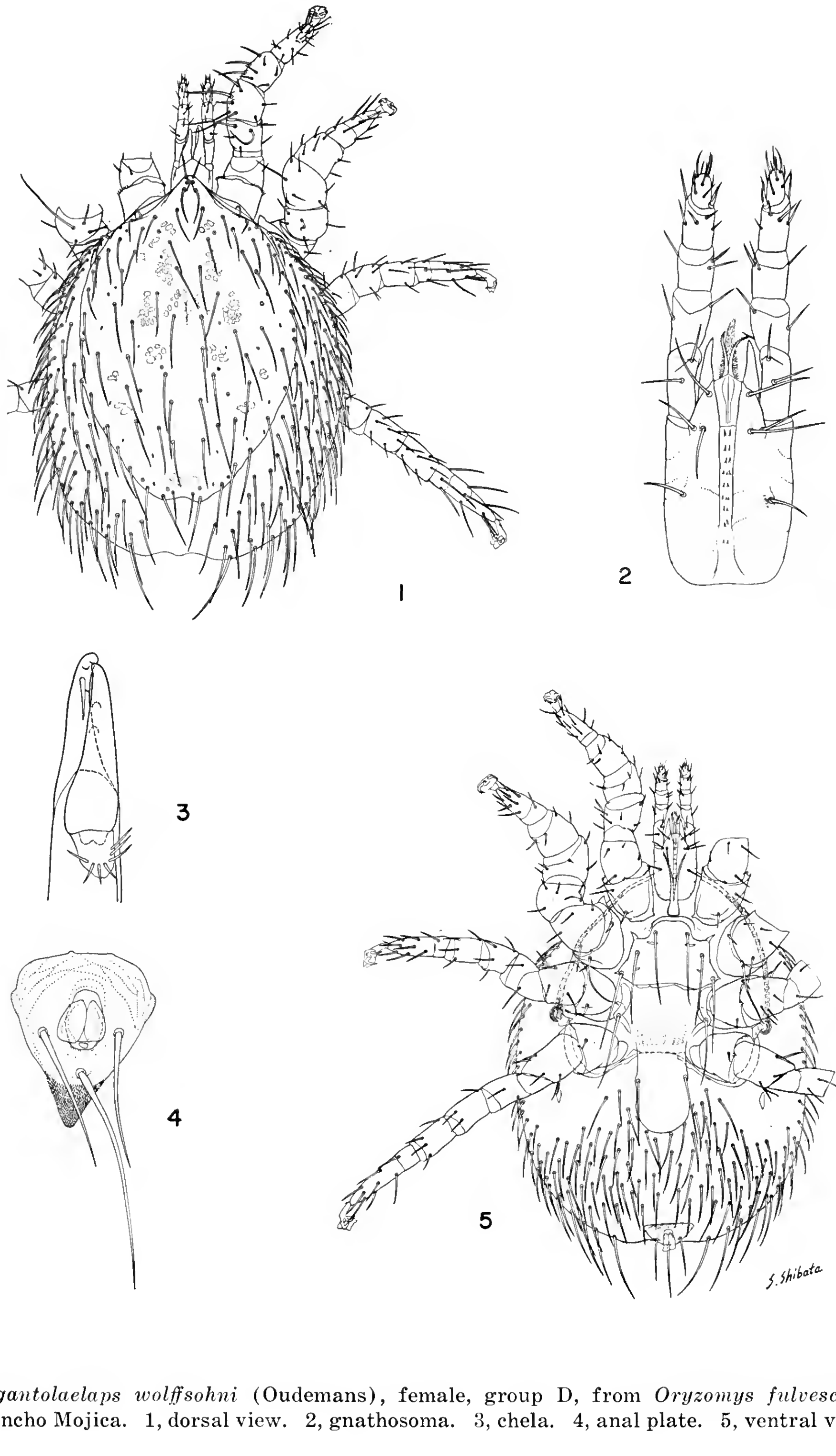
Gigantolaelaps wolffsohni (Oudemans), female, group A, from *Oryzomys caliginosus*, Cerro Campana. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



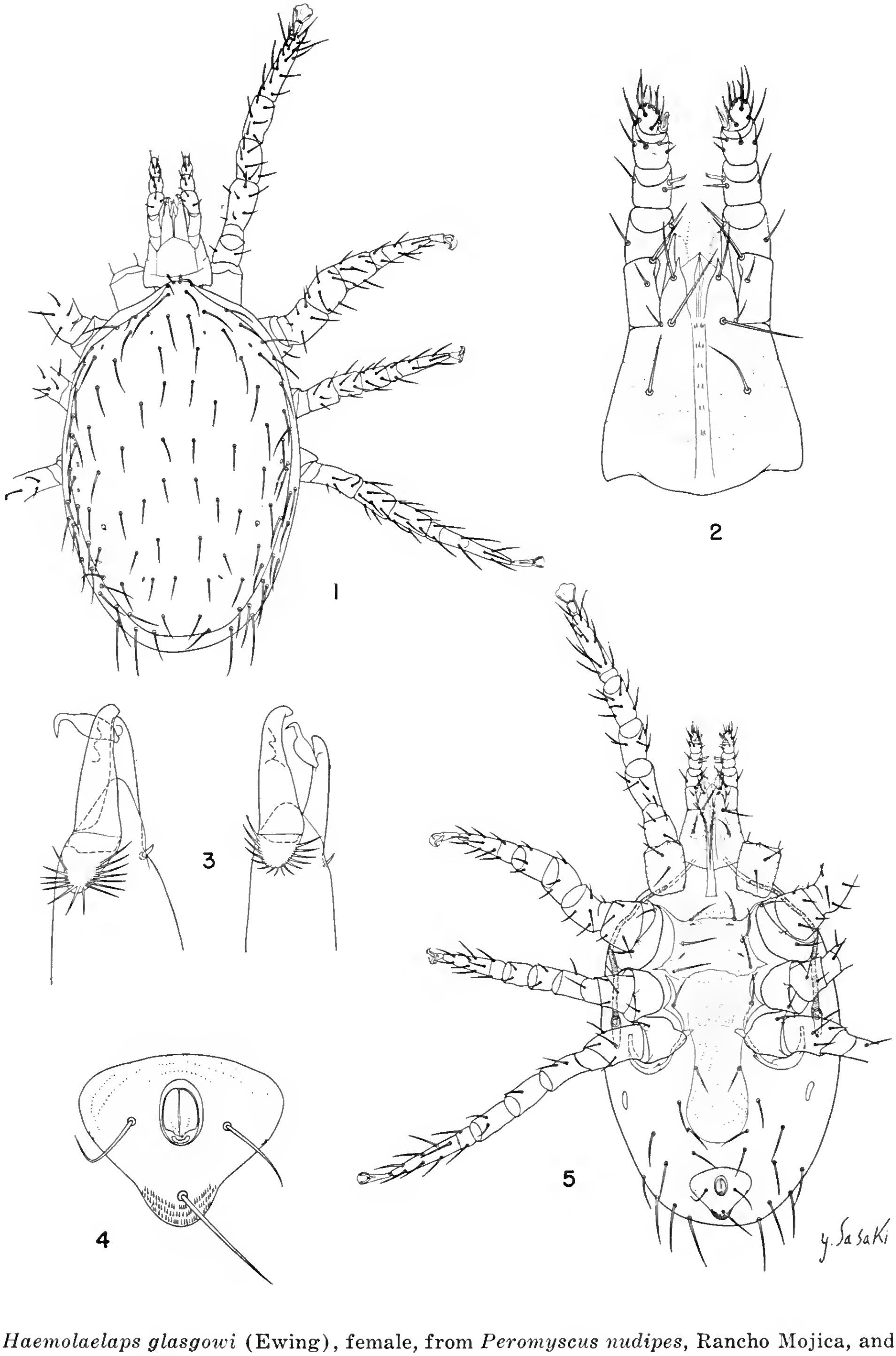
Gigantolaelaps wolffsohni (Oudemans), female, group B, from *Oryzomys capito* El Valle. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



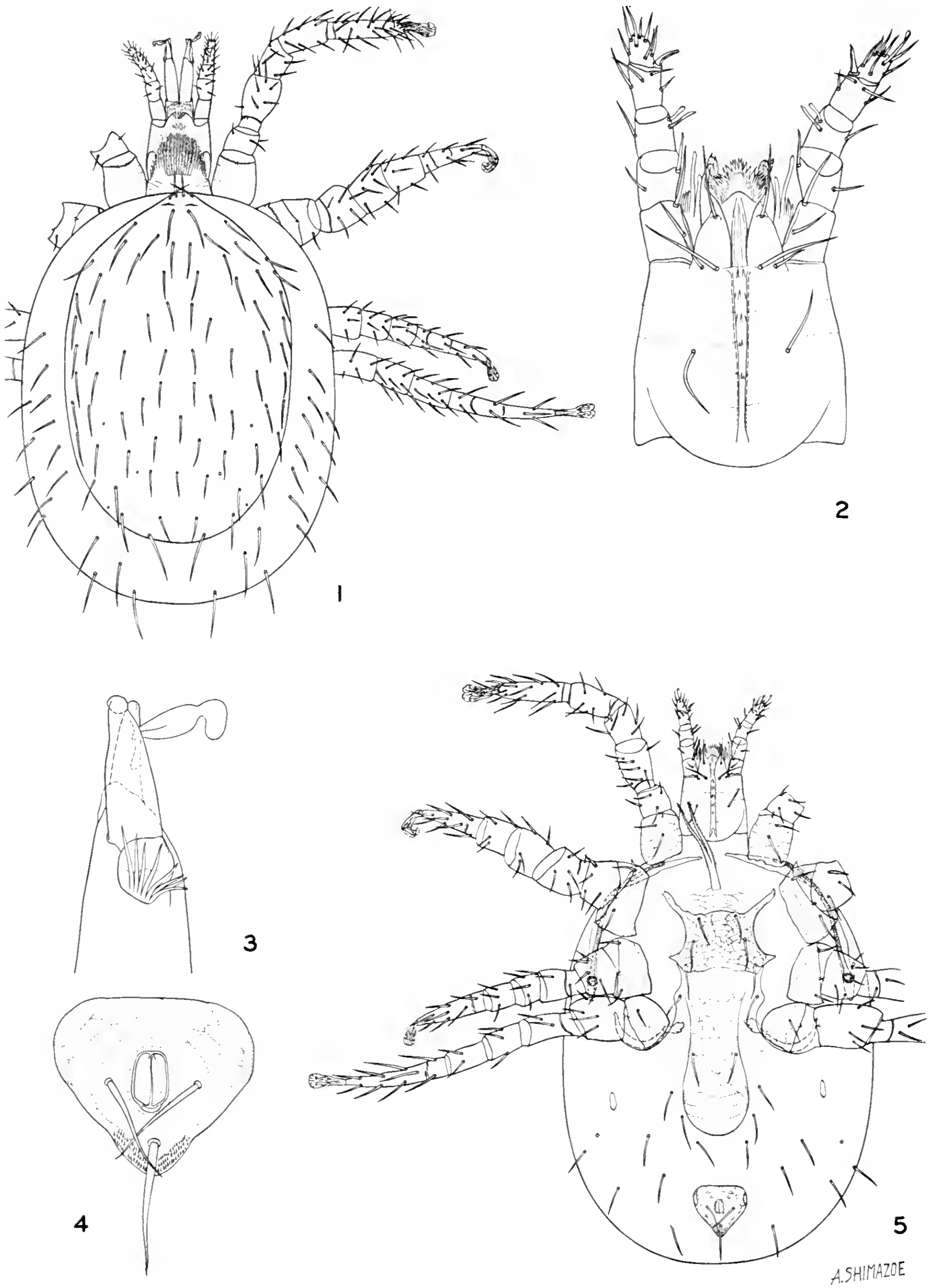
Gigantolaelaps wolffsohni (Oudemans), female, group C, from *Sigmodon hispidus*, Almirante. 1, dorsal view. 2, gnathosoma. 3, chela. 4, ventral view.



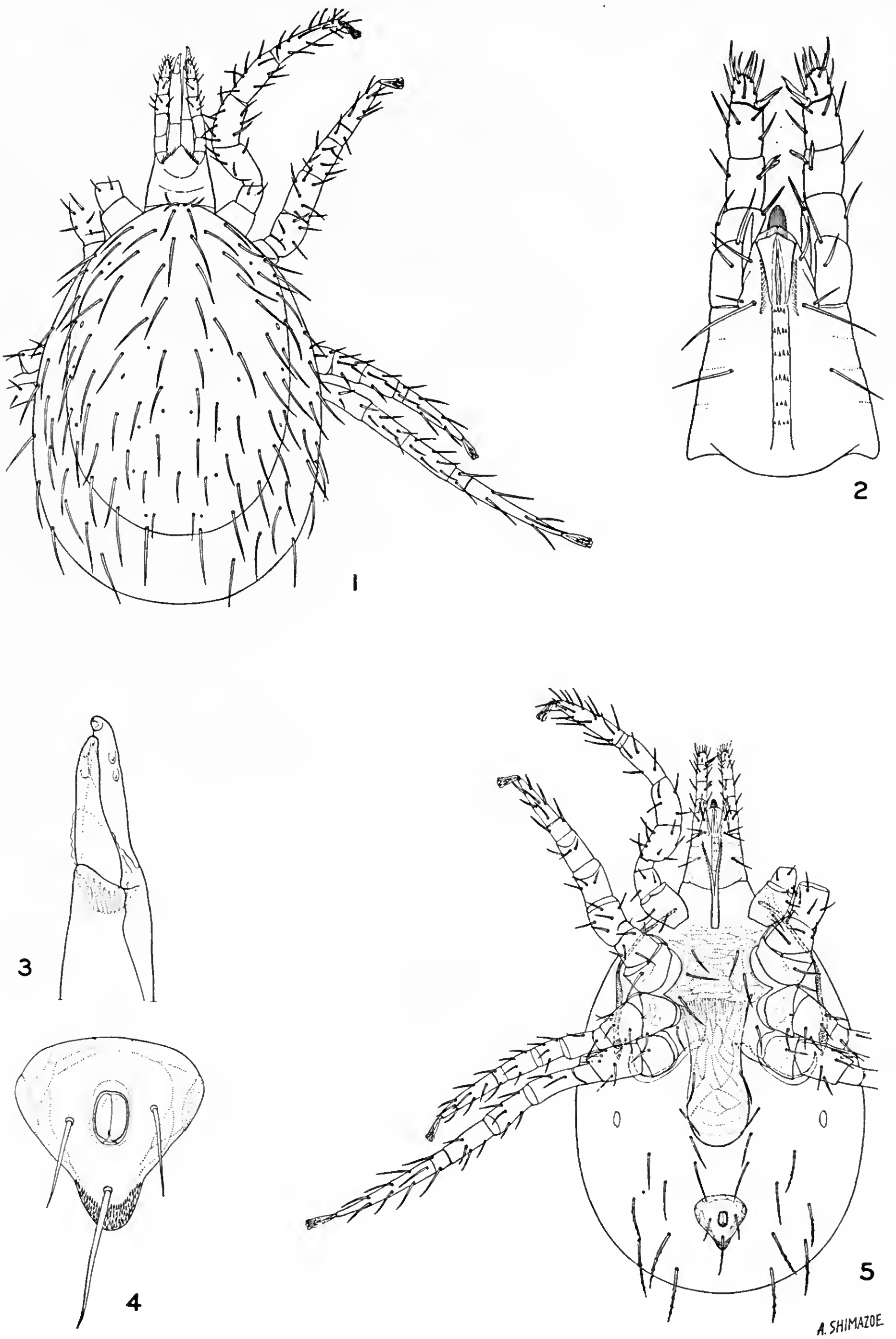
Gigantolaelaps wolffsohni (Oudemans), female, group D, from *Oryzomys fulvescens*, Rancho Mojica. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



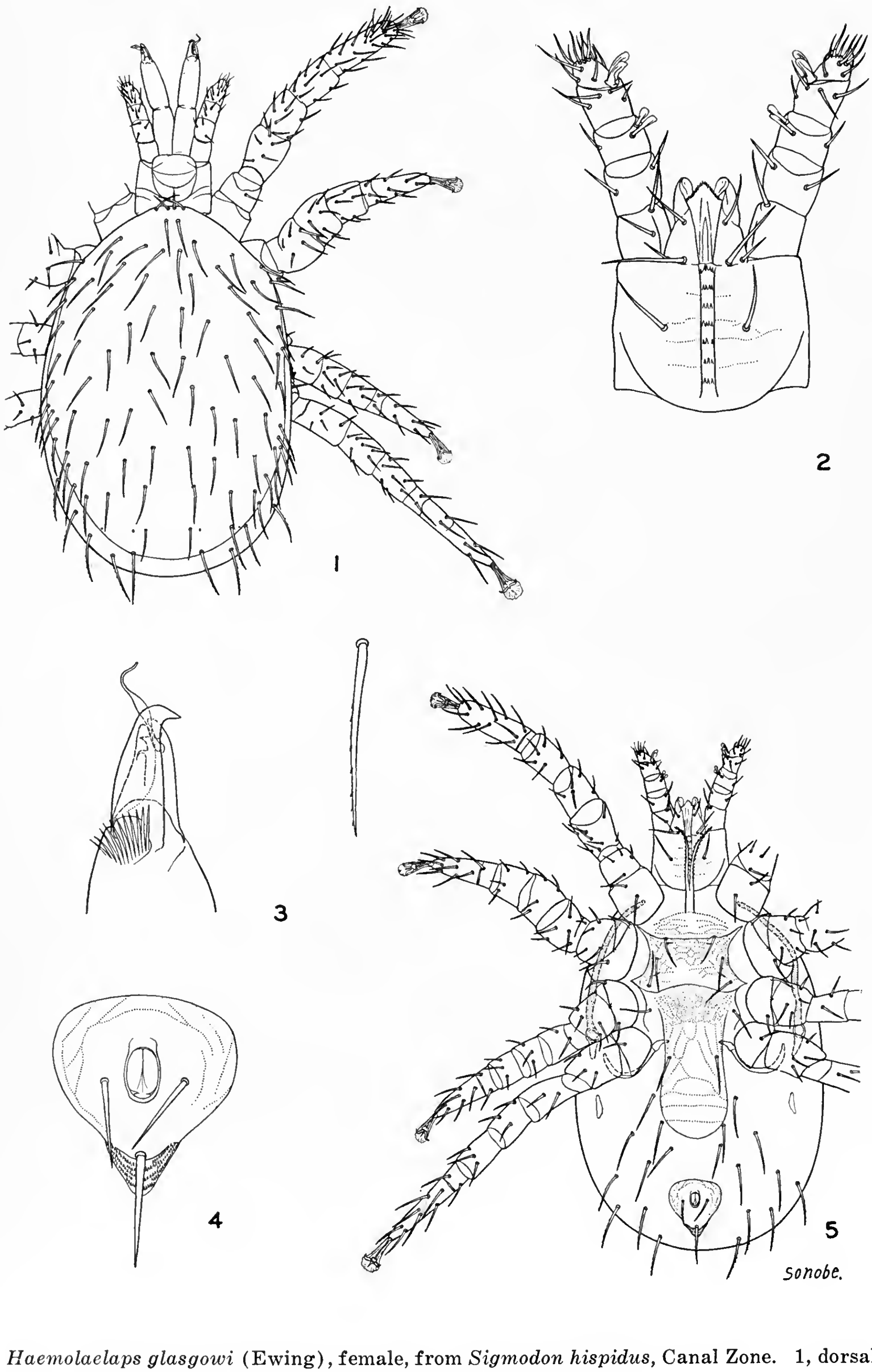
Haemolaelaps glasgowi (Ewing), female, from *Peromyscus nudipes*, Rancho Mojica, and *Reithrodontomys sumichrasti*, Cerro Punta. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



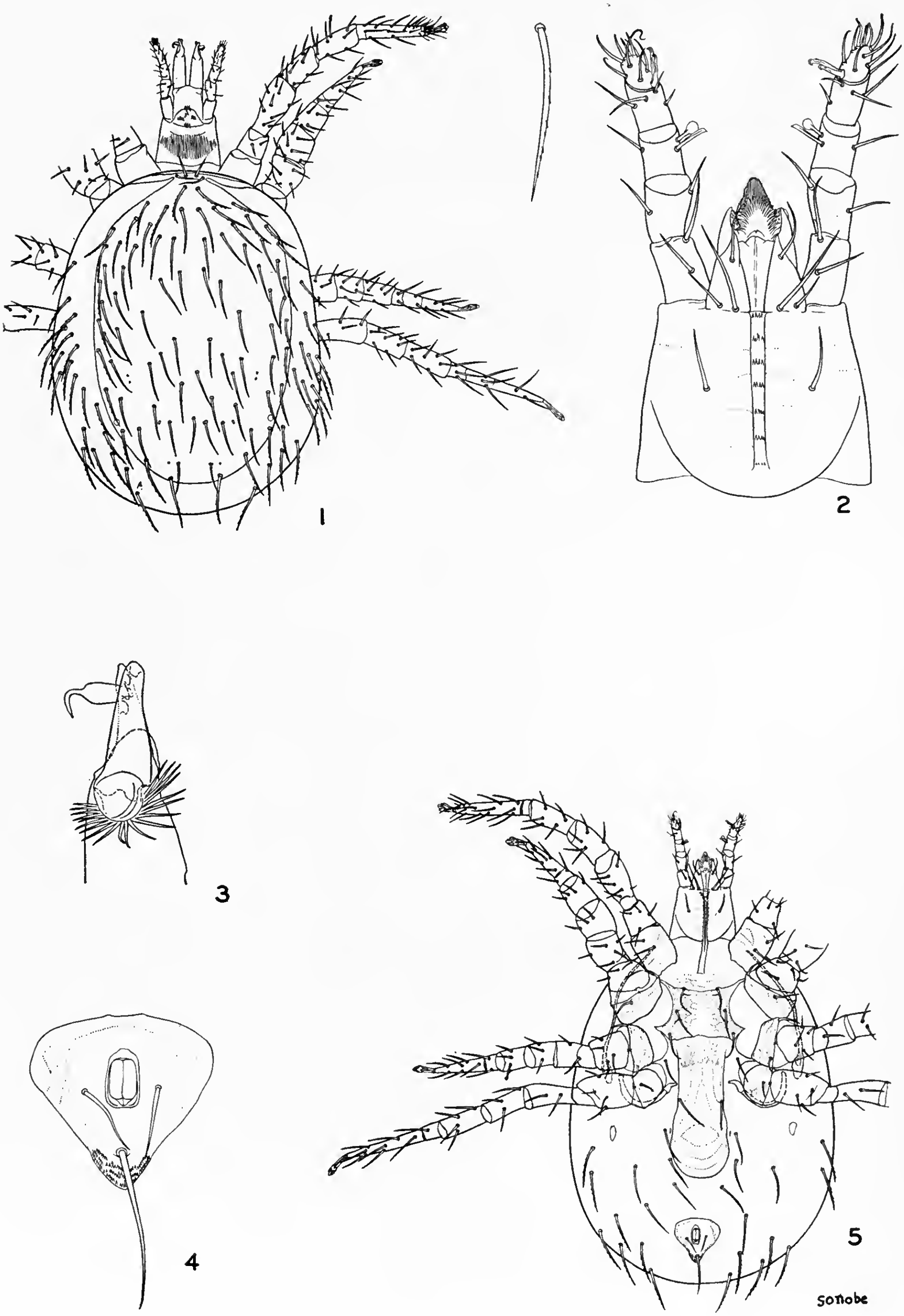
Haemolaelaps glasgowi (Ewing), female, from *Nyctomys sumichrasti*, Cerro Azul. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



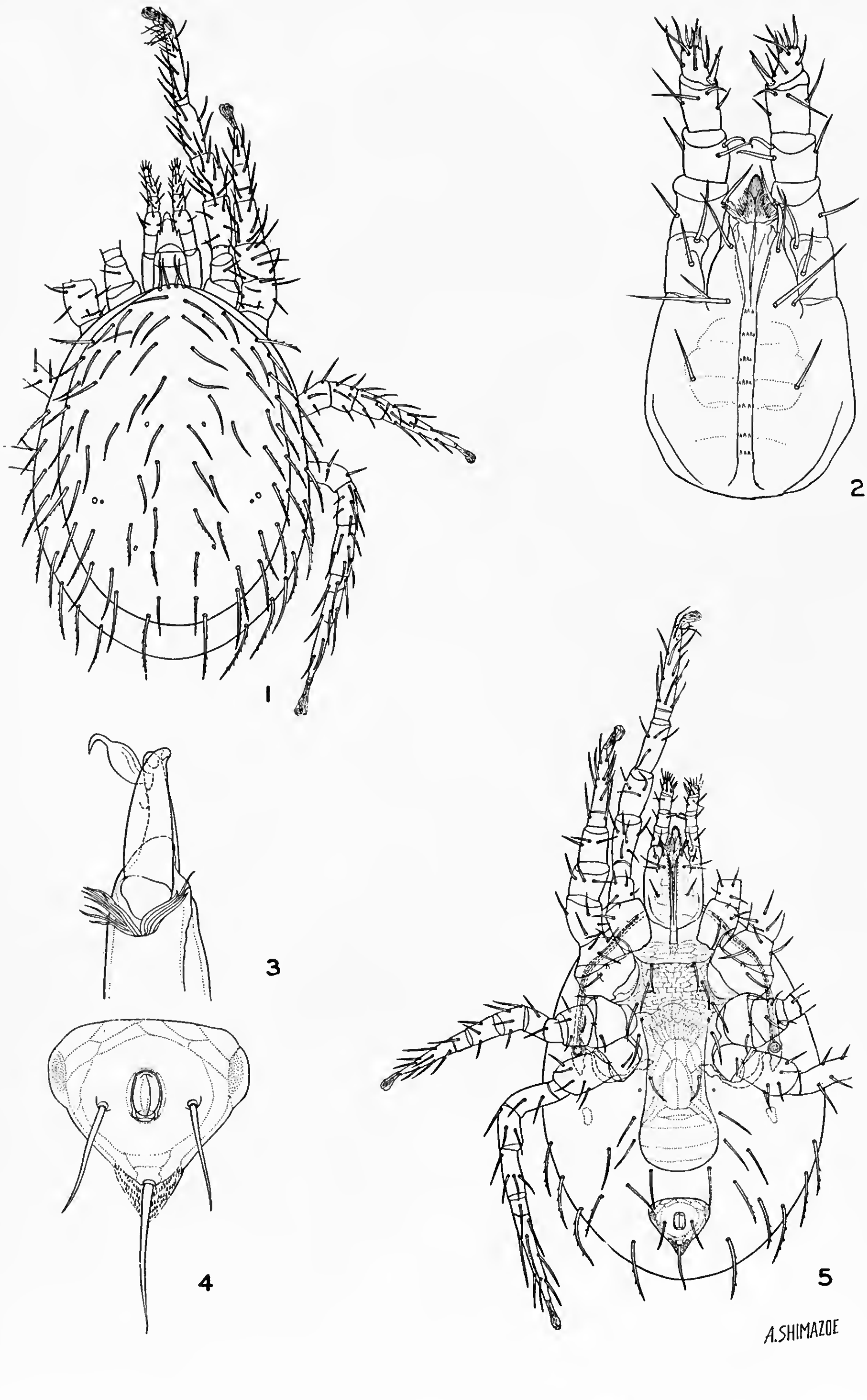
Haemolaelaps glasgowi (Ewing), female, from *Liomys adspersus,* Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



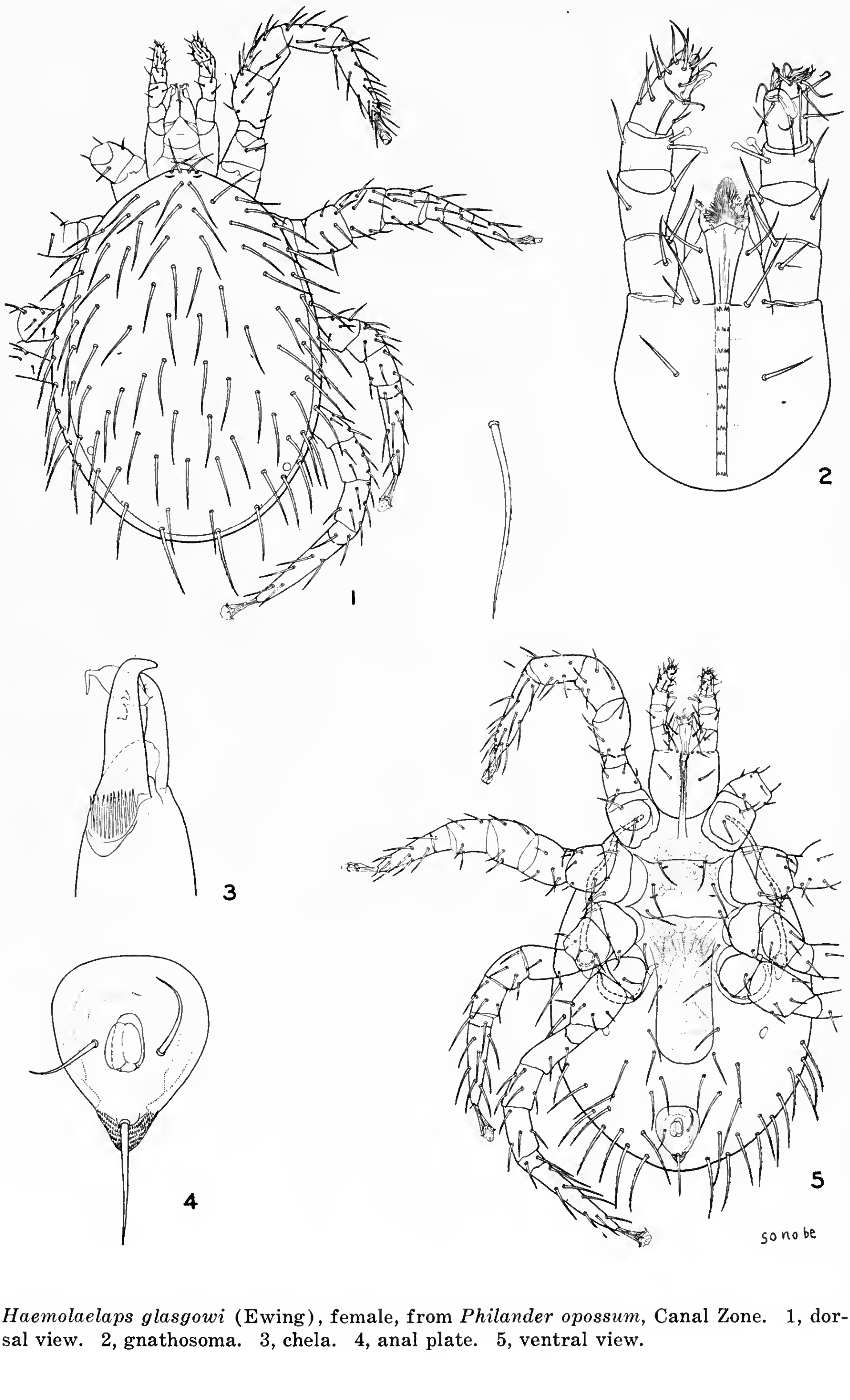
Haemolaelaps glasgowi (Ewing), female, from *Sigmodon hispidus*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



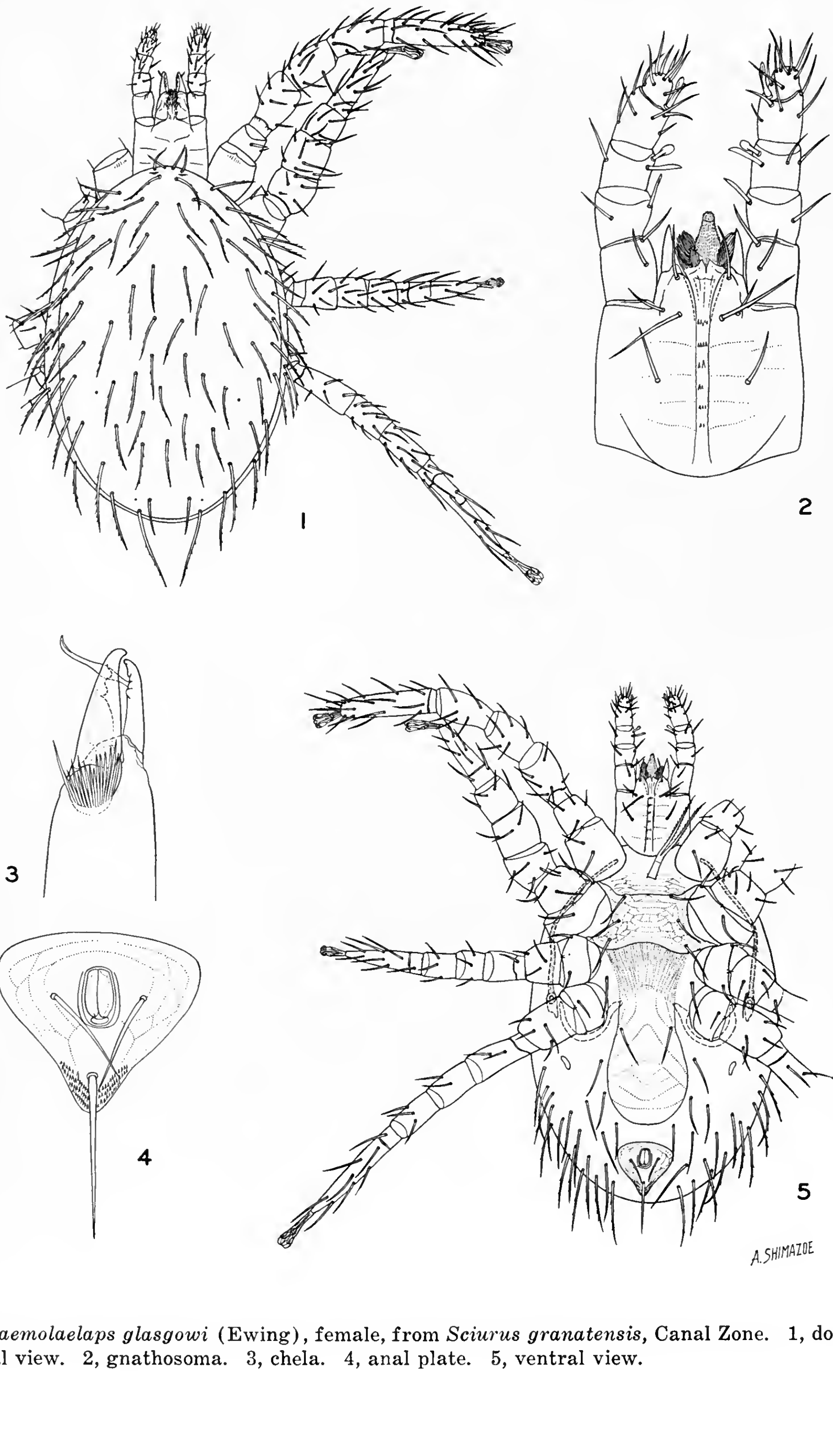
Haemolaelaps glasgowi (Ewing), female, from *Oryzomys fulvescens*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



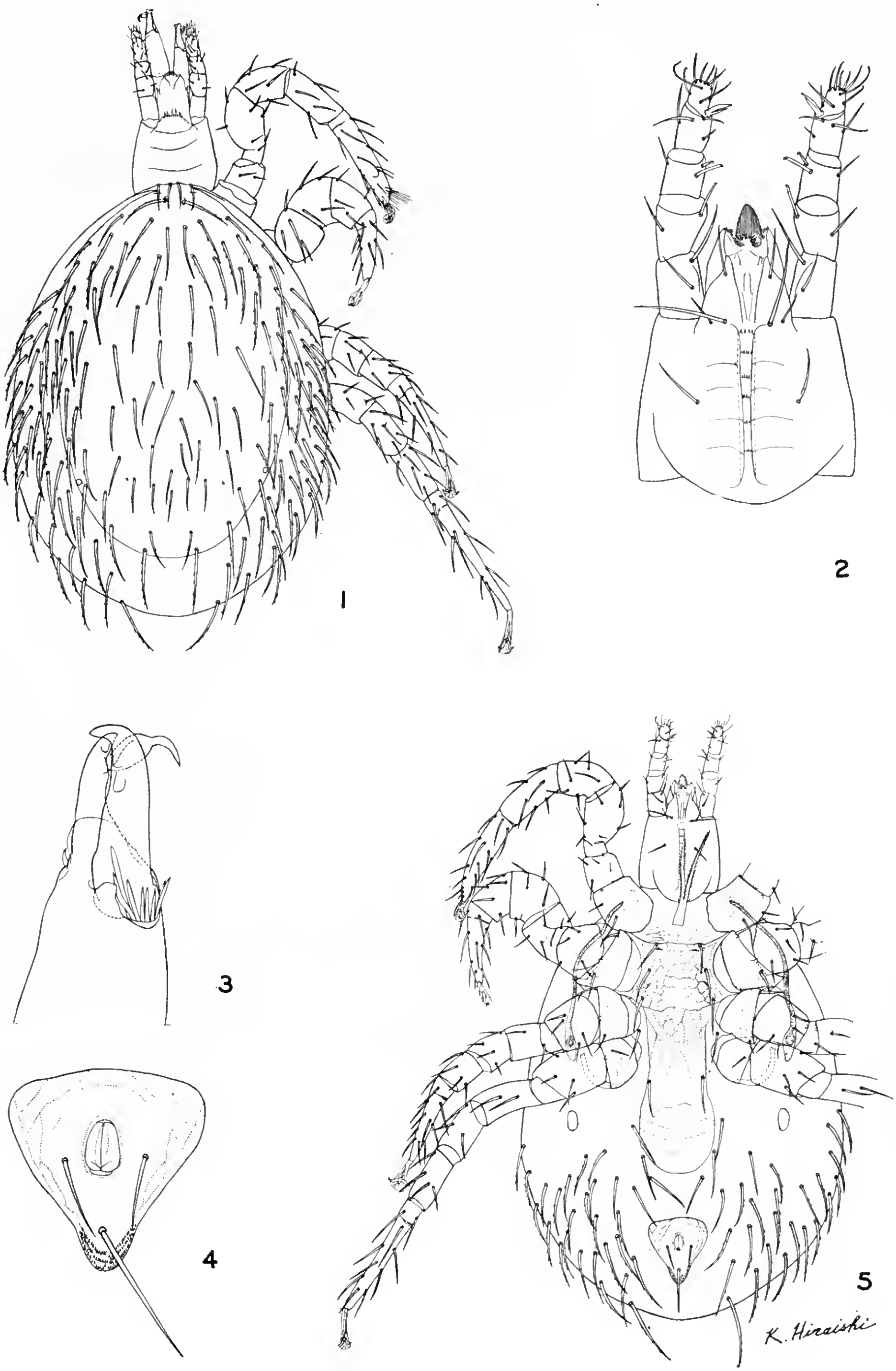
Haemolaelaps glasgowi (Ewing), female, from *Hoplomys gymnurus*, Cerro Azul. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



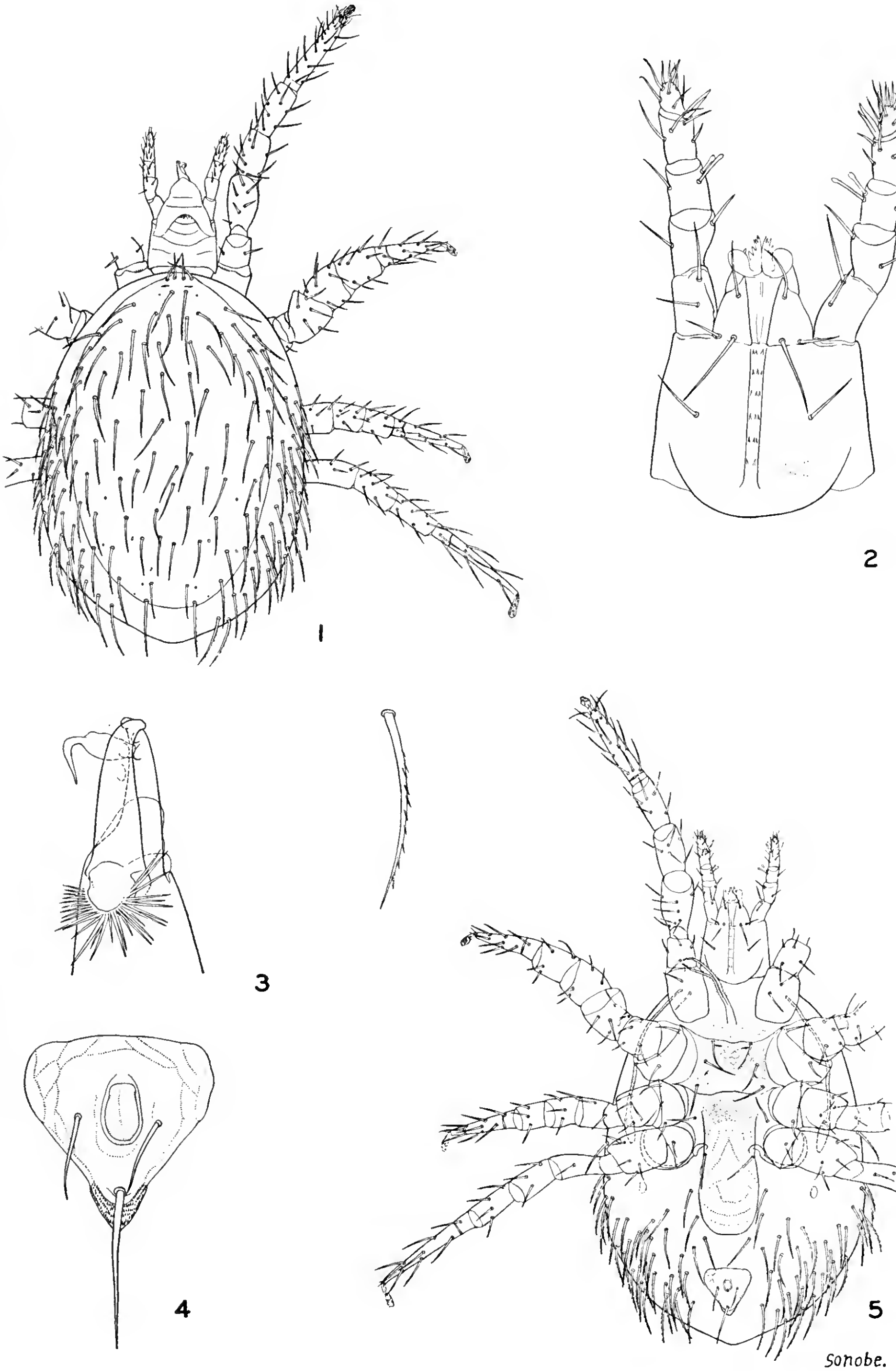
Haemolaelaps glasgowi (Ewing), female, from *Philander opossum*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



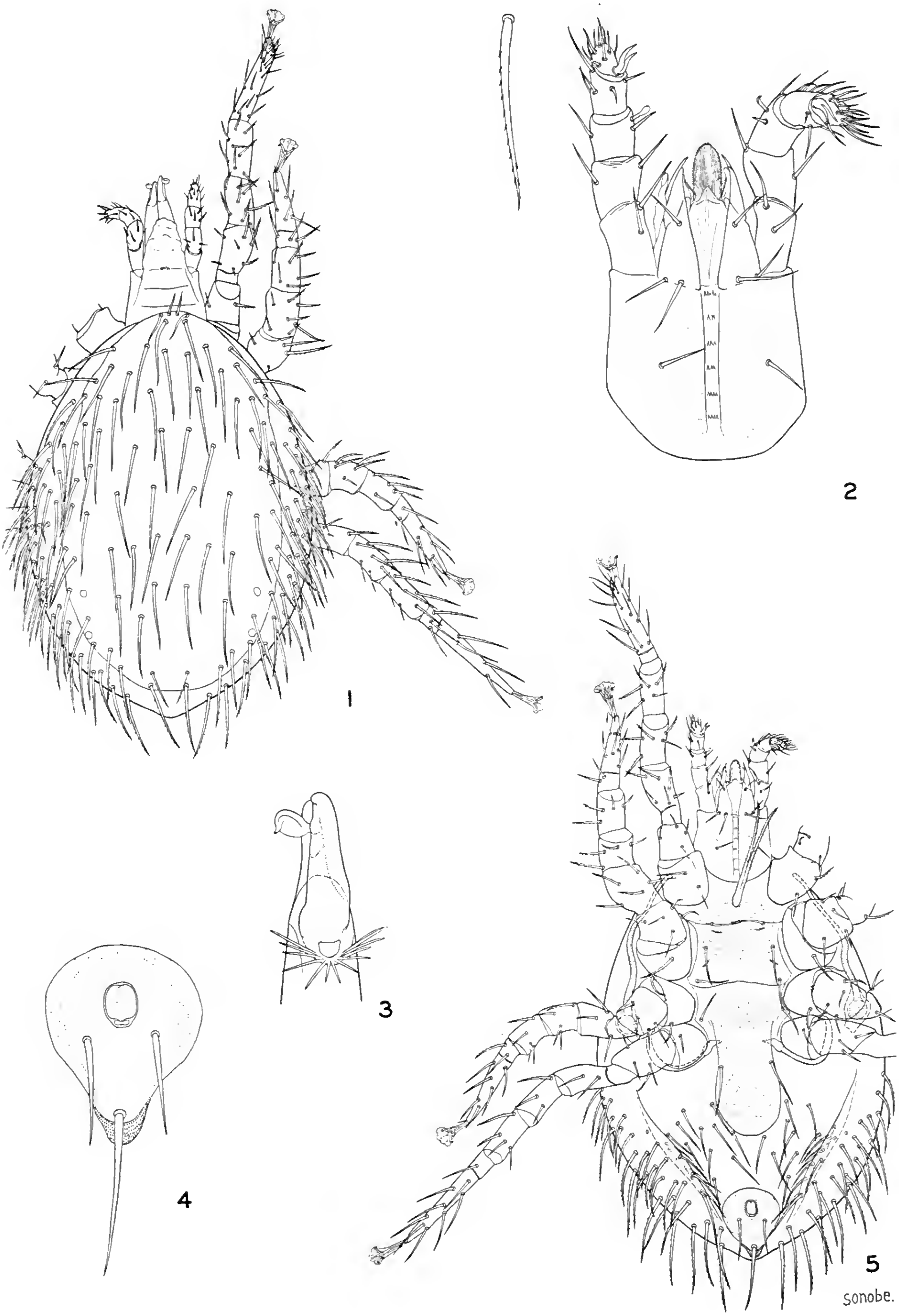
Haemolaelaps glasgowi (Ewing), female, from *Sciurus granatensis*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



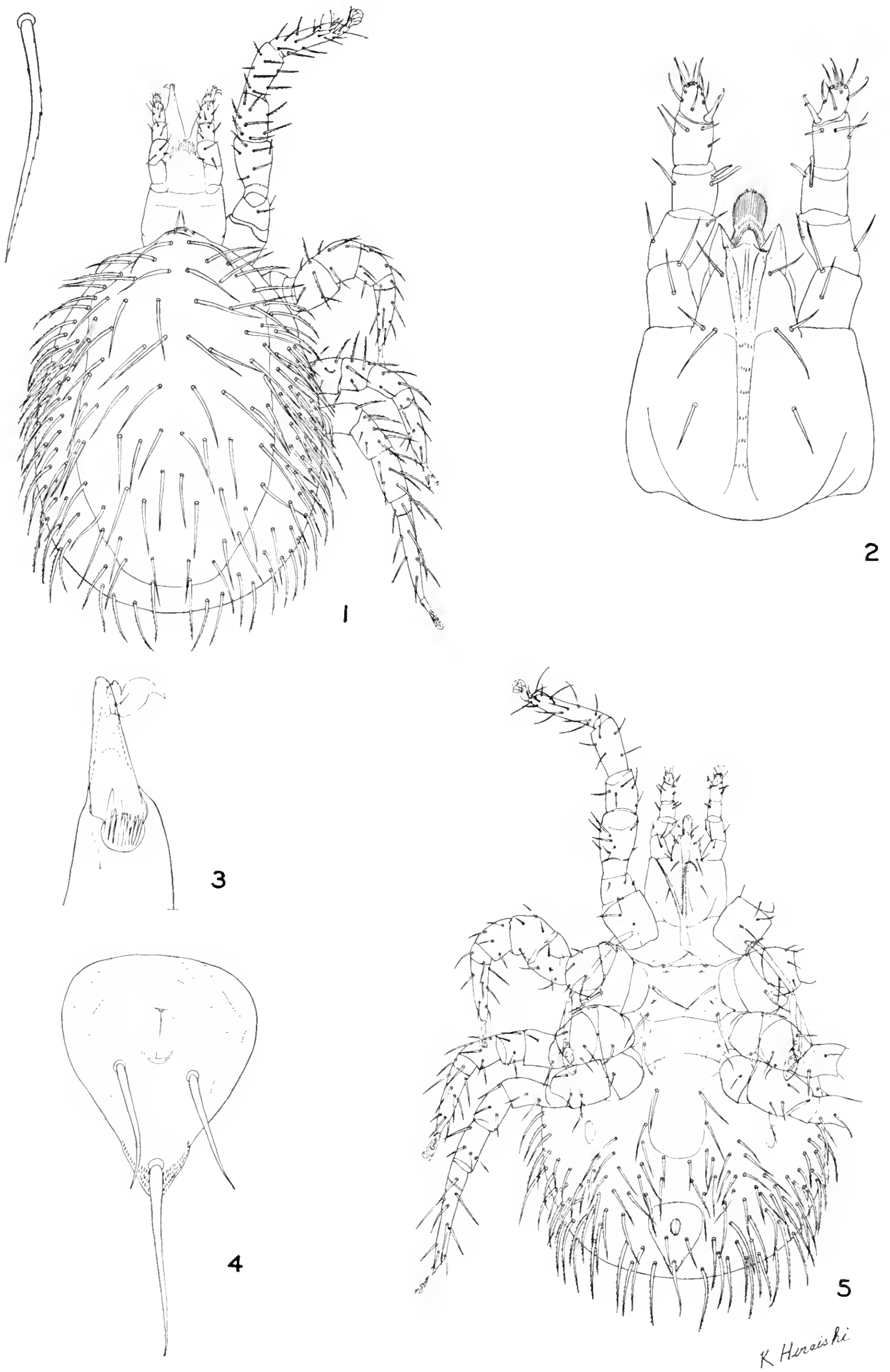
Haemolaelaps glasgowi (Ewing), female, from *Oryzomys capito*, Cerro Azul. 1, dorsal plate. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



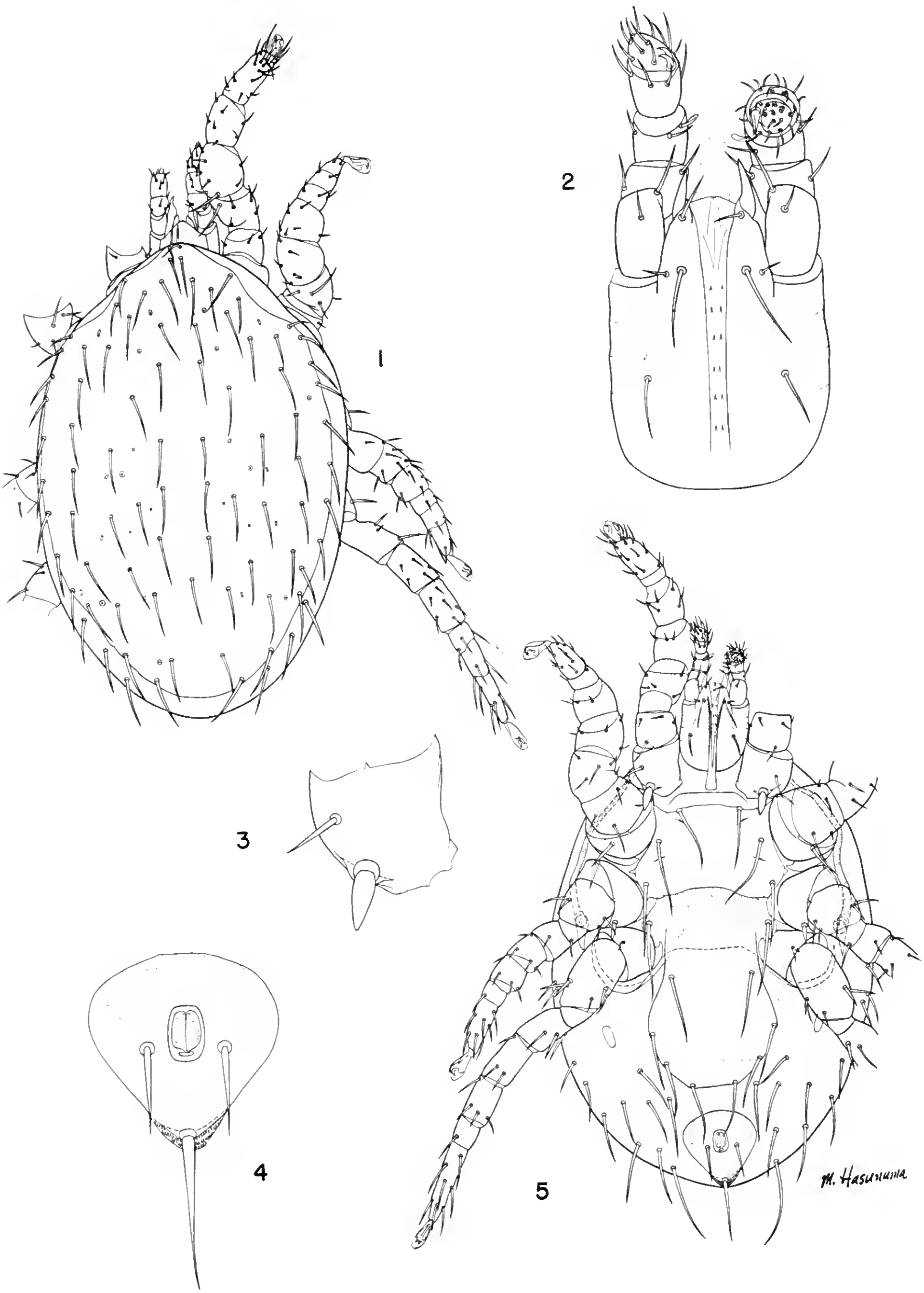
Haemolaelaps glasgowi (Ewing), female, from *Nectomys alfari*, Cerro Azul. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



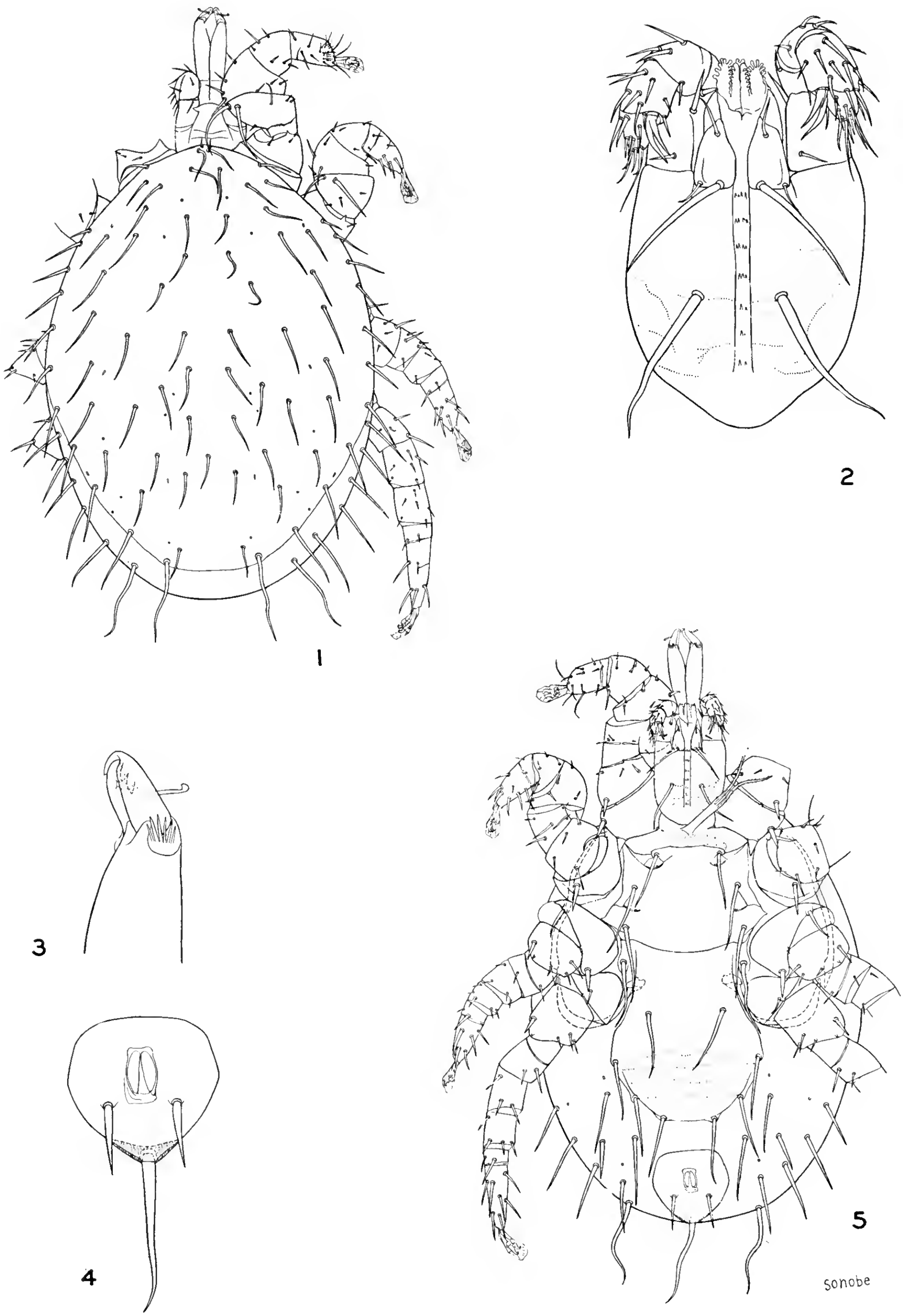
Haemolaelaps glasgowi (Ewing), female, from *Metachirus nudicaudatus*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



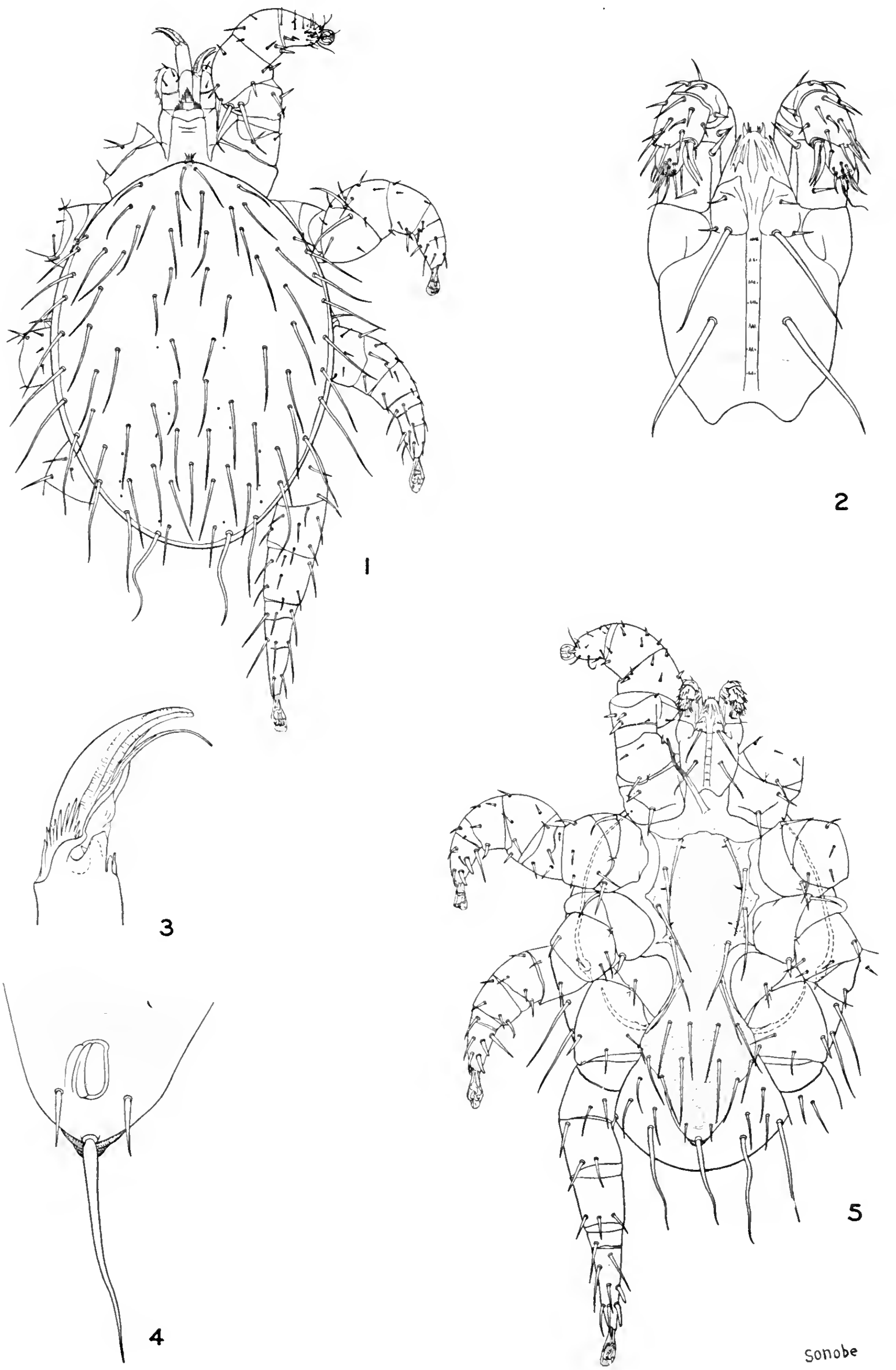
Haemolaelaps glasgowi (Ewing), female, from *Metachirus nudicaudatus*, Cerro Azul.
1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



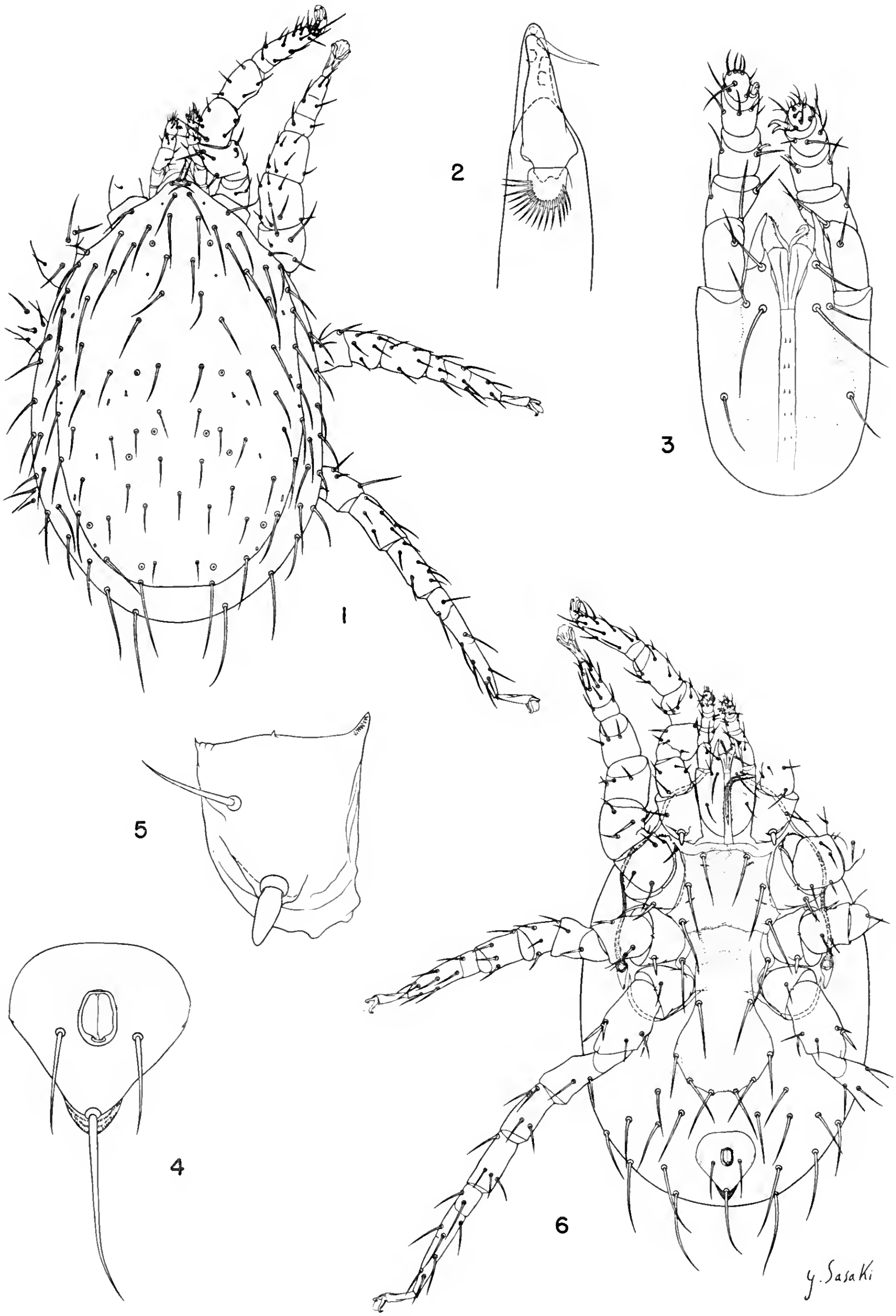
Laelaps castroi Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, coxa I. 4, anal plate. 5, ventral view.



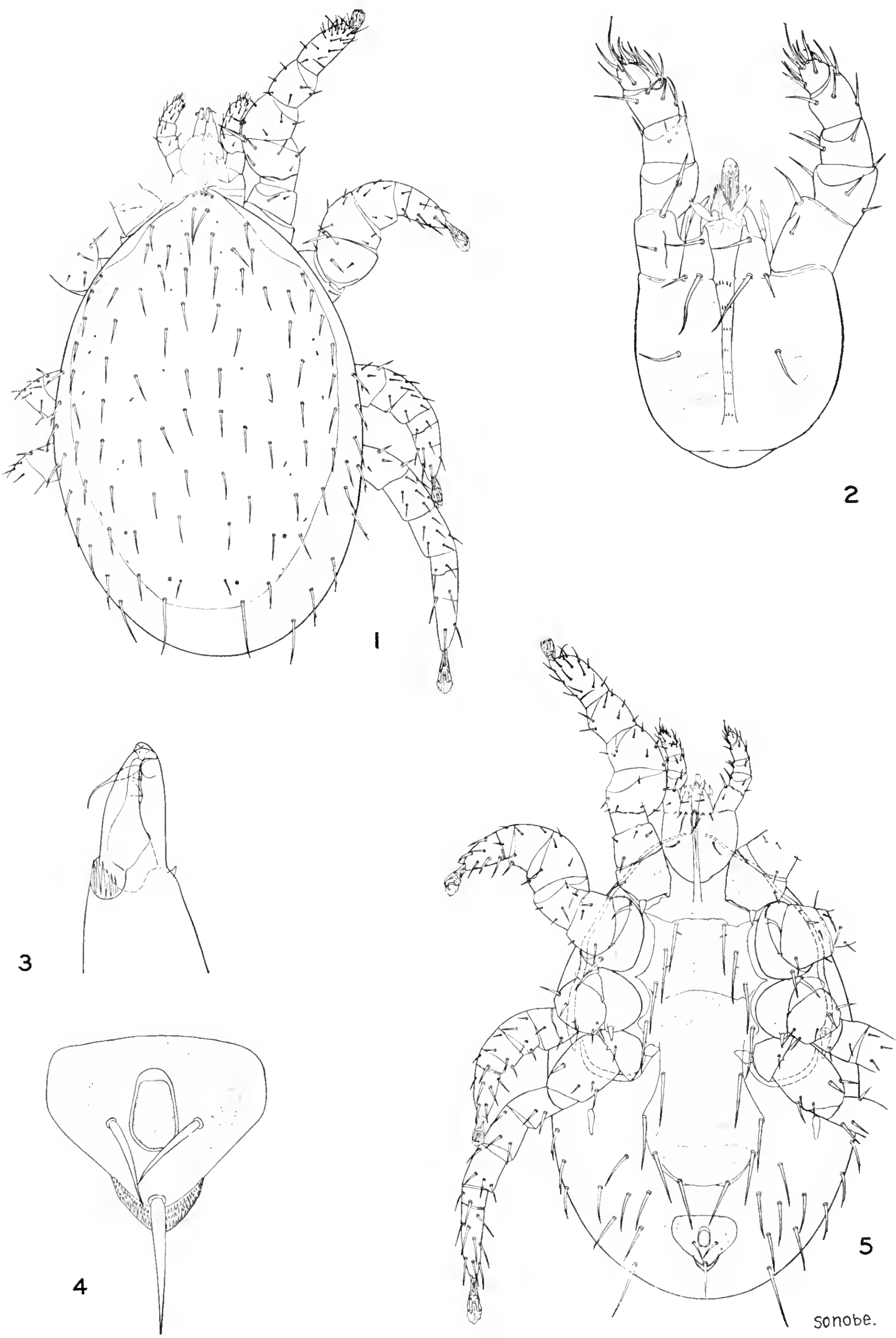
Laelaps dearmasi Furman and Tipton, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



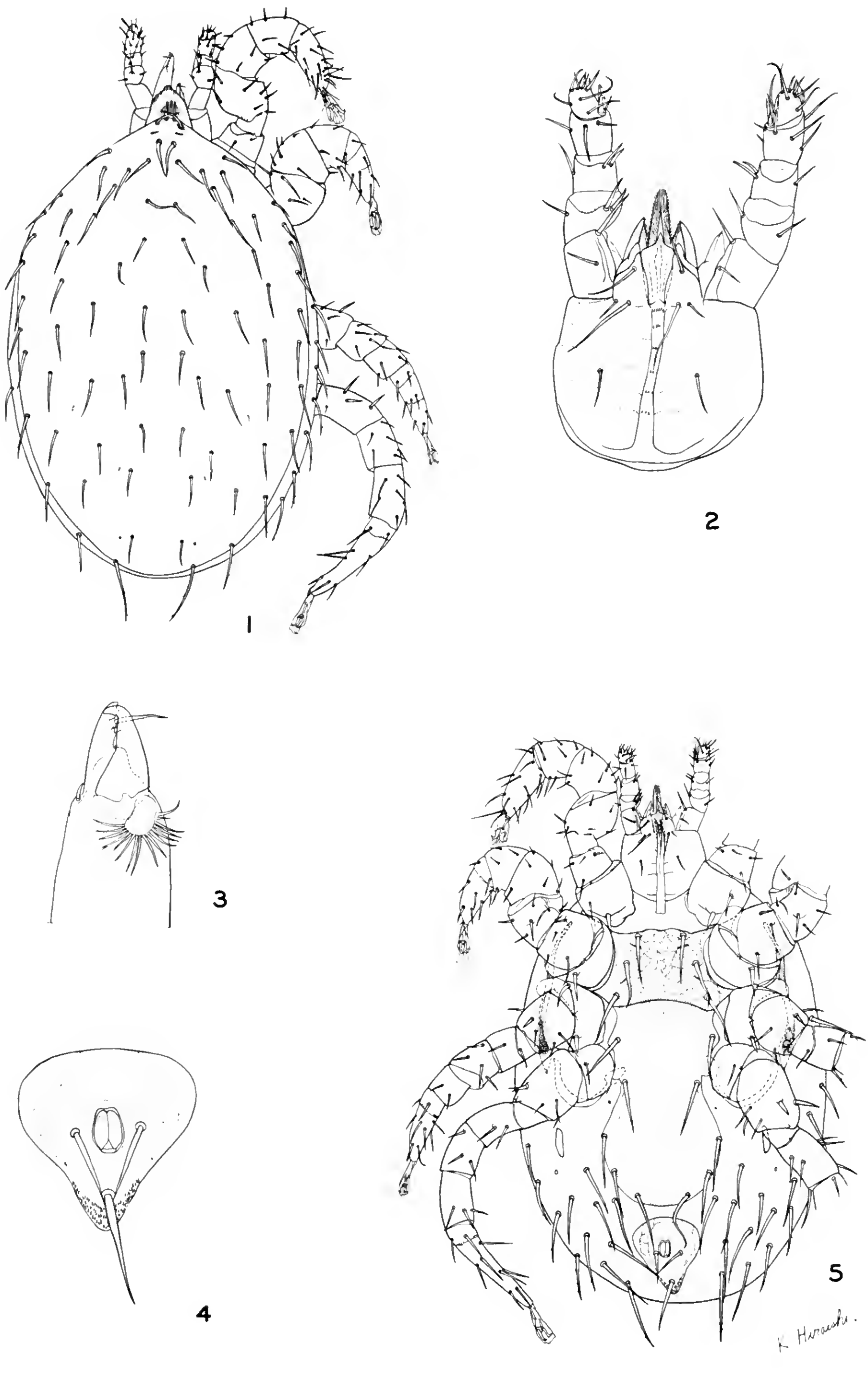
Laelaps dearmasi Furman and Tipton, male. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



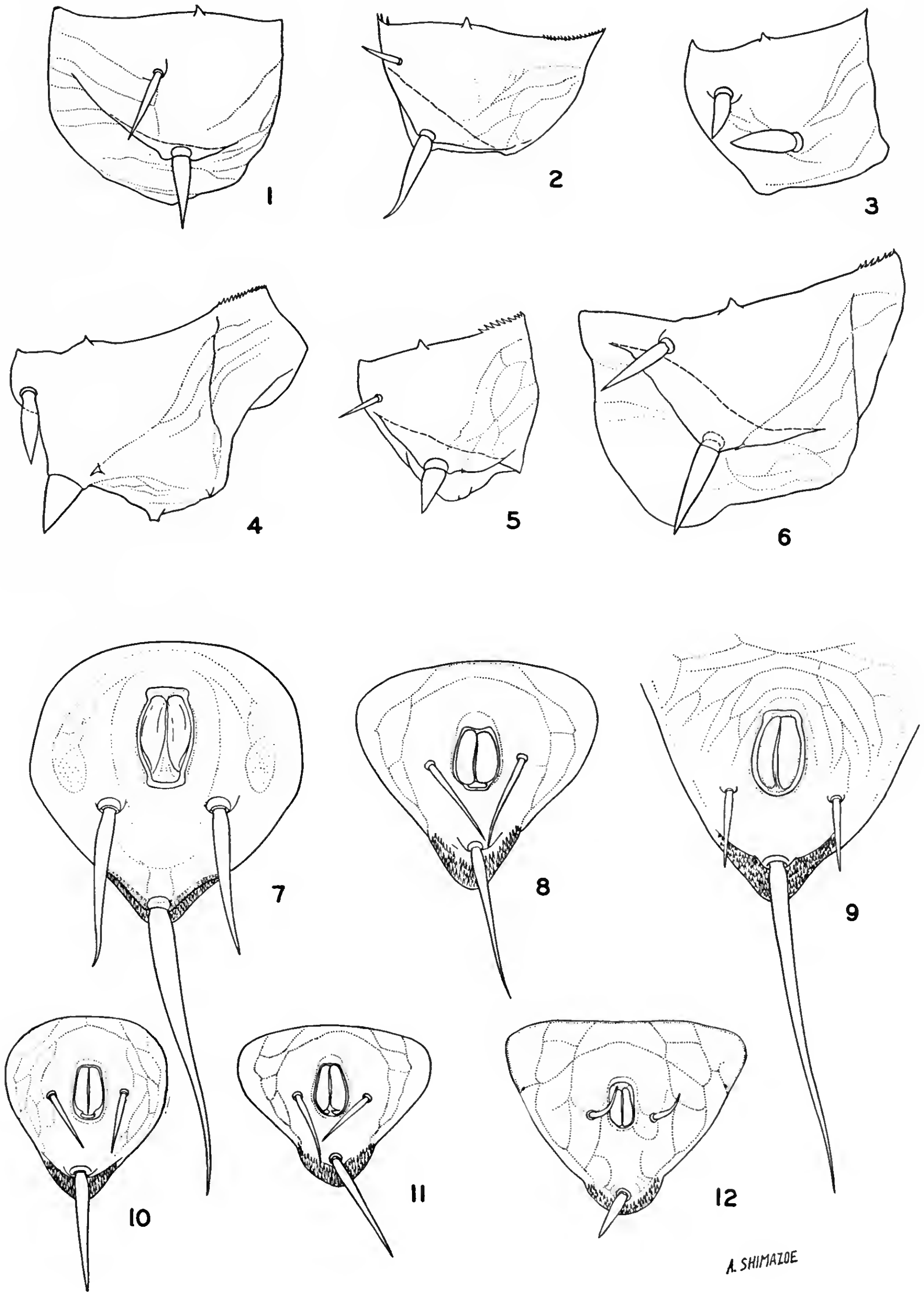
Laelaps paulistanensis Fonseca, female. 1, dorsal view. 2, chela. 3, gnathosoma. 4, anal plate. 5, coxa I. 6, ventral view.



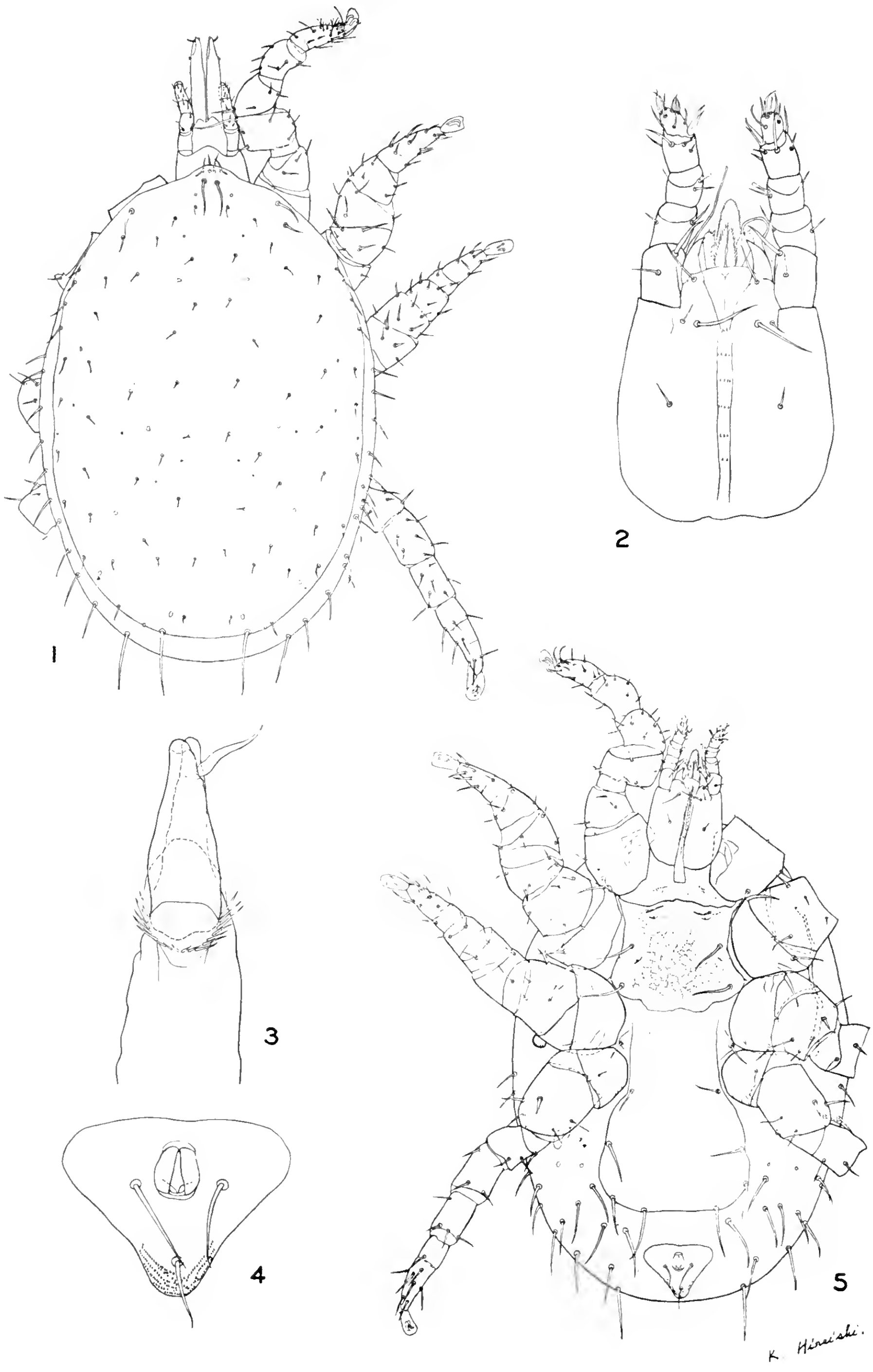
Laelaps pilifer Tipton, new species, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



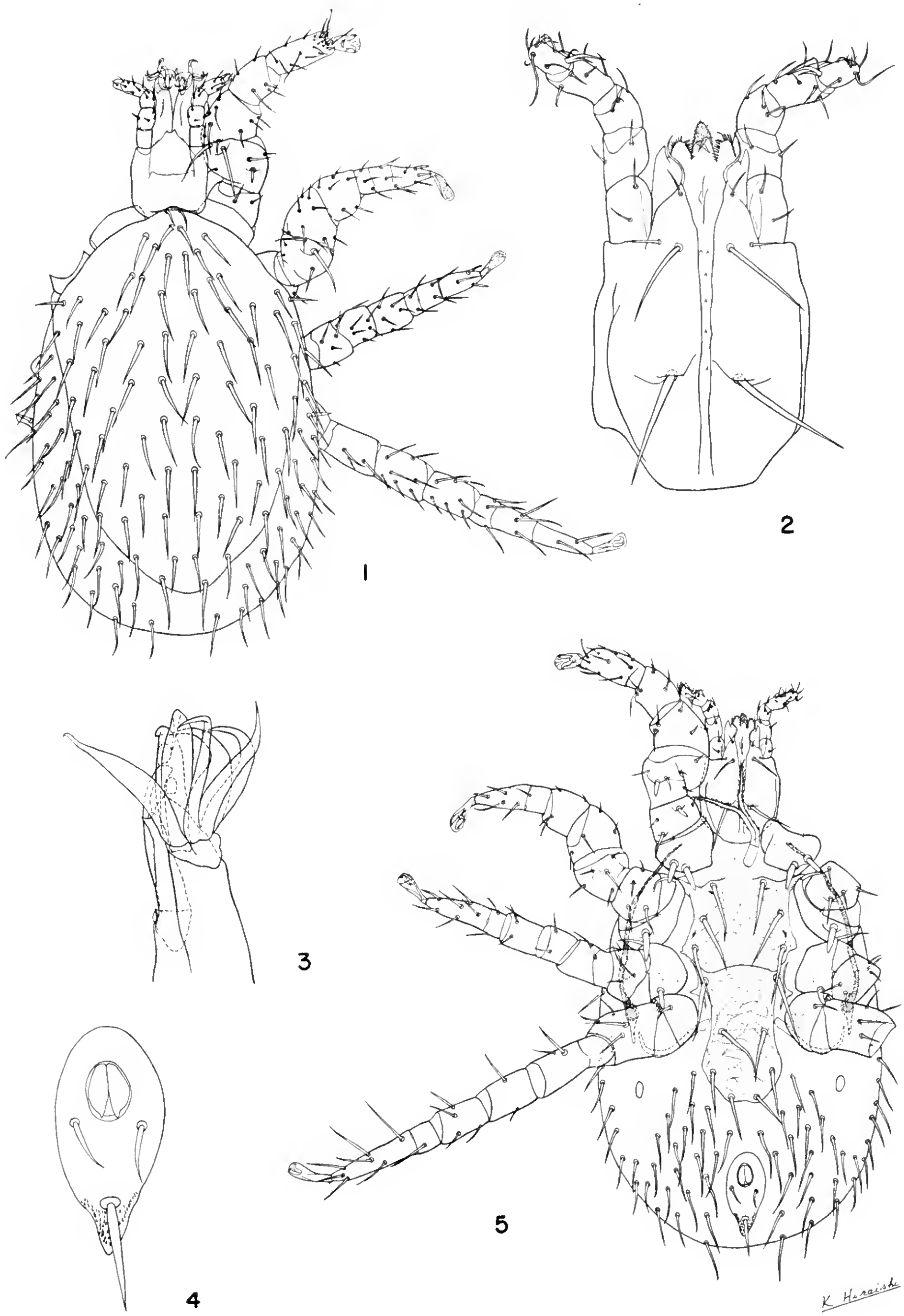
Laelaps thori Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



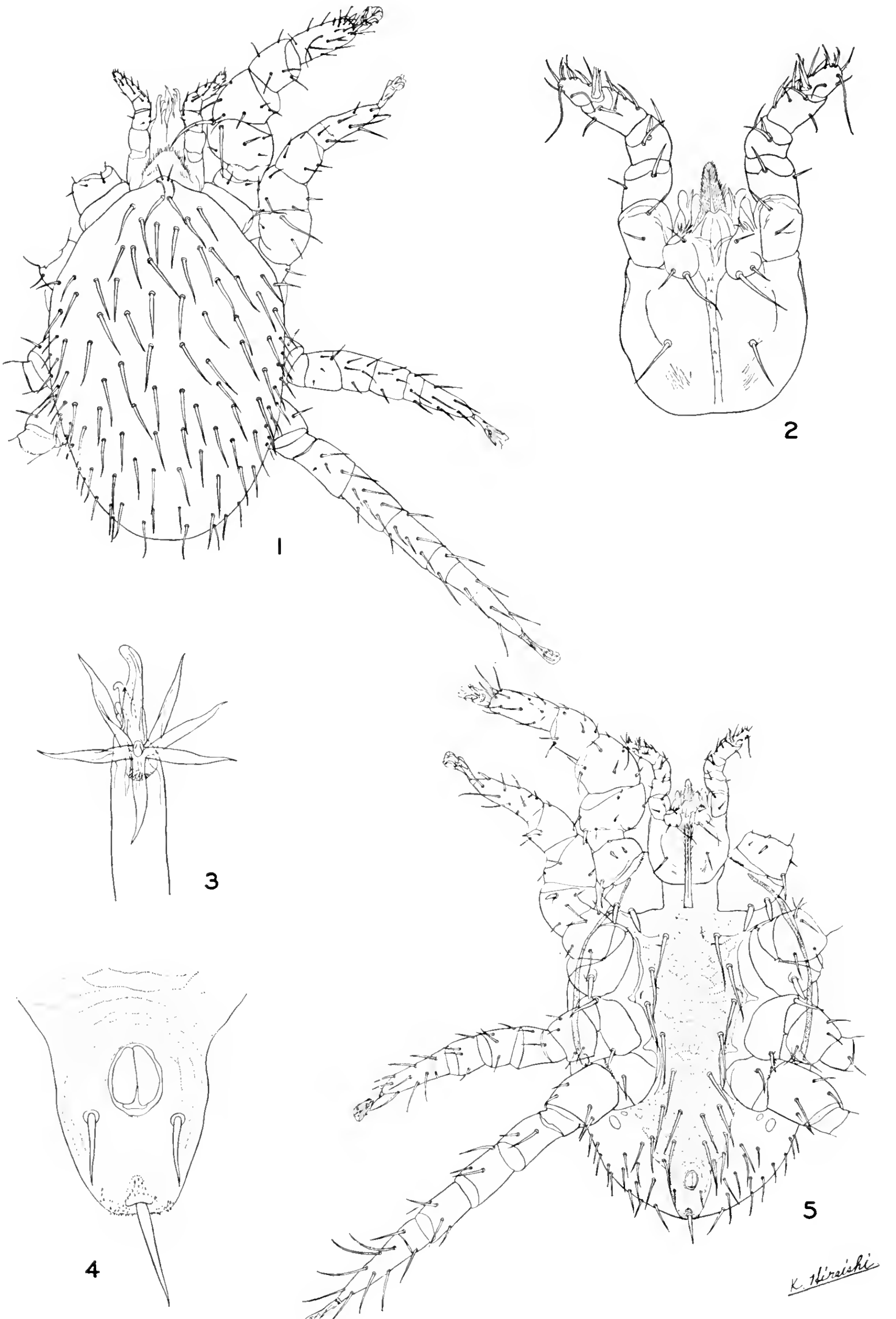
Coxa I and anal plate. *Laelaps dearmasi* Furman and Tipton, female (figs. 4, 7), male (figs. 6, 9). *L. pilifer* Tipton, new species, female (figs. 5, 11). *L. thori* Fonseca, female (figs. 1, 8). *Laelaps* sp., female (figs. 2, 10). *Tur anomalus* Tipton, new species, female (figs. 3, 12).



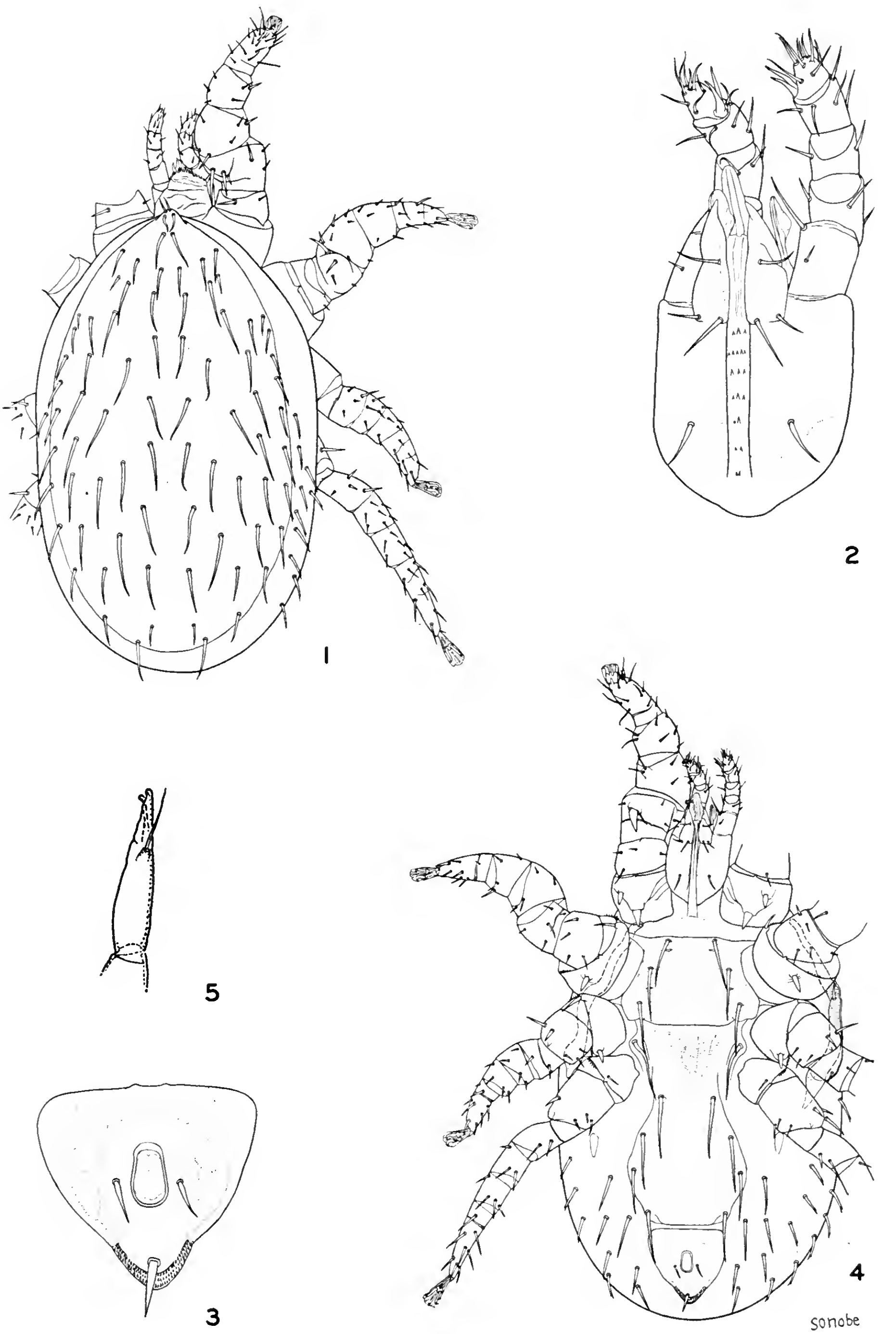
Mysolaelaps parvispinosus Fonseca, female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



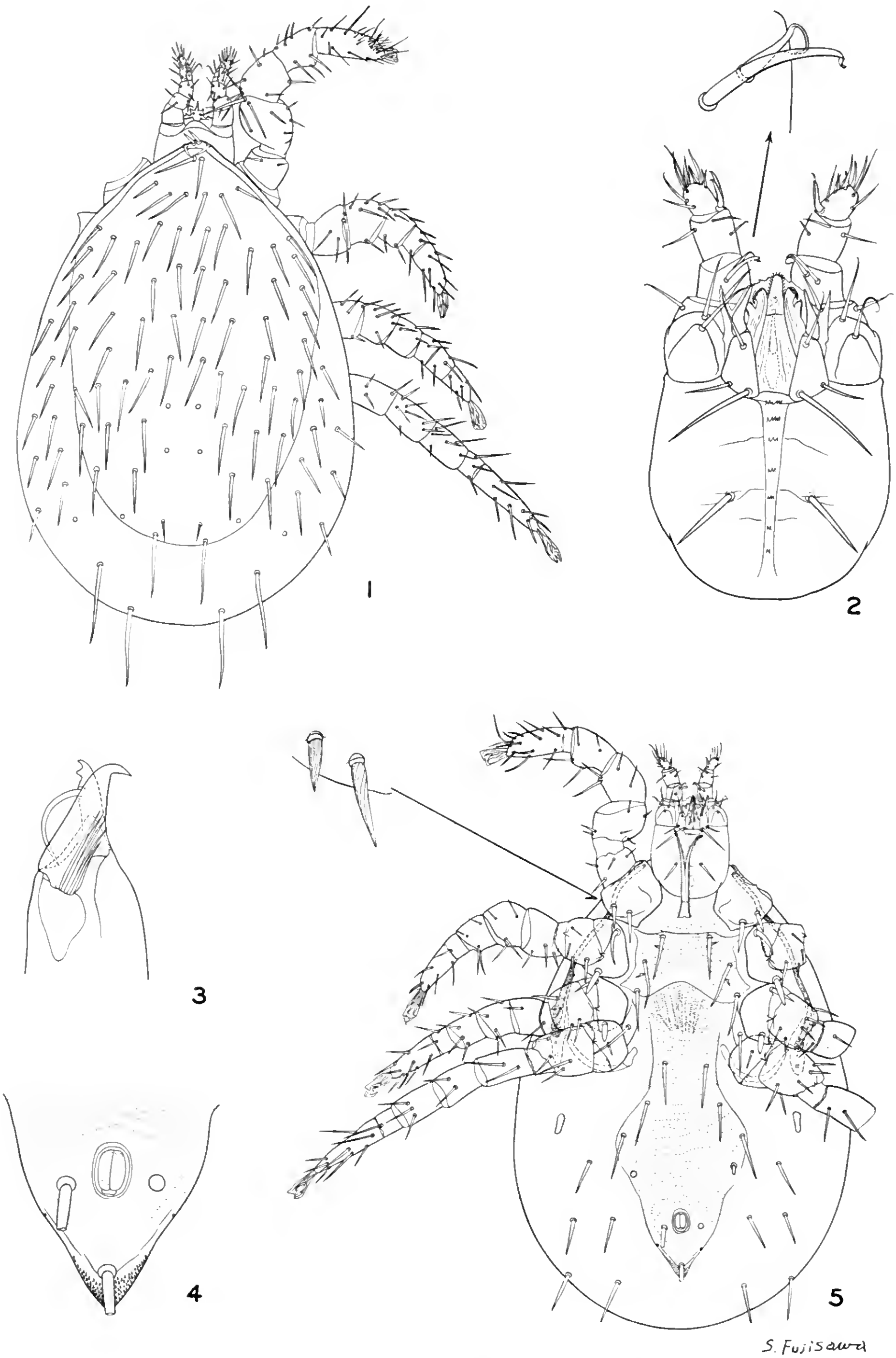
Steptolaelaps heteromys (Fox), female. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



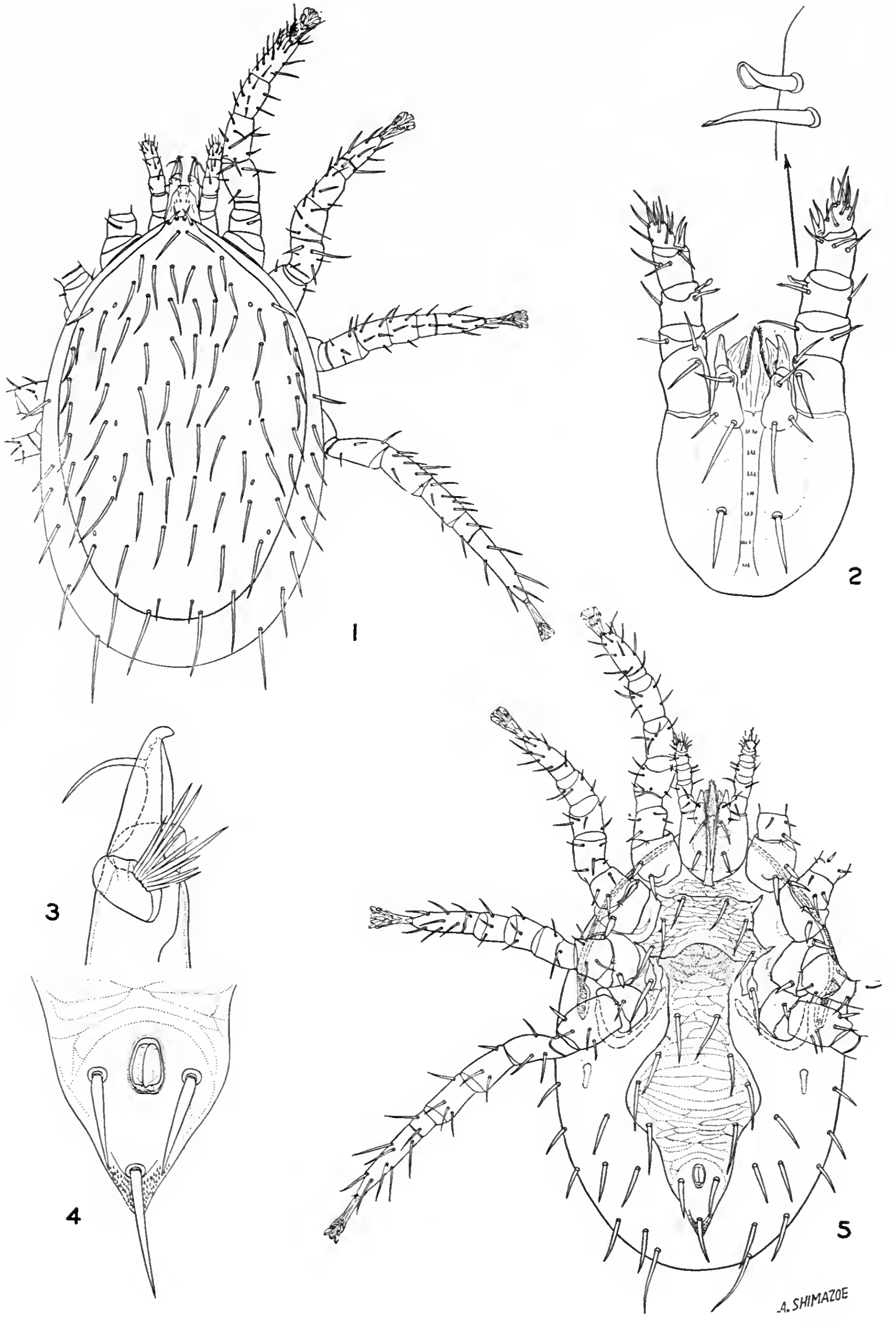
Steptolaelaps heteromys (Fox), male. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



Tur anomalus Tipton, new species, female. 1, dorsal view. 2, gnathosoma. 3, anal plate. 4, ventral view. 5, chela (drawn from photograph).



Tur uniscutatus (Turk), female, from *Proechimys semispinosus*, Canal Zone. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.



Tur uniscutatus (Turk), female, from *Hoplomys gymnurus*, Cerro Azul. 1, dorsal view. 2, gnathosoma. 3, chela. 4, anal plate. 5, ventral view.

The Dermanyssid Mites of Panama
(Acarina: Dermanyssidae)

CONRAD E. YUNKER [1] AND FRANK J. RADOVSKY [2]

The dermanyssid mites of Panama have previously been known only from a single record of *Ornithonyssus bursa* (Berlese), published by Ewing (1922). Intensive sampling of these blood-sucking parasitic mites was accomplished by the senior author from 1960 to 1962 in conjunction with a survey of acarine-borne diseases. Collections were made from over 3000 Panamanian vertebrates, mostly mammals. Hosts were collected by shooting or trapping. A large percentage of the bats were caught in mist nets. Parasites were taken either by combing carcasses that had been kept overnight in individual plastic bags, or from pans of water where they had dropped from carcasses suspended overnight by strings above the pans. Many hosts, but not all, were sampled for intranasal mites by a nasal washing technique (Yunker, 1961). As a result, 41 species of Dermanyssidae were found. At least 11 of these are new species, of which only four are described here. The remaining seven, all from bats, will be described in a revision of world-wide species of bat-infesting dermanyssids (Radovsky, in ms.). A new genus is erected for one of the new species described here, and *Neoichoronyssus dentipes* is transferred to another new genus. Keys to the species from Panama and a host list are provided.

Of particular interest is the absence of dermanyssid mites from rice rats (*Oryzomys* spp.). Over 100 rice rats representing at least seven species were examined, but dermanyssid mites were never found. Neither do Strandtmann and Wharton (1958) list dermanyssids for *Oryzomys*. Host specificity may account for this lack of association. On the other hand,

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infestation with dermanyssids may be precluded by the presence of species of *Gigantolaelaps,* the predominant mesostigmate mites on Panamanian *Oryzomys.*

The disease survey that permitted collateral collection of most of the mites reported here was originated by Dr. James M. Brennan, Rocky Mountain Laboratory, Hamilton, Montana. Dr. Alexis Shelokov, Chief, Laboratory of Tropical Virology and Dr. Henry Beye, Director, Middle America Research Unit, provided administrative support for the survey. Maj. Vernon J. Tipton and Mr. Charles M. Keenan, Environmental Health Branch, United States Army Caribbean, generously facilitated our collecting and on occasion provided field men, Pantaleón Sanchez, Vicente Alvarez, Victor Barria, and Wilbur Lowe, who worked long and hard and took an active interest in our program. Our own assistants, Bélgica Rodriquez R. and Angel Muñoz, Middle America Research Unit, enthusiastically and carefully performed the laborious preparatory work involved in such a program. Mammals were identified by Dr. Charles O. Handley, and Panamanian birds by Dr. Alexander Wetmore, both of the United States National Museum. Reptiles were identified by Mr. Hymen Marx, Chicago Natural History Museum. Dr. Edward W. Baker, United States National Museum, Dr. Gordon M. Clark, Rocky Mountain Laboratory, Mr. Pedro Galindo, Gorgas Memorial Laboratory, and Dr. Jesse S. White, Delta State Teachers' College, Cleveland, Miss., provided additional material for study. Dr. Joseph H. Camin, University of Kansas, Lawrence, examined *Draconyssus belgicae* and gave helpful advice. We are grateful to all of these persons.

KEY TO THE PANAMANIAN GENERA OF DERMANYSSIDAE

Females

1. Dorsal shield divided; metasternal setae absent; on birds........ *Pellonyssus* Clark and Yunker
   Without this combination of characters........2
2. Always on bats........6
   On rodents, birds, or reptiles; never on bats........3
3. At least some coxae bearing non-setigerous ventral spurs........4
   Coxae without ventral spurs or coxae I or III with a setigerous spur or pedicel........5
4. Spur of coxa I bifid and setigerous........*Acanthonyssus* n. gen.
   Spur of coxa I neither setigerous nor bifid........*Hirstionyssus* Fonseca
5. With a single dorsal shield; on rodents, marsupials or birds....*Ornithonyssus* Sambon
   With an anterodorsal prosomal shield and a posterodorsal pygidial shield or cluster of platelets; intranasal parasites of lizards........*Draconyssus* n. gen.
6. Dorsal shield divided........*Steatonyssus* Kolenati
   With a single dorsal shield........7
7. Caudal setae peg-like and barbed; sternal plate with band-like posterior thickening; (protonymphs—the stage most often collected—differing from all others on bats in having claws of leg II much larger than those on other legs)........ *Ichoronyssus* Kolenati (group I)
   All setae smooth; sternal plate without posterior band........8
8. Anterior margin of coxa II bearing one bifid spur or two simple spurs........ *Radfordiella* Fonseca
   Anterior margin of coxa II with one simple spur........9
9. Legs stout, leg I more so than leg II; with ridge-like ventral elevations on coxae I-IV; palpal trochanter without process........New genus no. 1

Legs moderate in thickness; leg I no stouter, usually more slender, than leg II; with ventral elevations on coxae II-IV but not on coxa I; palpal trochanter with ventral spur or ridge 10

10. Chelae edentate; palpal trochanter with ventral spur arising distally .... *Ichoronyssus* Kolenati (group II)

Fixed chela with two slender, curved, ventral teeth; palpal trochanter with ridge-like process arising along most of its length.... *Ichoronyssus* Kolenati (group III)

Genus **Pellonyssus** Clark and Yunker

Pellonyssus Clark and Yunker, 1956, Proc. Helminth. Soc. Wash., **23**: 93.

Type-species: *Pellonyssus passeri* Clark and Yunker, 1956.

KEY TO NEW WORLD SPECIES

Females

1. Peritreme long, reaching to mid-level of coxa I; anteromarginal spur of coxa II absent .... *P. marui* n. sp.

Peritreme short, not reaching past mid-level of coxa II; anteromarginal spur of coxa II present 2

2. First sternal setae short (<15 μ); sternal plate crescentic, nine or 10 times wider than long .... *P. passeri* Clark and Yunker

First sternal setae long (>40 μ); sternal plate rectangular, not more than six times wider than long .... *P. gorgasi* n. sp.

Pellonyssus marui, new species. Figure 1E–H.

DIAGNOSIS: Similar to *P. passeri* (fig. 1A–D); differing in size (smaller), in having a relatively longer sternal plate, in lacking an anteromarginal spur on coxa II and in the longer peritreme.

DESCRIPTION, HOLOTYPE FEMALE: Partially engorged; body approximately 330 μ wide at stigmata, 510 μ long exclusive of gnathosoma; dark brown in life.

Venter.—Tritosternum with two pilose laciniae. Sternal plate a short, wide band about 20 μ long by 165 μ wide. First pair of sternal setae about 19 μ long, second pair more than twice as long (45 μ) and third pair nearly three times as long (58 μ). Sternal plate with two pairs of slit-like pores. Third and fourth pairs of pores inserted on small circular platelets on integument; the former near coxae II, the latter near coxae III. Two similar pairs of pores on circular platelets seen ventrally on opisthosoma. Metasternal setae absent. Epigynial plate pointed posteriorly, reaching past fourth coxae; with a single pair of setae (26 μ). Anal plate ovoid, with flat anterior margin. Anal opening in anterior part of plate. Paired adanal setae (32 μ) arising on either side of anal opening just posterior to its midpoint. Single postanal seta shorter than adanals (20 μ) and arising anterior to cribrum. Peritremal plate posteriorly embracing coxa IV, anteriorly continuing on venter to humeral region, proceeding dorsally for a short distance at level with coxa I. Peritreme about 230 μ long, arising posteriorly in stigma at level of coxa IV and terminating anteriorly at mid-level of coxa I. Postcoxal apodeme III continuous with peritremal plate and extending into the lateral vaginal wall as spur-shaped apodeme. Opisthosoma with 13 pairs of setae that increase in size posteriorly (from 25 μ at level of epigynial plate to 70 μ at end of idiosoma).

Dorsum.—Dorsal shield divided, both segments large, covering most of idiosoma. Anterior (prosomal) shield about 220 μ wide at posterior end, 220 μ long, roughly triangular; posterior margin straight; surface reticulate, bearing nine pairs of setae: five lateral and four submedian, the former about 23 μ long, the latter about 17 μ long, and a single pair of anterior, lyriform pores. A pair of minute vertical setae (5 μ) on integument just anterior to shield. Posterior shield slightly narrower than base of anterior shield, about 170 μ wide at anterior end, 260 μ long. Anterior margin straight, lateral margins tapering to a blunt point. Shield strongly reticulate, with six pairs of setae: the three posterior pairs submarginal, increasing in size posteriorly (13 μ–17 μ–26 μ), the three anterior pairs submedian, about 15–17 μ long. Dorsal integument with 27–28 pairs of setae (including verticals), those posterior and lateral heavier and longer (*e.g.*, 48 μ) than those anterior and median (e.g., 19 μ).

Gnathosoma.—Chelicerae with elongate, attenuate apical segment (210 μ long by 7–10 μ wide), and shorter wider basal segment (93 μ long by 14 μ wide); terminating in small, shear-like chelae. Chelae with two recurved teeth on movable digit, and a membranous fringe on fixed digit.

Legs.—All legs with caruncles and paired claws. Coxa II without obvious anteromarginal spur.

MALE: Body approximately 270 μ wide at stigmata, 430 μ long exclusive of gnathosoma. Holoventral plate irregular in outline, approximately parallel-sided between coxae, widening slightly posterior to coxae IV, markedly constricted at beginning of anal plate; surface reticulate, with six to eight pairs of setae in addition to three setae on anal plate. First sternal setae approximately 5 μ long, second and third approximately 23 μ long; metasternal setae absent; genital setae approximately 20 μ long; two to four pairs of ventral integumental setae of size similar to that of genital setae; paired adanal setae (30 μ) arising on either side of posterior of anal opening, shorter (21 μ) postanal seta arising anterior to cribrum. Ventral and ventrolateral aspects of unsclerotized venter with eight to ten pairs of setae, the lateral and terminal setae heavier and longer (*e.g.*, 46 μ) than the ventral setae (*e.g.*, 20 μ). Peritreme arising at stigma located at level of coxa IV, curving regularly to anterior level of coxa II; approximately 155 μ long. Tritosternum with two laciniae, pilose from base anteriorly. Coxa II without obvious anterodorsal spur. Dorsal shield entire, elongate and narrow (496 μ long by 225 μ wide), tapering to blunt point, surface reticulate, with 12 pairs of setae. Dorsum with 15–17 pairs of non-plate setae, of sizes similar to corresponding setae on venter. Chelicerae shorter and stouter than in female, basal segment expanded, remainder elongate and narrow, length of apical segment, including chelae, 130 μ. Spermatodactyl 19 μ long, bifurcate, with both members of nearly equal length, the thicker member trough-like. Fixed chela shorter and narrower than spermatodactyl. Deutosternum with eight teeth in single file.

PROTONYMPH (unfed): Body approximately 296 μ long by 185 μ wide. Sternal plate oval, 111 μ long by 93 μ wide; with three pairs of setae, each 25 μ long. Anal plate oval, 67 μ long by 56 μ wide, with a pair of adanal setae (37 μ) and a single postanal seta (19 μ). Anus near anterior margin of plate. Five pairs of non-plate setae on venter. Peritreme originating in stigma at level of coxa IV and extending anterior to level of middle of coxa III, approximately 37 μ long. Coxa II without obvious anteromarginal spur. Tritosternum with two indistinctly pilose laciniae. Dorsum with four shields: one large prosomal (177 μ long by 179 μ wide), one smaller pygidial (37 μ long by 92 μ wide) and two minute irregular platelets (18 μ diam.) just posterior to prosomal plate. Prosomal shield with nine pairs of setae, each 10 μ long; a pair of minute vertical setae on integument just anterior to shield. Pygidial shield with three pairs of setae, the anteriormost pair minute (7 μ long), the other two pairs heavier and longer (48 μ and 60 μ). Chelicera functional, similar in form to that of female. Apical segment, including chelae, approximately 150 μ long.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66608), 4 paratype females, 1 paratype protonymph and 2 paratype males from nest of *Cassidix mexicanus*, Ancón (Canal Zone), 10 May 1961, collected by C. E. Yunker and N. Smith; 17 paratype females, 11 paratype protonymphs and 2 paratype males from *Vireo flavoviridis*, and 7 paratype females from *Turdus grayi*, Carrasquilla (Panamá), 3 June 1961, collected by A. Muñoz; 2 paratype females from *Progne chalybea*, Corozal ice plant (Canal Zone), 11 April 1961, collected by C. M. Keenan; 4 paratype females, 2 paratype males and 1 paratype protonymph from nest and young of *Columbigallina* *talpacoti,* Corozal (Canal Zone), 26 June 1961, collected by C. E. Yunker and A. Muñoz.

Paratype specimens to be distributed among the collections of the following institutions: United States National Museum; Chicago Natural History Museum; British Museum (Natural History), London; Rocky Mountain Laboratory, Hamilton, Montana; Institute of Acarology, Ohio State University, Columbus; Department of Entomology and Parasitology, University of California, Berkeley; Snow Entomological Museum, University of Kansas, Lawrence; South African Institute for Medical Research, Johannesburg.

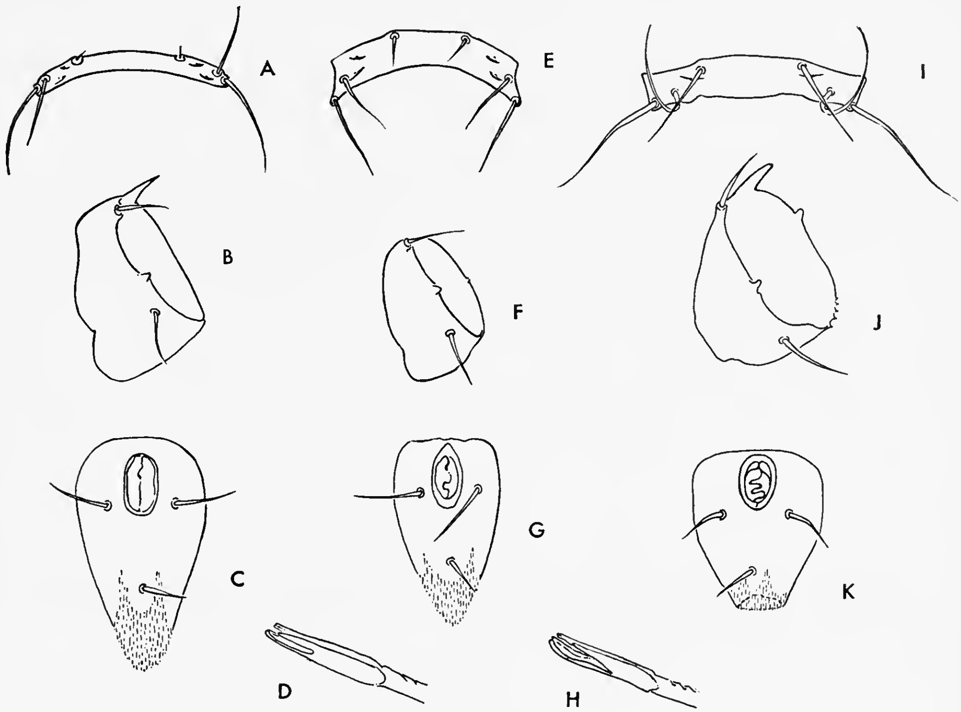

Fig. 1. *Pellonyssus passeri* Clark and Yunker. A, female sternal plate. B, female coxa II. C, female anal plate. D, male chelae. *Pellonyssus marui,* new species. E, female sternal plate. F, female coxa II. G, female anal plate. H, male chelae. *Pellonyssus gorgasi,* new species, female. I, sternal plate; J, coxa II; K, anal plate.

ADDITIONAL MATERIAL EXAMINED: *Pellonyssus marui* was also seen from neotropical areas other than Panama: 23 females and 1 male from *Pitangus sulfuratus,* Rio de Janeiro, Brazil, 29 December 1948, collected by H. W. Krumm; 3 females from "Gray kingbird," Little Inagua Island, British West Indies, "8-5-30," collected by H. S. Peters; 20 females, 42 protonymphs and 15 males from *Coereba portoricensis,* Mayaquez, Puerto Rico, 28 March 1948, collected by Virgilio Biaggi.

Pellonyssus gorgasi, new species. Figure 1 I–K.

DIAGNOSIS: Differing from *P. passeri* and *P. marui* in possessing elongate sternal setae I (nearly twice as long as plate); differing further from *P. marui* in having an anteromarginal spur on coxae II and a short peritreme.

DESCRIPTION, HOLOTYPE FEMALE: Damaged; body approximately 336 μ wide at stigmata, 580 μ long exclusive of gnathosoma.

Venter.—Tritosternum with two pilose laciniae. Sternal plate approximately rectangular, about 20 μ long by 113 μ wide. First pair of sternal setae 43 μ long, second pair 58 μ, and third pair 68 μ. Only the first pair of sternal pores evident on sternal plate of the holotype, lyriform; second sternal pores not seen. Third pair of pores circular, on soft integument near coxae II; a fourth pair similar to third pair on soft integument near coxae IV. Metasternal setae absent. Epigynial plate pointed posteriorly, reaching past fourth coxae; with a single pair of setae (35 μ). Anal plate broadly ovoid, with a truncate anterior margin. Anal opening in anterior of plate; paired adanal setae (26 μ) arising at level of posterior of anal opening. Single postanal seta (23 μ) arising anterior to cribrum. Peritremal plate posteriorly embracing coxa IV, anteriorly terminating at anterior level of coxa II. Peritreme about 154 μ long, posteriorly arising in stigma between coxae III and IV and anteriorly terminating at mid-level of coxa II. Postcoxal apodeme III continuous with peritremal plate and extending into lateral vaginal wall as spur-shaped apodeme. Opisthosoma with 22–24 pairs of setae that increase in size posteriorly (from 34 μ at level of epigynial plate to 50 μ at end of idiosoma).

Dorsum.—Dorsal shield divided, both segments large, covering most of idiosoma. Anterior (prosomal) shield 255 μ wide at posterior end, 280 μ long, roughly in the shape of a triangle; posterior margin straight; surface reticulate, bearing nine pairs of setae: five lateral and four submedian, the former 20–25 μ long, the latter 10–15 μ long, and one pair of anterior lyriform pores. A single pair of minute (<10 μ) vertical setae on integument just anterior to shield. Posterior shield slightly narrower than base of anterior shield, about 220 μ wide at anterior end, 270 μ long. Anterior margin concave. Posterior of shield terminating in blunt point; lateral margins not tapering evenly to this point, but indented near posterior end. Shield reticulate, only five pairs of setae visible (but pygidial area poorly cleared): the two posterior pairs marginal, the terminal pair longer (16 μ) than the subterminal (10 μ); the three anterior pairs submedian, about 12 μ long. Dorsal integument with 30–34 pairs of setae (including verticals), those posterior and lateral heavier and longer (*e.g.*, 50 μ) than those anterior and sublateral (e.g., 18 μ).

Gnathosoma.—Chelicerae with elongate, attenuate apical segment (233 μ long by 10 μ wide), and shorter, wider basal segment (18 μ long by 20 μ wide). Chelae poorly cleared; shear-like and apparently edentate.

Legs.—All legs with caruncles and paired claws. Coxa II with an elongate anteromarginal spur.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66607) from *Phaethornis guy*, Cerro Punta (Chiriquí), about 5200 feet elevation, 27 April 1961, collected by C. E. Yunker. Known only from the type specimen.

Genus **Ornithonyssus** Sambon

Ornithonyssus Sambon, 1928, Ann. Trop. Med. Parasit., **22**: 105.

Type-species: *Dermanyssus sylviarum* Canestrini and Fanzago, 1878.

KEY TO PANAMANIAN SPECIES

FEMALES

1. Proximal seta of coxa I arising from a spur-like elevation.... *O. wernecki* (Fonseca)
   Proximal seta of coxa I not pedicillate...2

2. Sternal plate with two pairs of setae....................................3
   Sternal plate with three pairs of setae..................................4
3. Medial and sublateral setae of dorsal shield short, not over 25 μ; on birds........
   ....*O. sylviarum* (Canestrini and Fanzago)
   All dorsal shield setae long, over 35 μ; on porcupines...*Ornithonyssus coendou* n. sp.
4. Setae of dorsal shield shorter than those on dorsal integument; on birds..........
   ....*O. bursa* (Berlese)
   Setae of dorsal shield at least as long as those on dorsal integument; on rodents....
   ....*O. bacoti* (Hirst)

Ornithonyssus sylviarum (Canestrini and Fanzago)

Dermanyssus sylviarum Canestrini and Fanzago, 1878, Atti R. Istit. Veneto Sci. Lett. Arti, (5), 4: 124.

The northern fowl mite is a common, serious, blood-sucking parasite of passeriform birds and domestic fowl in temperate regions throughout the world. Thirteen females were taken from a toucan, *Aulacorhynchus prasinus,* in Cerro Punta (Chiriquí), at approximately 5200 feet altitude. This is apparently the southernmost New World record for *O. sylviarum,* previously not recorded south of the United States. It is noteworthy, however, that it has not yet been found in the tropical lowlands. This parasite should be searched for in other areas of Panama.

Ornithonyssus bacoti (Hirst)

Leiognathus bacoti Hirst, 1913, Bull. Ent. Res., 4: 122.

The tropical rat mite is a common blood-sucking parasite of many species of rodents throughout the world, and is capable of attacking birds and many mammals including man. In Panama, it was the most common dermanyssid encountered and was taken during all months of the year. Preferred hosts were *Proechimys semispinosus* and *Sigmodon hispidus.* In the higher elevations of Chiriquí Province, it was collected only from *Peromyscus nudipes.*

Although taken on nine occasions from *Liomys adspersus,* a spiny pocket mouse, it was never seen on *Heteromys desmarestianus,* a closely related rodent, despite extensive collection of the latter. Other infrequent hosts were *Zygodontomys microtinus* and *Rattus rattus.* Localities involved were: both Atlantic and Pacific sides of Canal Zone; Achiote (Colón); Las Palmitas and Guánico (Los Santos); Cerro Punta, Bambito and El Hato (Chiriquí).

Ornithonyssus bursa (Berlese)

Leiognathus bursa Berlese, 1888, Boll. Soc. Ent. Italiana, **20**: 208.

The tropical fowl mite, common on many species of birds in warmer climates of the world, was recorded by Ewing (1922) "on common hen" in the Canal Zone. Subsequent records are lacking, and the species was not encountered in this study. Here, however, birds were not frequently examined. We have seen specimens from domestic fowl in Costa Rica and the species is recorded from Colombia; there is no reason to doubt its presence in Panama.

Ornithonyssus coendou, new species. Figure 2.

DIAGNOSIS: Similar to *O. sylviarum,* differing: in size (larger), in possession of long, subequal setae on dorsal shield, and in having adanal setae that arise at posterior level of anal slit. Known only from the porcupine, *Coendou rothschildi.*

DESCRIPTION, HOLOTYPE FEMALE: Body approximately 425 μ wide at stigmata, 670 μ long exclusive of gnathosoma.

Venter.—Tritosternum with two pilose laciniae. Sternal plate rectangular, about 36 μ long at mid-line by 92 μ wide at sternal setae II; with two pairs of setae and two pairs of lyriform pores; surface adjacent to setae ornamented with cell-like reticulations; parts of these reticulate areas covered with punctations. Third sternal setae on integument between sternal plate and epigynial opening. Metasternal setae present, adjacent to coxae III. Third sternal pores located between sternal setae III and metasternal setae. Epigynial plate narrow, pointed posteriorly, broad and fan-shaped anteriorly, with a pair of setae. A pair of circular pores on integument near genital setae. Anal plate ovoid, with the usual three setae and posterior denticulate cribrum. Adanal setae arising at a level with posterior of anus, slightly shorter than postanal seta. Stigma large (21 μ diam.) circular, located lateral and posterior to coxa III. Peritreme wide, extending anteriorly, bending dorsally, and terminating over mid-region of coxa I. Peritremal plate fusing with endopodal apodeme to nearly encircle coxa IV. Ventral integument with about 30 pairs of non-plate setae, those anterior smallest (*e.g.*, 33 μ), those lateral and posterior longest (*e.g.*, 47 μ). All posteroventral setae distinctly terminally branched (fig. 2B). A pair of narrow elongate platelets flanking posterior end of epigynial shield. Metapodal platelets irregular, small, in lateral post-coxal area.

Dorsum.—With a single, long shield having sinuous lateral margins and tapering posteriorly to a narrow, rounded point. Shield with 17 pairs of setae, anteriormost pair relatively minute, others elongate (about 40 μ), terminally branched. Dorsal integument with about 50 pairs of non-plate setae, all well developed, terminally branched and elongate. Those lateral and posterior longest (*e.g.*, 45 μ).

Legs.—I and IV subequal in length, longer than II and III, which are also subequal. Each leg with a pretarsus bearing ambulacral claws and a small membranous caruncle. All segments without obvious spurs or protuberances, except coxa II, which bears an anteromarginal spur. All but distal leg setae terminally branched, those dorsal somewhat longer and thicker than those ventral, especially on legs I and II.

Gnathosoma.—Internal hypostomal setae much longer than external and anterior hypostomal setae and gnathosomal base setae. With nine or 10 deutosternal teeth arranged in a single file. Hypostomal processes elongate. Palpal trochanter with a small ventral protuberance. Chelicerae chelate; chelae edentate, resembling those of other species of *Ornithonyssus.*

MALE: Body approximately 278 μ wide at stigmata, 450 μ long, exclusive of gnathosoma. Holoventral plate irregular in outline, with 21 setae (occasionally one member of a pair off plate). With 10 pairs of ventral non-plate setae. Stigma as in female; peritreme extending anteriorly, bending dorsally and terminating over anterior region of coxa II. Dorsal shield broad, covering most of dorsum, tapering posteriorly to a point; with 19-21 pairs of setae similar to those of female. Dorsum with nine or 10 pairs of non-plate setae. Coxa II with usual anteromarginal spur. Palpal femur with a large ventral protuberance bearing a spiniform seta (fig. 2F). Chelicera as in female except for chela, which bears a scapiform spermatodactyl (fig. 2G).

PROTONYMPH: Body approximately 520 μ long by 325 μ wide. Sternal plate shield-shaped, with three pairs of setae. Anal plate oval, with three setae. Six pairs of non-plate setae on venter. Peritremalia a short, lateral crescent. Coxa II with a small, blunt anteromarginal spur. Dorsum with prosomal plate having 10 pairs of setae, a pygidial plate having three pairs of setae, and two small, bare platelets just posterior to prosomal plate. Eleven pairs of non-plate dorsal setae.

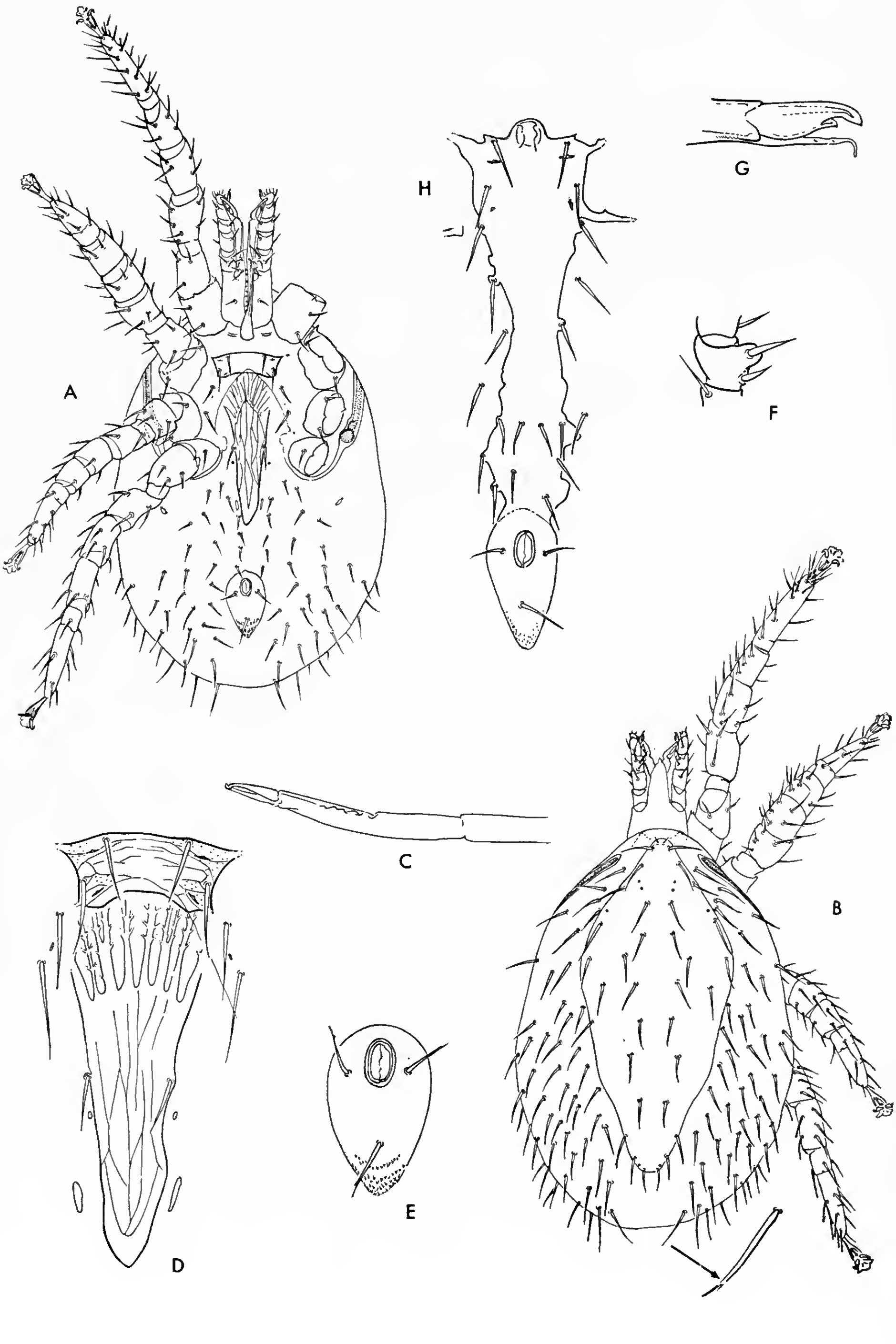

Fig. 2. *Ornithonyssus coendou*, new species. A, female venter. B, female dorsum. C, female chelicera. D, female sternal and epigynial area. E, female anal plate. F, male palpal trochanter. G, male chelae. H, male holoventral plate.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66610), 1 paratype female and 2 paratype nymphs from *Coendou rothschildi,* near Pedro Miguel River, Paraíso (Canal Zone), 21 February 1962, by J. M. Brennan and C. E. Yunker, deposited in United States National Museum. Allotype male, and 10 paratype nymphs, same data, but 12 March 1962, in United States National Museum. One paratype female and 7 paratype nymphs, same data, but 26 February to 20 March 1962, in collection of Rocky Mountain Laboratory, Hamilton, Montana.

Ornithonyssus wernecki (Fonseca)

Liponyssus wernecki Fonseca, 1935a, Mem. Inst. Butantan, 9: 70, figs. 1–8.

This species is a common parasite of marsupials in Panama. Hosts from which we collected it are *Didelphis marsupialis, Marmosa robinsoni, Philander opossum* and *Metachirus nudicaudatus.* Localities include France Field, Fort Sherman and Fort Gulick (Atlantic side of Canal Zone); Cerro Campana and Cerro Azul (Panamá). Collected mainly during the drier months, March and April, we also have a collection taken in November, France Field (Canal Zone), from *Didelphis marsupialis.*

Acanthonyssus, new genus

Type-species: *Ichoronyssus dentipes* Strandtmann and Eads, 1947.

DIAGNOSIS: Macronyssinae; all setae smooth; dorsal shield entire and broadly rounded posteriorly; all coxae bearing one or more stout ventral spurs; coxa II with one simple anterodorsal spur; outer ventral spur of coxa I bifid and bearing proximal seta at furcation; some middle segments of legs II-IV bearing strong recurved spurs.

FEMALE: sternal plate short, without surface markings other than usual sculpturing and pores; sternal setae II much closer to III than to I; epigynial plate cuneate, with well-defined scale-like, anterior sculpturing; peritremes moderately broad, terminating over coxa I; chelae simple, without setae, teeth or other processes; palpal trochanter with distal ventral spur.

MALE: ventral armature entire; palpal trochanter without process.

REMARKS: Furman and Radovsky (1963) synonymized *Neoichoronyssus* by transferring the type-species, *N. wernecki,* to *Ornithonyssus.* In doing so, they left the generic status of *N. dentipes* unresolved. This new genus is proposed for *N. dentipes.*

Acanthonyssus dentipes (Strandtmann and Eads), *new combination.*

Ichoronyssus dentipes Strandtmann and Eads, 1947, Jour. Parasit., 33: 31, figs. 1–3.

Described from *Sigmodon hispidus* in Texas, this species was recovered mainly from *Proechimys semispinosus* in the Canal Zone (Miraflores, Summit, Gamboa, Coco Solo, France Field and Fort Gulick). It was taken only during the drier months, December to May, 1960-1962. Two collections, however, from Almirante (Bocas del Toro), August 1960, by P. Galindo were from the type host, *Sigmodon hispidus.*

Some of the material from *Proechimys* showed various but not obviously consistent morphological differences from specimens from the type host.

These variations were particularly noticeable in the dimensions of the sternal plate (range = 23 μ long by 118 μ wide to 32 μ long by 112 μ wide), the degree of biconcavity of the lateral margins of the dorsal shield, and the number and relative size of the ventral setae. It is possible that two species are involved here.

Genus **Hirstionyssus** Fonseca, 1948

Hirstionyssus Fonseca, 1948, Proc. Zool. Soc. London, 118: 266.

Type-species: *Dermanyssus arcuatus* Koch, 1839.

Seven species of *Hirstionyssus* are known from Panama. They are described and keyed by Strandtmann and Yunker elsewhere in this volume. Of these, all but one are from heteromyid and cricetid rodents. The exception is from squirrels. A list of the species and their hosts is included in the host list of this paper.

Draconyssus, new genus

Type-species: *Draconyssus belgicae,* new species.

DIAGNOSIS: Dermanyssidae; with two dorsal shields or with a single prosomal shield and a cluster of pygidial platelets; second cheliceral segment extremely elongate, but not attenuate, at rest deeply withdrawn into idiosoma; sternal plate with two pairs of setae; metasternal setae absent; epigynial setae off plate; peritreme extending to level of middle of coxa II. Male unknown.

REMARKS: At this point we are unable to assign *Draconyssus* to a subfamily within the Dermanyssidae. We suspect it to be macronyssid and to have affinities with *Ophionyssus* and *Sauronyssus.* Cheliceral conformation —the sole basis for subfamilial placement—is not applicable here. The chelicerae of *Draconyssus belgicae,* n. sp., although extremely elongate and withdrawn into the idiosoma as in the Dermanyssinae, are also strongly chelate and definitely not attenuate, as in the Macronyssinae. A similar, but not as pronounced, elongation of the chelicerae is seen in *Pellonyssus* and *Ophionyssus* (Macronyssinae). *Hystrichonyssus* (Hystrichonyssinae) shows elongate attenuate chelicerae, but here the proximal segment is elongate whereas the second segment is normal. It has been obvious to us for some time that cheliceral modifications are unsatisfactory indicators of phylogeny in this group. Until a better basis for classification is reached, *Draconyssus* must remain as an unassigned genus of Dermanyssidae.

Draconyssus belgicae, new species. Figure 3.

DESCRIPTION, HOLOTYPE FEMALE: Body approximately 405 μ wide at stigmata, 668 μ long exclusive of gnathosoma.

Venter.—Tritosternum with two pilose laciniae and serrate lateral membranes. Sternal plate roughly rectangular with irregular borders, about 54 μ long at mid-line by 93 μ wide at sternal setae II; with two pairs of setae and two pairs of lyriform pores; surface densely covered by coarse punctations that become less dense posterior to sternal setae II. Third sternal setae on integument between sternal plate and epigynial opening. Metasternal setae absent. Epigynial setae on unsclerotized integument between lateral margins of epigynial plate and coxae IV. Sternal and epigynial setae subequal in length. Third sternal pores circular, on integument just posterior to sternal setae III, and overlapped by hyaline anterior margin of epigynial plate. A fourth pair on unsclerotized integument just posterior of epigynial setae and three similar pairs on hysterosoma. Epigynial plate narrow, pointed posteriorly, broad and fan-shaped anteriorly, and biconcave laterally in region of coxae IV. Anal plate ovoid, with the usual three setae and posterior denticulate cribrum; adanal setae arising at a level with posterior of anus, subequal in length to postanal seta. Peritreme arising at stigmata located lateral to and between coxae III and IV, extending anteriorly and becoming dorsal at termination over mid-region of coxa II; peritremal plate fusing with endopodal apodeme to nearly encircle coxa IV. Ventral integument with 15 or 16 pairs of non-plate setae; those lateral and posterior longest (about 53 μ); those medial and anterior of anal plate shorter, subequal to sternal and epigynial setae (about 37 μ). All ventral setae terminally branched. A pair of narrow elongate platelets flanking posterior end of epigynial shield. Metapodal platelets irregular crescents, located in lateral post-coxal area.

Dorsum.—With two sclerotized shields. Propodosomal shield biconvex; twice longer than wide; with six pairs of setae. Pygidial shield minute, irregular in outline, without setae. Dorsal integument with 25 or 26 pairs of non-plate setae, including verticals. All dorsal setae well developed, terminally branched, and subequal (about 50 μ long). Two pairs of circular pores dorsal on hysterosoma.

Legs.—I and IV subequal in length, longer than II and III, which are also subequal. Each leg with a pretarsus bearing ambulacral claws and membranous caruncles. All segments without obvious spurs or protuberances. Leg setae as in body setae, terminally branched; those dorsal somewhat longer and thicker than those ventral, especially on legs I and II.

Gnathosoma.—Internal hypostomal setae much longer than external and anterior setae and gnathosomal base setae. With eight or nine deutosternal teeth arranged in a single file. Hypostomal processes elongate, ensheathed by lateral folds of tectum. Tectum forming an elongate tube, extending to level with base of palpal tarsi. Chelicerae elongate and whip-like. Basal segment short (21 μ); distal segment sinuous and elongate (363 μ). Chelae chelate and edentate, the movable digit somewhat shorter and stouter than the fixed digit; the latter with a slight, recurved tip (fig. 3C).

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66609) intranasal in *Ameiva bifrontata*, a teiid lizard, Nuevo Emperador (Canal Zone), 10 August 1961, collected by C. E. Yunker and A. Muñoz. Three paratype females bearing the same data as the holotype; 3 paratype females intranasal in *Ameiva* sp., K-9 Road (Pacific side of Canal Zone), 18 October 1961, collected by C. E. Yunker and A. Muñoz. The holotype and a paratype will be deposited in the United States National Museum; remaining paratypes will be distributed among the collections of Chicago Natural History Museum; Rocky Mountain Laboratory, Hamilton, Montana; Institute of Acarology, Ohio State University, Columbus; Snow Entomological Museum, University of Kansas, Lawrence.

REMARKS: Variation was seen in the shapes of the dorsal shields and ventral plates, which were often eroded and irregular. The pygidial shield of certain specimens was represented only by a cluster of two or three irregular platelets. The epigynial plate varied in outline from an irregular, asymmetrical linguiform one, to one with perfectly parallel sides ending posteriorly in a glans-shaped expansion. The outline of the dorsal shield was occasionally irregular, and in one specimen it included the bases of two lateral setae typically found on the bare integument. The sternal shield was often seen to be eroded on its posterior margin.

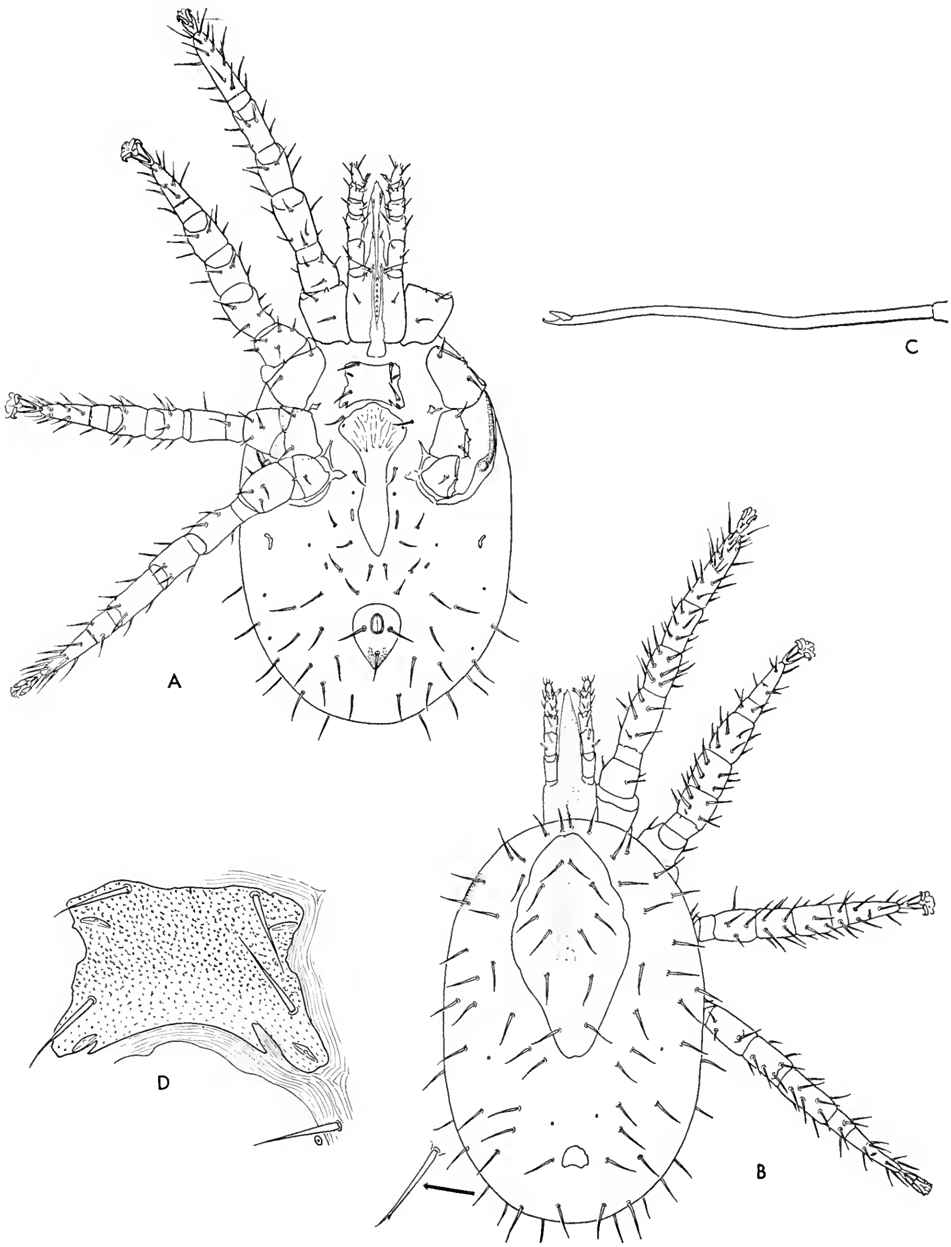

Fig. 3. *Draconyssus belgicae*, new genus, new species, female. A, venter. B, dorsum. C, chelicera. D, sternal plate.

The species is named for Miss Bélgica E. Rodriquez R., Middle America Research Unit, who first recovered specimens from nasal washings.

Genus **Steatonyssus** Kolenati

Steatonyssus Kolenati, 1858, Wien. Ent. Monatschr., 2: 6.

Type-species: *Dermanyssus murinus* Lucas, 1840 (= *Dermanyssus periblepharus* Kolenati, 1858).

Steatonyssus occidentalis (Ewing)

Ceratonyssus occidentalis Ewing, 1933, Proc. U.S. Nat. Mus., 82: 10, pl. 3 (fig. 5), pl. 4 (fig. 1).

This is the only species of this large, widely distributed genus taken in Panama. It was recovered from an unidentified bat in El Valle (Coclé), 1 June 1961, collected by W. E. Woodcock. In North America, the usual host is *Eptesicus fuscus;* the range of this bat includes Panama.

Genus **Ichoronyssus** Kolenati

Ichoronyssus Kolenati, 1858, Wien. Ent. Monatschr., 2: 5.

Type-species: *Ichoronyssus scutatus* Kolenati, 1858.

The interpretation of *Ichoronyssus* followed in this paper is that of Strandtmann and Wharton (1958). It will be reinterpreted in a revision by the junior author (in manuscript). The genus (*sensu* Strandtmann and Wharton) is here divided into three groups of related species.

Group I

KEY TO PANAMANIAN SPECIES

Females

1. Third pair of sternal setae on platelets joined to sternal plate by thread-like connections .... *I. robustipes* (Ewing)
   At most, slight constrictions between portions bearing sternal setae III and remainder of plate 2
2. Sternal plate without constrictions proximal to third pair of setae; anteromedial setae on dorsal shield about 40 μ or more .... *I. venezolanus* (Vitzthum)
   Sternal plate with slight constrictions proximal to third pair of setae; anteromedial setae on dorsal shield about 25 μ or less .... *I. haematophagus* (Fonseca)

Protonymphs

1. Coxa I with blunt lateral spur .... *I. venezolanus* (Vitzthum)
   Coxa I without lateral spur 2
2. Unarmed venter with five pairs of setae lateral or anterior to anal plate .... *I. haematophagus* (Fonseca)
   Unarmed venter with seven pairs of setae lateral or anterior to anal plate .... *I. robustipes* (Ewing)

Ichoronyssus robustipes (Ewing)

Liponyssus robustipes Ewing, 1925, Ent. News, 36: 20.

This species is a common parasite of *Tadarida brasiliensis*, a bat ranging over much of North and South America and the West Indies. In Panama, *I. robustipes* was thrice taken from this host in a cave in Cerro Punta

(Chiriquí), 3 April 1961, by C. E. Yunker. Several mites also were taken from *Myotis nigricans* roosting in the same cave.

Ichoronyssus venezolanus (Vitzthum)

Liponyssus venezolanus Vitzthum, 1932, Zeitschr. Parasitenk., 4: 9, figs. 3–13.

Previously known from the type collection from *Molossus nasutus* in Venezuela, protonymphs of *I. venezolanus* were collected from *M. coibensis* and "molossid bats" in a church attic in Pacora (Panamá), 6 June 1961, by C. M. Keenan and C. E. Yunker.

Ichoronyssus haematophagus (Fonseca)

Liponyssus haematophagus Fonseca, 1935b, Mem. Inst. Butantan, **10**: 43, figs. 1–2.

Protonymphs of this species were taken from a molossid bat, probably *Molossus coibensis*, in a church attic in Pacora (Panamá), 6 June 1961, by C. M. Keenan and C. E. Yunker. The type collection is from southern Brazil, from *Molossus rufus*.

Group II

KEY TO PANAMANIAN SPECIES

Females

Sternal setae III arising from posterior angles of sternal shield, and shield with slight, neck-like constrictions proximal to these setae; dorsal shield with 26 or 27 pairs of setae .... *I. kochi* Fonseca

Sternal setae III arising slightly anterior to posterior angles of shield, not set apart by constrictions; dorsal shield with 24 pairs of setae .... New species no. 1

Ichoronyssus kochi Fonseca

Ichoronyssus kochi Fonseca, 1948, Proc. Zool. Soc. London, **118**: 278, figs. 17–20.

The type host is *Artibeus* sp. from Brazil, and our records indicate that *Artibeus* is the usual host genus. In Panama, *I. kochi* was taken from *Artibeus toltecus*, Cerro Punta (Chiriquí), April 1961, and Río Changena (Bocas del Toro), September 1961; from *Artibeus jamaicensis*, Juan Mina (Canal Zone), June 1961, and Río Changena (Bocas del Toro), September 1961, by C. E Yunker.

Ichoronyssus (group II), new species no. 1

This species was found in Panama on *Vampyrops vittatus*. Collections were made from several bats at Río Changena (Bocas del Toro), September 1961, by V. J. Tipton and C. E. Yunker and from a single bat at Cerro Punta (Chiriquí), February 1960, by V. J. Tipton.

Group III

KEY TO PANAMANIAN SPECIES

Females

Peritreme ending over coxa I; dorsal shield with longest anterolateral setae about two or three times as long as shortest anteromedial setae .... *I. crosbyi* (Ewing and Stover)

Peritreme ending over coxa II; dorsal shield with longest anterolateral setae about nine or ten times as long as shortest anteromedial setae .... New species no. 1

Ichoronyssus crosbyi (Ewing and Stover)

Liponyssus crosbyi Ewing and Stover, 1915, Ent. News, **26**: 112, pl. 4, fig. 3.

In Panama, *I. crosbyi* was recovered from *Myotis chiloensis* and from a mixed lot of *M. chiloensis* and *Myotis nigricans* roosting in a cave in Cerro Punta (Chiriquí), 5 May 1961, by C. E. Yunker. At least one bat was infested with this species and with *Ichoronyssus* (group III), n. sp. no. 1. The latter parasite was far more numerous at this site. In the United States, *I. crosbyi* is known from several other *Myotis* species.

Ichoronyssus (group III), new species no. 1

Large numbers of this species were found on many individual *Myotis nigricans* in a cave in Cerro Punta (Chiriquí), 5 May 1961, by C. E. Yunker. In the same cave, it was taken on a few specimens of *Myotis chiloensis*. A single collection was taken on *M. nigricans* in Cerro Punta (Chiriquí), in March 1962, by V. J. Tipton.

Genus **Radfordiella** Fonseca

Radfordiella Fonseca, 1948, Proc. Zool. Soc. London, **118**: 270.

Type-species: *Radfordiella oudemansi* Fonseca, 1948.

KEY TO PANAMANIAN SPECIES

Females

1. Spur on anterior margin of coxa II bifid; sternal shield short (length at mid-line about 25 μ), with strongly arched posterior margin........*R. oudemansi* Fonseca
   Coxa II with two simple spurs on anterior margin; sternal shield length at mid-line over 50 μ..........2
2. Dorsal shield length over 410 μ and usually more than 430 μ; sternal shield with moderately arched posterior margin reaching slightly beyond level of trichopores of sternal setae III..........New species no. 1
   Dorsal shield length under 410 μ; sternal shield with weakly arched posterior margin rarely reaching beyond level of pores of sternal setae III..New species no. 2

Radfordiella oudemansi Fonseca

Radfordiella oudemansi Fonseca, 1948, loc. cit., **118**: 274, figs. 45–48.

R. oudemansi has not been collected in Panama, but it probably occurs there and hence is included in the key. The type material was taken on *Desmodus rotundus* in Brazil.

Radfordiella, new species no. 1

The common vampire bat, *Desmodus rotundus,* appears to be the normal host. Mites were taken in Panama from a number of individuals of *D. rotundus* at Las Palmitas (Los Santos), January 1962, by C. O. Handley and F. Greenwell. We have seen material from the same host in Guatemala and Trinidad.

Radfordiella, new species no. 2

This species was collected in Panama as follows: from *Carollia perspicillata,* Sardanillo, Summit (Canal Zone), 12 August 1961; in a mixed collection of *C. perspicillata* and *Lonchorhina aurita,* same locality and date;

from *C. perspicillata,* Juan Mina (Canal Zone), 30 June 1961; from *Carollia castanea,* Cerro Pirre (Darién), 3 February 1961, by C. E. Yunker. Only the first of these collections contained more than one specimen.

New Genus no. 1

Three undescribed species belonging to to this genus were found in Panama. All of these were taken from phyllostomid bats, as follows: n. sp. no. 1 from *Glossophaga soricina,* Río Changena (Bocas del Toro), 19 September 1961, by C. E. Yunker; n. sp. no. 2 from *Sturnira ludovici* same data; n. sp. no. 3 from *Carollia perspicillata,* Juan Mina (Canal Zone), 20 June 1961, by C. E. Yunker. We also have specimens of n. sp. no. 1 from a phyllostomid bat collected in Costa Rica by J. S. White.

Species inquirendae

Ten collections, consisting solely of protonymphs or males were seen. Due to the existing lack of knowledge concerning immature and male mesostigmates they are not fully identifiable. Two of these, from rodents, are not referable to any of the species known from Panama. They are: Subfamily *Dermanyssinae,* 2 protonymphs from *Hoplomys gymnurus,* Cerro Azul (Panamá), 17 March 1961; Subfamily *Macronyssinae,* 4 protonymphs of *Ornithonyssus* sp. from *Dasypus novemcinctus,* near Pedro Miguel River, Paraíso, (Canal Zone), 27 February 1962.

The remaining eight collections, all macronyssines from bats, are referable to *Radfordiella, Ichoronyssus* (group II), new genus no. 1, and an unknown genus. These probably all represent new species, but material is inadequate for treatment.

Addenda

Since this paper was set in type, Till (1964: 90, 92) has synonymized *Pellonyssus passeri* Clark and Yunker, the type-species of *Pellonyssus* Clark and Yunker, under *Steatonyssus reedi* Zumpt and Patterson (1952: 163, fig. 3).

A summary reclassification (Radovsky, 1966a), including the bat-parasitizing Dermanyssidae referred to here, has been in press at the same time as the present paper. The subfamily Macronyssinae is treated as a separate family, Macronyssidae, which would include nearly all of the Panamanian Dermanyssidae given in this paper (exception: Dermanyssinae *incertae sedis* off *Hoplomys gymnurus*). *Ichoronyssus* (group I) is interpreted as *Chiroptonyssus* Augustson. *Ichoronyssus* (group II) is placed in a new genus. *Ichoronyssus* (group III) is included in *Macronyssus* Kolenati. New genus No. 1 is described, with its new species No. 1 described and designated as type-species of the genus. Descriptions of the six other new species off bats, referred to here by code numbers, are included in a fuller revisionary work (Radovsky, 1966b) to be published soon.

Abstract

Forty-one species of Dermanyssidae were collected from Panamanian vertebrates, mostly mammals. Of these, at least 11 are new species; the remainder are new records for Panama. Described here are: *Ornithonyssus coendou* n. sp. from *Coendou rothschildi; Draconyssus belgicae* n. gen., n. sp. from *Ameiva bifrontata; Pellonyssus marui* n. sp. from *Cassidix mexicanus; Pellonyssus gorgasi* n. sp. from *Phaethornis guy.* The remaining seven new species, from bats, are not described here. *Acanthonyssus* n. gen. is erected for *Neoichoronyssus dentipes* Strandtmann and Eads. Keys to the genera and species and a host list are provided.

HOST-PARASITE LIST

Class Reptilia

Order Squamata
Family Teiidae

Ameiva bifrontata
Draconyssus belgicae n. sp.

Ameiva sp.
Draconyssus belgicae n. sp.

Class Aves

Order Galliformes
Family Phasianidae

"common hen"
Ornithonyssus bursa (Berlese)

Order Columbiformes
Family Columbidae

Columbigallina talpacoti
Pellonyssus marui n. sp.

Order Apodiformes
Family Trochilidae

Phaethornis guy
Pellonyssus gorgasi n. sp.

Order Piciformes
Family Ramphastidae

Aulacorhynchus prasinus
Ornithonyssus sylviarum (Canestrini and Fanzago)

Order Passeriformes
Family Hirundinidae

Progne chalybea
Pellonyssus marui n. sp.

Family Turdidae

Turdus grayi
Pellonyssus marui n. sp.

Family Vireonidae

Vireo flavoviridis
Pellonyssus marui n. sp.

Family Icteridae

Cassidix mexicanus
Pellonyssus marui n. sp.

Class Mammalia

Order Marsupialia
Family Didelphidae

Marmosa robinsoni
Ornithonyssus wernecki (Fonseca)
Philander opossum
Ornithonyssus wernecki (Fonseca)
Metachirus nudicaudatus
Ornithonyssus wernecki (Fonseca)
Didelphis marsupialis
Ornithonyssus wernecki (Fonseca)

Order Chiroptera
Family Phyllostomidae

Glossophaga soricina
New genus n. sp. no. 1
Carollia castanea
Radfordiella n. sp. no. 2
Carollia perspicillata
Radfordiella n. sp. no. 2
New genus n. sp. no. 3
Sturnira ludovici
New genus n. sp. no. 2
Vampyrops vittatus
Ichoronyssus (group II) n. sp.
Artibeus jamaicensis
Ichoronyssus kochi Fonseca
Artibeus toltecus
Ichoronyssus kochi Fonseca
mixed collection of
Carollia perspicillata and
Lonchorhina aurita
Radfordiella n. sp. no. 2
phyllostomid bat
New genus n. sp. no. 1

Family Desmodidae

Desmodus rotundus
Radfordiella n. sp. no. 1

Family Vespertilionidae

Myotis chiloensis
Ichoronyssus crosbyi (Ewing and Stover)
" (group III) n. sp. no. 1

Myotis nigricans
Ichoronyssus robustipes (Ewing)
" (group III) n. sp. no. 1

Mixed lots of **Myotis nigricans** and **Myotis chiloensis**
Ichoronyssus crosbyi (Ewing and Stover)

Family Molossidae

Tadarida brasiliensis
Ichoronyssus robustipes (Ewing)

Molossus coibensis
Ichoronyssus venezolanus (Vitzthum)

molossid bat
Ichoronyssus haematophagus (Fonseca)

Family unknown

bat
Steatonyssus occidentalis (Ewing)
Ichoronyssus venezolanus (Vitzthum)

Order RODENTIA

Family Sciuridae

Sciurus granatensis
Hirstionyssus keenani n. sp.

Sciurus variegatoides
Hirstionyssus keenani n. sp.

Family Heteromyidae

Liomys adspersus
Hirstionyssus microchelae n. sp.
Ornithonyssus bacoti (Hirst)

Heteromys desmarestianus
Hirstionyssus heteromydis n. sp.
" *panamensis* n. sp.
" *minutus* n. sp.
" *microchelae* n. sp.
" *lunatus* n. sp.

Family Cricetidae

Peromyscus nudipes
Hirstionyssus galindoi n. sp.

Zygodontomys microtinus
Ornithonyssus bacoti (Hirst)

Scotinomys xerampelinus
Hirstionyssus galindoi n. sp.

Sigmodon hispidus
Acanthonyssus dentipes (Strandtmann and Eads)
Ornithonyssus bacoti (Hirst)

Family Muridae

Rattus rattus
Ornithonyssus bacoti (Hirst)

Family Erethizontidae

Coendou rothschildi
Ornithonyssus coendou n. sp.

Family Echimyidae

Proechimys semispinosus
Acanthonyssus dentipes (Strandtmann and Eads)
Ornithonyssus bacoti (Hirst)

Hoplomys gymnurus
Ornithonyssus sp.

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The Genus *Hirstionyssus* Fonseca in Panama
(Acarina: Dermanyssidae)

Russell W. Strandtmann [1] and Conrad E. Yunker [2]

Seventeen species of the relatively large genus *Hirstionyssus* are known from the New World. With the exception of *H. butantanensis* (Fonseca, 1932) from Brazil, all of these records are North American. A recent collection from Panamanian rodents contained seven new species, described below. Six (*H. heteromydis, panamensis, minutus, galindoi, lunatus,* and *microchelae*) are from heteromyid and cricetid rodents, and one (*H. keenani*) is from squirrels. Three (*H. heteromydis, panamensis,* and *minutus*) form a closely related group. A key to the females of *Hirstionyssus* of Panama is included.

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Genus **Hirstionyssus** Fonseca

Hirstionyssus Fonseca, 1948, Proc. Zool. Soc. Lond., 118: 226.

Type-species: *Dermanyssus arcuatus* C. L. Koch, 1839.

Hirstionyssus heteromydis, new species. Figures 4, 5.

DIAGNOSIS: The female is 700 μ long and one-half as wide. Its sternal plate is rectangular and not quite twice as wide as long; its epigynial plate narrowly linguiform, and its anal plate elliptical. The movable chela is about

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one-half the length of the second cheliceral segment. The coxal spur formula is 0-2-2-0. Tarsus II is without apical claw-like spurs.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—767 μ long by 378 μ wide.

Venter (fig. 4D).—With 20–25 pairs of subequal and rather delicate opisthosomal setae. Sternal plate (fig. 4F) rectangular, sides slightly concave, posterior margin straight, anterior angles projected between coxae I and II, posterior angles broadly truncate; with three pairs of setae and two pairs of circular pores; first sternal setae just off the plate; entire plate lightly stippled, with very faint reticulations. Presternal area sclerotized and reticulated. Tritosternum (fig. 4F) without hyaline margins; basal portion lightly wrinkled; with two laciniae, weakly plumose at tips. Metasternal seta and pore present but metasternal plate absent. A narrow endopodal apodeme present between coxae III and IV. Epigynial plate slender, linguiform, obtusely pointed posteriorly, surface punctate with two median, longitudinal, slightly divergent lines; with a single pair of setae; membranous anterior portion partly overlapping sternal plate. A pore each side on soft integument near genital setae. Anal plate about twice as long as wide, elliptical; with a pair of small, circular marginal pores (generally more marginal than shown); paired adanal setae at the anterior margin of the anus; anal setae slightly smaller than the ventral setae. All coxae with piliform setae; small fimbria present on anterior peripheral margins of coxae. Coxa I with two setae. (Both coxae I of the holotype have a noticeable longitudinal furrow adjacent to the proximal seta as in fig. 4D. This is seen as a shallow depression in some paratypes and is not evident at all in others.) Coxa II with two setae; anterior marginal spur prominent; posterior margin sharply angulate; the single ventral spur low, broad and dolabrate. Coxa III with two setae, a blunt ventral spur and a slender, sharp, posterior marginal spur. Coxa IV with a single seta; without spur. Stigma ventral, appearing between femora III and IV; peritremalia narrow and curving posterior to coxa IV: Peritreme bending dorsally before coxa II and terminating at a point level with middle of coxa I; peritremal plate narrow, widening at level of seta L2, continuing forward to anterior margin of coxa I.

Dorsum (fig. 4E).—Dorsal plate with straight or slightly convex sides, tapering posteriorly to a point; with a pair of slit-like pores at anterior margin and at least eight pairs of small circular pores scattered over remainder of plate; with about 25 pairs of small, widely separated setae, those anterior about twice the size of the others. Some 27 pairs of small setae on unarmored dorsum. (Under oil-immersion magnification the posterior setae may be seen to have one or two small barbs.)

Gnathosoma (figs. 4A–C).—With 16–18 rows of one or two deutosternal teeth per row; hypostomal processes drawn out into two, long indistinct lacinae; corniculi lacking or not visibly defined (as is true of all Dermanyssidae), tectum a transparent, flaccid membrane with a transverse, blunt, denticulate anterior margin; chela slender, edentate and very long, making up almost one-half of the length of the second cheliceral segment; setae of gnathosoma slender; of the two apical setae on dorsal side of pedipalp, the inner is blunt and a bit heavier than the outer.

Legs.—Setation as shown; without unusual modifications; femora I and II each with three setae more robust than others; all ventral setae longer than dorsal setae and especially long on tarsus where there are two ventral whip-like setae as long as the segment; without clawlike setae or spurs at apex of tarsus II.

Measurements of sample.—Ten female specimens were measured. The numbers are averages. Idiosoma, length (exclusive of gnathosoma) 700 μ; width 355 μ. Dorsal shield, length 600 μ; width 300 μ. Sternal plate, length (at midline) 70 μ; width (at bases of second sternal setae) 127 μ. Epigynial plate, length 240 μ; width (just posterior to genital setae) 75 μ. Anal plate, length (anterior border to base of postanal seta) 85 μ; width 60 μ. Legs (including coxa but excluding pretarsus): I, 410 μ; II, 335 μ; III, 320 μ; IV, 390 μ.

ALLOTYPE MALE (figs. 5B–D): Length 460 μ; width 270 μ. Legs: I, 330 μ; II, 260 μ; III, 260 μ; IV, 330 μ. Coxae I–III are as in female; coxa IV has a sharply pointed posterior marginal spur, and tarsus II has two apical claw-like setae ventrally. The holoventral plate is slightly more heavily sclerotized in the region of the genital pore

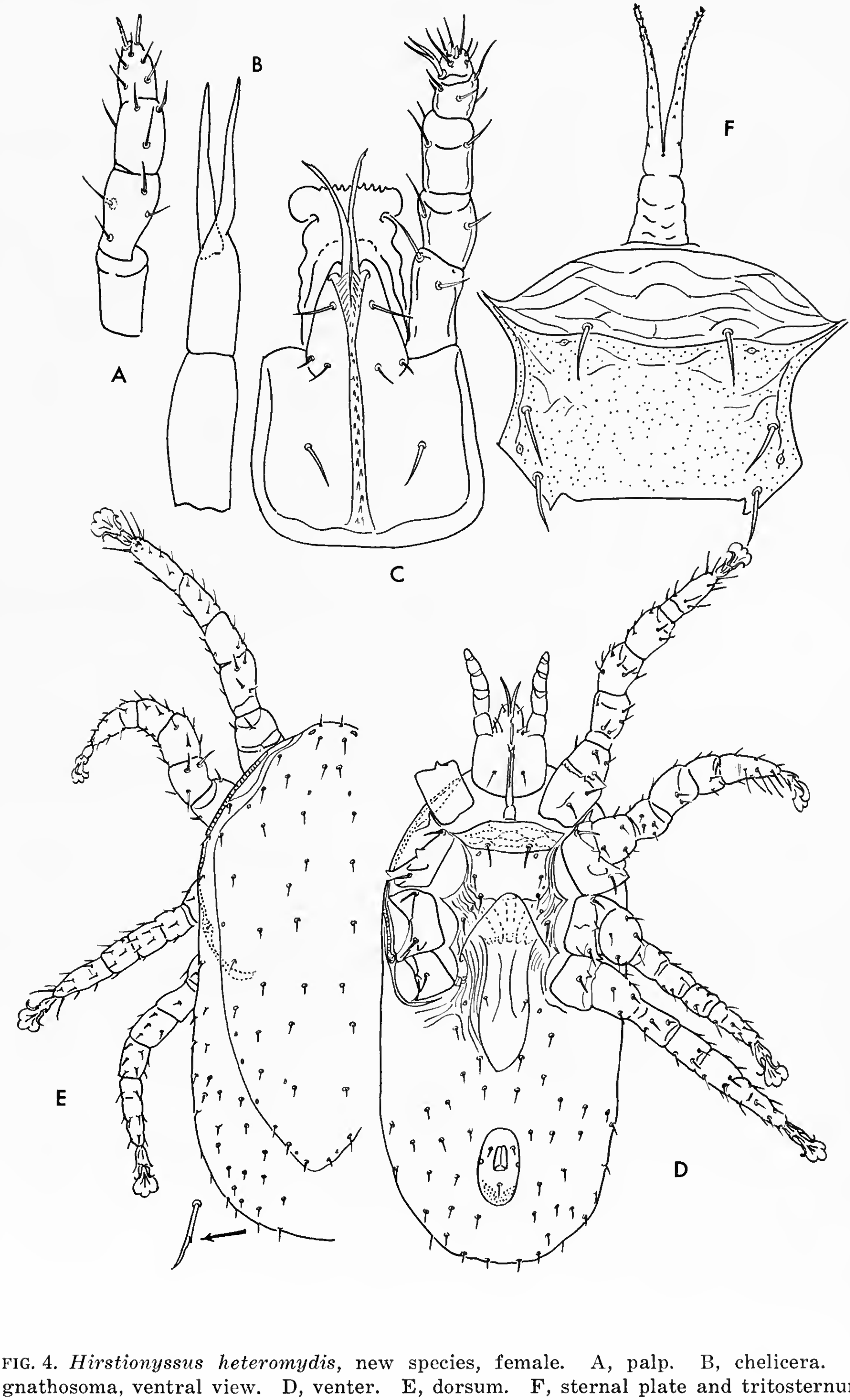

FIG. 4. *Hirstionyssus heteromydis,* new species, female. A, palp. B, chelicera. C, gnathosoma, ventral view. D, venter. E, dorsum. F, sternal plate and tritosternum.

than elsewhere. The sternal pores are circular, as in the female. The dorsal plate tapers less than in the female and covers almost all of the dorsum.

DEUTONYMPH (figs. 5E–H): Length 490 μ (480–550). Legs: I, 330 μ; II, 280 μ; III, 270 μ; IV, 310 μ. The three pairs of terminal setae on the dorsal plate are progressively larger toward the end, and are faintly serrate (the terminal pair, which is twice as long as the subterminal pair, is shown greatly enlarged in fig. 5F).

TYPE MATERIAL: Holotype female (U.S.N.M. no. 2817) and 10 paratype females from *Heteromys desmarestianus*, Piña (Canal Zone), 20 December 1960, collected by C. E. Yunker, in the United States National Museum. Allotype male, same data but 13 December 1960, in the United States National Museum. Remainder of material, including 26 paratype females, 3 paratype males and 5 paratype nymphs, same data but 13-20 December 1960, distributed among the collections of Rocky Mountain Laboratory, Hamilton, Montana; Texas Technological College, Lubbock; Institute of Acarology, Agriculture Experiment Station, Wooster, Ohio; Snow Entomological Museum, University of Kansas, Lawrence; British Museum (Natural History), London; Entomology Research Institute, Canada Department of Agriculture, Ottawa; Zoological Institute, Academy of Sciences U.S.S.R., Leningrad; Natal Museum, Pietermaritzburg; Musée National d'Histoire Naturelle, Paris; Institute Royal des Sciences Naturelle de Belgique, Brussels; and Instituto Butantan, São Paulo.

ADDITIONAL MATERIAL EXAMINED: 19 females of *H. heteromydis* from *Heteromys desmarestianus*, from Piña (Canal Zone), 6-21 December 1960; 10 females from same host, from Fort Gulick (Canal Zone), 1 February 1961; a single female from same host, Río Changena (Bocas del Toro), at lower camp, approx. 22 miles WSW of Almirante, 9 September 1961; all collected by C. E. Yunker.

REMARKS: Very little variation was seen in the sample. The denticulation on the distal margin of the coxae, however, was quite variable, and in addition, it could not always be established clearly that coxa III had two spurs. The first sternal setae do not always appear to be off the plate, but are sometimes seen to be connected to the plate by indistinct sclerotized bridges.

Hirstionyssus panamensis, new species. Figure 6.

DIAGNOSIS: The female is slightly less than 600 μ long and is one-half as wide. Its sternal plate is rectangular, three times wider than long, its genitoventral plate linguiform, and its anal plate oval. The movable chela is one-third the length of second cheliceral segment. The coxal spur formula is 0-2-2-1. Tarsus II is without apical claw-like spurs.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—537 μ long by 310 μ wide.

Venter (fig. 6A).—With 18–21 pairs of short, piliform opisthosomal setae. Sternal plate rectangular, anterior margin and sides nearly straight, posterior margin concave, anterior angles acute, posterior angles rounded; nearly three times wider than long; with three pairs of setae, first pair on anterior margin of plate; with two pairs of slit-like sternal pores; anterolaterally with reticulations. Presternal area sclerotized and reticulated. Tritosternum similar to that of *H. heteromydis.* A pair of metasternal setae and a circular pore present on soft integument adjacent to coxa III. Epigynial plate linguiform, not greatly constricted in middle; rounded posteriorly; surface punc-

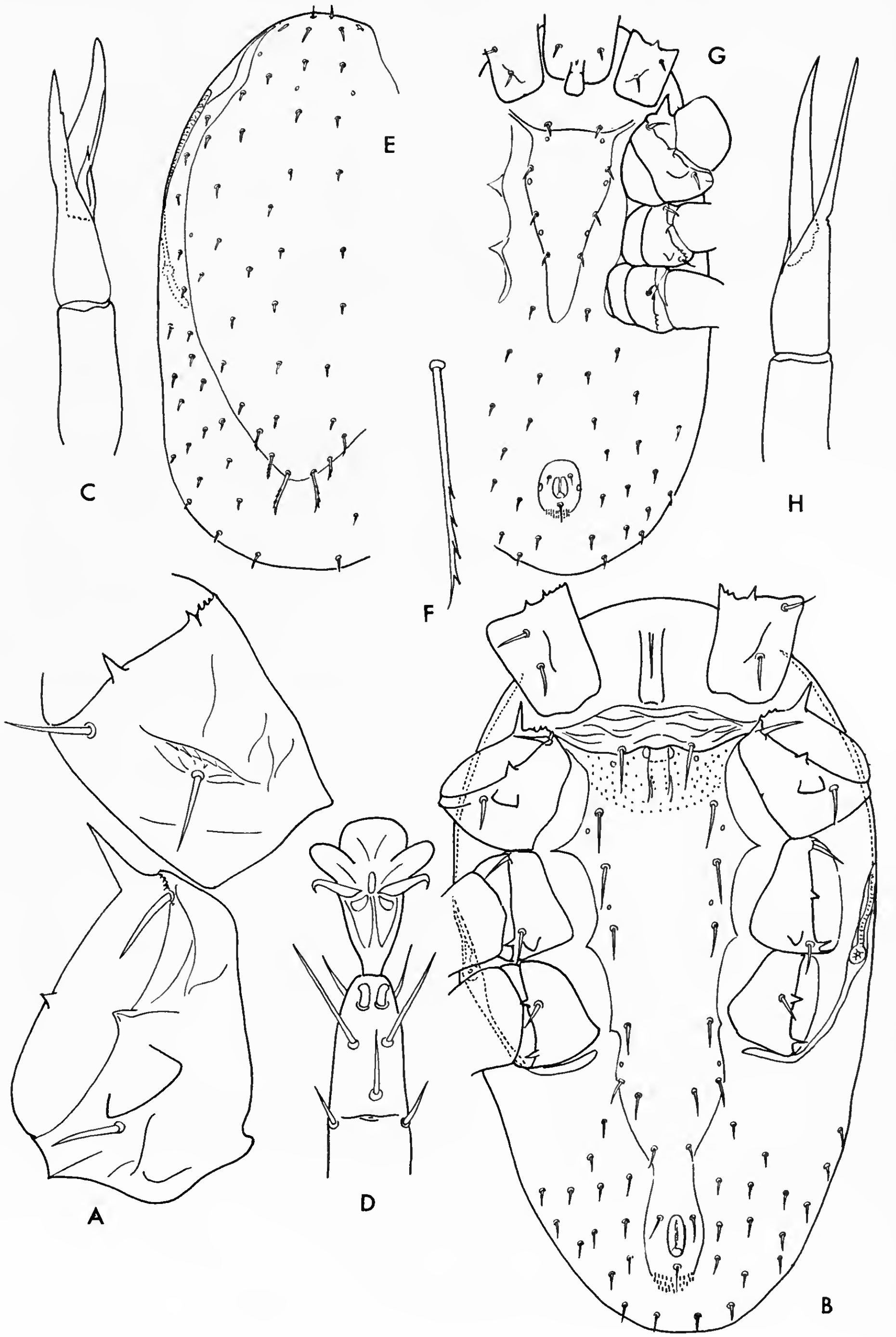

FIG. 5. *Hirstionyssus heteromydis*, new species, female (A), male (B–D), deutonymph (E–H). A, coxae I and II. B, venter. C, chelicera. D, tarsus II, ventral view. E, dorsum. F, terminal seta of dorsal shield. G, venter. H, chelicera.

tate; membranous anterior portion slightly overlapping sternal plate. A circular pore on soft integument either side of plate. Anal plate broadly oval, about three-fourths as wide as long; paired marginal pores appearing as minute punctations; anus in anterior of plate; adanal setae arising at a level with middle of anus. Coxa I with two piliform setae; coxa II with two piliform setae, a sharp anterior marginal spur, a broad dolabrate ventral spur and a sharply angulate posterior margin; coxae III with two piliform setae, a broad sharp ventral spur, and a slender, sharp, posterior marginal spur; coxa IV with a single piliform seta and a small, ventral, posterior marginal spur. Stigma ventral, appearing between femora III and IV; peritremalia narrow and curving posterior to coxa IV. Peritreme bending dorsally in area of coxa II and terminating at a point level with middle of coxa I. Peritremal plate narrow, widening at level of seta L2, continuing forward to anterior margin of coxa I.

Dorsum (fig. 6B).—Dorsal plate with straight sides, tapering posteriorly to a point, with at least 25 pairs of piliform setae, those anterior longest, those posterior slightly shorter than the 16–20 pairs of setae on adjacent soft integument.

Gnathosoma (fig. 6C–E).—Similar to that of *H. heteromydis* except that the movable chela forms no more than one-third of the total length of the chelicera. Deutosternal teeth not seen.

Legs.—Not significantly different from those of *H. heteromydis* except femora I and II without robust setae and tarsus II without whiplike setae (fig. 6F).

Measurements of sample.—Four females were measured. The numbers are averages. Idiosoma, length (exclusive of gnathosoma) 590 μ; width 300 μ. Dorsal shield, length 540 μ; width 260 μ. Sternal plate, length (at midline) 40 μ; width (at bases of second sternal setae) 115 μ. Epigynial plate, length 200 μ; width 80 μ. Anal plate, length (anterior border to base of postanal seta) 65 μ; width 50 μ. Legs: I, 310 μ; II, 240 μ; III, 225 μ; IV, 290 μ.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 2818) from *Heteromys desmarestianus,* Piña (Canal Zone), 20 December 1960, collected by C. E. Yunker, in the United States National Museum. Three paratype females, same data but 13 December 1960, distributed among the collections of United States National Museum; Rocky Mountain Laboratory, Hamilton, Montana; and Texas Technological College, Lubbock.

REMARKS: *H. panamensis* is similar to *H. heteromydis* in the tectum, tritosternum, hypostomal processes, and ventral spur on coxa II. It differs in many ways from the latter. In *panamensis* the sternal plate is much wider and shorter, has rounded posterolateral angles, and possesses slit-like pores. In addition, its epigynial plate is broad in relation to length, and is rounded posteriorly. Its adanal setae originate at a point level with the middle of the anus. The movable chela forms less than one-third the length of the second cheliceral segment. The peritremalia is relatively wide posterior to the stigma. Tarsus II has only short setae.

None of the material before us offered a distinct view of the complete peritremalia, the deutosternum or the dorsal plate. It is probable that a pair of anterior pores are present on the dorsal plate, as well as more small pores and setae than we show. Some paratypes showed small barbs on the posterior dorsal setae.

Hirstionyssus minutus, new species. Figure 7.

DIAGNOSIS: This is a small species. The female is 400 μ long and the male 280 μ. The female sternal plate is rectangular, about twice wider than long. Its epigynial plate is linguiform and perceptibly broader in the post-

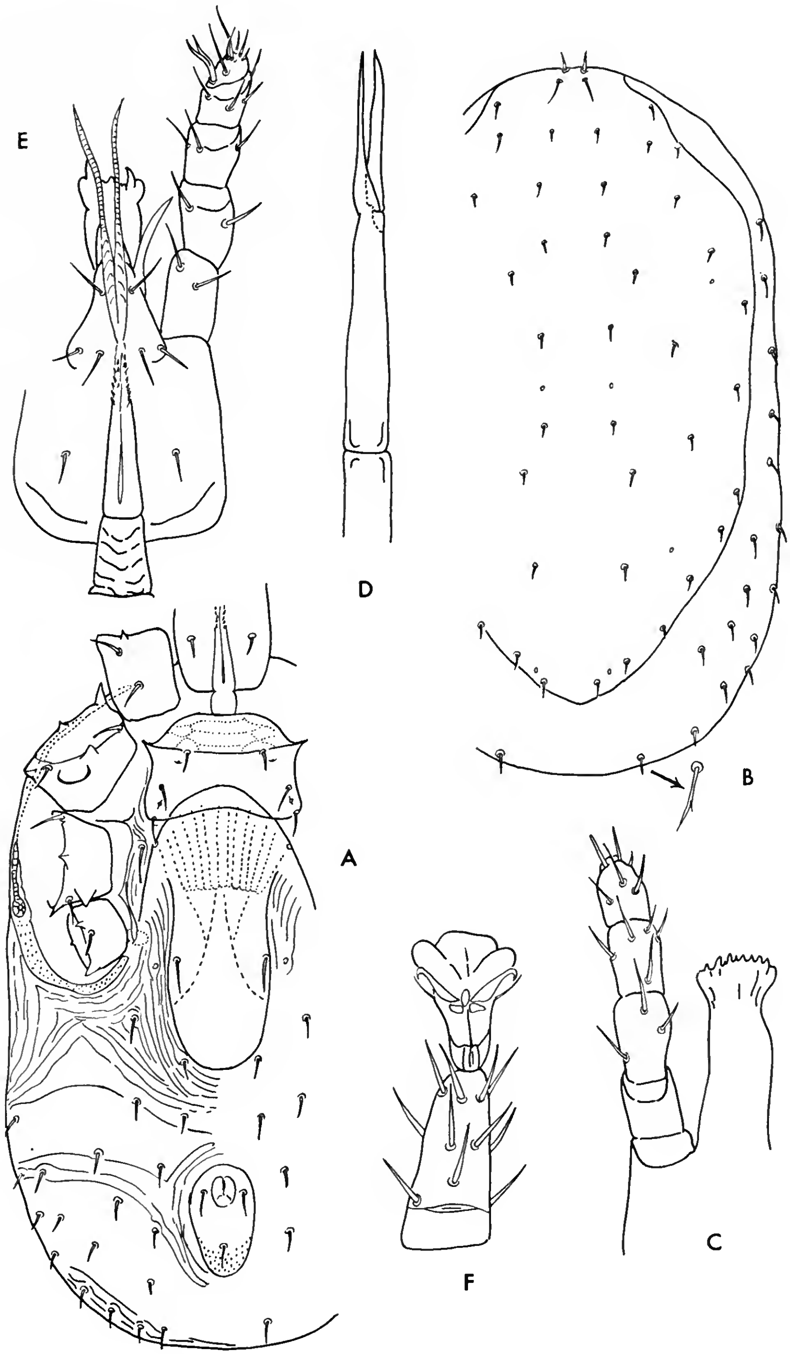

FIG. 6. *Hirstionyssus panamensis*, new species, female. A, venter. B, dorsum. C, gnathosoma, dorsal view. D, chelicera. E, gnathosoma, ventral view, and tritosternum. F, tarsus II, ventral view.

coxal area than in the intercoxal area. The movable chela is more than one-half the length of the second cheliceral segment. The coxal spur formula is 0-2-1-1. Tarsus II is without apical claw-like setae.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—425 μ long by 242 μ wide.

Venter (fig. 7A).—With 12-17 pairs of short, piliform opisthosomal setae, that become progressively shorter posteriorly. Sternal shield rectangular, anterior margin straight, lateral and posterior margins concave; with three pairs of setae and two pairs of pores; first sternal setae on anterior margin of plate; surface of plate with indistinct longitudinal wrinkles, anterolateral corners and presternal area reticulate. Tritosternum as in *H. heteromydis.* Metasternal seta and pore present but metasternal plate absent. A narrow endopodal apodeme between coxae III and IV. Epigynial plate linguiform, relatively broad in postcoxal area; bluntly rounded caudally; anteriorly overlapping part of sternal plate; with a pair of setae; surface densely covered with minute punctations. Anal plate a rounded oval, nearly as wide as long; with a pair of minute marginal pores; paired adanal setae at anterior margin of anus. Coxa I with two piliform setae; coxa II with two piliform setae, a sharp anterior marginal spur, a broad, dolabrate, ventral spur and a sharply angulate posterior margin; coxa III with two robust setae and a sharp ventral spur, coxa IV with a single piliform seta and a small, sharp posterior marginal spur. Stigma ventral, appearing between femora III and IV; peritremalia narrow and curving posterior to coxa IV; peritreme bending dorsally in region of coxa II, terminating at a point level with middle of coxa I; peritremal plate narrow.

Dorsum (fig. 7B).—Dorsal plate oval, broadly rounded caudally, covering most of dorsum; with 27–30 pairs of small setae and many small circular pores; anteriormost pair and posteriormost pair of setae 6 or 7 μ long, remainder extremely minute (less than 3 μ). About eight pairs of minute setae on unsclerotized dorsum.

Gnathosoma (figs. 7C–F).—Similar to that of *H. heteromydis* but movable chela slightly more than one-half length of second cheliceral segment, and a mediodorsal, apical, tarsal seta is markedly thick and blunt.

Legs.—Similar to those of *H. heteromydis*: ventral setae generally longer and more robust than dorsal setae, except on femora I and II where reverse is true; tarsus II with some moderately long ventral setae.

Measurements of sample.—Four females were measured. The numbers are averages. Length (exclusive of gnathosoma) 400 μ; width 230 μ. Dorsal shield, length, 382 μ; width 205 μ. Sternal plate, length (at mid-line) 45 μ; width (at basees of second sternal setae) 95 μ. Epigynial plate, length 177 μ; width (at widest point) 75 μ. Anal plate, length (to base of postanal seta) 39 μ; width 46 μ. Legs: I, 260 μ; II, 195 μ; III, 170 μ; IV, 225 μ.

ALLOTYPE MALE (figs. 7G–J): Length, 296 μ; width, 180 μ. Legs: I, 236 μ; II, 180 μ; III, 130 μ; IV, 210 μ; coxae as in female; tarsus II with two blunt claw-like setae ventrally. Holoventral plate expanded posterior to coxae; fused with anal plate; with nine pairs of setae plus the single postanal seta; with five pairs of pores; the first sternal pores slit-like, the rest circular. Dorsal plate similar to that of female.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 2819), paratype female and allotype male from *Heteromys desmarestianus*, Piña (Canal Zone), 20 December 1960, collected by C. E. Yunker, in the United States National Museum. A paratype female, same data, in collection of Rocky Mountain Laboratory, Hamilton, Montana, and another, same data, in collection of Institute of Acarology, Agriculture Experiment Station, Wooster, Ohio. A paratype male and female, same data, but 7 December 1960, in collection of Texas Technological College, Lubbock.

REMARKS: *H. minutus* resembles *H. heteromydis* in the tectum, tritosternum, hypostomal processes, chelicerae and leg setation. It differs from the latter in size, by having only one spur on coxa III, by having less than

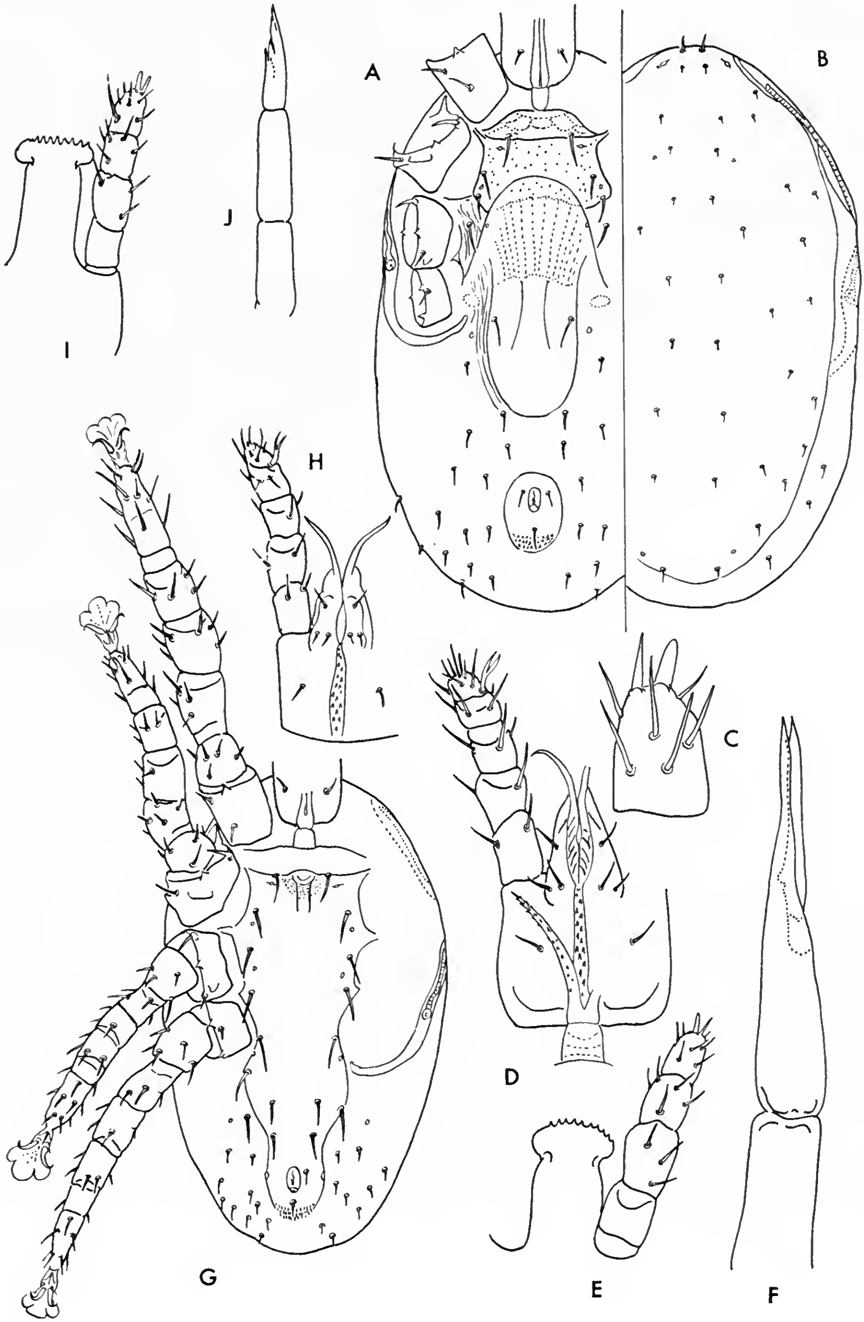

FIG. 7. *Hirstionyssus minutus*, new species, female (A–F), male (G–J). A, venter. B, dorsum. C, palpal tarsus, dorsal view. D, gnathosoma, ventral view, and tritosternum. E, tectum and palp, dorsal view. F, chelicera. G, venter (one adanal seta omitted). H, gnathosoma, ventral view. I, tectum and palp, dorsal view. J, chelicera.

17 pairs of opisthosomal setae, and by having many minute dorsal shield setae. In addition, shapes of the body plates are typical. The dorsal shield, epigynial plate and posterolateral angles of *H. minutus* are broadly rounded posteriorly; the epigynial plate is relatively expanded posterior to coxae IV and the anal plate is almost circular.

It differs from *H. panamensis* in chela/chelicera length-ratio, by adanal setae that arise at the anterior margin of the anus; by a longer sternal plate, by having only one spur on coxa III, by the minute dorsal setae, and by the robust, blunt mediodorsal seta of the palpal tarsus.

The dorsal setae are so small that it is difficult to distinguish between a setal base and a pore.

Hirstionyssus microchelae, new species. Figure 8A–D.

DIAGNOSIS: The female is 620 μ long and 440 μ wide at its greatest width. Its sternal plate is rectangular and three times wider than long. Its epigynial plate is linguiform and truncate, and its anal plate circular. Its chelicerae are slender and the movable chelae are small, each less than one-seventh the length of the second cheliceral segment. The coxal spur formula is 0-2 (3?) -2-1. Tarsus II is without apical claw-like setae. The posterior dorsal setae are serrate.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—590 μ long by 384 μ wide.

Venter (fig. 8A)—With about 22–25 pairs of opisthosomal setae. Sternal plate rectangular, with straight anterior and lateral margins and a slightly convex posterior margin; nearly three times wider than long; with three pairs of setae and two pairs of slit-like pores; first sternal setae on anterior margin of plate; anterolateral corners and presternal area reticulate. Tritosternum as in *H. heteromydis.* Metasternal seta and pore present, but metasternal plate absent. A narrow endopodal apodeme between coxae III and IV. Epigynial plate linguiform, not greatly widened in postcoxal area; bluntly rounded caudally; anteriorly overlapping part of sternal plate; with a pair of setae; surface densely punctate. Anal plate circular; with a pair of minute marginal pores; paired adanal setae at a level with posterior of anus. Coxa I with two piliform setae, its peripheral margins fimbriate; coxa II with two piliform setae, a large, sharp anterior marginal spur, a small blunt ventral spur, and a sharp, angulate posterior dorsal margin that may be spur-like; coxa III with two piliform setae, a blunt ventral spur, and a sharp posterior dorsal spur; coxa IV with one piliform seta and a small, sharp posterior marginal spur. Stigma ventral, appearing between femora III and IV; peritremalia narrow and curving posterior to coxa IV; peritreme bending dorsally in region of coxa II, terminating at a point level with middle of coxa I; peritremal plate visible on either side of peritreme, widening abruptly in anterior third, terminating adjacent to paired, slit-like, dorsal shield pores.

Dorsum (fig. 8B).—Dorsal shield elliptical, sides slightly convex, tapering caudally to a blunt point; with 26 pairs of short setae, those posterior serrate; with 19 or 20 pairs of small circular pores and a pair of large, slit-like, anterior pores. With 40–50 pairs of setae on adjacent soft integument.

Gnathosoma (fig. 8C).—Similar to that of *H. panamensis,* except that the chelicerae are relatively narrow and elongate. The movable chela is less than one-sixth the length of the second cheliceral segment (fig. 8D).

Legs.—Not significantly different from those of *H. panamensis.*

Measurements of sample.—Three females were measured. The numbers are averages. Idiosoma, length 572 μ; width 378 μ. Dorsal shield, length 500 μ; width 290 μ. Sternal plate, length (at mid-line) 41 μ; width (at bases of second sternal setae) 122 μ. Epigynial

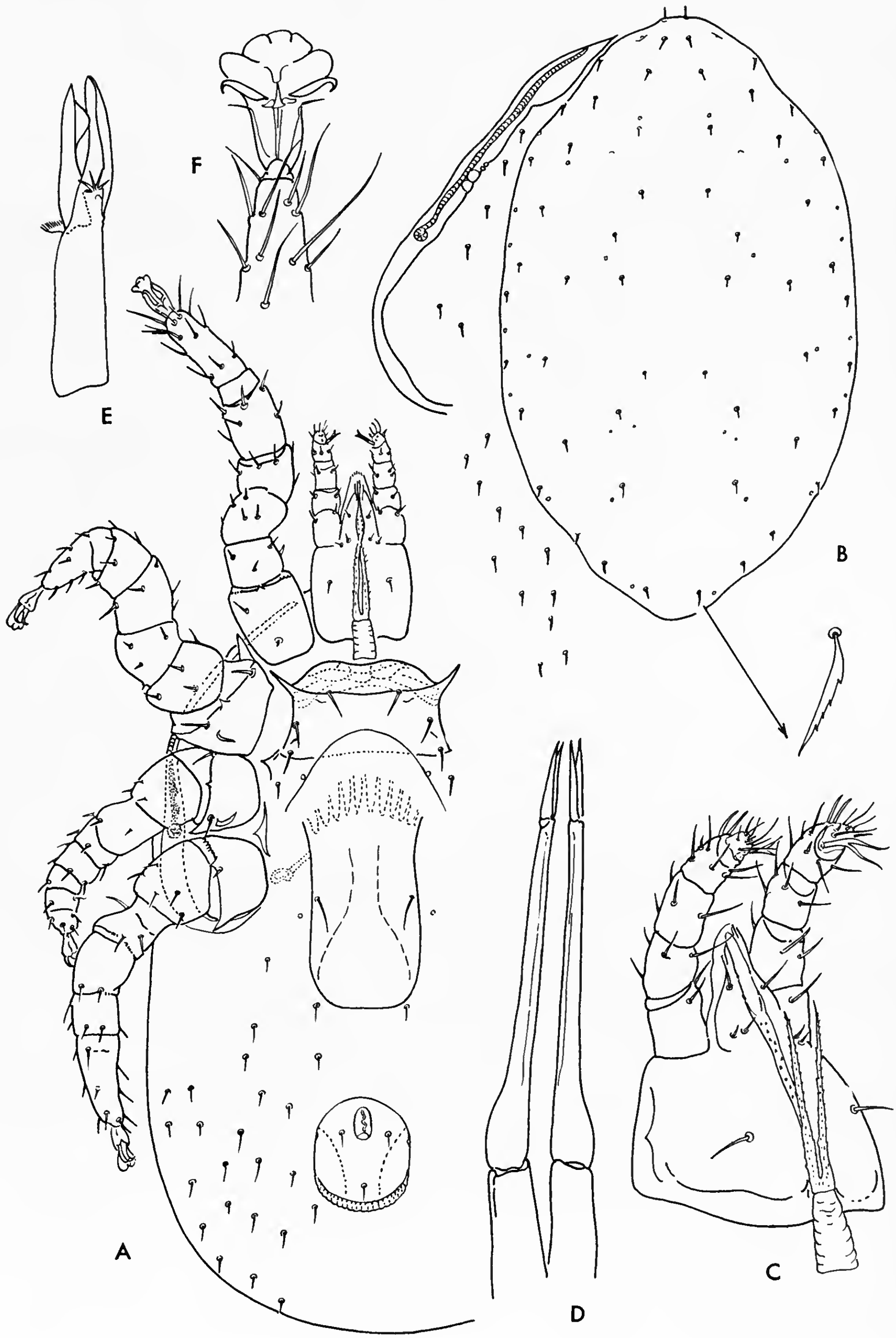

FIG. 8. *Hirstionyssus microchelae*, new species, female. A, venter. B, dorsum and peritremalia. C, gnathosoma and tritosternum, oblique view. D, chelicerae. *Hirstionyssus keenani*, new species, female. E, chelae. F, tarsus II, ventral view.

plate, length 220 μ; width 100 μ. Anal plate, length (to base of postanal seta) 70 μ; width 80 μ.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 2820) and 4 paratype females from *Heteromys desmarestianus*, Piña (Canal Zone), 13 December 1960, collected by C. E. Yunker, in the United States National Museum. Six paratype females, same data, distributed among the collections of Rocky Mountain Laboratory, Hamilton, Montana; Texas Technological College, Lubbock; Institute of Acarology, Agriculture Experiment Station, Wooster, Ohio; and British Museum (Natural History), London.

ADDITIONAL MATERIAL EXAMINED: Two females from type host and locality, but 29 December 1961; 1 female from *Liomys adspersus*, Guánico, Las Palmitas (Los Santos), 10 February 1962, collected by C. O. Handley and F. Greenwell; 2 females from type host, Almirante (Bocas del Toro), 7 September 1960, collected by P. Galindo; 7 females from type host, Río Changena (Bocas del Toro), at lower camp, 22 miles WSW of Almirante, elevation about 2800 feet, 17 September 1961, collected by C. E. Yunker.

REMARKS: *H. microchelae* is easily distinguished from other Panamanian species by the chela/chelicera length-ratio and the circular anal plate. In addition, crushed specimens reveal a pair of circular pores on the medial aspect of the peritremal plate anterior to the stigma. These are closely associated with a pair of square, cell-like depressions or muscle-scars (fig. 8B). Variation was apparent in the shape of the posterior margin of coxa II. In some specimens this margin was angulate and distinctly spur-like; in others, including the holotype, no such modification could be seen. It is possible that this difference is an artifact of mounting.

The type specimens were taken from a host that was simultaneously infested with *heteromydis, panamensis* and *minutus*. All females of *microchelae* appeared to be engorged on blood, whereas none of the other species did.

Hirstionyssus keenani, new species. Figures 8E–F, 9.

DIAGNOSIS: This is a typical *Hirstionyssus* species, characterized by a female sternal plate that is deeply concave at its posterior margin and acute, elongate coxal spurs. The female is 500μ long ± 30 μ, and approximately one-half as wide. The coxal spur formula is 0-2-2-1, tarsus II lacks claw-like setae, and the dorsal shield setae are noticeably shorter than the ventral setae.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—513 μ long by 325 μ wide.

Venter (fig. 9A).—With 20–24 pairs of setae. Sternal plate deeply emarginate posteriorly, seven times wider than long; with three pairs of approximately equal setae, and two pairs of circular pores; first sternal setae on anterior margin of plate; anterolateral corners and presternal areas reticulate. Tritosternal base punctate; laciniae weakly ciliate. Metasternal setae and pore present, but metasternal plate absent. A narrow endopodal apodeme present between coxae III and IV. Epigynial plate linguiform, not greatly widened posterior to coxae, rounded caudally; surface densely covered with minute punctae; with a single pair of setae. A circular pore on each side near genital setae. Anal plate oval; surface punctate; anus in anterior third of plate; paired adanal setae arising at a level with middle of anus. Coxa I with two piliform setae, the distal one longer and heavier than the proximal one; coxa II with two piliform setae, a sharp anterior marginal spur and an acute, elongate ventral spur; coxa III with two pili-

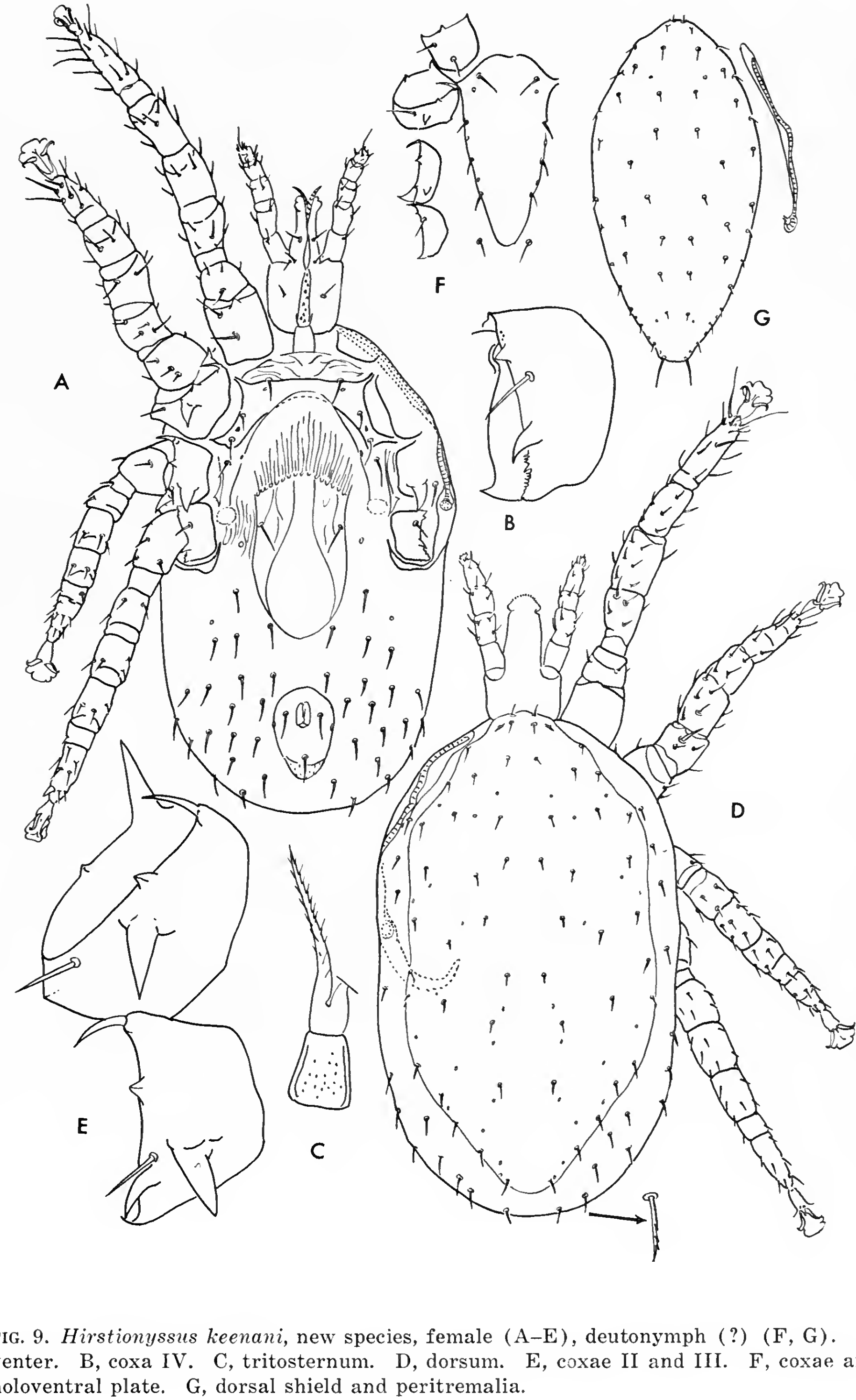

FIG. 9. *Hirstionyssus keenani*, new species, female (A–E), deutonymph (?) (F, G). A, venter. B, coxa IV. C, tritosternum. D, dorsum. E, coxae II and III. F, coxae and holoventral plate. G, dorsal shield and peritremalia.

form setae and two acute, elongate spurs; coxa IV with a single piliform seta and a small, sharp marginal spur. Stigma ventral almost marginal, appearing between femora III and IV; peritreme bending dorsally in region of coxa II, continuing anteriorly as far as anterior margin of coxa I; peritremal plate narrow.

Dorsum (fig. 9D).—Dorsal shield elliptical with straight, parallel sides; tapering caudally in a blunt point; with 26 pairs of piliform setae shorter than those on adjacent soft integument; with 17 pairs of pores, the anteriormost pair slit-like, the remainder circular. With 20–22 pairs of setae on adjacent soft integument, slightly shorter than ventral setae.

Gnathosoma.—With 12–14 deutosternal teeth arranged in an irregular file. Hypostomal processes drawn out into two long lacinae. Tectum a transparent, long membrane with a truncate, fimbriate anterior margin. Movable chela elongate, about one-third the length of the second cheliceral segment; with a transparent, triangular medial tooth, and a ciliated basal lobe. Fixed chela with a hyaline, stellate, seta-like structure arising opposite base of movable chela, adjacent to a small circular pore (fig. 8E).

Legs.—Setation typical of *Hirstionyssus* spp. Femur I with two and femur II with one robust dorsal setae. Tarsus II with some long, whip-like ventral setae (fig. 8F). Tarsus IV with a terminal spur-like seta.

Measurements of sample.—Five females were measured. The numbers are averages. Idiosoma, length (exclusive of gnathosoma) 500 μ; greatest width 320 μ. Dorsal shield, length 450 μ; greatest width 252 μ. Sternal plate, length (at mid-line) 15 μ; width (at bases of second sternal setae) 126 μ. Epigynial plate, length 257 μ; width (just posterior to genital setae) 93 μ. Anal plate, length (anterior border to base of postanal setae) 63 μ; width 63 μ. Legs: I, 333 μ; II, 260 μ; III, 245 μ; IV, 315 μ.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 2821) and two paratype females from *Sciurus variegatoides,* Gamboa (Canal Zone), 4 December 1960, collected by C. E. Yunker, in the United States National Museum. Three paratype females, same data, distributed among the collections of Rocky Mountain Laboratory, Hamilton, Montana, and Texas Technological College, Lubbock.

ADDITIONAL MATERIAL EXAMINED: Two females and one deutonymph from *Sciurus granatensis chiriquensis,* Martinz's dairy, Cerro Punta (Chiriquí), elevation about 6800 feet, 2 May 1961, collected by C. E. Yunker. One female, same type host and locality, but 12 March 1962, and one deutonymph, data same as holotype (figs. 9F, G). Coxae III and IV of the nymph lack the marginal spur seen in the female. The dorsal plate setae are similar to those of the female, except that the terminal pair is long (a characteristic of immature specimens of *Hirstionyssus*).

REMARKS: The combination of arcuate sternal plate, coxal spur formula 0-2-2-1, and lack of claw-like setae at the ventral apex of tarsus II is shared by only one other species, *H. neotomae* Eads and Hightower, 1951. The latter, however, has a sternal plate less deeply concave (length-width ratio is 1:4.3, as compared with 1:7.4 for *H. keenani*) ; its coxal spurs are much smaller, and the anterior dorsal setae are longer. In *H. neotomae,* the first three rows of dorsal plate setae overlap, whereas in *H. keenani* none of the setae on the dorsal plate are long enough to reach the bases of those in the succeeding row. *H. keenani* also resembles *H. isabellinus* (Oudemans, 1913), but in this latter species the sternal plate is even less arcuate than in *H. neotomae* and coxa IV lacks a spur.

H. keenani is named for Charles M. Keenan, Chief, Vector Control Section, Environmental Health Branch, United States Army Caribbean, and Canal Zone naturalist.

Hirstionyssus galindoi, new species. Figure 10.

DIAGNOSIS: The female sternal plate is about four times wider than long. The chelae are one-half the length of the second cheliceral segment. The

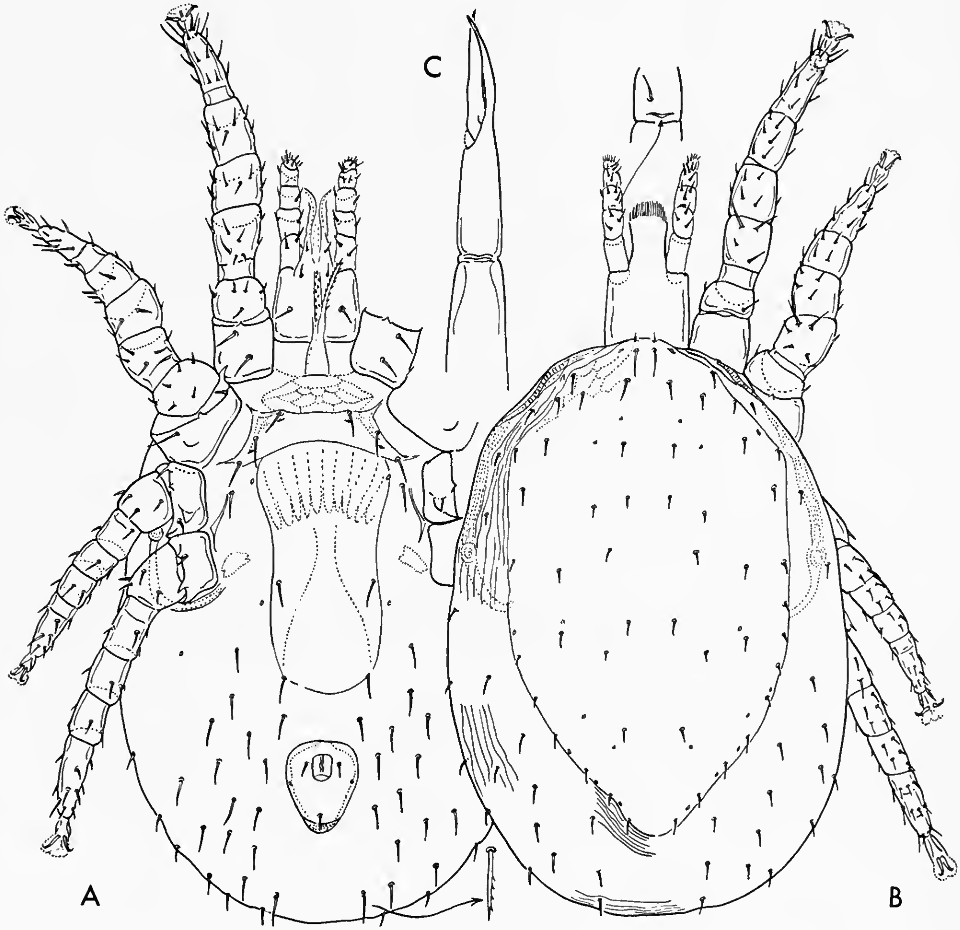

FIG. 10. *Hirstionyssus galindoi,* new species, female. A, venter. B, dorsum. C, chelicera.

coxal spur formula is 0-1-2-1 or 0-2-2-1, coxa II sometimes having a small, rounded ventral knob that might be taken for a spur. Tarsus II is without claw-like setae.

DESCRIPTION, HOLOTYPE FEMALE: *Idiosoma.*—462 μ long by 326 μ wide.

Venter (fig. 10A).—Sternal plate short, about four times wider than long, deeply and broadly concave posteriorly, anterior margin nearly straight; lightly reticulated at sides; the three pairs of subequal sternal setae shorter than plate. Presternal area lightly reticulated. Tritosternum without basal hyaline margins; laciniae ciliate and extending nearly to the apical hypostomal setae. Metasternal setae subequal to sternals. Without metasternal plates. Epigynial plate linguiform; genital and all ventral setae subequal, longer than dorsals; one pair of ventrals on the posterior margin of the plate or apparently so. Posterior ventral setae as well as smaller marginal and dorsal setae weakly serrate on one side (fig. 10A). Anal plate broadly ovate; the three anal setae slender, subequal, and shorter than anal slit. Adanal setae inserted opposite the middle of the anal slit. With 15 or 16 pairs of ventral non-plate setae. Metapodal plates absent. Peritreme ventrolateral, becoming dorsal over coxa II, and extending to level of middle of coxa I; surrounded by a narrow peritremal plate, which encircles coxa IV posteriorly.

Dorsum (fig. 10B).—Dorsal shield with sides subparallel, tapering posteriorly to a blunt wedge; with 26 pairs of short setae which are a bit longer anteriorly and peripherally; lightly reticulated in scapular area. With 10–12 pairs of dorsal, non-plate setae.

Gnathosoma.—Setation weak; deutosternal teeth in a double file, with about 14–17 denticles. Malae internae long, slender; tectum truncate, with a deeply ciliated margin. Chelicerae relatively short and heavy, the chelae (fig. 10C) forming one-half the length of the second cheliceral segment. Palpal genu with a transverse dorsal pore near base (fig. 10B).

Legs.—Setae of legs slender and piliform; femora I and II each with two slightly enlarged dorsal setae; femora III and IV each with one slightly enlarged dorsal seta. Coxa I with two subequal piliform setae; coxa II with an anteromarginal spur and a small, rounded ventral boss; coxa III with a ventral and a posteromarginal spur, both small and acute; coxa IV with one small, sharp marginal spur. Tarsus II without claw-like subapical setae.

DEUTONYMPH: Length of idiosoma, 305 μ. Sternal shield extending to level of posterior margin of coxa IV, as is usual for deutonymphs of this family. The first four pairs of setae are marginal, the fifth pair is off the margin near the posterior end. Coxa II with a slight ventral elevation; coxa III with an acute ventral spur; coxa IV without a spur but with small denticles on the posteroapical margin. Dorsal plate entire, bearing two long, weakly barbed setae at posterior tip. Peritreme extending to level of posterior margin of coxa I; poststigmal plate lacking.

MALE: Unknown.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66415) and one paratype female from *Scotinomys xerampelinus*, Cerro Punta (Chiriquí), elevation about 7000 feet, 14 March 1962, in the United States National Museum; three paratype females and 3 paratype nymphs from *Peromyscus nudipes*, same data, but 9 to 14 March 1962; all collected by C. M. Keenan. Paratypes distributed among collections of United States National Museum; Texas Technological College, Lubbock; and Rocky Mountain Laboratory, Hamilton, Montana.

REMARKS: This species is closest to *H. breviseta* Strandtmann and Morlan, 1953. The latter, however, is without ventral spurs or knobs on coxa II and its first sternal setae are extremely close set; in addition, the spurs of coxa III are not as pronounced as in the present species. *H. galindoi* also resembles *H. transiliensis* Bregetova, 1956, but in the latter species there are no ventral non-plate setae so close to the epigynial plate as to appear to be touching it. The ventral idiosomal setae of *H. galindoi* are long enough to reach the bases of succeeding setae, while those of *H. transiliensis* are quite short.

H. galindoi is named for Sr. Pedro Galindo V., Gorgas Memorial Laboratory, Panama, who kindly provided certain specimens examined in this study.

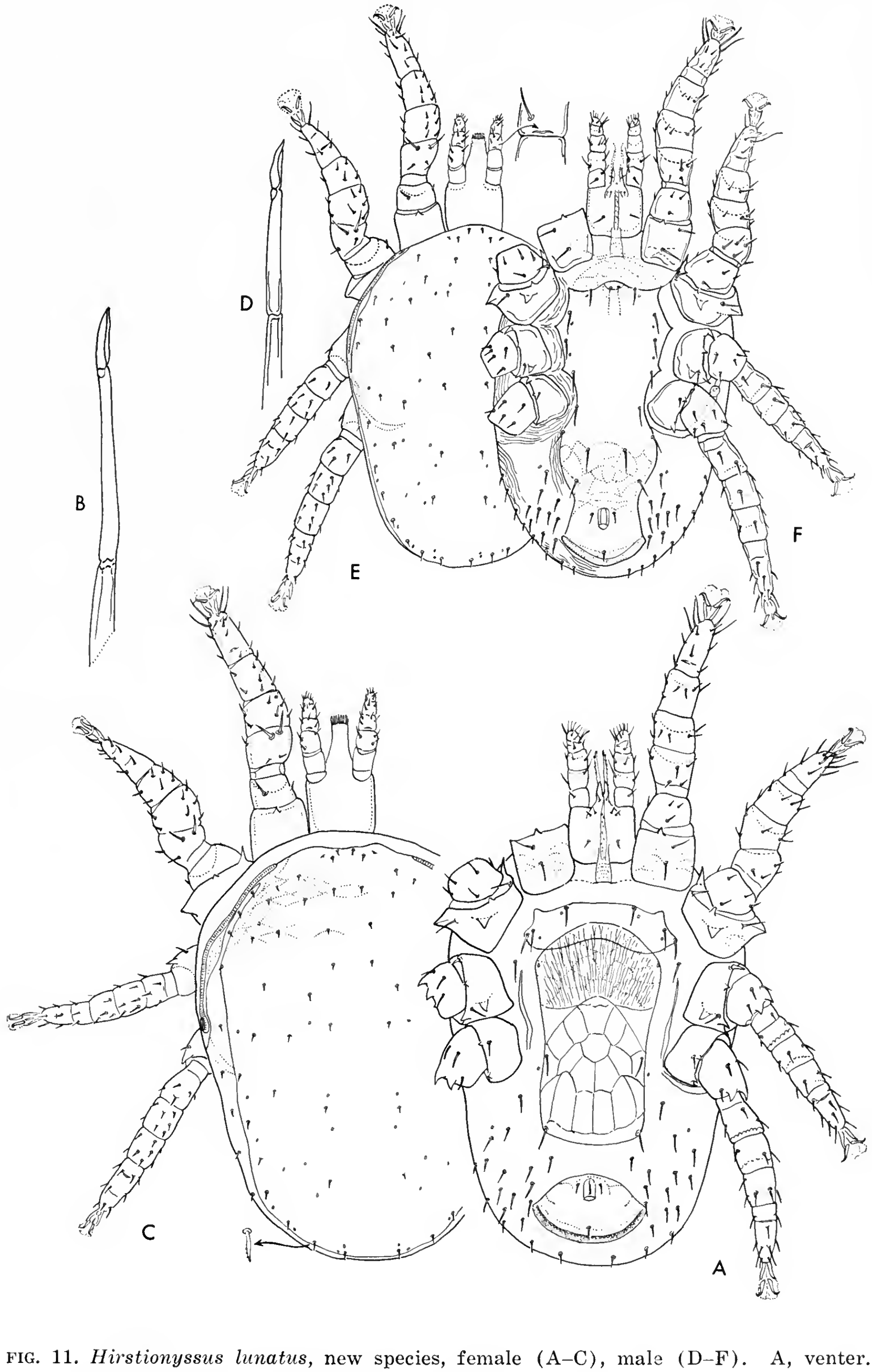

FIG. 11. *Hirstionyssus lunatus*, new species, female (A–C), male (D–F). A, venter. B, chelicera. C, dorsum. D, chelicera. E, dorsum. F, venter.

Hirstionyssus lunatus, new species. Figure 11.

DIAGNOSIS: This is a small species; the female is 350 μ long and has short, delicate setae. It is instantly recognizable by the unusual shape of the anal plate and especially the wide cribrum, which subtends the plate as a semicircular crescent. The epigynial plate is uniquely scaly in appearance. The coxal spur formula is 0-3-3-1, and trochanters III and IV each bear two heavy apical spurs. Tarsus II is without claw-like apical setae.

DESCRIPTION, HOLOTYPE FEMALE (figs. 11A–C). Idiosoma 340 μ long by 238 μ wide.

Venter (fig. 11A). Sternal plate slightly arched, smooth or only faintly lined; the corners rounded, not noticeably projecting between the coxae. First sternal setae mesad of first sternal pores; second sternal pores well mesad of sternal setae 2 and 3. Sternal pores small and circular. Sternal setae 2 and 3 close set. Sternal setae 1 slightly shorter than 2 and 3. Presternal area not heavily sclerotized, very faintly lined. Tritosternum weak, transparent; basal portion transversely wrinkled; laciniae finely ciliated. Epigynial plate broad and anteriorly overlapping part of sternal plate; posterior margin broad, slightly convex, with one pair of epigynial setae; in addition a single pair of setae arise from the posterolateral margins of the plate; entire plate reticulate and scaly in appearance. Anal plate unusual for genus. Posterior margin broadly flared; cribrum subtending posterior margin as a crescentic band. Anal opening near anterior margin of plate. Adanal setae arising at anterior level of anal slit, and subequal to it in length. Postanal seta well removed from anal slit; near cribrum; subequal to adanals. From seven to 11 pairs of ventral non-plate setae which become shorter and heavier laterally.

Dorsum (fig. 11C).—Dorsal shield covering most of dorsum, straight sided, and broadly rounded anteriorly and posteriorly. With 26 pairs of minute setae that are a bit larger posteriorly. At least posteriormost of these slightly serrate on one side (fig. 11C). Stigma dorsolateral; peritreme mostly dorsal; enclosed in a narrow plate that attaches to dorsal shield over coxa II. Peritreme extending nearly to level of middle of coxa I.

Legs.—Majority of setae short and slender. Both setae of coxa I piliform, the proximal somewhat longer. Coxa II with an anteromarginal spur, a ventral triangular spur, and the posterior margin produced into a large, acute projection, here counted as a spur; with two piliform setae. Coxa III with a ventral spur, a posteromarginal spur and two setae; the anteromarginal seta slender and spiniform, the posteromarginal setae piliform. Coxa IV with a marginal tooth and a single piliform seta. Anterior apical margin of trochanters III and IV each with three sharp spurs or teeth. Femora I and II with each a pair of enlarged dorsal setae. Tarsus II modified into a slight hook at apex but without claw-like setae. One pair of slender, flagelliform medioventral setae on tarsus II. Inner margin of femora and genua III and IV slightly crenulated.

Gnathosoma.—Setae small and slender. Hypostomal and gnathosomal setae small. Malae internae long and slender. Tectum extending as far as level of middle of palpal tibiae; with a ciliate margin. Chelicerae long and slender; chelae about one-fourth as long as second cheliceral segment (fig. 11B).

MALE (figs. 11D–F): *Idiosoma.*—275 μ long by 188 μ wide.

Venter (fig. 11F).—Holoventral plate slightly expanded behind coxa IV, with eight pairs of setae, none of which quite reaches the base of the succeeding seta, plus three smaller anal setae; the latter slender and shorter than anal slit. Anal plate wide, with crescentic cribrum as in female.

Dorsum (fig. 11E).—Dorsal shield nearly covering dorsum; with 28 pairs of very small setae that are slightly longer posteriorly. Peritreme extending nearly to level of middle of coxa I. Stigma ventrolateral.

Legs.—Tarsus II with two subapical clawlike setae, basad of these are two long flagelliform setae. Trochanters II and III lack the marginal spurs of the female. Coxa

IV with one or two anteromarginal teeth as well as the posteromarginal spur. The coxal spurs are relatively smaller than those of the female.

Gnathosoma.—Not significantly different from that of the female. Chelicerae slender, chelae unmodified.

TYPE MATERIAL: Holotype female (U.S.N.M. no. 66611), three paratype females and one allotype male from *Heteromys desmarestianus*, Río Changena (Bocas del Toro), lower camp, approximately 22 miles WSW of Almirante, elevation about 2800 feet, 27 September 1961, collected by C. E. Yunker. Two paratype females from type host, Piña (Canal Zone), 13 December, 1960, collected by C. M. Keenan. Holotype female, allotype male and one paratype female deposited in the United States National Museum. One paratype female in the collection of Rocky Mountain Laboratory, Hamilton, Montana, and one paratype female in the collection of Texas Technological College, Lubbock.

KEY TO THE PANAMANIAN SPECIES OF *HIRSTIONYSSUS*

Females

1. Epigynial plate with scalelike pattern and two pairs of setae; anal plate much wider than long, laterally angulate; trochanters III and IV with large distal marginal spurs .... *H. lunatus* n. sp.
   Without this combination of characters 2
2. Sternal plate approximately rectangular; ventral spur of coxa II broad and dolabrate, reduced, or absent, on heteromyid or cricetid rodents 3
   Sternal plate arcuate, posterior border deeply emarginate; ventral spur of coxa II acute and elongate; on *Sciurus* .... *H. keenani* n. sp.
3. Chelicerae slender, long; movable chela at most one-sixth the length of second cheliceral segment; anal plate circular .... *H. microchelae* n. sp.
   Chelicerae normal; movable chela at least one-third as long as second cheliceral segment 4
4. Dorsal shield setae normal or reduced but not minute; coxae III with two spurs...... 5
   Dorsal shield setae extremely minute; coxa III with one spur; a small species about 400 μ long; with less than 18 pairs of ventral opisthosomal setae....... .... *H. minutus* n. sp.
5. Sternal plate at least three times wider than long; sternal pores slitlike; coxa IV with one spur 6
   Sternal plate not quite twice wider than long; sternal pores circular; coxa IV without spurs .... *H. heteromydis* n. sp.
6. Sternal plate three times wider than long; movable chela one-third length of second cheliceral segment .... *H. panamensis* n. sp.
   Sternal plate four times wider than long; movable chela one-half length of second cheliceral segment .... *H. galindoi* n. sp.

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The Spinturnicid Mites of Panama[1]
(Acarina: Spinturnicidae)

Deane P. Furman[2]

In recent years, particularly extensive collections have been made of ectoparasites from Central American mammals and birds. These have chiefly been obtained in the course of epidemiological investigations of arthropod-borne diseases that are transmissible to man, or as a prerequisite to such investigations, because knowledge of the systematics and biology of ectoparaites is basic to understanding potential pathogen-vector relationships.

The present report on the Spinturnicidae, mites which are exclusively parasitic on bats, deals with the Panamanian collections and, with few exceptions, those Trinidadian collections pertaining to new species that occur in both Panama and Trinidad. The rich Panamanian collections were made available to the author by Lt. Col. Vernon J. Tipton, then Chief, Environmental Health Branch, Preventive Medicine Division, United States Army, Caribbean. Concurrently, the author studied extensive collections of Trinidadian bat mites lent through the courtesy of Dr. Thomas H.G. Aitken of the Trinidad Regional Virus Laboratory of the Rockefeller Foundation at Port of Spain. Trinidad collections will be dealt with in a separate paper. All collecting localities mentioned in this paper are in Panama, unless otherwise stated.

The author acknowledges with appreciation the loan of collections by Lt. Col. Tipton and Dr. Aitken and staff of the Trinidad Regional Virus Laboratory. Gratitude is expressed to Dr. Marc André for making available a specimen of *Periglischrus caligus* identified by Kolenati, to E. P. Catts for inking the drawings and to the several graduate students in parasitology who helped with various phases of the work. To Mr. Arthur M. Greenhall

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and Dr. Charles O. Handley, grateful acknowledgment is expressed for aid in problems of bat identification, but the author accepts responsibility for accuracy of host names recorded here.

An excellent revision of the family Spinturnicidae was given by Rudnick (1960). The reader is referred to this publication for complete synonymical lists, for details characteristic of the family and for a key to the genera of Spinturnicidae.

Representatives of three genera from Panama are recorded here: *Periglischrus, Spinturnix,* and *Paraspinturnix.* All Panamanian species key out to the proper genus in Rudnick's (1960) key, except for a new species of *Periglischrus,* the male of which has peritremes, vestigial to apparently absent anterior to coxae III.

Genus **Periglischrus** Kolenati

Periglischrus Kolenati, 1857, Wien. Ent. Monatschr., 1, (2), p. 60. Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 195 (complete bibliographical synonymy).

Type-species: *Periglischrus caligus* Kolenati, 1857, by subsequent designation (Oudemans, 1903, Tidschr. Ent., 45:135).

DIAGNOSIS (based on adults and modified from Rudnick, 1960): *Dorsum.*—Two dorsal plates closely approximated, occupying greater part of podosoma in female, and most of idiosoma of male; anterior plate much larger than posterior plate. Five pairs setae bordering anterior dorsal shield anterior to stigmata. One pair setae slightly posteromedial to stigmata. Peritreme completely dorsal, usually extending from level of coxa IV to level of coxa I.

Venter.—Lacking tritosternum. Female sternal plate with three pairs marginal setae which may be set off plate. Male sternal plate with five pairs setae. Epigynial plate reduced to narrow sclerotization with pair of small genital setae close to or on lateral margins of plate near posterior tip. Opisthosoma of non-teneral females usually greatly expanded to relatively flat, broad, fan-shaped appearance, with characteristically shaped areas of heavy sclerotization. Opisthosoma of male reduced, scarcely projecting posterior to level of coxae IV; six to eight pairs setae, exclusive of adanal pair, ventrally posterior to sternal plate. Anal plate in female small, subterminal, narrow, with pair adanal setae and dorsal postanal seta; anus terminal or dorsal. Male anal plate usually large, occupying much of area between coxae IV, with minute, dorsoterminal postanal seta.

Legs.—Large caruncles and claws on all legs. Dorsal and lateral setae short to long. Ventral setae usually short with exception of long, subterminal, tarsal trichobothria. Tarsus I of males with two long, bluntly tipped dorsal sensory setae located respectively at basal one-third and apical positions.

REMARKS: The previously known species of the genus *Periglischrus* were recorded only from bats of the family Phyllostomidae. The major part of the records of *Periglischrus* reported here are from the Phyllostomidae, but several collections are from the Desmodidae of the same superfamily and several are recorded from bats of the family Natalidae of the Vespertilionoidea. A single collection of several specimens is also recorded from a bat of the family Noctilionidae, superfamily Emballonuroidea.

Various instars of *Periglischrus* species commonly are encountered on their hosts. In common with other members of the family, species of this genus pass the larval stage of development in the body of the female. The first active stage seen is the protonymph which is characterized as follows: three pairs sternal setae; metasternal setae absent; four pairs dorsal propodosomal setae; peritreme short, extending barely, if at all, anterior to level of posterior margin of coxa II. Female deutonymphs, as far as known, have a pair of metasternal setae, five pairs dorsal propodosomal setae and a long, dorsal peritreme extending to or near level of coxa I. Chelicerae as in adult female. Male deutonymphs resemble female deutonymphs but differ in having fewer setae ventrally between coxae IV, and these are arranged in the adult male pattern.

KEY TO THE SPECIES OF *PERIGLISCHRUS* OF THE WORLD

Females

1. Peritreme of normal size over coxa III, narrow and thread-like from coxa III to I; from *Natalus mexicanus* .... *natali* n. sp.
   Peritreme of normal size throughout 2
2. Sternal plate about twice or more as wide as long; seven pairs of dorsal opisthosomal setae 3
   Sternal plate longer or approximately as long as wide; less than seven pairs of dorsal opisthosomal setae 4
3. Sternal plate with broad, antero-median projection bearing first pair of setae; anterior end of adanal plate flanked by pair of shell-like sclerotized areas; four pairs strong, prominently plumose setae on unsclerotized venter in addition to normal setae; all legs with ventral broad, flat setae prominently fringed; common on *Pteronotus parnellii fuscus* .... *elongatus* n. sp.
   Anterior margin of sternal plate slightly concave; adanal plate not flanked by shell-like sclerotizations; opisthosoma lacking prominently plumose setae ventrally; ventral leg setae of normal shape and at most narrowly fringed; from *Mormoops* spp. .... *strandtmanni* Tibbetts
4. Several pairs of ventral body setae with grossly expanded bases and acuminate tips; first and second pairs of dorsal propodosomal setae minute; from *Phyllostomus hastatus* .... *inflatiseta* n. sp.
   Ventral body setae simple, not with grossly expanded bases; first pair dorsal propodosomal setae may or may not be reduced; second pair not reduced 5
5. Femur, patella and tibia of legs III and IV each with an inflated, straight, blade-like postero-ventral seta 6
   Femur, patella and tibia of legs III and IV lacking straight, blade-like postero-ventral setae; leg IV with three apically recurved postero-ventral setae 7
6. First pair of dorsal propodosomal setae minute, usually embedded on margins of anterior dorsal plate; ratio of distance between first pair of propodosomal setae to that between first and second pairs less than 3:1; from numerous genera of phyllostomid hosts, particularly *Artibeus* .... *iheringi* Oudemans
   First pair of dorsal propodosomal setae well developed, inserted on unarmed cuticula; ratio of distance between first pair of propodosomal setae to that between first and second pairs greater than 4:1; common hosts *Sturnira* spp. .... *aitkeni* n. sp.
7. Dorsal propodosomal setae relatively long, the longest measuring over 60 μ; tibia and tarsus of legs I and II lacking inflated, recurved postero-ventral setae 8
   Dorsal propodosomal setae relatively short, the longest measuring not over 50 μ; tibia and tarsus of leg I and patella and tibia of II each with an inflated, recurved, postero-ventral seta, superficially appearing blunt 10
8. Femur II with only one of dorsal setae tiny; ratio of distance between first pair of propodosomal setae to that between first and second pairs greater than 4:1; common on *Desmodus* .... *desmodi* n. sp.
   Femur II with two of dorsal setae tiny; ratio of distance between first pair of propodosomal setae to that between first and second pairs less than 3:1 9
9. Palpal tibia with strong medio-distal lobe; leg IV with large, broadly inflated scimitar-like postero-ventral setae; dorsal opisthosoma bearing four small setae; from *Glossophaga soricina* .... *caligus* Kolenati

Palpal tibia lacking medio-distal lobe; leg IV with elongate, setaceous, curved postero-ventral setae; dorsal opisthosoma bearing six medium to large setae; hosts: *Anoura, Lonchoglossa, Trachops*......................*vargasi* Hoffmann

10. Sternal plate broadly jug-shaped with short, narrow neck; anterior dorsal plate longer than broad (320 μ by 281 μ); coxa III with relatively large posterior seta; anterior legs, exclusive of ambulacrum, over 500 μ long; hosts: common on *Phyllostomus, Trachops* ....*tiptoni* n. sp.

Sternal plate narrowly pear-shaped with eroded margins and a long neck; anterior dorsal plate about as broad as long measured on the mid-line (243 μ); coxa III with very small posterior seta; anterior legs, exclusive of ambulacrum, less than 400 μ long; common on *Micronycteris*................*micronycteridis* n. sp.

MALES

1. Peritreme constricted and thread-like anterior to mid-level of coxa III...*natali* n. sp.

Peritreme of normal size throughout......................................2

2. Unarmed ventral cuticula of idiosoma with numerous minute, thornlike mammillations 3

Unarmed ventral cuticula of idiosoma lacking such mammillations..............4

3. Coxa II with two long, subequal setae; distal seta of coxa I simple, setiform ....*elongatus* n. sp.

Coxa II with posterior seta much larger than anterior seta; distal seta of coxa I expanded, blade-like ....*strandtmanni* Tibbetts

4. Legs I and II with several blunt, fusiform setae; some ventral setae between coxae IV inflated...*inflatiseta* n. sp.

Not as above..5

5. Sternal plate setae short; anterior pair extending about one-half distance to level of second pair..6

Sternal plate setae relatively long; anterior pair extending about four-fifths or more of distance to level of second pair..................................7

6. A small mite with idiosoma less than 400 μ long; posterior seta of coxa II about 50 μ long; dorsal propodosomal setae short, not over 45 μ long....*caligus* Kolenati

Idiosoma over 500 μ long; posterior seta of coxa II about 130 μ long; longest dorsal propodosomal setae over 65 μ long..........................*vargasi* Hoffmann

7. Tarsi III and IV with coarsely barbed dorsal setae; ratio of length of posterior seta to that of anterior seta of coxa II less than 2:1.................*tiptoni* n. sp.

Tarsi III and IV superficially nude; ratio of length of posterior seta to that of anterior seta of coxa II over 2:1...8

8. Anterior dorsal propodosomal setae relatively close together; ratio of distance between bases of first pair of setae to that between bases of first and second pairs about 2:1...*iheringi* Oudemans

Ratio of distance between bases of first pair of setae to that between bases of first and second pairs about, or more than 4:1.................................9

9. Three pairs setae on unarmed dorsal opisthosoma; ventral pair setae behind sternal plate about three-fourths length of posterior setae of sternal plate..*desmodi* n. sp.

One pair setae on unarmed dorsal opisthosoma; ventral pair setae behind sternal plate minute 10

10. Relatively large mite with anterior legs, exclusive of ambulacra, over 500 μ long; spermatophoral process less than 100 μ long, shaped as a shepherd's crook ....*aitkeni* n. sp.

Relatively small mite, anterior legs about 400 μ long exclusive of ambulacra; spermatophoral process over 150 μ long, extensively recurved.*micronycteridis* n. sp.

Periglischrus natali, new species. Plate 37.

Both sexes of this mite differ from other known species of the genus in the sharp constriction of the peritremes to a thread-like appearance anterior to the level of coxae III.

DESCRIPTION, FEMALE (pl. 37, figs. 1, 2): A small mite for the genus, broadly rounded anteriorly and posteriorly and with lateral margins constricted at level of anterior opisthosoma. Idiosoma 486–540 μ long by 280–380 μ wide. Legs short, stout.

Dorsum.—Overall outline of two dorsal plates ovate. Plates separated only by lateral invaginations opposite stigmata, extending inward one-fourth width of plate, and by a suture in mid-region. Anterior plate 209 μ long on mid-line by 209 μ wide; slightly angulate shoulders at level of second pair propodosomal setae; with 10 pairs distinct alveoli. Posterior plate 92 μ long on mid-line by 148 μ wide; with nine pairs alveoli; pair minute setae in posterior pair alveoli. Anterior pair propodosomal setae 25 μ long, others progressively smaller proceeding posteriorly; ratio of distance between bases of first pair propodosomal setae to that between first and second pairs 0.7:1. Peritremes of normal length for genus but abruptly constricted and thread-like from mid-level of coxae III to level of anterior margins of coxae II, of normal width at anterior tip and posteriorly. Unarmed opisthosoma with six pairs minute setae. Posterior tip of anal plate extending dorsally, with minute postanal seta dorsal.

Venter.—Sternal plate broadly jug-shaped with short, anterior, "neck" ending bluntly; 101 μ long by 91 μ wide; three pairs fine short (7 μ) setae just off plate; two pairs pores on plate. Pair metasternal setae subequal to sternals, located postero-lateral to plate. Epigynial plate small, fan-shaped anteriorly, constricted centrally and slightly expanded at posterior tip; pair genital setae subequal to sternals, inserted off plate opposite constriction. Pattern of opisthosomal sclerotized areas basically as in *Periglischrus tiptoni*, but not visible in some specimens. Opisthosomal setae minute, slightly longer posteriorly; 11 pairs excluding adanal pair; adanal pair longer, 18 μ, and set anterior to anal opening on subterminal, pyriform anal plate.

Legs.—Short, stout; leg I 286 μ long exclusive of ambulacrum. All coxal setae delicate, minute except for posterior one of coxa II which is strong and about 73 μ long. Setae of other leg segments relatively small for the genus, otherwise not strikingly modified. Numbers of minute dorsal setae on femora I to IV respectively are 0, 1, 2, 2. Posterior margin of femur, patella and tibia IV each with quite long, narrow, sickle-shaped seta.

Gnathosoma.—Inner and outer hypostomal setae absent; distal hypostomal and gnathosomal setae subequal, simple, about 11 μ long. Palpal tibia with slight mediodistal lobe.

MALE (pl. 37, figs. 3, 4): A relatively small, elliptical to ovoid mite with setation less robust than is typical of the genus. Idiosoma 324 μ long by 243 μ wide.

Dorsum.—Dorsal plates similar to those of female but fusion of anterior and posterior plates more complete; combined plates cover all but narrow lateral margins of idiosoma; anterior plate 211 μ long on mid-line by 178 μ wide; posterior plate 86 μ long by 119 μ wide. Propodosomal setae relatively short, anterior two pairs about 24 μ long, others slightly shorter; ratio of distance between bases of first pair to that between bases of first and second pairs about 0.55:1. Unarmed opisthosoma bearing one pair of small setae postero-laterally in addition to subequal postanal seta terminally. Peritreme more reduced than in female, only the posterior extremity to the mid-level of coxa III of normal width; constricted portion reduced to vestigial state and all but invisible even in stained specimens.

Venter.—Sternal plate longer than wide, modified cordate with relatively long anteromedian projection and prominent antero-lateral shoulders; four pairs marginal and one pair submedian well developed, acicular setae; posterior pairs noticeably shorter than anterior pair. Two pairs pores on plate. Pair of small setae just behind sternal plate about one-third size of posterior sternal setae. Anal plate longer than broad with irregular margins, extending from mid-level of coxae IV to posterior body margin, widest at mid-level. Acicular setae on and around anal plate slightly smaller than posterior sternal setae; one pair anterior to anal plate, one at level of anterior one-fifth of plate and one pair opposite constriction of posterior one-third of plate; three pairs setae on plate anterior to adanal pair of setae; latter smaller than other setae and situated just anterior to anus. Anus terminal. Pair small adanal platelets flanking postero-lateral margins of anal plate appearing typically as sinuous, longitudinally oriented bars.

Legs.—Leg I of allotype 297 μ long exclusive of ambulacrum. Proximal seta of coxa I and anterior seta of coxa III very small, others relatively long; posterior seta of coxa II longest, 56 μ, over twice as long as next longest coxal seta. Ventral leg setae small, acicular. Dorsal leg setae acicular, nude or very minutely and sparsely barbed; few long setae, majority small to minute; one minute seta each on femora II, III and IV, none on femur I.

Gnathosoma.—Pair gnathosomal setae 12 μ long, slightly longer than distal hypostomal pair. Inner and outer hypostomal setae absent. Hypostomal processes elongate with membranous expansion. Usual pair of blunt, sinuous setae on tip of tibia very strongly developed. Chelicerae normal, each with spermatophoral process tubular, recurved, about 96 μ long. Tectum a simple lobe with narrowly rounded apex and broad base with slight proximal constriction.

MALE DEUTONYMPH: Characteristic of the genus except that peritreme is abruptly constricted over anterior one-third of coxa III and continued anteriorly as thread-like, sinuous, dorsal line to posterior level of coxa I.

TYPE MATERIAL: Holotype female and allotype male, together with 2 female, 2 male and 1 deutonymphal paratypes (host no. 6729) collected by C. M. Keenan and V. J. Tipton from *Natalus stramineus mexicanus* at San Lorenzo Caves, Fort Sherman (Canal Zone), 15 March 1961. Five paratypes including 3 females, 1 male and 1 protonymph with same collection data as type but taken as a separate collection. Holotype, allotype and 2 paratypes in the United States National Museum; 2 paratypes, male and female, Chicago Natural History Museum; 1 male paratype, Trinidad Regional Virus Laboratory; remaining paratypes in collection of author.

ADDITIONAL MATERIAL EXAMINED: 1 female, same data as the type, and 4 males from *Natalus tumidirostris haymani*, Mount Tamana Caves, Trinidad, by T. H. G. Aitken, 20 November 1957.

REMARKS: This is the only spinturnicid collected from bats of the genus *Natalus*. Goodwin and Greenhall (1961) recorded *Natalus tumidirostris haymani* in Trinidad roosting in caves in association with several other species of bats, which are recorded in the present paper as hosts of five other distinct species of *Periglischrus*. In view of the apparent opportunity for transfer of mites from host to host under such conditions, failure to find any evidence of such transfer indicates a rather strict host specificity of *P. natali* to bats of the genus *Natalus*.

Periglischrus elongatus, new species. Plate 38.

Females of *Periglischrus elongatus* are characterized by a sternal plate which is broader than long and with the first pair of setae on a broad anterior projection of the plate; the legs bear numerous ventral, prominent, flattened, bipectinate setae. Both sexes, in common with *Periglischrus strandtmanni,* have numerous minute, ventral, thorn-like mammillations. Males differ from the latter species in having a long, typically setiform, distal seta on coxa I and in having two long, subequal setae on coxa II.

DESCRIPTION, FEMALE (pl. 38, figs. 1, 2): An elongate mite with relatively short, stout legs. Idiosoma 1000 μ long by 405 μ wide at level of coxae IV.

Dorsum.—Plates relatively small; larger anterior one 250 μ long by 232 μ wide, without pronounced shoulders of *Periglischrus strandtmanni;* with 11 pairs circular alveoli, at least two pairs with minute setae. Small posterior plate 69 μ long by 110 μ wide, with seven pairs alveoli, posterior pair bearing minute setae. First pair propodosomal setae about one-half length of remaining four pairs which measure up to 55 μ long; ratio of distance between bases of first pair to that between first and second pairs 1.8:1. Opisthosoma with seven pairs well developed setae. Peritreme normal. Anal opening dorsal, subterminal; sclerotized rim of anus subcircular; postanal sclerotization anterior to anus in form of inverted U with slightly serrated inner rim; minute postanal seta centered on inner rim of postanal sclerotization.

Venter.—Sternal plate shorter than broad, 61 μ long on mid-line by 128 μ wide, with broad anteromedian projection bearing first pair setae; posterior margin slightly concave in middle; three pairs sternal setae subequal, approximately 28 μ long; second and third pairs located on posterior margin of plate; two pairs rounded pores on plate. Pair metasternal setae about one-half length of sternal setae, located midway between sternal and epigynial plates. Genital opening a small transverse slit in mid-line at level of posterior margins of coxae III. Epigynial plate a narrow longitudinal strip 67 μ long by 9 μ wide bearing two prominent, lightly pilose, long setae, 61 μ long, on posterior margin. Adanal pair setae similar to genital setae but somewhat shorter, arising from posterior margin of ventral platelet which is a narrow, elongate bar, slightly enlarged posteriorly and widely separated from dorsally situated anus; anterior end of platelet in a cavity bordered by two lateral shell-like sclerotized areas. Opisthosomal cuticula minutely striated, bearing nine pairs setae; pair larger setae anterior to adanal setae and two pairs on postero-lateral margins prominently bipectinate; other setae smaller and most arising from cup-shaped alveoli as illustrated. Podosomal cuticula in region of sternal plate furnished with numerous minute, thorn-like mammillations.

Legs.—Relatively short and stout; legs I 383 μ long exclusive of ambulacrum; posterior seta of coxa II modified to appearance reminiscent of palmate hairs of *Anopheles* mosquito larvae, with enlarged, flattened basal section gradually tapering toward apex and bipectinate throughout; distal seta coxa I slightly shorter than posterior seta of II, typically setiform, sparsely and minutely barbed; anterior setae of II and III similar but smaller; other coxal setae simple, short. Coxa II with antero-dorsal marginal spur and coxa III with posterior marginal spur. Prominent palmate setae similar to that of coxa II present on ventral side of most other leg segments distal to coxae, in addition to unmodified setae, several of which are slightly pectinate. Dorsal setae well developed, simple; long setae very minutely and sparsely barbed; no minute setae on femora.

Gnathosoma.—Pair distal hypostomal setae 16 μ long, somewhat longer than gnathosomal pair. Inner hypostomal setae absent; outer hypostomal pair represented only by pair of small alveoli. Palpi unmodified except for sclerotized ventro-medial, bidentate to tridentate flange on each trochanter, flanking mouthparts. Chelicerae normal.

MALE (pl. 38, figs. 3–5): A relatively long-legged mite with ovoid body 350 μ long by 285 μ wide in allotype. Other specimens up to 430 μ long.

Dorsum.—Dorsal plates closely approximated and covering all but narrow margin of idiosoma. Anterior plate 226 μ long by 235 μ wide, with narrowly rounded anterior margin, moderate shoulders over coxae I and widest at level between coxae II–III; posterior margin truncate and angularly concave; surface with 12 pairs alveoli. Posterior plate 75 μ long by 104 μ wide; subtriangular; surface with seven pairs alveoli, posterior pair bearing minute setae. Propodosomal setae all of moderate length, up to 34 μ long; ratio of distance between bases of first pair to that between first and second pairs 1.7–2.4:1 based on four specimens. Peritremes normal for genus except that they bend laterad markedly between coxae II and III and dip to ventral surface at this point on some specimens. Unarmed opisthosoma lacking setae.

Venter.—Sternal plate broadly flask-shaped with long anterior neck, 151 μ long on mid-line by 140 μ wide at level of second pair setae; with four pairs marginal and one pair post-centrally located setae; anterior pair 33 μ long, others subequal or slightly shorter; surface with pattern of transverse lines. Pair submedial setae posterior to sternal plate three-fourths length of posterior sternal setae. Five pairs simple setae, subequal to posterior sternals, located between coxae IV on unarmed cuticula; adanal setae stouter and longer and located on small anal plate just anterior to terminal anus; anal plate small with ill-defined margins. Postanal seta minute and dorsal. Ventral cuticula of idiosoma furnished with minute thorn-like mammillations as illustrated.

Legs.—Relatively long; leg I 470 μ long exclusive of ambulacrum. Coxal setae simple, well developed; anterior and posterior setae of coxae II subequal, other segments ventrally with setae normal, relatively short. Coxa II with antero-dorsal marginal spur and coxa III with posterior marginal spur. Dorsal setation normal for genus with all setae essentially nude.

Gnathosoma.—Gnathosomal and distal hypostomal setae simple, small, subequal. Outer hypostomal setae vestigial, set in relatively prominent alveoli. Inner hypostomal setae absent. Hypostomal processes long, elliptical, each with membranous, blade-like expansion. Palpi relatively long, thin. Chelicerae each with short, recurved spermatophoral process about 55 μ long.

FEMALE DEUTONYMPH: Idiosoma shape similar to that of male, 432 μ long by 356 μ wide, but legs relatively stout in relation to length; leg I 443 μ long exclusive of ambulacrum. Peritreme extending only to level of posterior one-fifth of coxa II, posterolaterad of dorsal propodosomal seta IV. Dorsal plates as in male. Venter with angulate mammillations as in male. Sternal plate subcircular with anterior margin slightly projected; surface with transverse lines; three pairs setae on plate. Two pairs setae in space between sternal plate and level of anterior margin of coxae IV. Unarmed cuticula between coxae IV and anterior to anal plate with seven pairs simple setae. Three pairs minute peg-like setae lateral to anal plate. Anal plate ovate, broader posteriorly, terminal, with pair well developed adanal setae.

MALE DEUTONYMPH: Idiosomal shape as in female deutonymph but legs not as stout in relation to length. Dorsum as in female deutonymph; typical specimen appears to have narrower margin of body unprotected by dorsal plates. Sternal plate with anteromedian lobe more pronounced than in female deutonymph; three pairs setae on plate and three pairs immediately posterior to it. Unarmed cuticula between coxae IV and anterior to anal plate with five pairs simple setae; lacking three pairs peg-like setae lateral to anal plate. Angulate mammillations and other ventral features as in female deutonymph.

PROTONYMPH: A broadly elliptical mite with short, stout legs bearing rather delicate setae. Idiosoma 395 μ long by 319 μ wide. Leg I 405 μ long exclusive of ambulacrum. Dorsal plates as in male. Only four pairs propodosomal setae similar in size to those of male. Peritreme dorsal, extending anteriorly only to space between coxae II and III, ending on lateral margin of body or even ventro-laterally. Sternal plate margins indistinct, with three pairs well developed, simple setae and two pairs pores; surface transversely sculptured. Ventral area between coxae IV and anterior to anal plate with four pairs simple setae. Leg setae simple, nude. Gnathosomal and distal hypostomal setae relatively longer than in male. Outer hypostomal setae small but distinct, much larger than in male.

TYPE MATERIAL: Holotype female (colln. no. T275) together with paratype female collected by W. G. Downs from "*Chilonycteris rubiginosa fusca*" at Mt. Tamana Caves, Trinidad, 12 June 1956. Allotype male and one paratype male (colln. no. T269) with same collection data as type. Other paratypes include 2 protonymphs with same data as type; 13 males, 1 female deutonymph and 1 protonymph from same host and locality taken by T. H. G. Aitken, 20 November 1957; 2 males from same host at Heights of Guanapo, Trinidad, by T. H. G. Aitken, 19 May 1957, and 1 female, 5 males and 3 protonymphs with same data but collected 1 October 1957; 6 females, 31 males, 3 female deutonymphs, 4 male deutonymphs and 8 protonymphs from same host species taken at Paraíso (Canal Zone), by C. M. Keenan and V. J. Tipton, 24 July 1959.

Holotype, allotype and 9 paratypes, including 4 males, 1 female, 2 protonymphs and 2 deutonymphs (male and female), in the United States National Museum; 8 paratypes, including all stages, Chicago Natural History

Museum; 4 paratypes (males and females), Trinidad Regional Virus Laboratory; remaining material in the collection of the author.

ADDITIONAL MATERIAL EXAMINED: From *Pteronotus parnellii fuscus:* Paraíso (Canal Zone), 16 September 1959; Madden Air Field (Canal Zone), 23 May and 3 October 1961; Chilibrillo Caves (Panamá), 2 August 1960; Bocas del Toro Province, 1 February 1960; Cerro Hoya (Los Santos), 18 February 1962. From *Pteronotus suapurensis*, a single collection of 3 males, Chilibrillo Caves (Panamá), collected by C. M. Keenan and V. J. Tipton, 8 March 1960.

REMARKS: *Periglischrus elongatus* is most closely related to *Periglischrus strandtmanni* Tibbetts, which also occurs on chilonycterine bats, but of the genus *Mormoops*.

The question of degree of intraspecific variation in *Periglischrus elongatus* is still open. Two abnormal female specimens are at hand from *Pteronotus parnellii fuscus* taken in Peninsula de Azuero (Los Santos Province), 24 February 1962. In these the characteristics of the species are for the most part greatly exaggerated. The legs are stouter and more heavily sclerotized, and more of the ventral setae are modified into heavily fringed "palmate" setae. More striking is the presence of a strong, deep camerostome bordered posteriorly by the sternal plate and laterally by heavily sclerotized margins. The dorsal propodosomal setae are modified into short, stout, blunt spines. Whether these two specimens represent genetic freaks or are actually representative of a distinct population is unknown. The single male at hand from this area is apparently normal.

Periglischrus strandtmanni Tibbetts

Periglischrus strandtmanni Tibbetts, 1957, Jour. Kansas Ent. Soc., **30**, (1), p. 14, pls. 1–3—United States National Museum, Washington (Frio Cave, Uvalde County, Texas, from *Mormoops megalophylla senicula*). Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 199.

This mite has been recorded previously only from the type collection, from Texas, and while it has not been collected in Panama, a recent collection from Trinidad indicates its probable occurrence in Panama.

Comparison of a female specimen from Trinidad with Tibbetts' description and figures demonstrates close agreement. However, the "Y"-shaped anal plate with two long posterior setae described by Tibbetts as dorsal in position is actually ventral just as in the new species, *P. elongatus*, described in the present publication; the two long setae are adanal setae. Tibbetts' species lacks the pair of adanal, shell-like sclerotized platelets flanking the anal plate of *P. elongatus*. The anal opening and minute postanal seta are dorsal in position and appear just as described for *P. elongatus*. Many of the ventral leg setae are sparsely bipectinate, but none show the inflated "palmate" appearance characteristic of *P. elongatus*. Other differential characters are given in the discussion of the latter species.

The specimen recorded here is a female taken from *Mormoops megalophylla tumidiceps* Miller, at Mount Tamana Caves, Trinidad, by T. H. G. Aitken, 20 November 1957.

Periglischrus inflatiseta, new species. Plate 39.

The female of *Periglischrus inflatiseta* differs from all other members of the genus in possessing characteristically inflated setae on the venter. The male is very similar to *Periglischrus tiptoni* from which it differs in its smaller size, its much shorter and broader, blunt, ventral setae on legs I and II, shorter anterior legs, and in the absence of strongly serrated setae on tarsus III.

DESCRIPTION, FEMALE (pl. 39, figs. 1, 2): A relatively small mite for the genus with idiosoma of gravid specimens broadly rounded anteriorly and opisthosoma moderately flared in fan shape. Idiosoma of type specimen 760 μ long by 454 μ wide.

Dorsum.—Overall outline of two dorsal plates ovate with broad end anterior. Anterior plate 230 μ long on mid-line by 244 μ wide; broadest at level of coxae II; with 10 pairs of obvious alveoli, some bearing microsetae; a longitudinal median slit seen in all mounted specimens may represent merely a zone of weakness resulting in an artifact; posterior margin truncate and bridged to posterior plate by two small, submedian lobes. Posterior plate approximately triangular with posterior apex rounded; 83 μ long by 151 μ wide; seven pairs alveoli of which subterminal pair bear microsetae. Propodosomal setae minute, especially first two pairs; ratio distance between bases first pair setae to that between first and second pairs approximately 2:1. Pair of minute metapodosomal setae mesad of stigmata. Four pair minute setae on opisthosoma. Minute postanal seta subterminal. Peritremes extend almost to level of second pair propodosomal setae.

Venter.—Sternal plate longer (100 μ) than wide (98 μ), pentagonal with rounded corners, concave antero-lateral margins, and straight to concave posterior margin; three pairs short simple setae on margins, first pair 18 μ long, others 26 μ long. Pair metasternal setae lateral to posterior corners sternal plate, strongly sclerotized, flattened and broadly fusiform basally, abruptly acuminate distally, 39 μ long by 15 μ wide. Pair epigynial setae similar to metasternals but smaller, arising from small, poorly sclerotized epigynial platelet behind transverse genital slit; small, fan-shaped pattern of striae on cuticula anterior to genital slit. Opisthosomal pattern of sclerotization similar to that of *P. iheringi.* Opisthosoma with 10 pairs setae in addition to adanal pair: pair small, normal, submedian setae on anterior of opisthosoma followed in diverging rows posteriorly by two pairs prominent inflated setae of same type as metasternals but larger; smaller inflated pair submedian setae at mid-opisthosomal level; remaining setae on posterior half of opisthosoma normal, slightly fusiform, arranged as in *P. tiptoni.* Anal plate as described for *P. tiptoni.*

Legs.—Short, stout; leg I 405 μ long exclusive of ambulacrum. Coxal setae well developed: I with two acicular setae, basal slightly longer than distal; anterior seta of II fusiform, posterior one longer than others (72 μ), minutely barbed; anterior seta of III small, normal, posterior one large, 34 μ long, broadly fusiform, similar to metasternals; seta of IV well developed, normally setiform with slightly fusiform base. Ventrally trochanter, femur and tarsus I and segments of II exclusive of coxa, each with one or more prominent, short, stout, blunt, flattened setae with tendency toward slight barbs on one edge; III and IV with several strong postero-ventral setae, fusiform basally, acutely tipped. Dorsally setal vestiture normal for genus with long setae minutely barbed; femora I and II each with minute antero-basal seta; III and IV each with two small basal setae.

Gnathosoma.—Gnathosomal setae small, acicular; distal hypostomal pair similar, but twice as long; outer hypostomal pair vestigial; inner pair absent. Palpal tibia with very slight medio-distal lobe; trochanter with blunt, ventral, flap-like emargination distally. Chelicerae normal for genus.

MALE (pl. 39, figs. 3, 4): Idiosoma broadly ovoid, widest at level of coxae II–III; 405 μ long by 356 μ wide. Opisthosoma rudimentary.

Dorsum.—Dorsal plates as in *Periglischrus tiptoni* but smaller; anterior plate 246 μ long by 246 μ wide; posterior plate 120 μ long by 148 μ wide. Propodosomal setae short, subequal, 16–20 μ long; ratio of distance between first pair of setal bases to that between first and second pairs approximately 2:1. Unarmed opisthosoma bearing one pair small setae.

Venter.—As described for *Periglischrus tiptoni* with following exception: first and third pair of large setae in space between coxae IV basally inflated.

Legs.—Leg I 440 μ long exclusive of ambulacrum. Coxae with relatively long setae; posterior seta of II 59 μ long, that of III 48 μ long. Ventrally trochanter and femur I each with two prominent, blunt, broadly fusiform, short setae; similar though less prominent setae on patella and tibia; tarsus I with short, broad fusiform seta proximal to mid-level. Ventrally leg II with short, broad fusiform setae on all segments but coxa. Ventral setae of III and IV tend to be basally inflated and terminate in acute tips. Tarsi III and IV ventrally each with one proximal and a pair of short, subapical, bluntly conical, stout setae in addition to others. Dorsally femur I with one to two minute setae, femur II with one, femur III with two, and femur IV with one minute setae. Tarsus IV with pair strongly serrate dorsobasal setae; tarsus III lacking serrate setae.

Gnathosoma.—Gnathosomal and distal hypostomal setae subequal, 17 μ long; outer hypostomal setae minute; inner hypostomals absent. Similar in general appearance to *P. tiptoni* but lateral seta of palpal femur not prominently serrated, and two stout apical setae of tibia are particularly well developed in *P. inflatiseta.*

TYPE MATERIAL: Holotype female, allotype male, and 5 paratypes including 3 females, 1 male and 1 female deutonymph (host no. 43065) collected by V. J. Tipton from *Phyllostomus hastatus panamensis* at Panama City (Panamá), June 1961. Paratype series also includes the following: 1 female from *Phyllostomus hastatus panamensis,* Chepo Road (Panamá), C. M. Keenan and V. J. Tipton, 8 October 1959. From *Phyllostomus hastatus hastatus,* 1 female and 2 males, Heights of Guanapo, Trinidad, T. H. G. Aitken, 19 May 1958; a female, male and protonymph, at Heights of Guanapo, Trinidad, W. G. Downs, 7 November 1956; 3 females and 1 male from same location, T. H. G. Aitken, 11 August 1957.

Holotype, allotype and 2 paratypes, male and female, in the United States National Museum; 2 paratypes (male and female), Chicago Natural History Museum and Trinidad Regional Virus Laboratory; remaining material in the collection of the author.

OTHER MATERIAL EXAMINED: In addition to the paratypes listed above, 1 male and 2 females were taken from (2) *Phyllostomus hastatus* by K. von Sneidern at La Macarena, Río Guapayá, Colombia, 14 March 1957.

REMARKS: *Periglischrus inflatiseta* is usually found in association with *Periglischrus tiptoni* on subspecies of *Phyllostomus hastatus,* but the more common *tiptoni* apparently occurs on a wider range of host species.

Periglischrus iheringi Oudemans

Periglischrus iheringi Oudemans, 1902, Ent. Ber., 1, (6), p. 38—Rijksmuseum für Naturlijke Historie, Leiden (São Paulo, Brazil, from *Vampyrops lineatus*). Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 197, pl. 30.

This species was adequately redescribed by Rudnick (1960). Specimens identified as this species in the current study agree closely with Rudnick's description. Slight intraspecific differences appear in some characters such as the length of the small antero-basal seta on the dorsal aspect of femur II of the female. For example, in specimens from *Artibeus lituratus palmarum* this seta is consistently larger than in specimens from *Artibeus j.*

jamaicensis; in Rudnick's (1960) figure of this species he has omitted the small, dorsal, antero-basal seta of femur II. On some females three pairs of ventral alveoli can be seen, arranged in two diverging rows between and posterior to coxae IV; minute setae are visible in the alveoli on some well-mounted specimens.

The female may be distinguished from other species by the following combination of characters: A large mite with expansile, fan-shaped opisthosoma. Palpal tibia lacking prominent subapical lobe. Anterior pair dorsal propodosomal setae tiny, usually inserted on dorsal plate; other propodosomal setae long (up to 67 μ). Ratio of distance between bases of first pair propodosomal setae to that between bases of first and second pairs less than 3:1. Posterior seta coxa II much longer than other coxal setae, minutely barbed; posterior seta coxa III approximately 55 μ long, inflated, blade-like; postero-ventral margins legs III and IV with several straight, blade-like setae. Proximal dorsal seta of femur, genu and tibia II long.

The male of *Periglischrus iheringi* resembles that of the new species *Periglischrus aitkeni.* It may be differentiated by the longer, dorsal, propodosomal setae (up to 73 μ long), by the longer spermatophoral processes (198 μ long) and by the position of the anterior pair of dorsal propodosomal setae which are more closely approximated; the ratio of the distance between the bases of the first pair of propodosomal setae to that between the first and second pair ranges from 1.7:1 to 2.2:1 (19 specimens measured); this compares to a ratio of 5.5:1 for *P. aitkeni.* From the closely related *Periglischrus vargasi,* males of *P. iheringi* may be distinguished by the presence of, at most, one small to medium-sized dorsal seta on femur II, in contrast to two minute to small setae in this position on *P. vargasi.*

Periglischrus iheringi is the most commonly encountered spinturnicid in collections seen from Panama. Not only does it occur in considerable numbers on its hosts, but it infests an unusually large number of bat genera of the family Phyllostomidae, and even extends to the Desmodidae.

MATERIAL EXAMINED: The following new distribution records represent collections made by V. J. Tipton alone or with C. M. Keenan. Each collection was from a single bat. From *Uroderma b. bilobatum:* Summit Gardens (Canal Zone), 3 collections of 1 female, of 1 male, and of 4 females, 2 males and 1 nymph, 11 September 1959; Bocas del Toro Province, 3 females, 5 February 1960; Escobal (Colón), 1 female, 28 September 1960; Rodman Dispensary (Canal Zone), 5 females, 2 males and 3 nymphs, 27 April 1961. From *Vampyrops vittatus:* Cerro Punta (Chiriquí), 2 females, 2 males, 2 nymphs, 5 February 1960; Río Changena (Bocas del Toro), 3 females, 4 males, 1 nymph, 24 September 1961, and 2 males, 1 nymph, 20 September 1961. From *Vampyrops helleri:* Fort Sherman (Canal Zone), male and nymph, 2 December 1959; Almirante (Bocas del Toro), 2 collections of 2 males and of a female, male, 2 nymphs, 23 January 1960, and of a female and 2 males, 24 January 1960; Cerro Hoya (Los Santos), 1 male, 10 February 1962, 1 male on 13 February 1962 and 1 female on 24 February 1962. From *Vampyressa pusilla:* from Cerro Hoya, two collections of 1 female and of 1 nymph on 10 February 1962, 3 females and 1 male on 22 February 1962 and 2 females on 24 February 1962. From *Vampyrodes major:* Bocas del

Toro Province, 1 male, 25 January 1960; Peña Point (Darién), two collections comprised of 3 females, 3 males, 2 nymphs, 24 March 1960; Río Seteganti (Darién), 1 female and 1 male on 1 February 1961, 1 male on 23 September 1961 and 2 females, 1 male and 2 nymphs on 24 September 1961. From *Chiroderma salvini:* Río Changena (Bocas del Toro), 1 male, 22 September 1961. From *Artibeus toltecus:* Casa Lewis, Cerro Punta (Chiriquí), two collections of 1 female and 1 nymph and of 1 female on 5 February 1960, and of 1 male on 3 February 1960; Río Changena (Bocas del Toro), two collections of 1 female each, 20 September 1961. From *Artibeus j. jamaicensis:* Fort Kobbe (Canal Zone), numerous specimens, 13 October 1960, and 1 male and a nymph on 24 July 1959; Bocas del Toro Province, 4 collections of 1 male, of 6 females, of 1 female and of 2 females, 1 male and 1 nymph on 23 January 1960; other collections from the same area are 3 collections of several specimens on 24 January 1960, two collections totaling 5 specimens on 25 January 1960, 1 female on 26 January 1960, one to several specimens from single collections on 27, 28 and 30 January 1960 and 1 February 1960; Peña Point (Darién), female and nymph, 24 March 1960; Fort Clayton (Canal Zone), 3 females, 19 October 1960; Río Setegantí (Darién), 8 collections of from 1 to 5 specimens each from 1 to 5 February 1961, and 2 collections of several specimens each on 17 and 20 September 1961. From *Artibeus j. jamaicensis:* Río Changena (Bocas del Toro), female, 2 males and nymph on 21 September 1961, 1 male and nymph on 22 September 1961 and 1 female on 23 September 1961. From *Artibeus lituratus palmarum:* Paraíso (Canal Zone), male, 5 November 1959; Fort Sherman (Canal Zone), male and nymph, 4 December 1959; Fort Clayton (Canal Zone), several, 19 October 1960; Bocas del Toro Province, male, 24 January 1960; Río Setegantí (Darién), 7 collections from 1 to 5 February 1961, each containing from one to several mites; Juan Mina (Canal Zone), female, 29 June 1961; from Cerro Hoya, one female, 21 February 1962. From *Artibeus cinereus:* Río Changena (Bocas del Toro), 4 collections, 18 to 24 September 1961, each containing from one to several mites; from Cerro Hoya, one female, 12 February 1962. From *Artibeus aztecus:* Chiriquí Province, 2 collections of 1 female and 2 females, 2 March 1962. From *Artibeus* species: Río Changena (Bocas del Toro), several specimens, 24 September 1961. From *Enchisthenes harti:* Cerro Hoya (Los Santos), 3 females, 5 males, 8 March 1962; from same locality, 4 collections of 1 to 3 mites each, 9 to 18 February 1962. From *Desmodus rotundus murinus:* Bocas del Toro Province, female and male, 23 January 1960, and 2 males, 25 January 1960; Cerro Punta (Chiriquí), 2 females, 5 February 1960.

Periglischrus aitkeni, new species. Plate 40.

Periglischrus aitkeni resembles *Periglischrus iheringi,* from which females may be distinguished in having the first pair of dorsal propodosomal setae well developed and inserted very near the bases of the second pair of propodosomal setae. Males differ in having a relatively short spermatophoral process, less than 100 μ long, and in having the anterior, dorsal propodosomal setae displaced far laterad.

DESCRIPTION, FEMALE (pl. 40, figs. 1, 2): A large, typical number of the genus with idiosoma broadly rounded anteriorly and opisthosoma moderately flared. Idiosoma 1134 μ long by 594 μ wide.

Dorsum.—Anterior plate approximately 310 μ long on mid-line by 275 μ wide, with broadly rounded anteromedial projection, and pronounced shoulders; sides slightly concave anteriorly and slightly convex posteriorly; posterior margin truncate, slightly concave and joined to posterior plate by two submedian lobules; 11 pairs alveoli in pattern similar to that in *Periglischrus iheringi.* Posterior plate bluntly triangular, 130 μ long by 190 μ wide, widest anteriorly and terminating in broadly rounded posterior margin; bearing five pairs prominent alveoli, the posterior pair bearing microsetae. Propodosomal setae all moderately developed, second pair 45–50 μ long, others obviously shorter; ratio of distance between bases of first pair to that between first and second pairs approximately 5:1. Unarmed opisthosoma with four pairs small setae. Postanal seta minute, subterminal.

Venter.—Sternal plate as broad as long, 146 μ, outline that of broadly rounded pentagon with narrowest angle anterior; three pairs small sternal setae located just off margins of plate; two pairs pores on plate, in some specimens serving as foci for invaginations of eroded plate margins. Epigynial platelet a small, narrow, longitudinal sclerite with membranous posterior enlargement; pair small genital setae located off plate anterior to posterior lobe. Pattern of sclerotized opisthosomal areas and opisthosomal setation as in *P. tiptoni* and *P. iheringi,* but anterior three pairs setae vestigial or absent and represented only by alveoli; other setae small. Anal plate as described for *P. tiptoni,* but adanal setae 33 μ long, over twice as long as other opisthosomal setae.

Legs.—Well developed, stout; leg I 545 μ long exclusive of ambulacrum. Posterior seta coxa II 195 μ long, minutely barbed; posterior seta coxa III 39 μ long, broadly blade-like; other coxal setae much smaller, acicular. Other ventral leg segments with mostly short, simple setae, usually with inapparent, minute barbs on longer setae; several posterior setae of legs III and IV expanded, blade-like. Longer dorsal setae minutely barbed. Dorsal surfaces of femora with a minute seta only on legs II and III.

Gnathosoma.—Distal hypostomal setae 22 μ long, about twice as long as gnathosomal pair. Inner and outer hypostomal setae apparently absent. Palpal tibia lacking pronounced medio-distal lobe; trochanter with blunt, ventral, flap-like emargination distally. Chelicerae normal for genus.

MALE (pl. 40, figs. 3–5): Idiosoma ovoid, widest at level of coxae II–III; 600–620 μ long by 488–513 μ wide. Legs stout, of moderate length.

Dorsum.—Shape of dorsal plates and alveolar pattern similar to those of *Periglischrus iheringi;* some of alveoli bearing microsetae as illustrated. Propodosomal setae well developed, setiform, measuring 49–55 μ long; ratio distance between bases of first pair to that between first and second pairs approximately 5.5:1. Unarmed opisthosoma with pair of short (18 μ) setae subterminally. Postanal seta minute, dorsoterminal.

Venter.—Sternal plate longer than wide, modified cordate with pronounced medial anterior projection and prominent shoulders; with five pairs well developed acicular setae, anterior-most of which extend to level of imaginary line projected between bases of second pair; pair of minute setae behind sternal plate. Anal plate large, elongate, occupying most of space between coxae IV, truncate anteriorly with sides constricted slightly just anterior to adanal setae; adanal setae inserted just anterior to anus; three other pairs subequal setae anteriorly on anal plate and three pairs bordering plate. Pair of subterminal accessory platelets bordering posterior end of anal plate.

Legs.—Well-developed, stout; leg I approximately 540 μ long exclusive of ambulacrum. Coxal setae all well developed, typically setiform; posterior seta of coxa II over twice as long as other coxal setae, approximately 165 μ long; anterior seta of coxa III shortest, 30 μ long. Other leg segments ventrally with short but strong simple setae; ventro-lateral setae of legs III and IV longer and minutely barbed; pair of short subterminal setae of tarsus II spine-like. Long dorsal setae minutely barbed and notched apically. Femur II with only one of dorsal setae minute; no minute setae on other femora.

Gnathosoma.—Gnathosomal and distal hypostomal setae subequal, well developed, 28 μ long. Inner hypostomal setae absent; outer hypostomals vestigial but alveoli easily observed. Palpi normal for genus. Spermatophoral process a strong tubular structure recurved in shallow hook distally, short for the genus, measuring approximately 80 μ long in allotype.

TYPE MATERIAL: Holotype female and allotype male (colln. no. T60) together with 3 paratype females collected by T. H. G. Aitken from *Sturnira lilium lilium,* at the 15¾ mile mark on Churchill-Roosevelt Highway, Trinidad, 17 June 1958. Other paratypes are as follows: 3 females from *Sturnira lilium parvidens,* at the Río Mandinga (San Blas), V. J. Tipton, 27 May 1957; 5 females from *Sturnira lilium,* at Rancho Grande, Venezuela, C. O. Handley, 30 March 1960; 3 females and 1 protonymph from the same host, Los Santos Province, V. J. Tipton, 24 February 1962; one female from *Sturnira ludovici,* Cerro Punta (Chiriquí), Republic of Panamá, C. M. Keenan and V. J. Tipton, 30 April 1961. Holotype, allotype and 3 female paratypes, in the United States National Museum; 2 paratypes (male and female), Chicago Natural History Museum and Trinidad Virus Laboratory; remaining material in the collection of the author.

OTHER MATERIAL EXAMINED: From *Sturnira lilium,* Bocas del Toro Province, 1 female, C. M. Keenan and V. J. Tipton, 23 January 1960; from *Sturnira ludovici,* Cerro Punta (Chiriquí), C. M. Keenan and V. J. Tipton, 1 male and 1 female deutonymph on 2 February 1960, 1 female, 1 male and 1 male deutonymph on 3 February 1960, 2 females on 3 February 1960, 1 male deutonymph on 3 February 1960, 1 male and 1 protonymph on 15 February 1960, 1 female, 1 May 1960, and 1 male on 1 May 1960; from the same host, Chiriquí Province, a male, male deutonymph and a protonymph, V. J. Tipton, 6 March 1962; from *Sturnira* species in Los Santos, 3 females and 2 protonymphs on 1 host specimen and 2 males on another specimen, V. J. Tipton, 6 March 1962; from *Noctilio leporinus* at Guánico (Los Santos), 5 females and 2 males, V. J. Tipton, 24 January 1962.

REMARKS: *Periglischrus aitkeni* is a rather common parasite of phyllostomid bats of the genus *Sturnira* in Central America. In view of the usually rather restricted host range of *Periglischrus,* it was surprising to find several typical specimens of *P. aitkeni* from a single *Noctilio leporinus,* a fish-eating bat of the superfamily Emballonuroidea.

This species is name in honor of Dr. T. H. G. Aitken, entomologist at the Trinidad Regional Virus Laboratory of the Rockefeller Foundation, who collected the type specimens and has provided many of the other collections upon which this study is based.

Periglischrus desmodi, new species. Plate 41.

Periglischrus desmodi is closely related to *P. vargasi.* Characters distinguishing the female include the very widely spaced first pair of dorsal propodosomal setae, the characteristic shape of the sternal plate and the presence of only one minute basal seta on the dorsum of femur II instead of two. Characters distinguishing the male include long sternal plate setae, three pairs of dorsal opisthosomal setae and a pair of well-developed setae behind the sternal plate.

DESCRIPTION, FEMALE (pl. 41, figs. 1, 2): Idiosoma broadly rounded anteriorly, with opisthosoma slightly to moderately expanded; approximately 920 μ long by 486 μ wide; a moderately robust species with long setae.

Dorsum.—Anterior dorsal plate large, 297 μ long on mid-line, by 292 μ wide; rounded apex projecting from broad anterior margin; broad, relatively straight posterior margin at level of coxae IV, with two submedian rounded protuberances received by anterior margin of posterior plate; bearing nine pairs of prominent alveoli, three pairs of which bear minute setae. Posterior plate small, with anterior margin contacting anterior plate with two submedian emarginations to receive corresponding projections from anterior plate; broader than long with posterior margin broadly rounded; with eight pairs of alveoli, of which two pairs bear minute setae. Propodosomal margin with five pairs long, subequal setae of approximately 85 μ; ratio of distance between first pair to that between first and second pairs varies from 6.6:1 to 8.4:1. Opisthosoma with six pairs setae, of which the longest are anterior. Posterior tip of anus normally dorsal, bearing minute postanal seta.

Venter.—Sternal plate a modified pentagon longer than wide, with broad base, rounded sides and narrowly tapering anterior apex; three pairs of short setae may be off plate although on type first and third pair are included in plate; two pairs of pores on plate. Pair of short metasternal setae. Epigynial plate reduced, slender, long, slightly expanded anteriorly; pair of short genital setae located off plate, insertions spaced 10 μ apart. Opisthosoma bearing three pairs small setae in two diverging rows behind epigynial plate; three pairs on median sclerotized area anterior to anal plate, two pairs anterior to this sclerotization, two pairs postero-lateral and one pair lateral to the sclerotization. Sclerotized areas of opisthosoma as illustrated, similar to to those of *P. iheringi.* Anal plate ventro-terminal, elongate, narrow with pair adanal setae subequal to adjacent opisthosomal setae; canal-like structures extending anteriorly from adanal setal bases. Minute postanal seta dorsal.

Legs.—Relatively short, stout; leg I 476 μ long exclusive of ambulacrum; coxal setae, with exception of posterior seta of II, short, nude and unmodified; posterior seta of II elongate and minutely barbed; most other ventral leg setae normal with larger setae minutely barbed; legs I and particularly II with row of inflated, leaf-like setae very prominently serrated; femur, patella and tibia IV each with a slightly inflated, scimitar-shaped, postero-ventral seta; dorsal setae of legs strong, many elongate; of two basal setae on femur II the posterior one is of medium size and anterior one is small.

Gnathosoma.—Inner and outer hypostomal setae absent; pair distal hypostomal setae about twice as long as short gnathosomal pair; long paired hypostomal processes present. Palpi with five movable segments; tibia with moderately developed medial distal lobe. Chelicerae normal for genus.

MALE (pl. 41, figs. 3–5): Idiosoma ovoid, widest at level of coxae II–III; 485 μ long by 350 μ wide. Opisthosoma rudimentary.

Dorsum.—Anterior and posterior dorsal plates similar to those of female in size, shape, surface markings and setation, although the posterior plate tends to have concave postero-lateral margins and the plates appear compressed together, rendering the line of separation indistinct; the two plates cover most of idiosoma. Propodosomal setae as in female but approximately 60–67 μ long; ratio of distance between alveoli of first pair to that between first and second pairs approximately 6:1. Three pairs small setae on narrow cuticular margin bordering postero-lateral edges of posterior dorsal plate; postanal seta minute, terminal.

Venter.—Sternal plate modified cordate with elongate antero-median projection terminating at male genital opening; longer than wide; bearing five pairs well-developed setae ranging from 63 μ long anteriorly to 43 μ for posterior pair. Pair of medium-sized setae 30 μ long posterior to plate. Five and occasionally six pairs setae up to 36 μ long located in space between coxae IV and anterior to anal plate. One pair setae lateral to anal plate and mesad of pair of small adanal platelets. Anal plate small, elongate, with indistinct anterior margins; pair of adanal setae about 20 μ long anterior to anal opening, which is terminal.

Legs.—Leg I 450 μ long exclusive of caruncle. With exception of posterior seta of coxa II, coxal setae longer than in female although of same type; other ventral leg setae simple, acicular, small; dorsal setae similar to those of female, but tarsus I bearing two long, specialized, blunt setae.

Gnathosoma.—Pair gnathosomal setae 18 μ long, acicular; outer hypostomal pair minute; distal hypostomal setae subequal to gnathosomal pair. Palpal tibia lacking medial lobe of female; trochanter with distal flange-like lobe. Chelicerae with fixed digit well developed, bearing numerous sharp subterminal "teeth" on surface opposed to movable digit; latter slightly longer than fixed digit and bearing blunt-tipped teeth along inner surface; spermatophoral process a long tubular, recurved structure over 150 μ in length.

MALE DEUTONYMPH: Idiosoma shape similar to that of male, 497 μ long by 362 μ wide.

Dorsum.—Similar to that of male.

Venter.—Sternal plate approximately diamond-shaped with corners rounded, bearing three pairs well-developed acicular setae; pair setae bordering postero-lateral margins of plate. Anal plate and remaining setae of venter as in male.

Legs.—As in male but lacking long, blunt-tipped setae on tarsus I.

Gnathosoma.—Similar to that of male, but chelicerae as in female.

PROTONYMPH: A broadly elliptical mite with relatively short, very robust legs.

Dorsum.—Anterior and posterior plates similar in shape and sculpturing to those of female, but covering most of idiosoma. Propodosomal margin bearing four pairs long setae. Peritremes short, entirely dorsal, extending from level of posterior margin of coxae III, terminating posterior to insertion of fourth pair propodosomal setae. Pair of long metapodosomal setae inserted just mesad of stigmata as in adults.

Venter.—Sternal plate very lightly sclerotized, roughly diamond-shaped with rounded corners, bearing three pairs well-developed setae. Four pairs well-developed setae between sternal plate and anal plate. Anal plate elongate, narrow with rounded anterior margin; pair of well-developed adanal setae on plate anterior to anal opening; postanal seta minute.

Legs.—Setation similar to that of male deutonymph.

Gnathosoma.—Similar to that of male deutonymph but palpi relatively short and stout.

TYPE MATERIAL: Holotype female (colln. no. T279) collected by T. H. G. Aitken from *Desmodus rotundus rotundus* at St. Patrick's Estate, Arima Valley, Trinidad, 16 May 1957. Allotype male (host. no. 9182) collected by V. J. Tipton from *Desmodus rotundus* at Guánico (Los Santos), 27 January 1962. Four paratypes (1 female, 1 deutonymph and 2 protonymphs) same data as male allotype; 1 paratype protonymph same data as holotype female; 4 paratype females from (3) *Desmodus rotundus,* Chiriquí Province, V. J. Tipton, 6, 7, 11 March 1962; 1 paratype female from *Desmodus rotundus murinus,* Casa Tilley, Cerro Punta (Chiriquí), C. M. Keenan and V. J. Tipton, 6 February 1960; 14 paratypes (10 females, 3 males, 1 deutonymph) from *Desmodus r. rotundus* at Antilles (Kern Trinidad Oilfields Ltd.), La Brea, Trinidad, T. H. G. Aitken, 14 April 1958.

Holotype, allotype, 3 male and 2 female as well as proto- and deutonymph paratypes in the United States National Museum; 1 male, 2 female paratypes, Chicago Natural History Museum; 2 male, 2 female paratypes, Trinidad Regional Virus Laboratory; remaining material in the collection of the author.

Many other specimens of this species from Trinidad are in the author's collection, all taken from *Desmodus r. rotundus.*

Periglischrus caligus Kolenati. Plate 42.

Periglischrus caligus Kolenati, 1857, Wien. Ent. Monatschr., 1, (2), p. 60—Type deposition unknown (Brazil and Surinam, from *Glossophaga soricina*). Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 196.

Periglischrus caligus bears a general resemblance to *P. vargasi* from which females may be separated by the presence of a strong medio-distal lobe on the palpal tibia; females differ from all species of the genus in having broadly inflated, scimitar-shaped setae on the postero-ventral margins of legs IV. Males are characterized by their small size, short legs, simple leg setae, small sternal plate setae and position of the dorsal propodosomal setae.

As pointed out by Rudnick (1960), this species has been known only from Kolenati's (1857) original figures and description, which do not present valid characters for a specific diagnosis. Through the courtesy of Dr. Marc André, a female specimen was examined which had been identified as this species by Kolenati and deposited in the Museum National d'Histoire Naturelle, Paris. This proved to be the same as numerous specimens collected recently from *Glossophaga soricina leachii* from Panama, and *Glossophaga s. soricina* from Trinidad.

Since the location of the types of *Periglischrus caligus* is unknown, the female is redescribed and illustrated here and the male is described for the first time.

DESCRIPTION, FEMALE (pl. 42, figs. 1, 2): A large, broadly rounded mite with inflated opisthosoma and relatively short, stout, strongly setose legs. Idiosoma 890–1080 μ long by 640 μ wide.

Dorsum.—Anterior plate approximately as wide as long, widest at level of posterior one-third, with broadly rounded anterior margin, slight shoulders and convex sides; posterior margin truncate, slightly concave and joined to posterior plate by two submedian lobules; with 11 pairs alveoli arranged as illustrated. Posterior plate bluntly triangular, 98 μ long by 146 μ wide, bearing seven pairs of alveoli, the posterior pair containing microsetae. Propodosomal setae all long, measuring up to 70 μ; ratio of distance between bases of first setal pair to that between first and second pairs ranges from 1.2:1 to 1.4:1 based on five specimens. Unarmed opisthosoma with four small setae. Postanal seta minute, subterminal.

Venter.—Sternal plate longer (110 μ) than broad (82 μ), roughly pentagonal with tapering anterior margin terminating in narrowly rounded tip; bearing two pairs pores; three pairs small setae about 11 μ long located off margin of plate; subequal pair metasternal setae postero-lateral to plate. Epigynial plate a small, narrowly longitudinal sclerotization between coxae IV, slightly constricted opposite insertion of very small pair of genital setae which are off the plate. Pattern of sclerotized opisthosomal areas, including anal plate, and opisthosomal setation as described for *Periglischrus tiptoni* except that the three pairs of minute anterior setae arranged in diverging rows are reduced to two pairs of alveoli with no evident setae. Adanal pair of setae 18 μ long.

Legs.—Relatively short, stout, strongly setose. Leg I 350–370 μ long exclusive of ambulacrum. Posterior seta of coxa II 91 μ long, minutely barbed; other coxal setae all minute, simple and very fine. In addition to usual ventral setation legs I and II with strongly serrated, leaf-like setae on posterior margins; similar setae on anterior margins of legs III and IV; femur, patella and tibia IV each with large, inflated, scimitar-like posterior seta. Dorsally long setae superficially appear nude but minute barbs present; femur and patella II each with two minute to small basal setae plus two long setae.

Gnathosoma.—Distal hypostomal setae about one-third longer than short setiform gnathosomal pair; inner hypostomal setae absent, outer pair vestigial with only alveoli visible. Palpal tibia with prominent medio-distal lobe; trochanter with flap-like emargination extending from ventral medial sclerotization which is normally adpressed to other mouthparts. Chelicerae normal.

MALE (pl. 42, figs. 3, 4): A relatively small, ovoid mite with short, stout legs radially arranged. Idiosoma 377 μ long by 297 μ wide.

Dorsum.—Shape of dorsal plates and alveolar pattern similar to that of *Periglischrus vargasi.* Anterior plate 198 μ long by 230 μ wide. Posterior plate 104 μ long by 135 μ wide. Propodosomal setae all well developed, setiform, measuring up to 38 μ long; ratio distance between bases of first pair to that between bases of first and second pairs approximately 2.8:1. Unarmed opisthosoma with pair of short setae subterminally. Postanal seta minute, dorso-terminal.

Venter.—Sternal plate longer (159 μ) than broad (147 μ), general shape as in *P. vargasi* but postero-lateral margins concave; with usual five pairs setae of which the longer ones, anteriorly, measure approximately 24 μ and reach about halfway to imaginary line drawn between second pair. Pair of minute setae behind sternal plate. Anal plate, accessory posterior platelets and opisthosomal setae between coxae IV as in *P. vargasi.*

Legs.—Short, stout, radially arranged; leg I approximately 380 μ long exclusive of ambulacrum. Coxal setae normal, setiform; posterior seta of coxa II longest (50 μ), about one and one-half times as long as anterior seta of II; proximal seta of coxa I shortest of coxal setae (12 μ). Other leg segments ventrally with short, simple setae except for usual long tarsal trichobothria. Dorsal setae simple, setiform, superficially nude, but longer ones with minute barbs; in addition to other setae femora I and II bear two small setae, III and IV each bear one minute and one small seta.

Gnathosoma.—Gnathosomal and distal hypostomal setae subequal, acicular, about as long as distance between bases of the hypostomal pair; inner hypostomal setae absent, outer hypostomal pair of setae minute. Pair of hypostomal processes long, slightly sinuous, stylet-like structures with membranous inner borders. Chelicerae normal, with spermatophoral process recurved, approximately 150 μ long.

MATERIAL EXAMINED: Plesiotype female and male (host no. 9840) were collected from *Glossophaga soricina* at Los Santos Province, by V. J. Tipton, 10 February 1962; 2 additional males, same collection as plesiotype. Two females collected in the Canal Zone by C. M. Keenan and V. J. Tipton from *Glossophaga soricina leachii* at Empire Range, 30 September 1959, and at Coco Solo, 20 October 1959, respectively. In addition several collections identified as this species are recorded here from Trinidad, taken from *Glossophaga soricina soricina.* The plesiotype male and female are in the United States National Museum; 2 females, Chicago Natural History Museum; 1 female, Trinidad Regional Virus Laboratory; remaining specimens in the collection of the author.

Periglischrus vargasi Hoffmann

Periglischrus vargasi Hoffmann, 1944, Rev. Salub. y Enferm. Trop., Mexico, 5, (2), p. 91—Instituto de Salubridad y Enfermedades Tropicales de Mexico, Mexico, D.F. (Yerbabuena, Guerrero, Mexico from *Leptonycteris nivalis yerbabuenae*). Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 199, pl. 31.

Specimens identified as this species from Panama agree closely with the redescription given by Rudnick (1960). All females seen, including forms from the type host from Mexico, differ from figures given by both Rudnick (loc. cit.) and Hoffmann (1944) in one respect: femur, genu and tibia IV each has a relatively long (45 μ), stout, postero-ventral seta with an attenuated, recurved tip; these setae differ from comparable setae in *Periglischrus caligus* in that they are not inflated.

The following characters suffice to diagnose *Periglischrus vargasi* females: Large, stout mites approximately 1 mm. long of typical appearance for the genus. Palpal tibia lacking medio-distal lobe. All dorsal propodosomal setae well developed, the longest from 70–80 μ long. Ratio of distance between bases of first pair of dorsal propodosomal setae to that between bases of first and second pairs ranges from 1.1–1.5 :1. Six pairs medium to large dorsal opisthosomal setae. Sternal plate longer than wide, broadly jug-shaped. Posterior seta of coxa III small. Two minute dorsal setae on femur II. The male of *P. vargasi* resembles closely that of *Periglischrus iheringi* from which it differs in possessing two minute dorsal setae on femur II and in the relatively small size of the posterior seta of coxa III, which is only 1.7 times as large as the anterior seta. The spermatophoral process, approximately 110 μ long, is considerably shorter than those measured for *P. iheringi.*

MATERIAL EXAMINED: From *Trachops cirrhosus* taken at Los Santos Province, 1 female collected by V. J. Tipton, 14 February 1962. From *Anoura geoffroyi,* Cerro Punta (Chiriquí), C. M. Keenan and V. J. Tipton, 1 male, 1 February 1960, and 1 female, 1 male and a protonymph, 3 February 1960; from 2 specimens, the same host, Cerro Hoya (Los Santos), V. J. Tipton, 11 February 1960, 7 females, 2 males and 1 protonymph. From *Anoura cultrata,* Chiriquí, 1 male, V. J. Tipton, 12 March 1962; Río Changena Camp, 1 male and 1 female, V. J. Tipton, 27 September 1961.

Previously recorded collections of *Periglischrus vargasi* have been made from Texas on the north to Guatemala on the south. In addition to the Panamanian collections recorded here, numerous specimens have been taken from Trinidad bats, to be reported in detail in a subsequent paper, and several specimens have been taken from Venezuela. For purposes of record the latter are included here. From (2) *Anoura cultrata* (?), Rancho Grande, Venezuela, 2 females, 2 males and 1 protonymph, C. O. Handley, 30 March 1960; from *Anoura caudifera* at the same locality, 1 female, C. O. Handley, 20 March 1960.

Periglischrus tiptoni, new species. Plates 43, 44.

DIAGNOSIS: The female is distinguishable from other species of the genus by the following combination of characters: broadly jug-shaped sternal plate; five well-developed, although small, dorsal propodosomal setae, the first pair of which are very widely spaced; palpal tibia with a pronounced apical, median lobe; leg II with only one minute dorsal seta on femur in addition to large setae. It is closely related to *Periglischrus micronycteridis* n. sp., from which it is distinguished by the shape of the sternal plate, longer anterior legs and well-developed posterior seta on coxa III, as well as by host association. Males are characterized by coarsely barbed dorsal seta on tarsi III and IV and by a pair of subapical, flattened, peg-like setae ventrally on tarsi III and IV. They are similar to males of *P. inflatiseta* but lack blunt, fusiform setae ventrally on legs I and II, and no ventral setae between coxae IV are inflated.

DESCRIPTION; FEMALE (pl. 43, figs. 1, 2): A robust typical member of the genus with idiosoma broadly rounded anteriorly and opisthosoma broadly flared in fan shape. Idiosoma 1080 μ long by 810 μ wide. An occasional unfed, teneral female has a much reduced, unexpanded opisthosoma.

Dorsum.—Overall outline of two dorsal plates ovate with anterior three-fourths consisting of the broad anterior plate; anterior plate 324 μ long by 275 μ wide; plates connected by two submedian lobes. Nine pairs alveoli on anterior plate, eight pairs on posterior plate; pair of minute setae arising from penultimate alveoli of posterior plate. Five pairs of propodosomal setae all well developed although relatively short, the longest about 45 μ long; insertions of first pair very close to those of second pair: ratio of distance between bases of first pair to that between first and second pair varies from 4.4:1 to 7:1. Peritremes extend just anterior to level of second pair propodosomal setae. Unarmed opisthosoma with four pairs of small setae. Posterior tip of anal plate extending dorsally and bearing minute postanal seta.

Venter.—Sternal plate longer (159 μ) than wide (120 μ), broadly jug-shaped with short, narrow, anterior neck and broad posterior base; with two pairs pores; three pairs short (20 μ) sternal setae just off margins of plate. Pair of metasternal setae subequal to sternals. Epigynial platelet a small longitudinal structure partially divided on anteromedian line, bearing two minute setae subterminally on slightly inflated posterior lobe of platelet. Pattern of sclerotized opisthosomal areas similar to those of *Periglischrus iheringi.* Opisthosomal setae small: three pairs minute setae arranged in diverging rows behind epigynial platelet, followed by a pair anterolateral and two pairs lateral to posteromedian, ventro-anal sclerotization, two pairs on anterior part of the latter plate and two pairs lateral to anal plate proper; anal plate proper, ventroterminal, narrowly elongate, and apparently tenuously connected to more anteriorly located, posteromedian sclerotization; pair of short adanal setae terminal on opisthosoma. Adanal setae and two pairs setae lateral to anal plate with canal-like structures extending anteriorly from alveoli.

Legs.—Well developed, stout; leg I 512 μ long exclusive of ambulacrum. Coxal setae, with exception of long, minutely barbed, posterior seta of II, acicular, nude; posterior seta of III relatively large. Ventral setation of other segments characteristic of species; posterior margins of legs I, II and IV and anterior margins of legs III and IV with long, minutely barbed setae, none markedly inflated; tibia and tarsus of leg I and patella and tibia of II each with posterodistal, inflated, recurved seta superficially appearing as a blunt, ragged cone. Dorsally most long setae inserted near distal margin of segments, minutely barbed; femoral setae normal with only anterobasal one on femur II minute and two on femur III small.

Gnathosoma.—Inner and outer hypostomal setae absent; distal hypostomal pair slightly longer than very small pair of gnathosomal setae. Palpal tibia with pronounced medio-distal lobe; trochanter with blunt, ventral, flap-like emargination distally. Chelicerae normal for genus.

MALE (pl. 43, figs. 3, 4): Idiosoma ovoid, widest at level of coxae II–III; 530 μ long by 405 μ wide. Opisthosoma rudimentary. Legs long.

Dorsum.—Shape of dorsal plates similar to those of *Periglischrus vargasi;* anterior plate as long on mid-line as broad, 351 μ; posterior plate 162 μ long by 222 μ wide; anterior plate with 12 pairs of alveoli; posterior plate with nine pairs alveoli; microsetae visible in two pairs alveoli of posterior plate and possibly present in some of those on anterior plate. Propodosomal setae relatively short, measuring 39 μ long or less; ratio of distance between first pair of setal bases to that between first and second pairs approximately 3.5:1. Unarmed opisthosoma bearing one pair small posterior setae in addition to subequal postanal seta.

Venter.—Sternal plate longer than wide, modified cordate with pronounced medial anterior projection and prominent shoulders; with five pairs long, strong setae and two pairs submedian pores; two additional pairs of lateral marginal pits. Pair of minute setae behind sternal plate. Six pairs well-developed setae in addition to slightly smaller adanal pair in space between coxae IV; three pairs bordering anal plate (two pairs of these may occur on plate), one pair between anal plate and pair of small adanal platelets, two pairs on anterior half of anal plate; adanal setae border anterior margin anal opening. Anal plate elongate, broadly rounded anteriorly, broadest at mid-level and with concave posterolateral margins, ending bluntly at anterior margin of anal opening.

Legs.—Leg I of allotype 600 μ long exclusive of ambulacrum, up to 670 μ in some paratypes. Coxae with relatively long setae; posterior seta of coxa II 81 μ long, less than one and one-half times as long as posterior seta of coxa III. Ventral leg setae tend to be flattened and tooth-like; tarsus I and tibia and tarsus II each with a broad, serrated, blunt seta; tarsi III and IV each with pair of subapical flattened peg-like setae. Dorsal setae strong, with longer setae coarsely barbed and several of shorter setae serrate; one minute seta on femur II, III and IV; tarsi III and IV with strong, coarsely barbed setae.

Gnathosoma.—Gnathosomal and distal hypostomal setae subequal, 27 μ long; outer hypostomal setae minute; inner hypostomals absent. Palpal tibia without medio-distal lobe; femur with prominent serrated lateral seta. Chelicerae normal for genus, each with very elongate (over 170 μ), recurved, tubular, spermatophoral process terminating in two minute fimbriae.

FEMALE DEUTONYMPH (pl. 44, figs. 1, 2): Very similar to adult male, from which it differs as follows: Idiosoma 650 μ long. Unarmed dorsal opisthosoma with five pairs small (approximately 10 μ long) marginal setae in addition to small postanal seta. Sternal plate a rounded diamond shape, longer than wide, bearing three pairs well-developed setae and two pairs pores; pair of setae subequal to sternals located off posterolateral margins of plate; slightly smaller pair just posterior to plate, followed by pair of very small setae. Eleven additional pairs well-developed setae on unarmed ventral integument between coxae IV. Anal plate terminal, pear-shaped with broad end posterior; adanal setae well developed, anterior to anal opening which is on posterior tip of body. Chelicerae as in female. Tarsi of legs I lack the two long, blunt-tipped sensory setae observed in adult males.

MALE DEUTONYMPH (pl. 44, figs. 3, 4): Similar to female deutonymph, from which it differs in having only one pair small setae on the unarmed margin of dorsal posterior opisthosoma, and in posssessing only six pairs of setae on the unarmed ventral integument between coxae IV.

PROTONYMPH (pl. 44, figs. 5, 6): Similar in general appearance, size and body shape to deutonymphs, from which it is immediately distinguishable by short dorsal peritremes extending from level between coxae III–IV to just beyond posterior margin of coxa II. Propodosoma possessing only four pairs relatively short marginal setae, ranging from 24–30 μ long. In other respects dorsum as in male deutonymph.

Venter as in male deutonymph from which it differs as follows: Lacking pair of well-developed setae posterolateral to sternal plate and pair just posterior to plate; small pair of setae behind sternal plate somewhat larger than in deutonymph and located in region between coxae IV; total of four pairs setae arising from unarmed cuticula in area between coxae IV. Gnathosoma and legs as in deutonymphs.

TYPE MATERIAL: Holotype female and allotype male (host no. 43065) collected by V. J. Tipton from *Phyllostomus hastatus panamensis* at Panama City (Panamá), June 1961. Paratype series, all, unless noted, collected by C. M. Keenan and V. J. Tipton: female, female deutonymph and male from *Phyllostomus h. panamensis* at Chepo Road (Panama), 8 October 1959; male deutonymph, same host, Fort Kobbe (Canal Zone), 9 October 1959; female, same host, Chilibrillo Caves (Panamá), 28 October 1959; 3 females, same collection data as preceding, but 17 July 1959; 1 female, same host, Chilibrillo River (Panamá), 27 August 1957; 8 females and 1 male same host, Fort Sherman (Canal Zone), 30 July 1959; 1 male, same host, Bocas del Toro, 22 January 1960; 4 males, 1 female, 2 deutonymphs and 3 protonymphs, from *Phyllostomus h. hastatus,* Heights of Guanapo, Trinidad, T. H. G. Aitken, 11 July 1957; 2 females, 1 male, 1 deutonymph and 2 protonymphs, same host and locality, W. G. Downs, 7 November 1956.

Holotype, allotype, 3 male, 2 female, 1 protonymph, 1 male and 1 female deutonymph paratypes in the United States National Museum; 2 paratypes (male and female) each in Chicago Natural History Museum and Trinidad Regional Virus Laboratory; remaining material in the collection of the author.

ADDITIONAL MATERIAL EXAMINED: Several collections from *Phyllostomus d. discolor* taken in Trinidad. From *Trachops cirrhosus* taken in Panama: Fort Sherman (Canal Zone), 1 female, C. M. Keenan and V. J. Tipton, 23 November 1959; Los Santos, V. J. Tipton, 2 females, 1 male, on 10 February 1962, 1 male from collection of 2 bats on 11 February 1962, 4 females, 2 males and 4 protonymphs from 7 bats on 14 February 1962, 6 females, 7 males, 5 male deutonymphs, 3 protonymphs from 4 bats on 21 February 1962. A single collection of 1 female from *Trachops cirrhosus* in Trinidad. A single collection of 1 female and a protonymph from *Myotis chiloensis,* Chiriquí Province, V. J. Tipton, 6 March 1962. Two collections of this mite have been seen from Colombia, from *Phyllostomus hastatus* (CNHM no. 88066) taken at La Macarena, Río Guapayá by Kjell von Sneidern, 14 March 1957, and from *Phyllostomus elongatus* (CNHM no. 88063) at Los Micos, San Juan de Arama, 21 February 1957, by the same collector.

REMARKS: *Periglischrus tiptoni* is a common parasite of bats of the genera *Phyllostomus* and *Trachops* in Panama and Trinidad, where it is often found in association with another new species, *Periglischrus inflatiseta.* It is named in honor of Lt. Col. Vernon J. Tipton, United States Army, who collected many of the spinturnicids recorded in this work.

Periglischrus micronycteridis, new species. Plate 45.

Periglischrus micronycteridis is closely related to *P. tiptoni,* both species occurring on genera of Phyllostominae, although never encountered on the same genera. *P. micronycteridis* is a smaller species with stubby legs; female with the posterior seta of coxa III very small, the dorsal anterobasal seta of femur I very small to minute, and the sternal plate of engorged specimens roughly tongued-shaped. Males of *P. micronycteridis* differ from *P. tiptoni* in smaller size, short legs and lack of coarsely barbed, dorsal leg setae.

DESCRIPTION, FEMALE (pl. 45, figs. 1, 2): Gravid specimens broadly rounded anteriorly and posteriorly, with opisthosoma expanded; idiosoma approximately 970 μ long by 756 μ wide. Legs relatively short and stout.

Dorsum.—Dorsal plate similar to that of *Periglischrus tiptoni,* but anterior plate as broad as long (245 μ); posterior plate 108 μ long by 155 μ wide. Propodosomal setae 19–24 μ long, second pair longer than first pair; ratio of distance between bases of first pair to that between first and second pair varies from 4.6:1–7.8:1. Peritremes extend just anterior to level of second pair propodosomal setae. Unarmed opisthosoma with four pairs small setae. Posterior tip of anal plate extends dorsally, with minute postanal seta.

Venter.—Sternal plate longer (126 μ) than wide (87 μ); in engorged type specimen, plate narrowly tongue-like with eroded margins; three pairs small setae approximately 12 μ long located just off sclerotized margins of plate; two pairs circular pores on plate; very faint hyaline border extending beyond sclerotized margins includes bases first two pairs setae; in unengorged specimen sternal plate appears uniformly dense throughout area encompassed by hyaline border and sclerotized central area of engorged specimens. Pair metasternal setae subequal to sternals, posterolateral to sternal plate. Epigynial platelet small, elongate, between coxae IV; preceded anteriorly by small, fan-shaped cuticular pattern; two minute setae lateral to platelet. Pattern of sclerotized opisthosomal areas similar to that of *Periglischrus tiptoni* on fed specimens; not visible in unengorged specimen. Opisthosomal setae as in *P. tiptoni.* Anal plate ventroterminal, elongate, widest posteriorly; adanal setae subequal to nearby ventral setae, 21 μ long, subterminal, arising anterior to anal opening which is terminal. Canal-like structures from adanal setae as in *P. tiptoni.*

Legs.—Short, stout; leg I exclusive of caruncles 350 μ long on type, ranging from 340–370 μ long on six representative specimens; posterior seta coxa II strong, minutely barbed, 110 μ long; others delicate and small; of latter, anterior seta of coxa III usually longest, 24 μ; ventral and dorsal setation of other segments similar to that in *P. tiptoni,* but with somewhat shorter setae and with dorsal, anterobasal seta of femur I very small (9 μ).

Gnathosoma.—As described for *P. tiptoni* but with medial lobe of palpal tibia less pronounced.

MALE (pl. 45, figs. 3, 4): A small mite for the genus, with stubby legs. Idiosoma ovoid, widest at level of coxae II–III; 421 μ long by 335 μ wide.

Dorsum.—Shape and alveolar pattern of dorsal plates as in *Periglischrus tiptoni;* anterior plate 237 μ long on mid-line by 255 μ wide; posterior plate 128 μ long by 160 μ wide; plates covering most of idiosoma. Propodosomal setae relatively short, measuring 38 μ or slightly less in allotype; ratio of distance between first pair setal bases to that between first and second pairs approximately 4.7:1. Unarmed opisthosoma bearing one pair small posterolateral setae in addition to smaller postanal seta. Peritremes normal for genus, extending almost to bases of second pair propodosomal setae.

Venter.—Sternal plate similar to that of *P. tiptoni* but setae relatively shorter, not overlapping bases of more posteriorly located setae of plate. Pair of reduced but not minute setae, 12 μ long, behind sternal plate. Six larger pairs setae in addition to subequal adanal pair in space between coxae IV; anal plate and setal pattern as in *P. tiptoni.*

Legs.—Relatively short; leg I 394 μ long exclusive of ambulacrum. Posterior seta of coxa II long (110 μ), minutely fimbriated, three times as long as next longest coxal setae, which are acicular. Ventral setae of other segments mostly relatively short and acicular; tarsi I and II each with one and III and IV each with three short, sharp, spiniform setae. Dorsal setae of legs with longer setae very minutely barbed, superficially appearing nude; shorter setae nude, or at most some minutely barbed; femora II, III and IV each with one minute seta in addition to larger setae.

Gnathosoma.—As described for *P. tiptoni* except that gnathosomal and distal hypostomal setae lengths are 16 μ and the lateral seta of palpal tibia is nude.

FEMALE DEUTONYMPH: Very similar to female deutonymph of *P. tiptoni* from which it differs as follows: a smaller mite with idiosoma approximately 430 μ long; legs short, stubby; leg I 430 μ long exclusive of ambulacrum; leg setae essentially nude, some with very minute barbs; posterior seta of coxa II relatively long (100 μ).

TYPE MATERIAL: Holotype female (host no. 7959) and 5 paratype females collected by R. L. Wenzel and C. M. Keenan from *Micronycteris megalotis microtis* near Borinquen Highway (Canal Zone), 24 October 1961. Allotype male (host no. 10010) with 2 male, 1 female and 1 female deutonymph paratypes collected by V. J. Tipton from *Micronycteris minuta,* Guánico (Los Santos), 24 February 1962. Other paratypes from *Micronycteris megalotis microtis:* 5 females, Borinquen Highway (Canal Zone), 24 October 1961 and 2 females, Cocoli (Canal Zone), 24 October 1961, R. L. Wenzel and C. M. Keenan; 4 females, Chiriquí Province, 6 March 1962, V. J. Tipton; 6 females, same data but 2 March 1962. Paratypes from Trinidad from *Micronycteris m. megalotis:* 7 females, Cocorite, West Port-of-Spain, 24 June 1958, and 9 females, Quinam Road, Siparia, 13 March 1959, T. H. G. Aitken.

Holotype, allotype, and 4 female paratypes in the United States National Museum; 2 female paratypes, Chicago Natural History Museum; 3 female paratypes, Trinidad Regional Virus Laboratory; remaining material in the collection of the author.

A single male from *Micronycteris megalotis microtis,* Barro Colorado Island (Canal Zone), collected by C. M. Keenan and V. J. Tipton, 12 January 1960, is doubtfully identified as *P. micronycteridis.* It appears abnormal in several minor characteristics.

REMARKS: *P. micronycteridis* specimens from different hosts and of different degrees of engorgement exhibit minor differences in morphology which are interpreted as intraspecific variation. Specimens from Trinidad bats have a short fine seta on the anterior margin of coxa III as well as II, while on all other specimens these are represented by longer, delicate setae. The single female associated with males is an unfed specimen with unexpanded idiosoma. On it, the characteristic shape of the sternal plate seen in engorged females appears quite different, with convex lateral margins instead of the roughly tongue-shaped structure illustrated here. However, in engorged specimens an almost transparent marginal area of the plate appears to represent the actual margins as seen in the unfed specimen.

Periglischrus species

A single female specimen designated species "D" represents a possible new species related to *Periglischrus desmodi.* It was collected by C. M. Keenan and V. J. Tipton from *Pteronotus parnellii fuscus,* Bocas del Toro Province, 1 February 1960. According to Goodwin and Greenhall (1961), this host is known to roost in caves with *Desmodus rotundus,* the common host of *Periglischrus desmodi.* It seems probable that the single specimen of species "D" recorded here may represent a slightly atypical specimen of *Periglischrus desmodi* which strayed from its normal host. It differs from typical *P. desmodi* in having shorter dorsal propodosomal setae measuring up to 51 μ long; in having shorter dorsal opisthosomal setae, and in having the scimitar-shaped posterior setae of leg IV inflated as in *Periglischrus caligus.*

A collection of two females, three males and three nymphs is designated as an undetermined *Periglischrus* species "K." It was taken from *Lonchophylla robusta* at Chilibrillo Caves (Panamá) by C. M. Keenan and V. J. Tipton, 20 August 1959. Species "K" probably represents a new species closely related to *P. desmodi,* but it is left undescribed here pending collection of additional specimens to settle the question of intraspecific variation. Females differ from *P. desmodi* in having a more angular sternal plate, shorter dorsal propodosomal setae and inflated, scimitar-like posteroventral setae on leg IV. Males possess only one pair of dorsal opisthosomal setae, shorter sternal plate setae and a small idiosoma about 378 μ long.

A single female designated species "G" was taken from *Macrophyllum macrophyllum* at natural bridge, Madden Dam (Canal Zone), by C. M. Keenan and V. J. Tipton, 31 July 1959. This undoubtedly will prove to be a new species, but since there is only a single, damaged specimen at hand, its description awaits further collection. In the key it comes out at couplet 5, but fits neither half of the couplet. Its outstanding characteristic is the possession of an expanded, pilidiform seta on the anterior margin of coxa III, a character possessed by no described species of the genus.

Genus **Spinturnix** von Heyden

Spinturnix von Heyden, 1826, Isis (Oken), 18, (6), p. 612. Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2) p. 200.

Type-species: *Pteroptus myoti* Kolenati, 1856, designated by Opinion 128 of the International Commission on Zoological Nomenclature (1936).

Spinturnix species differ from all other genera of the family in that the peritremes are short, dorsal over coxae III, with the anterior end bending ventrad, usually reaching the ventral surface between coxae II and III. They have a single dorsal plate. The tritosternum may be present or absent. Legs I and claws of female are not unusually enlarged; caruncles are large. All males seen by the author lack the two long, bluntly-tipped setae of tarsus I characteristic of *Periglischrus*.

The various instars of immature *Spinturnix* species seen by the author may be determined as follows: The female deutonymph lacks the epigynial plate but has dorsal opisthosomal setation similar to that of the adult female. The male deutonymph resembles the female deutonymph but has dorsal opisthosomal setation similar to that of the adult male. The protonymph has stigmata smaller in diameter than the width of the peritremes, in contrast to subsequent instars, and has fewer ventral setae between the sternal and anal plates than in deutonymphs.

Spinturnix americanus (Banks)

Pteroptus americanus Banks, 1902, Can. Ent., 34, (7), p. 173, fig. 6—Museum of Comparative Zoology, Harvard (Type locality a cave in Indiana, from "bat," probably *Myotis lucifugus lucifugus*).

Spinturnix americanus Banks, 1915, Rept. U.S. Dept. Agric., no. 108, p. 72, figs. 137, 138. Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 218, pls. 39, 40.

Spinturnix carloshoffmanni Hoffmann, 1944, Ann. Inst. Biol. Univ. Nac. Mexico, 15, (1), p. 185, figs. 1–5—United States National Museum, Washington (Cerro del Xitle, Tlalpan, Mexico, D.F., from *Natalus mexicanus mexicanus*). Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 222. *New synonymy.*

DIAGNOSIS: General appearance typical of genus. Tritosternum present, but small. Unarmed opisthosoma of female with 10–25 long dorsal, dorso-terminal and ventroterminal setae, those near posterior body margin longer than others. Legs of both sexes with ventral and ventrolateral setae mostly short; the pair of proximal dorsal setae of femora I and II are tiny and the proximal dorsal seta on each of femur III and IV is tiny. Males with two pairs of long opisthosomal setae on unarmed cuticula near posterior apex of dorsal shield.

PANAMANIAN MATERIAL EXAMINED: From *Myotis n. nigricans* the following collections were made by C. M. Keenan and V. J. Tipton. Fort Davis (Canal Zone), 1 female, 7 January 1960; Fort Clayton (Canal Zone), 1 female, 30 January 1960; and 6 females, 13 September 1960; Gamboa (Canal

Zone), 1 female, 1 female deutonymph and 2 protonymphs, 23 September 1960; Frijoles (Canal Zone), 2 females, 2 males, 28 March 1960; Barro Colorado Island (Canal Zone), 28 females, 20 males, 2 female deutonymphs, 2 male deutonymphs, 2 protonymphs, 12 June 1960; Bocas del Toro Province, 1 female, 23 January 1960; Juan Mina (Canal Zone), 11 females, 2 males, 1 female deutonymph, 1 male deutonymph, 2 protonymphs, 28 July 1960; cave at Finca Lara (Chiriquí), two collections of 1 male and of 1 female deutonymph, 3 May 1961. From *Myotis n. nigricans* or *Myotis chiloensis* at cave, Finca Lara (Chiriquí), 35 male, 2 female deutonymphs, 6 male deutonymphs, 28 protonymphs, C. M. Keenan and V. J. Tipton, 5 May 1961. From *Myotis n. nigricans* in Chiriquí Province, 1 male and 2 protonymphs, V. J. Tipton, 7 March 1962. From *Myotis albescens* in Bocas del Toro Province, 1 male, C. M. Keenan and V. J. Tipton, 25 February 1960. From *Myotis chiloensis*, Chiriquí Province, 1 male, 2 male deutonymphs, 6 protonymphs, V. J. Tipton, 7 March 1962. From *Myotis simus* at Cerro Punta (Chiriquí), 1 male, V. J. Tipton, 3 May 1960; 1 male, C. M. Keenan and V. J. Tipton, 3 May 1961; and 1 male, C. M. Keenan and V. J. Tipton, 5 May 1961.

REMARKS: Panamanian specimens of *Spinturnix americanus* show considerable variation in characters previously used to differentiate *S. americanus* and *S. carloshoffmanni*. The majority, which I designate as population "B", lacks a long posterolateral seta on tibia III and IV but has such a seta on patella III and IV. Associated with this is the presence of 10–12 long, subterminal and dorsal setae on the opisthosoma. Others, designated as population "A", have a long posterolateral seta on patella and tibia IV and on patella III associated with the presence of 18–24 long, subterminal and dorsal setae on the opisthosoma. Populations of both kinds occur on the same host species and in one collection both kinds were found on the same host specimen.

Rudnick (1960) also noted variation in the above characteristics. In view of the demonstrated variability of the criteria used for distinction of *S. americanus* and *S. carloshoffmanni* and the presence of such variation in series from a single host the latter species is considered a synonym.

Spinturnix subacuminatus, new species. Plate 46.

This species belongs to group III of Rudnick (1960), characterized by long lateroventral leg setae and lack of tiny dorsal setae on femora. It is related to *Spinturnix acuminatus* (C. L. Koch), from which females differ in possessing 28–33 dorsal opisthosomal setae, of which the posterior 6–9 are much the largest, by a broadly pentagonal tritosternum and by relatively well-developed ventral idiosomal setae. Males differ from *S. acuminatus* in possessing only one pair of dorsal opisthosomal setae, a tritosternum with a straight posterior border and well rounded anterior margin, and ventral idiosomal setae relatively well developed.

DESCRIPTION, FEMALE (pl. 46, figs. 1, 2): Idiosoma ovoid, approximately 1000 μ long by 730 μ wide.

Dorsum.—Dorsal plate ovoid, 570 μ long by 405 μ wide; with 11 pairs dorsal alveoli, some bearing minute setae; several irregular pore-like structures near posterior margin. Five pairs moderately long propodosomal setae surrounding dorsal plate anterior to peritremes, and spaced increasingly far apart proceeding posteriorly. Peritremes dorsal over coxae III, bending ventrad between coxae II and III. Metapodosomal setae subequal to propodosomals, inserted medial to posterior borders of stigmata. Twenty-eight to 33 opisthosomal setae of which subterminal six to nine are much larger; others subequal to propodosomal setae.

Venter.—Tritosternum roughly pentagonal, broader than long, with posterior margin broadly V-shaped. Sternal plate broadly jug-shaped, about as broad as long, broadly rounded posteriorly, with lateral margins converging anterior to second pair of setae; anterior margin bluntly rounded; three pairs setae approximately 36 μ long, partially imbedded on plate margins; surface of plate lightly reticulated; two pairs of pores. Pair metasternal setae on unarmed cuticula posterolaterad of sternal plate, subequal to sternals. Epigynial plate small; broadly rounded subcircular anterior portion lightly sclerotized; posterior lobe narrowly rectangular, with pair genital setae on posterior margin subequal to sternals. Pair small sclerotized bars lateral to epigynial plate. Twenty to 22 small ventral setae between epigynial and anal plates; submedian anterior pair minute. Anal plate small, subterminal, incompletely ovoid, longer than wide, with anterior heavily sclerotized arc bearing pair adanal setae at lateral ends of arc; postanal seta 18 μ long, subequal to adanals.

Legs.—Lateroventral setae mostly long; other ventral setae mostly medium length with few short setae. Dorsal setae mostly very long. No minute dorsal setae on femora. Posterior seta of coxa II 215 μ long, over two and one-half times longer than other coxal setae.

Gnathosoma.—Tectum a short rounded lobe. Gnathosomal setae slightly larger than distal hypostomal pair; other hypostomal setae lacking. Palpal tarsus with inner basal, blunt, stout, prominent spine. Chelicerae normal for genus.

MALE (pl. 46, figs. 3, 4): Idiosoma ovoid, 853 μ long by 641 μ wide.

Dorsum.—Similar to female with following differences: metapodosomal setae well posterior to stigmata, and only one pair posteriorly placed opisthosomal setae on unarmed integument; dorsal plate 730 μ long by 459 μ wide, lacking irregular pore-like structures near posterior margin.

Venter.—Tritosternum a lightly sclerotized small platelet with straight posterior margin and broadly rounded anterolateral margins, broader than long. Sternal plate lightly sclerotized, with reticular surface pattern; longer than wide, widest at level of second pair setae, tapering to width of genital opening anteriorly, and to rounded extremity posteriorly, with three pairs small marginal setae. Metasternal setae laterad of posterior tip of sternal plate. Pair small sclerotized, submedian bars posterior to sternal plate. Five pairs small, simple setae between posterior tip of sternal plate and anal plate. Anal plate similar to that of female.

Legs.—As in female.

Gnathosoma.—As described for female but with spermatophoral process a stout, recurved tubular structure approximately 96 μ long, tapered to blunt tip; basal spine of palpal tarsus very blunt and broad throughout.

TYPE MATERIAL: Holotype female (host no. 5536) from *Rhogeessa tumida,* taken in Bocas del Toro Province, by C. M. Keenan and V. J. Tipton, 9 February 1960. Allotype male (host no. 3925) from *R. tumida,* Fort Kobbe Beach (Canal Zone), C. M. Keenan and V. J. Tipton, 27 July 1959. Paratypes as follows: 9 females, 6 males, 3 deutonymphs and 2 protonymphs, same data as allotype; 3 females, 4 males and 1 deutonymph, same data as allotype but collected 16 November 1959. Holotype, allotype, and 2 paratypes, male and female, in the United States National Museum; 2 paratypes, male and female, Chicago Natural History Museum; remaining material in the collection of the author.

Spinturnix species

A single female specimen from *Myotis n. nigricans* taken by C. M. Keenan and V. J. Tipton at Building 519, Fort Clayton (Canal Zone), 22 May 1961. It closely resembles *Spinturnix subacuminatus*, but is distinguished by a broadly rounded sternal plate which is wider than long, by the apparent absence of a tritosternum, and by other minor differences. It probably represents a new species, but its description awaits collection of further material.

Genus **Paraspinturnix** Rudnick

Paraspinturnix Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 231.

Type-species: *Paraspinturnix globosus* Rudnick, 1960.

The description of this monotypical genus as given by Rudnick (1960) fits the specimens recorded from Panama with the exception that the idiosoma is typically spinturnicid-shaped instead of globose.

Paraspinturnix globosus Rudnick

Paraspinturnix globosus Rudnick, 1960, Univ. Calif. Publ. Ent., 17, (2), p. 231, pl. 48, figs. 1, 2—United States National Museum, Washington (Nickajack Cave, Marion County, Tennessee, from *Myotis sodalis*).

Female specimens from Panama identified as this species agree in all but a few minor respects with the description and figures given by Rudnick (1960). The idiosoma has the characteristic *Spinturnix* shape attributed by Rudnick (loc. cit.) to newly emerged, non-gravid females. No circular areas of heavy sclerotization appear on the shoulders of the dorsal plate. The metapodosomal pair of dorsal setae arise just medial to the stigmata.

A single collection of three females is designated as this species from a bat identified as *Myotis n. nigricans* or *Myotis chiloensis*, from a cave at Finca Lara (Chiriquí), C. M. Keenan and V. J. Tipton, 5 May 1961. From the same bat were collected numerous specimens of *Spinturnix americanus*.

Abstract

Thirteen species in three genera of spinturnicid mites are recorded for the first time from Panama. Descriptions are given of seven new species of *Periglischrus* recorded from both Panama and Trinidad, and one new species of *Spinturnix* recorded from Panama. The new species and type hosts are *P. natali* from *Natalus stramineus mexicanus*, *P. elongatus* from *Pteronotus parnellii fuscus*, *P. inflatiseta* from *Phyllostomus hastatus*, *P. aitkeni* from *Sturnira lilium lilium*, *P. desmodi* from *Desmodus rotundus rotundus*, *P. tiptoni* from *Phyllostomus hastatus*, *P. micronycteridis* from *Micronycteris megalotis*, and *Spinturnix subacuminatus* from *Rhogeessa tumida*. *Periglischrus caligus* Kolenati is redescribed. *Spinturnix carloshoffmanni* Hoffman is synonymized under *Spinturnix americanus* (Banks).

The spinturnicid genus *Periglischrus* occurs primarily on bats of the family Phyllostomidae. *Periglischrus* species are not uncommon on members of the related family Desmodidae, and one atypical species occurs only on bats of the family Natalidae of a different superfamily from the other bat hosts. With few exceptions, the primary hosts of a given *Periglischrus* species are limited to members of a single bat genus or to members of closely related genera. One exceptional species, *P. iheringi*, occurs on seven genera of Stenoderminae of the Phyllostomidae as well as on a genus of Desmodidae. *Spinturnix* species and *Paraspinturnix* are primarily limited to bats of the family Vespertilionidae. The primary hosts of each species of these two genera recorded from Panama are limited in each instance to host species of a single genus.

HOST-PARASITE LIST

Order CHIROPTERA
Superfamily Emballonuroidea
Family Noctilionidae

Noctilio leporinus
Periglischrus aitkeni n. sp.

Superfamily Phyllostomoidea
Family Phyllostomidae
Subfamily Chilonycterinae

Pteronotus parnellii
Periglischrus species "D"
" *elongatus* n. sp.
Pteronotus suapurensis
Periglischrus elongatus n. sp.

Subfamily Phyllostominae

Micronycteris megalotis
Periglischrus micronycteridis n. sp.
Micronycteris minuta
Periglischrus micronycteridis n. sp.
Macrophyllum macrophyllum
Periglischrus species "G"
Phyllostomus hastatus
Periglischrus tiptoni n. sp.
" *inflatiseta* n. sp.
Trachops cirrhosus
Periglischrus tiptoni n. sp.
" *vargasi* Hoffmann

Subfamily Glossophaginae

Glossophaga soricina
Periglischrus caligus Kolenati
Lonchophylla robusta
Periglischrus species "K"
Anoura cultrata
Periglischrus vargasi Hoffmann
Anoura geoffroyi
Periglischrus vargasi Hoffmann

Subfamily Carolliinae

Carollia perspicillata
Periglischrus sp.

Subfamily Sturnirinae

Sturnira lilium
Periglischrus aitkeni n. sp.
Sturnira ludovici
Periglischrus aitkeni n. sp.
Sturnira sp.
Periglischrus aitkeni n. sp.

Subfamily Stenoderminae

Uroderma bilobatum
Periglischrus iheringi Oudemans
Vampyrops helleri
Periglischrus iheringi Oudemans
Vampyrops vittatus
Periglischrus iheringi Oudemans
Vampyrodes caraccioli
Periglischrus iheringi Oudemans
Vampyressa pusilla
Periglischrus iheringi Oudemans
Chiroderma salvini
Periglischrus iheringi Oudemans
Artibeus cinereus
Periglischrus iheringi Oudemans
Artibeus jamaicensis
Periglischrus iheringi Oudemans
Artibeus lituratus
Periglischrus iheringi Oudemans
Enchisthenes hartii
Periglischrus iheringi Oudemans

Family Desmodidae

Desmodus rotundus
Periglischrus iheringi Oudemans
" *desmodi* n. sp.

Superfamily Vespertilionoidea
Family Natalidae

Natalus stramineus
Periglischrus natali n. sp.

Family Vespertilionidae
Subfamily Vespertilioninae

Myotis albescens
Spinturnix americanus (Banks)
Myotis chiloensis
Periglischrus tiptoni n. sp.
Spinturnix americanus (Banks)
Myotis nigricans
Spinturnix americanus (Banks)
" sp.
Myotis nigricans or Myotis chiloensis
Spinturnix americanus (Banks)
Paraspinturnix globosus Rudnick
Myotis simus
Spinturnix americanus (Banks)
Rhogeessa tumida
Spinturnix subacuminatus n. sp.

Family Molossidae

Tadarida brasiliensis
Spinturnix sp.

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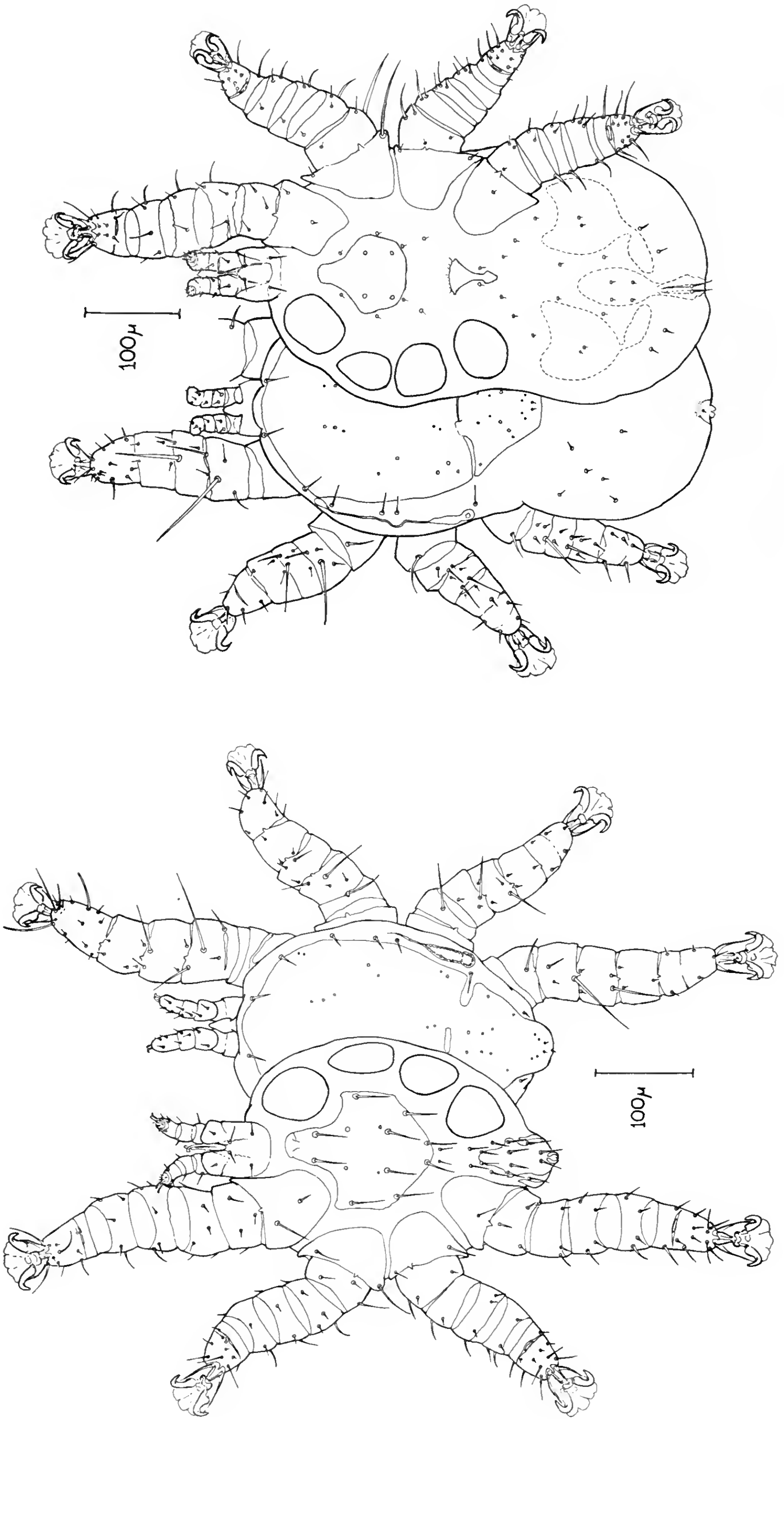
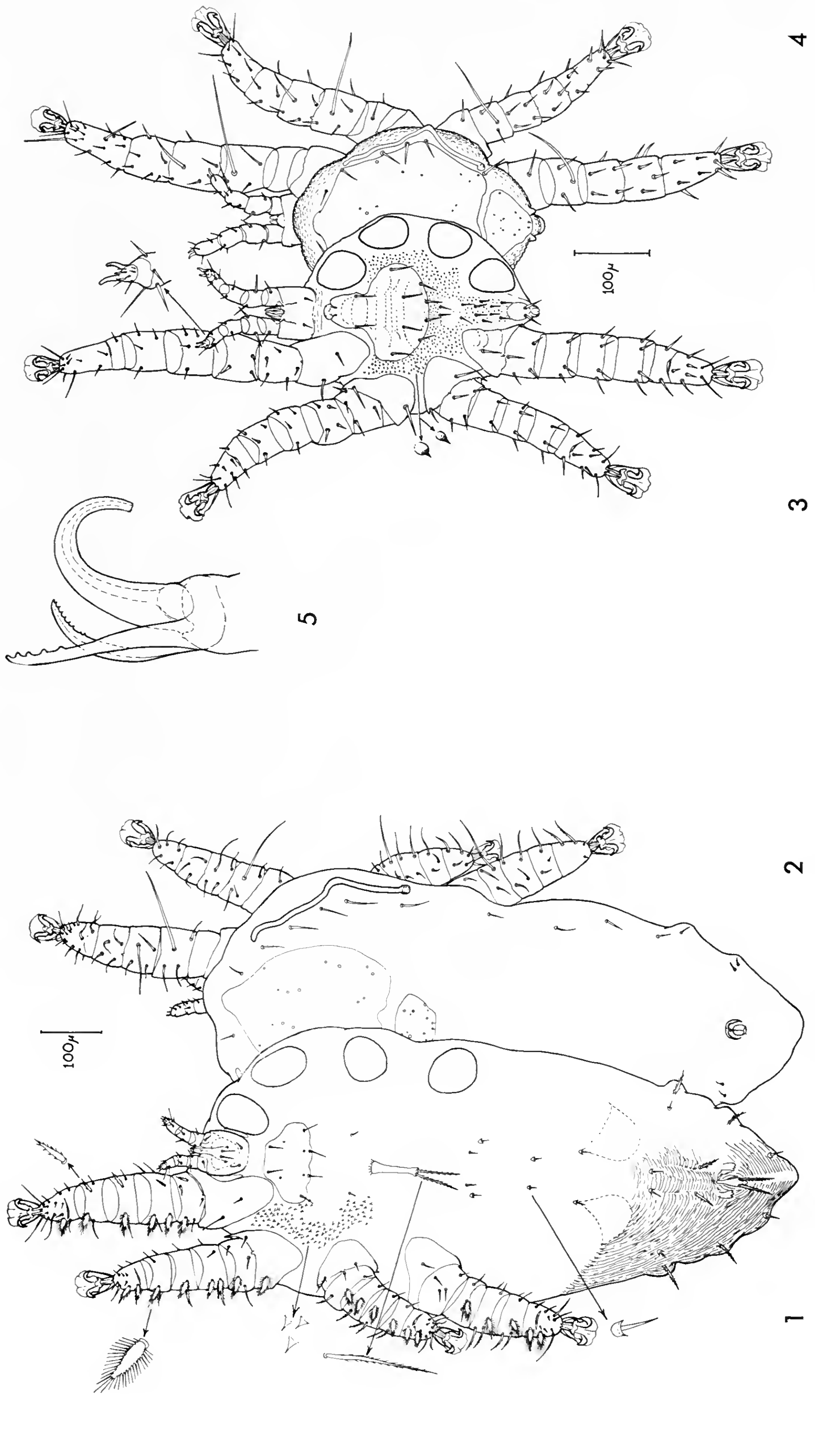
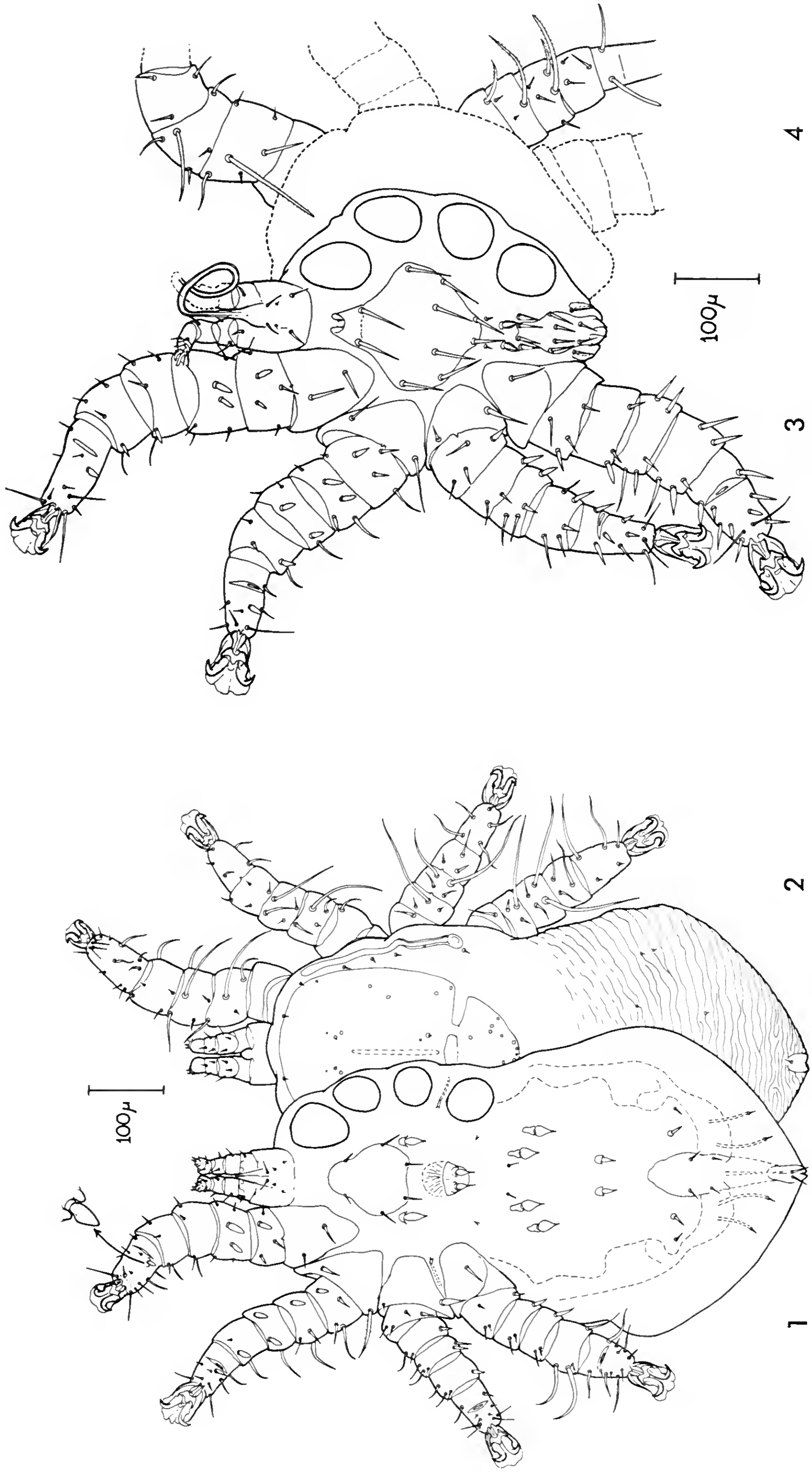


1 2 3 4

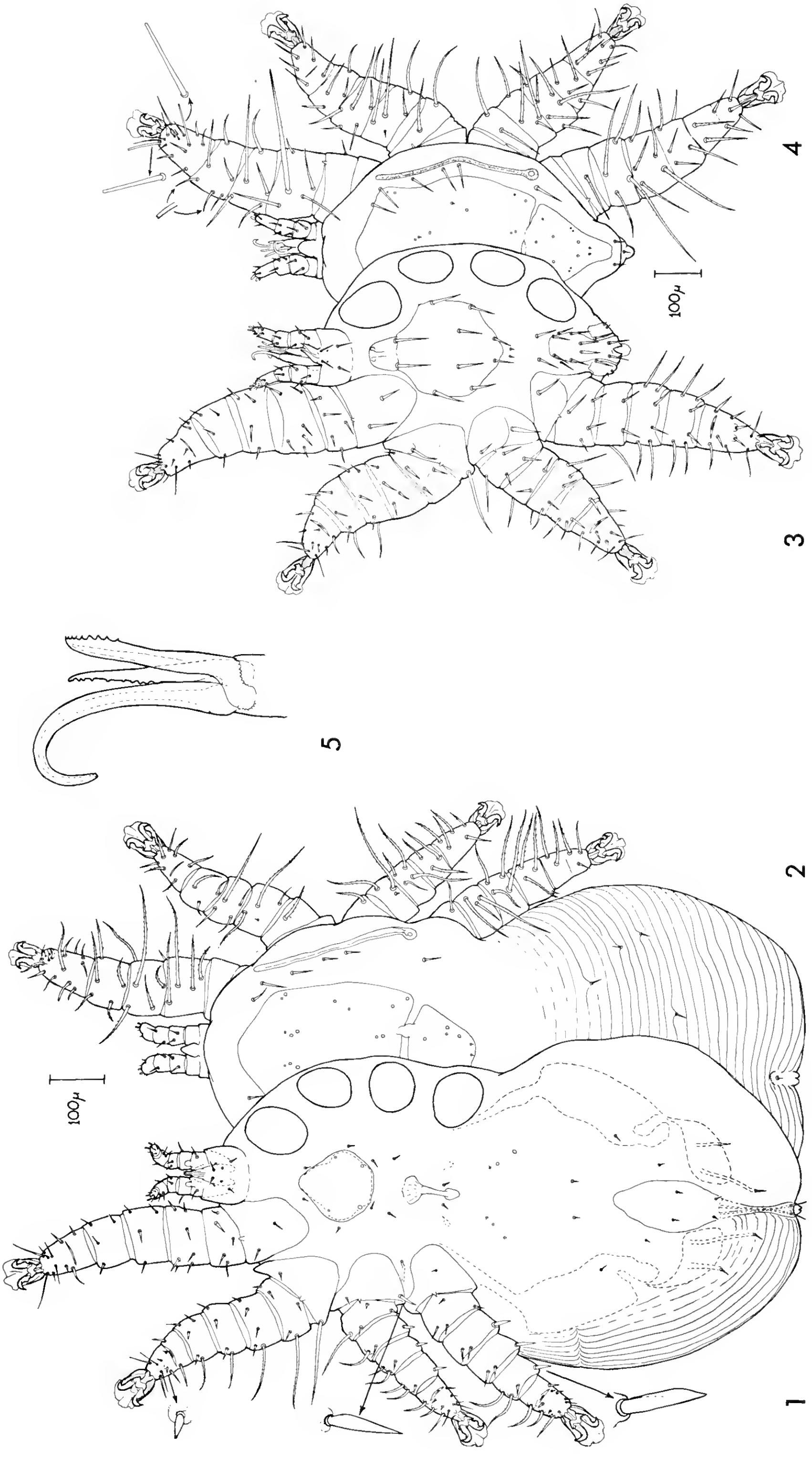
Periglischrus natali, new species. 1, dorsum and 2, venter of female. 3, venter and 4, dorsum of male.



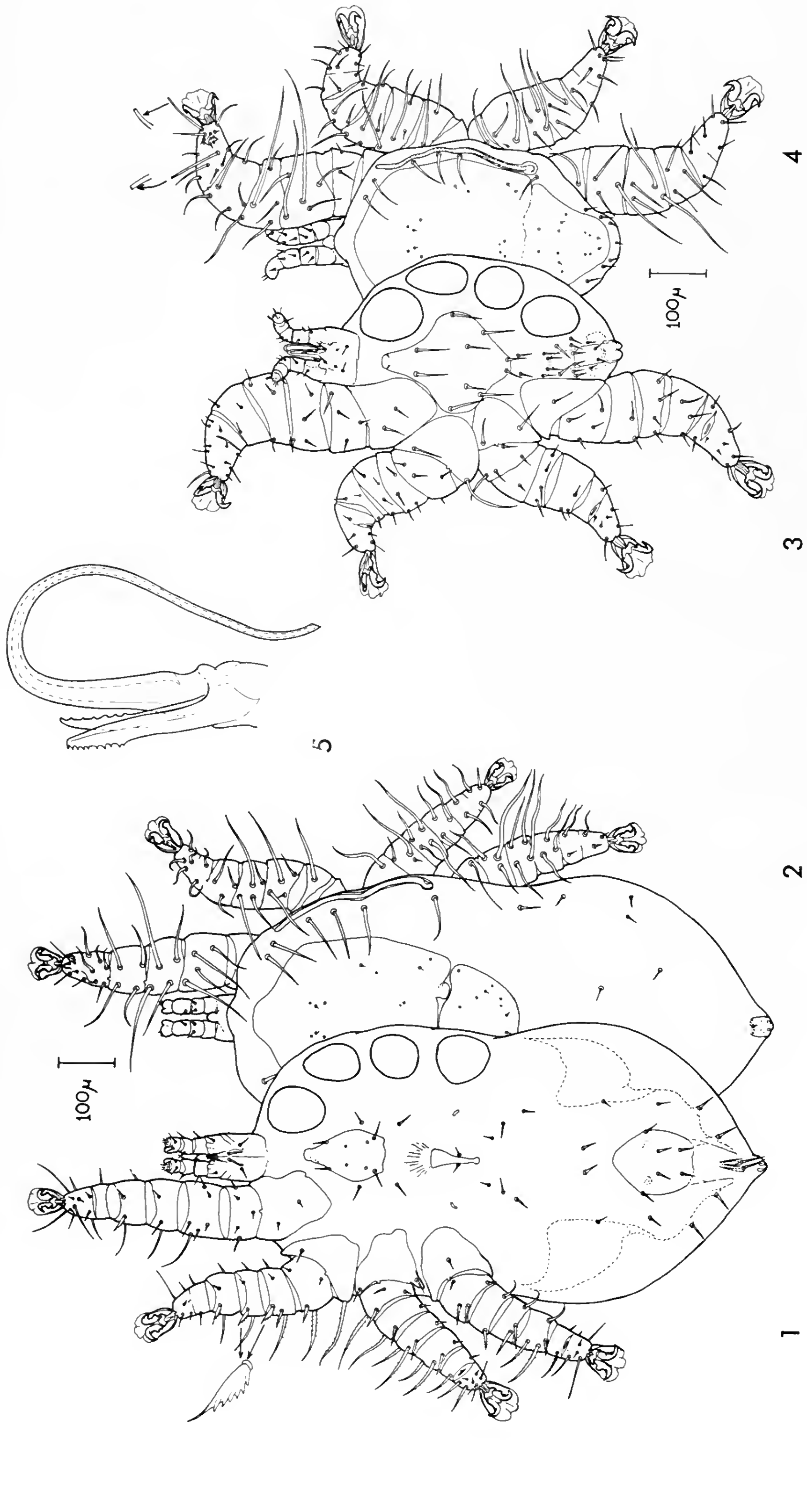
Periglischrus elongatus, new species. 1, venter and 2, dorsum of female. 3, venter, 4, dorsum and 5, chelicera of male.



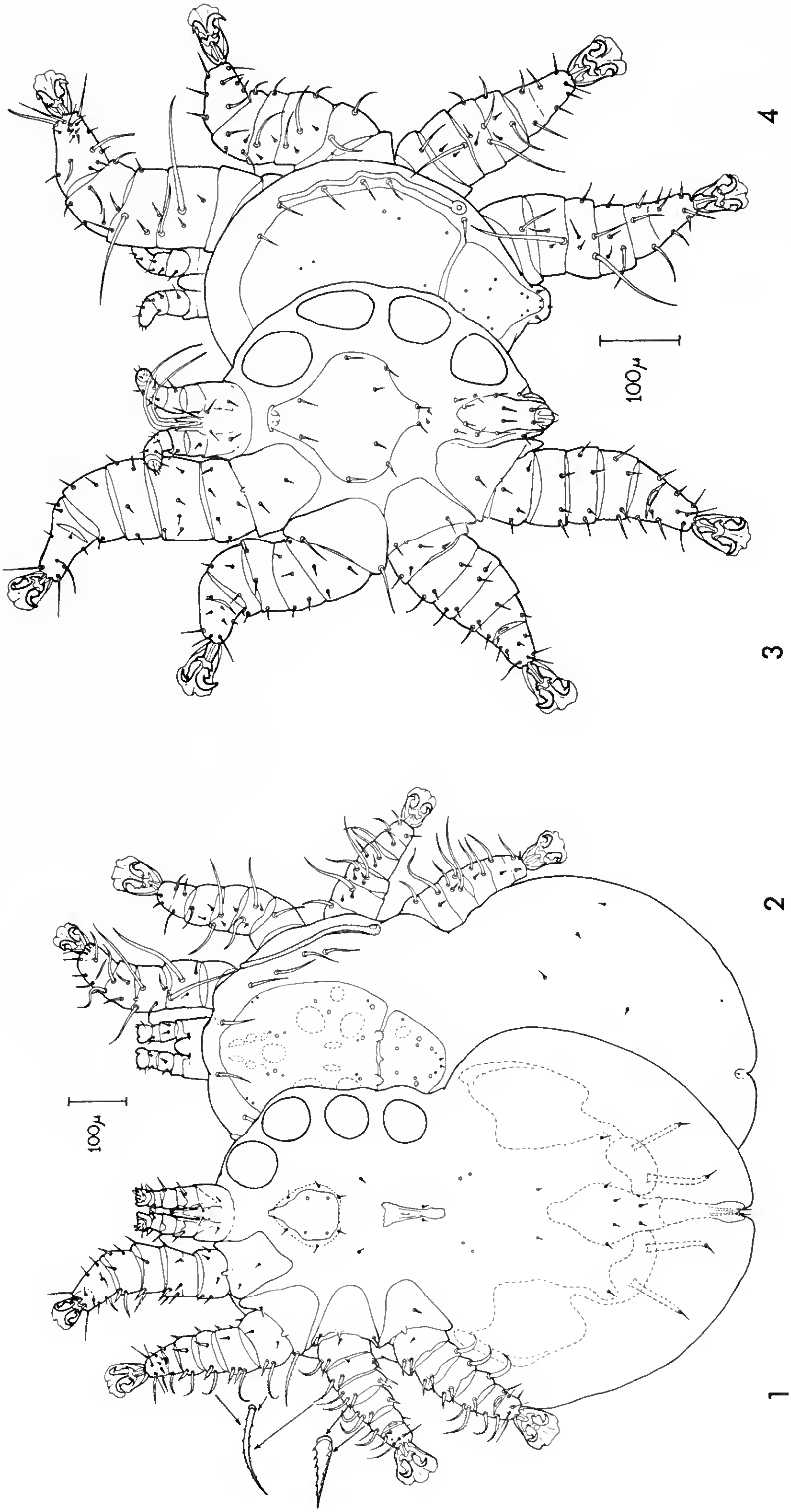
Periglischrus inflatiseta, new species. 1. venter and 2. dorsum of female. 3, venter, and 4, dorsum of male.



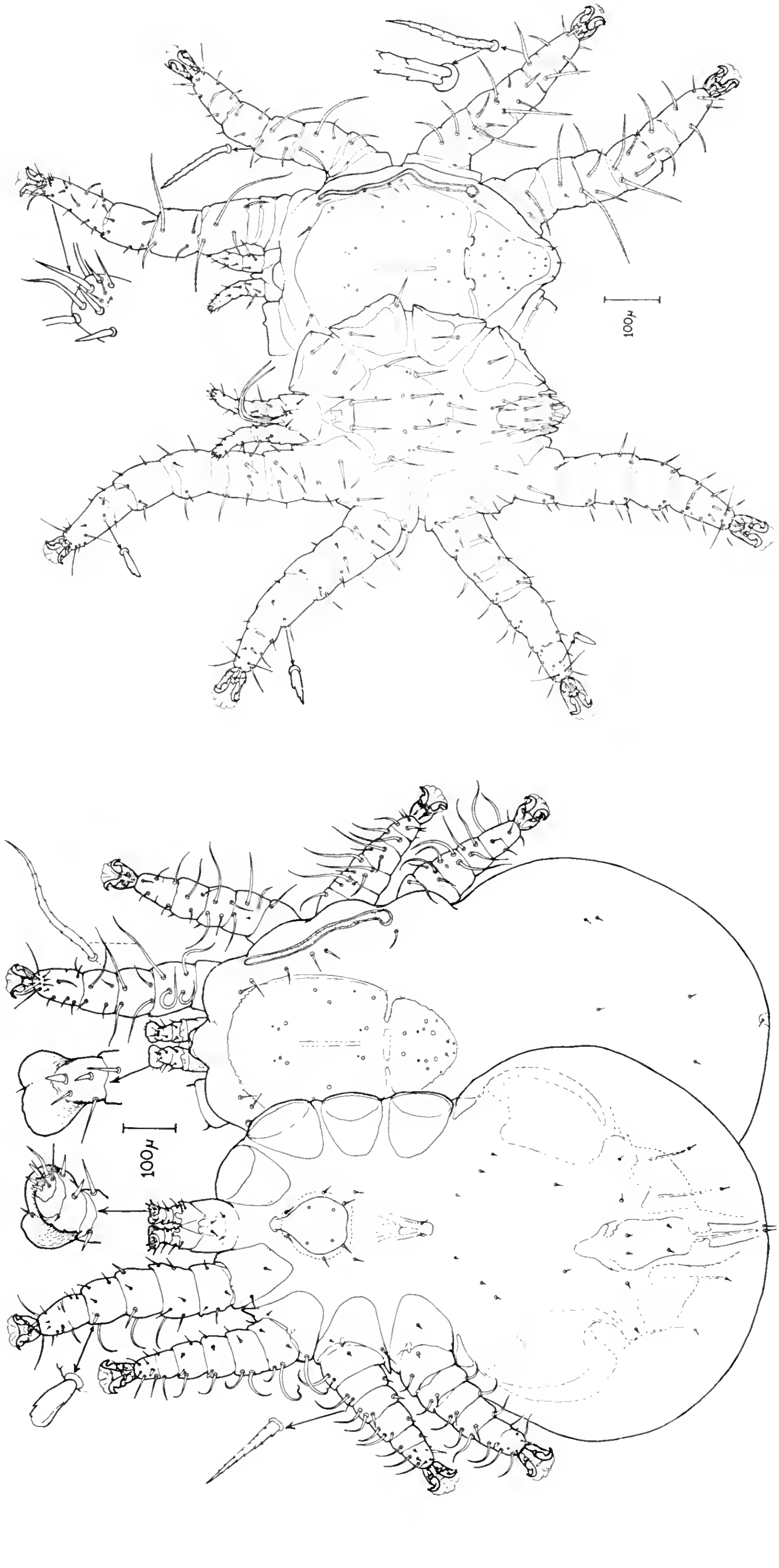
Periglischrus aitkeni, new species. 1, venter and 2, dorsum of female. 3, venter, 4, dorsum, and 5, chelicera of male.



Periglischrus desmodi, new species. 1, venter and 2, dorsum of female. 3, venter, 4, dorsum, and 5, chelicera of male.

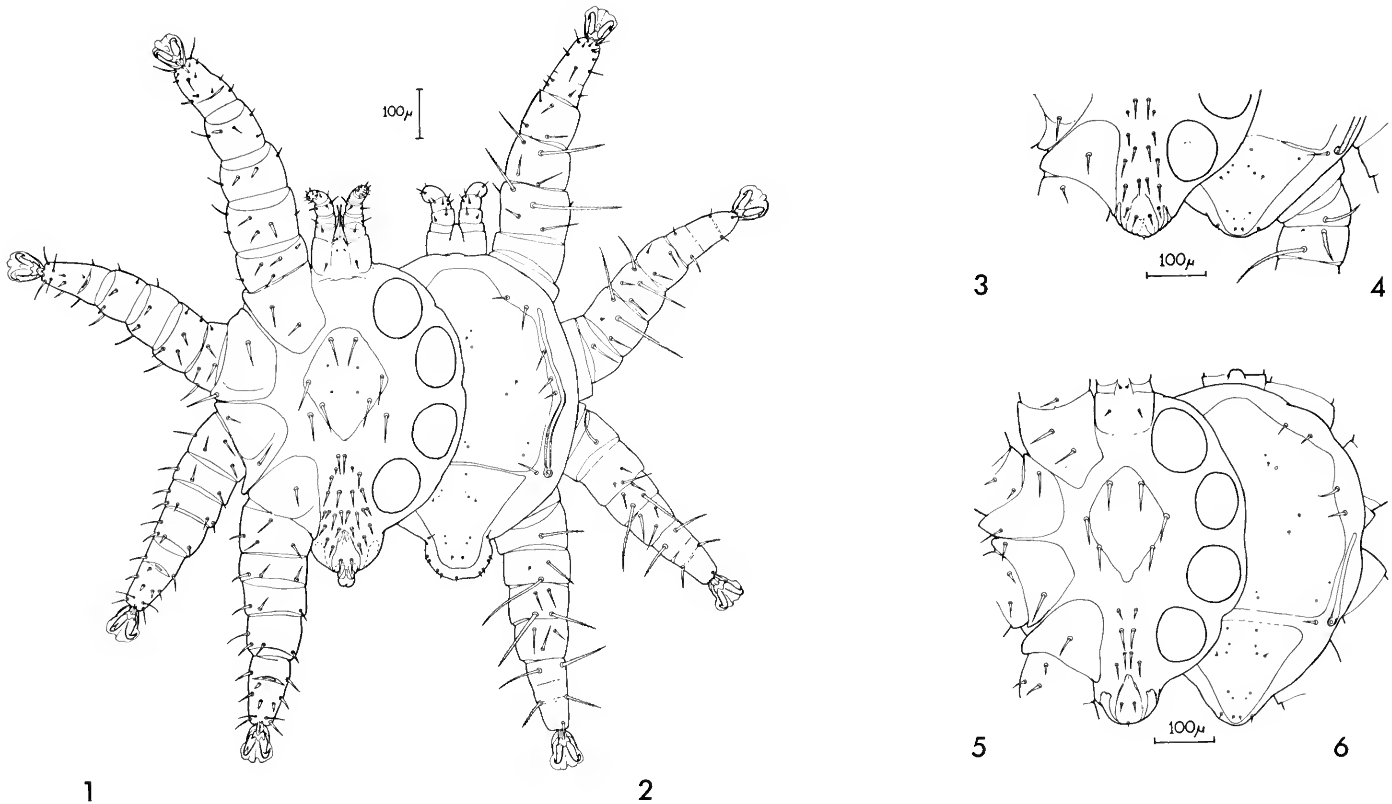


Periglischrus caligus Kolenati. 1, venter and 2, dorsum of female. 3, venter and 4, dorsum of male.

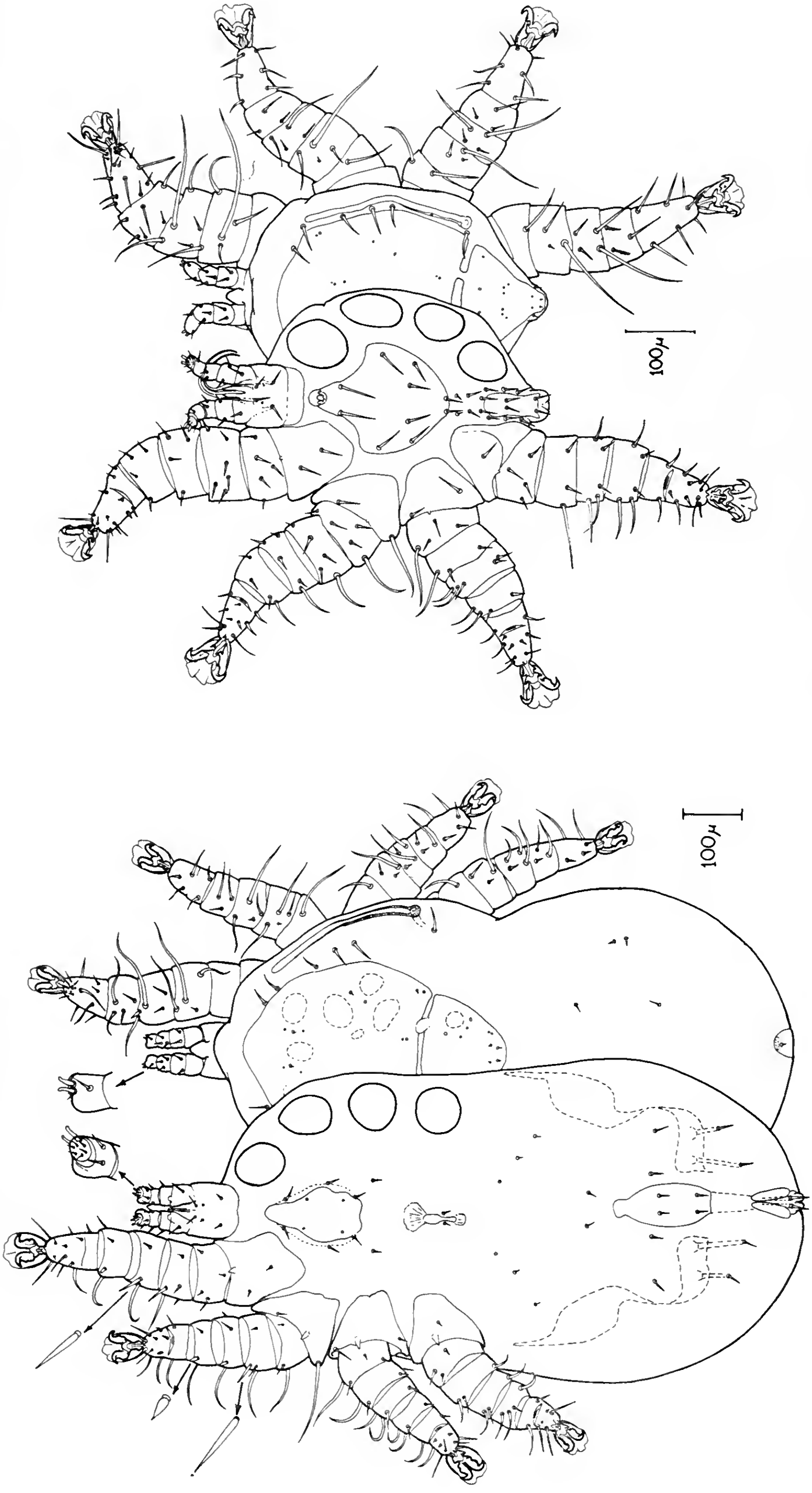


1 2 3 4

Periglischrus tiptoni, new species. 1, venter and 2, dorsum of female. 3, venter and 4, dorsum of male.

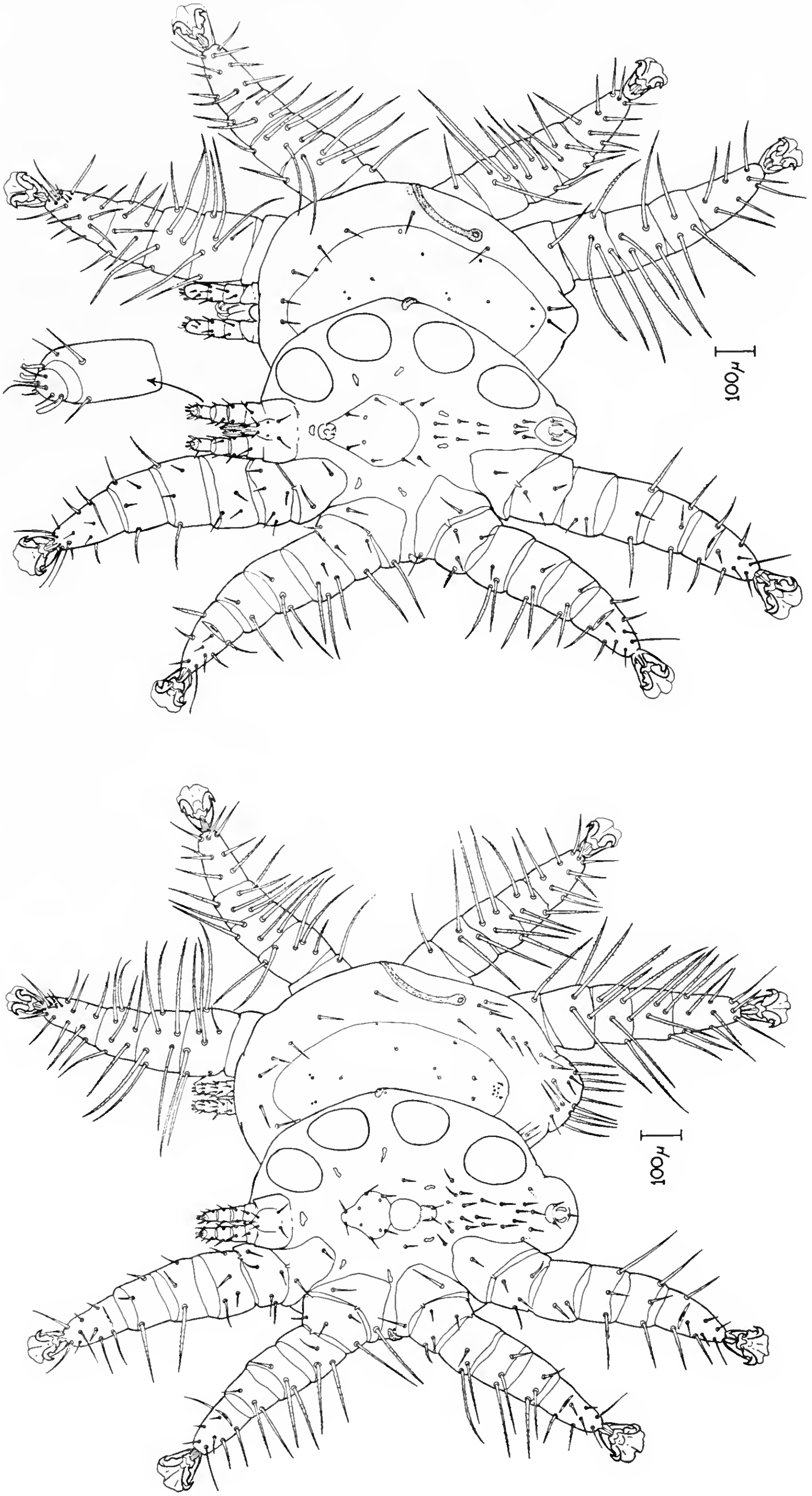


Periglischrus tiptoni, new species. 1, venter and 2, dorsum of female deutonymph. 3, posterior venter and 4, posterior dorsum of male deutonymph. 5, venter and 6, dorsum of protonymph.



1 2 3 4

Periglischrus micronycteridis, new species. 1, venter and 2, dorsum of female. 3, venter and 4, dorsum of male.



Spinturnix subacuminatus, new species. 1, venter and 2, dorsum of female. 3, venter and 4, dorsum of male.

Addendum

Since submission of the manuscript for this paper in 1962, a series of spinturnicids have been described by Machado-Allison. In 1965 (Acta Biologica Venezuelica, 4,(10), pp. 243–258) he described a new genus and species, *Cameronieta thomasi* from *Chilonycteris rubiginosa fusca*. His figure and description of the female agree with the specimens I have described as heteromorphic females of *Periglischrus elongatus*. The male he describes is indistinguishable from typical males of *P. elongatus*. His female deutonymph appears to be the typical adult female of *P. elongatus*. His male deutonymph appears to be an adult male, and his protonymph, probably a male. I conclude that *Cameronieta* is a synonym of *Periglischrus*, and *C. thomasi* becomes *Periglischrus thomasi* (Machado-Allison). This has close relationship with *P. elongatus* Furman and *P. strandtmanni* Tibbets. If further research demonstrates that my hypothesis for existence of heteromorphic females in *P. elongatus* is correct, this species will become a synonym of *P. thomasi*.

In 1965 Machado-Allison (Acta Biologica Venez. 4,(11), pp. 259–288) refers to his paper in press describing 4 new species of *Periglischrus*. In his Acta Biologica paper (loc. cit.) he keys out the 4 species of *Periglischrus* referred to in his unpublished paper and includes rather inadequate photomicrographs. From these I conclude *P. tiptoni* Furman is a synonym of *P. acutisternus* Machado-Allison. *P. aitkeni* Furman is a synonym of *P. ojastii* Machado-Allison; the latter has erroneously described and photographed a teneral adult female of this species as a female deutonymph. *P. micronycteridis* Furman may be a synonym of *P. parvus* Machado-Allison. Both occur on *Micronycteris* species, but the photomicrographs and key characters given for *P. parvus* are inadequate for certain identification. I consider *P. setosus* Machado-Allison to be a synonym of *P. caligus* Kolenati. *P. inflatiseta* Furman is a synonym of *P. torrealbai* Machado-Allison. *P. squamosus* Machado-Allison is a synonym of *P. vargasi* Hoffman. *P. desmodi* Furman is a synonym of *P. herrerai* Machado-Allison.

The Ticks of Panama
(Acarina: Ixodoidea)

Graham B. Fairchild,[1] Glen M. Kohls,[2] and Vernon J. Tipton [3]

Information on the ticks that occur in Panama is scattered and scanty. Most of the information hitherto available is due to the efforts of L. H. Dunn, who worked on the Isthmus for about twenty-five years. Beginning in 1915, he published a series of papers on the life histories, disease transmission potential, hosts and distribution of Panamanian ticks. Dunn's papers are listed in the bibliography. In 1941, Ernesto Osorno-Mesa published an extensive paper, with keys to genera and species, on the ticks of Colombia. In this are included a number of early records from Panama when this country was part of Colombia as well as later records assembled from the literature. Fairchild (1943) briefly summarized the records of ticks in a list which formed part of a general summary of the biting arthropods of Panama. Determinations in Osorno-Mesa's paper were largely checked by Joseph Bequaert; those in Fairchild's in part by R. A. Cooley. The Argasidae of Panama were reviewed by Cooley and Kohls (1944) in their monograph of the species occurring in North America, Central America and Cuba.

The present work is based on fairly extensive collections made in recent years by personnel of the Environmental Health Branch, Division of Preventive Medicine, Office of the Surgeon, United States Army Caribbean, especially by Charles M. Keenan, under the successive commands of Major Gordon Field, Major Robert M. Altman and Major Vernon J. Tipton; of collections made by Conrad E. Yunker and James M. Brennan of the Rocky Mountain Laboratory (RML) attached to the Middle America Research

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The authors are listed in alphabetical order. G. B. Fairchild and V. J. Tipton assembled the material. G. M. Kohls is responsible for the taxonomy.

Unit, United States Public Health Service, in connection with their studies of Panamanian Trombiculidae; and of collections made by personnel of the Gorgas Memorial Laboratory (GML), especially Lawrence H. Dunn, Pedro Galindo V., Eustorgio Méndez and G. B. Fairchild. These collections have been largely from wild animals trapped or shot in connection with other studies, or from animals brought in alive by country people for possible sale as pets or experimental animals. In some cases, engorged nymphs or larvae allowed to detach from hosts have been held alive until they molted to the next stage, and eggs and young larvae have been secured in a few cases by holding engorged females in the laboratory, but in general our records are based on adult ticks.

A total of forty-seven species are known to occur in Panama, twelve of which are here recorded for the first time for this country. Three species, *Ixodes fuscipes* Koch, *I. minor* Neumann and *Amblyomma americanum* (Linnaeus), previously reported for Panama, are not included. Nuttall and Warburton (1911) recorded and figured as *I. fuscipes* a female from Panama from *Felis pardalis*. Cooley and Kohls (1945) suggested that this specimen may be *I. boliviensis* Neumann, but since the palpi and hypostome are missing, certainty is impossible. *I. fuscipes* is recorded from Brazil from *Dasyprocta aguti* and *Cuniculus paca* and the Rocky Mountain Laboratory has a female of this species from "agouti" from Puno (Sandia), Peru. The female reported by Fairchild (1943) as *I. minor*, from *Peromyscus nudipes* or *Oryzomys devius*, Chiriquí Province, is in fact an *Ixodes* nymph which is not further determinable. As for *A. americanum*, Dunn (1923) reported that specimens had been taken by Dr. S. T. Darling on dogs and domestic hogs on San Miguel Island, one of the Pearl Islands in Panama Bay. We have not seen these specimens and have not made collections on San Miguel. No other specimens of this species have been reported from Panama and we seriously doubt its occurrence there. It appears to be restricted to parts of the United States and Mexico.

Much remains to be learned about the ticks of Panama, and it seems advisable to point out here some of the more obvious lacunae in our knowledge. Many species appear to utilize several hosts at different stages, and the larvae and/or nymphs of many of them remain unknown or at least undescribed. The species of *Amblyomma* infesting, as adults, the sloths and anteaters, are a case in point. The larvae and nymphs of these species are undescribed and their hosts are unknown, since pre-adult stages are seldom taken on the adult's hosts. Life history studies of only a few of the commoner species have been made and these have been mostly based on laboratory rearings rather than field studies. The limiting factors of temperature, humidity, etc. affecting ticks in this area remain to be studied. The lack of coincidence between the ranges of the ticks and those of their preferred hosts is in need of investigation.

Although little detailed information has been collected concerning the effect of environmental factors on Panamanian ticks, certain generalizations may be made. In table 4 (which excludes Argasidae, *Amblyomma crassum* and *A. pictum*), we have tabulated the occurrence of various species according to altitude (below 1000 feet, from 1000 to 5000 feet, and above 5000 feet) and according to climate (either wet or dry). As can be seen, only a few species occur in all three altitudinal zones. In some cases, the range of favored hosts may limit tick distribution, but in others, the range of the hosts is known to greatly exceed that of the ticks.

TABLE 4. DISTRIBUTION OF PANAMANIAN TICKS IN RELATION TO ALTITUDE AND CLIMATE
(See text for detailed explanation.)

	Approximate elevation (in feet)			Climatic conditions	
	over 5000	*1000-5000*	*under 1000*	*wet*	*dry*
Dermacentor halli	+			+	
" *imitans*	+	+	+	+	
" *latus*	+	+		+	
Anocentor nitens			+	+	+
Boophilus microplus	+once		+		+
Amblyomma auricularium			+	+	+
" *cajennense*	+once	+	+	+	+
" *calcaratum*		+	+	+	+
" *coelebs*		+	+	+	
" *dissimile*		+rare	+	+	+
" *geayi*			+	+	+
" *longirostre*		+	+	+	+
" *naponense*			+	+	+
" *nodosum*			+	+	+
" *oblongoguttatum*		+	+	+	+
" *ovale*		+	+	+	+
" *pacae*	+twice	+	+	+	+
" *parvum*			+		+
" *pecarium*			+	+	+
" *sabanerae*		+rare	+	+	+
" *tapirellum*		+	+	+	+
" *varium*			+	+	+
Haemaphysalis juxtakochi		+	+	+	+
" *leporispalustris*	+	+	+	+	+
Rhipicephalus sanguineus	+	+	+	+	+
Ixodes affinis		+	+	+	+
" *boliviensis*	+	+		+	
" *brunneus*	+			+	
" *lasallei*		+	+	+	
" *loricatus*		+		+	
" *luciae*		+	+	+	
" *pomerantzi*	+			+	
" *rubidus*	+			+	
" *tapirus*	+			+	
" *tiptoni*	+			+	
" *venezuelensis*		+		+	

In determining the effects of climate, it is not always possible to separate the effects of temperature and humidity. In Panama, for instance, heavier and more continuous rainfall usually occurs at higher altitudes. However, it may be generally assumed that the principal factor in limiting tick distribution in areas of high elevation will be temperature, and in areas of low or intermediate elevation, humidity.

In general, the species of *Dermacentor* and *Ixodes* apparently prefer higher altitudes and areas of heavier rainfall. Of the three species of *Dermacentor,* all have been taken above 5000 feet, and only one below 1000 feet, in an area of very heavy and continuous rainfall. Among the eleven species of *Ixodes,* five have been taken only above 5000 feet and only three below 1000 feet, while only one species has been taken in a dry area. In marked contrast are the seventeen species of *Amblyomma,* of which only two, *A. cajennense* and *A. pacae,* have been taken above 5000 feet, one species once, the other twice. Preference for dry or wet areas at low elevations is quite marked in a number of species, but only one, *A. coelebs,* has not been taken in a dry area. These facts suggest that micro-climatic factors affecting the free-living periods of some ticks may be as important in determining their distribution as are suitable hosts.

Considerable preliminary work on the disease-transmitting potential of Panamanian ticks was done by Dunn. However, complete epidemiologies have not yet been worked out, even for such obvious diseases as relapsing fever, piroplasmosis, and Rocky Mountain spotted fever. The interrelationships of ticks with wild animals and their infections, and their bearing upon general problems of parasitology and the epidemiology of diseases of man and domestic animals, comprise an area of investigation as yet almost totally unexplored.

Family **Argasidae**

The Argasidae or soft ticks differ from other ticks in lacking a hard sclerotized dorsal plate, or scutum, in all stages. In nearly all cases the life history includes a six-legged larval stage and several nymphal stages, as well as the adult. In most instances, only the larvae attach themselves strongly to the host; the nymphs and adults contact the host only for brief feedings, though there are some exceptions to this generalization. The nymphs and adults are thus generally to be found free in the habitat of the hosts, while the larvae are usually found attached to the host.

Three genera of Argasidae are known from Panama. The genus *Otobius* Banks is also included in the subjoined key, as it is possible that it may eventually turn up in the drier parts of the Republic.

KEY TO PANAMANIAN GENERA

Adults and large nymphs; after Cooley and Kohls, 1944

1. With a definite sutural line separating the dorsal and ventral surfaces of the body .... *Argas* (*persicus*)
   Sutural line absent 2
2. Nymphal integument beset with spines; hypostome well developed. Integument of adults granular; hypostome vestigial .... *Otobius* (*megnini*)
   Integument of adults and nymphs essentially alike, mammillated or tuberculated and lacking spines; hypostome of various forms in adults and nymphs but not vestigial 3
3. Hypostome broad at the base, scoop-like. Associated with bats .... *Antricola* (*mexicanus*)
   Hypostome of various forms but never scoop-like. Associated with various animals including bats .... *Ornithodoros* (7 species)

KEY TO PANAMANIAN GENERA AND SPECIES

Larvae

1. Claws absent, pulvilli greatly enlarged. Parasite of bats..... *Antricola* (*mexicanus*)
   Claws present, pulvilli not greatly enlarged. Parasites of various hosts including bats 2
2. Eyes present .... *Otobius* (*megnini*)
   Eyes absent 3
3. Palpal segment 4 as long or longer than other palpal segments; dorsum with 26–30 pairs of dorsal setae. Parasite of domestic fowl........ *Argas* (*persicus*)
   Not as above .... *Ornithodoros* 4
4. Parasitic on bats 5
   Parasitic on hosts other than bats........ 8
5. Basis capituli with a knob on each side and with a pair of pointed cornua-like extensions ventrally. .... *viguerasi*
   Not as above 6
6. Hypostome on a conical base much shorter than the hypostome itself........ *hasei*
   Base of hypostome about as long as the hypostome........ 7
7. Basal teeth of hypostome crowded and deformed........ *azteci*
   Basal teeth of hypostome not crowded and deformed........ *brodyi*
8. Hypostome short, approximately 0.112 to 0.130 mm. long, and bluntly rounded... *rudis*
   Hypostome long and pointed 9
9. Hypostome extremely long and slender, approximately 0.244 to 0.257 mm. long, 0.038 to 0.045 mm. wide........ *puertoricensis*
   Hypostome approximately 0.165 to 0.177 mm. long, 0.047 to 0.065 mm. wide..... *talaje*

Genus **Argas** Latreille, 1795

Argas persicus (Oken)

Rhynchoprion persicum Oken, 1818, Isis, 3: 1568, figs.

Argas persicus (Oken), Dunn, 1923, Amer. Jour. Trop. Med., 3, (2), p. 92, as *Argas miniatus* Koch; 1933, Amer. Jour. Trop. Med., 13, (5), p. 482. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog., no. 1, pp. 17–20, figs.

This species, the common fowl tick and the vector of fowl spirochaetosis, is the only species of the genus known from Panama. It is world-wide in distribution and is mainly a parasite of chickens; it rarely attacks man. Dunn (1923) and Fairchild (1943) report it as common throughout Panama, but our only definite record based on specimens is a large lot of nymphs and adults taken from fowl cages in the Panama City market by Fairchild a number of years ago.

Genus **Ornithodoros** Koch, 1844

KEY TO PANAMANIAN SPECIES

Adults and large nymphs

1. Hypostome pointed. Parasites of bats........ 2
   Hypostome truncated or notched at apex. Parasites of various animals including bats 3
2. Hypostome long, slender; denticles fine and limited to apical portion. Body ventrally without sclerotized plates or transverse band of columnar mammillae just posterior to coxae IV........ *azteci*

Hypostome short, flattened, in shape of an inverted V; denticles not evident when examined *in situ*. Body ventrally with sclerotized plates and with a transverse band of columnar mammillae just posterior to coxa IV................*viguerasi*

3. Discs large, conspicuous, and occupying much of the dorsal surface................4
   Discs small, superficial, inconspicuous, not occupying much of the dorsal surface....5
4. Small species, adults usually less than 4 mm. long. Discs as elevated shining areas. Mammillae only slightly elevated and difficult to distinguish from the discs in the posterior areas near the margin on both the dorsal and ventral surfaces. Parasite of bats..*hasei*
   Larger species, adults usually over 4 mm. long. Discs as large depressed areas. Mammillae conical, well elevated and readily distinguished from the discs. Parasites of animals other than bats........................*puertoricensis* and *talaje*
5. Dorsoventral groove present. Legs short, leg IV not extending to posterior margin of body. Parasite of animals other than bats; frequently found in native houses..*rudis*
   Dorsoventral groove absent. Legs long, leg IV extending beyond posterior margin of body. Parasite of bats..*brodyi*

Ornithodoros azteci Matheson

Ornithodoros azteci Matheson, 1935, Jour. Parasit., 21: 349–351, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog., no. 1, pp. 109–112, figs. (with *O. anduzei* Matheson 1941 as synonym).
Ornithodoros anduzei Matheson, 1941, Bol. Ent. Venez., 1: 3–5.

According to Matheson (1935), larvae have been taken on the bats *Carollia perspicillata azteca* and *Desmodus rotundus murinus*, while nymphs and adults were found in cracks and crevices in a culvert at Summit (Canal Zone), in a cave on Taboga Island, and in the Chilibrillo Caves. Larvae from *Noctilio labialis* in an old building at Summit, 9 Jan. 1944, K. W. Cooper and W. Kirkland, were possibly this species. Recent collections, all of larvae, have been 6 from *Lonchorhina aurita*, railroad culvert east of Summit Golf Club, 26 Oct. 1959, V. J. Tipton; 20 from *Desmodus rotundus*, 1.5 miles W. of Santa Clara (Coclé), 27 Oct. 1959, V. J. Tipton; 2 from *Peropteryx macrotis*, Quebrada Bonita (Colón), 9 Mar. 1962, GML; 2 from bats, cave near Cement Plant (Colón), 15 Feb. 1962, C. M. Keenan.

In addition to Panama, this species has been recorded from Cuba, Jamaica, and Venezuela. The Rocky Mountain Laboratory has several lots from bats and from a cave in Trinidad collected by T. H. G. Aitken of the Trinidad Regional Virus Laboratory.

Ornithodoros brodyi Matheson

Ornithodoros brodyi Matheson, 1935, Jour. Parasit., 21: 351–352, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog., no. 1, pp. 80–81, figs.

Larvae were taken from the short-tailed bat, *Carollia perspicillata*, and nymphs and adults from crevices in the walls and ceilings of the Chilibrillo Caves (Matheson, 1935). Fairchild (1943) records the species as common in the Chilibrillo Caves. Specimens, not now available, were taken 4 Jan., 18 Feb. 1940. Subsequent collections are as follows: Chilibrillo Caves, near Chilibre (Panamá), 27 Aug. 1944, W. W. Middlekauf, 4 adults on walls of cave; same locality, 6 and 18 Jan. 1941, K. W. Cooper and W. Kirkland, larvae from *Carollia perspicillata;* same locality and host, 28 Oct. 1959, V. J. Tipton and C. M. Keenan, larvae; same locality, 4 Dec. 1943, GML, 2 females on walls of cave; same locality, Dec. 1946, H. Trapido, 1 female; same locality, June 1957, GML, 1 male, 4 females, 1 nymph, on walls of cave; same locality, Nov. 1954, GML, 1 larva, from *Desmodus rotundus;* Cerro Hoya (Los Santos), 6 Feb. 1962, V. J. Tipton, 1 larva, from *Trachops cirrhosus;* same locality and host, 24 Feb. 1962, 1 larva; same locality, 10 Feb. 1962, from *Carollia perspicillata,* 1 larva; bat cave, Quebrada Bonita (Colón), 25 May 1962, 1 male, 1 female, 5 nymphs; and same locality, 25 July 1962, from ? *Rhynchonycteris* sp., 1 larva.

As far as we know, all collections of *O. brodyi* from the Chilibrillo Caves came from "Cave B," the middle cave of the complex of three which make up the Chilibrillo Caves. All three open from the sides of a sink hole in limestone about 100 meters west of the present Trans-Isthmian Highway. The fauna of these caves was extensively studied and collected by L. H. Dunn, but references to his findings are scattered in the literature. Formerly the caves could be reached only by hours of travel in dugout canoes up the Chagres and Chilibrillo Rivers, and at that time they contained a large and varied bat population. In recent years their accessibility has resulted in much disturbance, including treatment with smoke bombs in connection with an anti-rabies campaign against all bats. This has resulted in the virtual disappearance of bats from Cave B and no adult ticks have been recovered on visits to the cave in recent years.

The species also occurs in Guatemala as evidenced by a nymph in the Rocky Mountain Laboratory collection from cave wall, Cueva de Lanquin, Lanquin (Alta Vera Paz), 1000 feet elevation, 15 June 1948, R. D. Mitchell and Luis de la Torre, Chicago Natural History Museum Guatemala Zoological Expedition.

Ornithodoros hasei (Schulze)

Argas hasei Schulze, 1935, Zeitschr. Morph. Ökol. Tiere, **30**: 34, fig. (May); 1941, op. cit., **37**: 534, 547 (with *O. dunni* Matheson as synonym).

Ornithodoros dunni Matheson, 1935, Jour. Parasit., 21:347–349, figs. (October). Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog. no. 1, pp. 103–105, figs.

Schulze's material of *hasei* consisted of an unspecified number of larvae off the bat *Myotis nigricans* from "La Gueiira" (misprint for La Guaira?), Venezuela. Kohls has compared reared larvae of *O. dunni* with the larva of "*Argas*" *hasei* figured by Schulze and concurs with Schulze (1941) that *dunni* is a synonym.

Matheson's original specimens of *dunni* were reared from larvae taken from the bat *Dirias albiventer* (= *Noctilio labialis*) in Panama City and Summit (Canal Zone). Adults, nymphs and larvae have since been taken in some numbers from bat guano in the roof of an old church at Pacora (Panamá), June 21, 22, July 26, 1961. The bats inhabiting the church were *Noctilio labialis,* and one nymph and several larvae were taken from one of the bats. Several larvae, from which two nymphs later emerged, were secured from the same species of bat taken at the Navy firing point, Galeta Point (Canal Zone), 19 Nov. 1959. More recently, three lots of larvae were secured from *Noctilio leporinus,* five lots from *Noctilio labialis,* and one each from *Uroderma bilobatum, Vampyrops helleri* and *Tonatia silvicola,* all from the vicinity of Las Palmitas (Los Santos), Jan.–Feb. 1962. Also, nine lots of larvae were collected from *Noctilio* sp. taken in nets, Gamboa (Canal Zone), pipeline road, 14 May 1962, by C. Yunker.

This species has also been recorded from Brazil (Marajó Island near Belém), and the Rocky Mountain Laboratory collection contains several lots from Trinidad from bats, principally *Noctilio l. leporinus,* and their roosts, collected by T. H. G. Aitken.

Ornithodoros puertoricensis Fox

Ornithodoros puertoricensis Fox, 1947, Jour. Parasit., 33, (3), pp. 253–259; 1951, Jour. Parasit., 37, (1), pp. 85–95. Davis, 1955, Jour. Parasit., 41, (1), pp. 76–79. Fox and Garcia-Moll, 1961, Amer. Jour. Trop. Med. Hyg., **10,** (4), pp. 566–573.

This species was described by Fox (1947) from larvae and from nymphs and adults reared from larvae collected off domestic rats in Puerto Rico. He suggested the possibility that the species was also present in Panama but that it was being confused with *O. talaje.* The presence of this species in Panama is confirmed by the finding of a larva on *Sylvilagus brasiliensis* at Los Santos, 19 February 1962, and by re-examination of a lot labeled *O. talaje* consisting of numerous larvae, 10 males, 1 female and 7 nymphs, collected by Dunn in Panama but without further data, and by another lot consisting of 7 larvae labeled *O. talaje,* from "rat", 27 March, 1931. All specimens in these two lots proved to be *O. puertoricensis.*

The adults and nymphs of *puertoricensis* and *talaje* are so similar that we are as yet unable to distinguish the two species with certainty on the basis of these stages alone, although available specimens of *puertoricensis* are rather consistently smaller. The larvae, however, are quite distinct and are readily distinguished by characters of the hypostome. The hypostome of *puertoricensis* is much longer and narrower and ranges from approximately 0.244 to 0.257 mm. long by 0.038 to 0.045 mm. wide as compared to 0.165 to 0.177 mm. long by 0.047 to 0.065 mm. wide in *talaje* larvae reared from adults collected at and near the type locality in Guatemala.

The Rocky Mountain Laboratory has several collections of larvae from rodents (*Proechimys* and *Nectomys*) in Trinidad (T.H.G. Aitken), and larvae that were reared from adults collected at Ayacucho in Colombia. It is of interest to note that Davis (1955) interbred *O. puertoricensis* from Puerto Rico and "*O. talaje*" from Colombia and obtained fertile progeny.

Ornithodoros rudis Karsch

Ornithodoros rudis Karsch, 1880, Mitt. Münch. Ent. Ver., 4: 141–142. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), pp. 582–583. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog. no. 1, pp. 101–103, figs.

Ornithodoros talaje, Dunn, 1923, Amer. Jour. Trop. Med., 3, (2), pp. 92–93 (in part).

Ornithodoros venezuelensis, Dunn, 1933, Amer. Jour. Trop. Med., 13, (2), p. 203; 1933, Amer. Jour. Trop. Med., 13, (5), pp. 476, 482.

Dunn (1933) considers this species to be primarily a biter of man, at least in the post-larval stages. He records it as common in houses in the interior of Panama, hiding in cracks in furniture and walls and coming out to bite at night. Larvae were taken once on a chicken, and a few post-larval stages from crevices in chicken coops in the Panama City market. Fairchild collected adults and nymphs from crevices in furniture in a native house near Capira (Panamá), many years ago, and there are specimens at the Rocky Mountain Laboratory from native houses at New San Juan, Chagres River, 7 July 1939, W. Trager; from native house at Donoso (Colón), March 1947, G. B. Fairchild; and from native houses 40 miles west of Panama City, April 1954, G. B. Fairchild. No recent material has been seen, doubtless because it has not been searched for. It is also likely that extensive spraying of houses with insecticides to control malaria, beginning about 1946, has greatly reduced this domestic species. Dunn believed *O. rudis* to be the main vector to man of relapsing fever in Panama.

In addition to Panama, this species has been recorded from Colombia, Venezuela, Paraguay (Cooley and Kohls, 1944), and from Ecuador (León and de León, 1947), and the Rocky Mountain Laboratory has several collections from rodent nests from several localities in the Lancones District (Piura), Peru, October 1946 (Dr. A. Macchiavello).

Ornithodoros talaje (Guérin-Méneville)

Argas talaje Guérin-Méneville, 1849, Rev. Mag. Zool., 1: 342–344, pl. 9.
Ornithodoros talaje, Dunn, 1923, Amer. Jour. Trop. Med., 3, (2), p. 92 (in part); 1927, Jour. Parasit., 13: 177–182; 1931, Psyche, 38, (4), pp. 170–173; 1933, Amer. Jour. Trop. Med., 13, (5), pp. 475–483. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 582. Cooley and Kohls, 1944, Amer. Midl. Nat. Monog., no. 1, pp. 82–88, figs. 38–39, pl. 8. Fox, 1947, Jour. Parasit., 33: 253–259.
?*Ornithodoros dugesi* Mazzotti, 1943, Rev. Inst. Salub. Enferm. Trop., 4, (4), pp. 371–374; 1949, ibidem, **10**, (3), pp. 277–281.

With the recognition that *O. puertoricensis* occurs in Panama, all previous records of *O. talaje* in Panama must be regarded as questionable. Future reports must also be so regarded unless verified on the basis of larvae in view of the close similarity of the post-larval stages of the two species. Unfortunately, none of the larvae reported by Dunn (1923, 1927, 1931, 1933) are available for study, and a positive identification as *O. talaje* of the adults now remaining in the early and more recent collections cannot be made. Consequently, the following records may apply either to *talaje*, or to *puertoricensis*, or to both, although some of the specimens appear to be the former because of their size.

Dunn (loc. cit.) recorded larvae from domestic rats (*Mus rattus*, *M. alexandrinus* and *M. norvegicus*) as well as dogs, cats, opossums, monkeys, chickens, and snake. Adults were occasionally taken in houses, once (Dunn 1931) in sufficient abundance to cause annoyance to the inhabitants by their bites. Adults were also taken in small numbers in crevices in chicken coops in the Panama City market. Dunn was of the opinion that the tick was widespread in Panama, the larvae attacking a variety of animals, the adults mainly attacking rats. He reported material from Parita (Herrera), Santa Rosa (Colón), Gatún (Canal Zone), Chorrera and San Juan (Panamá), and the cities of Panamá and Colón. Fairchild has notes on specimens, not now available, from a native house at Villa Rosario (Panamá), 27 June 1941, sifted from dirt floor and in cracks in furniture, and a single engorged female from Juan Diaz (Panamá), July 1941, taken in a native house. Further specimens collected in houses at Villa Rosario, April 1954, are in the Rocky Mountain Laboratory collection. An adult specimen was taken while biting a man in bed, Panama City, 14 August 1944.

Cooley and Kohls (1944) stated that the range of *O. talaje* extends from Kansas and California to Argentina and noted that in the United States the species has been found only on wild rodent hosts and in association with them. Specimens taken in nests of "ratas silvestres [4]" near Sabinas (Coahuila), northern Mexico, were described by Mazzotti (1943) as a new species, *O. dugesi*. However, Kohls has been unable to detect any significant differences between the larval and post-larval stages of *dugesi* and those of *talaje* from the United States, from native houses in southern Mexico, and from the type area in Guatemala, and believes *dugesi* may be a synonym.

Ornithodoros viguerasi Cooley and Kohls

Ornithodoros viguerasi Cooley and Kohls, 1941, Pub. Hlth. Rept., **56**: 396–399, figs; 1944, Amer. Midl. Nat., Monog. no. 1, pp. 106–109, figs.

Our records for this species are based on larvae taken from bats, four from *Pteronotus parnellii* and one from *Pteronotus* sp. at Cueva de los Murcielagos, near Penonomé (Coclé), 4 Mar. 1955, A. Quiñonez, and 15 Dec. 1961, V. J. Tipton.

This species has been previously recorded from Cuba, and the Rocky Mountain Laboratory has several lots of larvae collected by T. H. G. Aitken from bats in Trinidad.

Genus **Antricola** Cooley and Kohls, 1942

Antricola mexicanus Hoffmann

Antricola mexicanus Hoffmann, 1959, An. Esc. Nat. Cienc. Biol., **9**: 97–102, figs. (1958) (Mexico).

This species was first taken (27 males, 21 females, 4 nymphs) in December, 1961, from Cueva de los Murcielagos (bat cave) about 1 km. NW. of Penonomé (Coclé). Ticks were present in fair numbers and were actively crawling about on the guano in the first chamber in the cave. Bats of several species, predominantly *Pteronotus* spp. with a few *Carollia* sp., were present in very large numbers, forming a nearly solid sheet on the ceiling and walls of the cave. A later visit, on 24 Jan. 1962, yielded several hundred adult ticks of both sexes and nymphs of several sizes as well as 20 larvae from *Pteronotus psilotis*. A fire had been built in the cave a short time previously and bats were much less numerous. Ticks were

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[4] *Neotoma micropus canescens* according to Mazzotti, 1949.

more in evidence, crawling actively on walls and floors of small side tunnels and packed into available crevices. The cave was hot and damp, the atmosphere almost unbreathable with ammonia fumes from the guano. Later, one female and one nymph were taken in a cave at Cerro Punta (Chiriquí), at an elevation of 5800 feet, and larvae from *Myotis nigricans* at the same locality.

This species was described from a female and a male found on bat guano in Gruta de Juxtlahuaca (Guerrero), Mexico. The Rocky Mountain Laboratory has a female and a nymph taken in a bat cave, elevation 6300 feet, at Chocoyos (Chimaltenango), Guatemala, 28 April 1948, by R. L. Wenzel, R. D. Mitchell and L. de la Torre, Chicago Natural History Museum Guatemala Zoological Expedition. The species resembles *A. coprophilus* (McIntosh) of the southwestern United States and Mexico, but it can be readily distinguished by the presence in females of tubercles, each bearing a tuft of long barbed hairs, on the posterior and posterolateral margins of the body.

Family **Ixodidae**

The Ixodidae or hard ticks are characterized by having a hard sclerotized scutum in all stages. This structure is small in the larval and nymphal stages and in the female, but covers the whole dorsum in the males. All stages attach to their hosts for relatively long periods of feeding. A few species stay on the same host in developing from larva to nymph to adult, but most species, in each stage, drop from the host on completion of feeding and after molting may parasitize the same or widely different host species. Seven genera, keyed below, have representatives in Panama.

KEY TO PANAMANIAN GENERA

Males and Females

1. Anal groove distinct and contouring the anus anteriorly. Eyes, ornamentation, and festoons absent. Venter of male more or less completely covered by seven hardened non-salient plates .... *Ixodes*

   Anal groove distinct or indistinct but contouring the anus posteriorly. Eyes, ornamentation and festoons present or absent. Venter of male with or without salient plates 2
2. Eyes absent, scutum inornate. Palps short and broad, base of second segment projecting laterally beyond the basis capituli. Festoons present. Venter of male without plates .... *Haemaphysalis*

   Eyes present 3
3. Palps usually long and slender, longer than the basis capituli; segment 2 at least one and one-half times longer than segment 3. Scutum usually ornate. Venter of male without extensive salient plates, rarely with small sclerotized non-salient plaques near the festoons. Coxa IV of males not greatly enlarged.... *Amblyomma*

   Palps short and broad, not longer than the basis capituli; segment 2 about as long as segment 3.......... 4
4. Basis capituli rectangular. Scutum ornate or inornate. Male without ventral plates. Coxa IV of male much larger than other coxae.......... 5

   Basis capituli hexagonal. Scutum inornate. Male ventrally with adanal and accessory plates. Coxa IV of male not greatly enlarged.......... 6
5. Scutum ornate. Festoons 11 in number. Denticles of hypostome arranged in three longitudinal rows on each side of the median line. Spiracular plate not or only slightly raised above body surface; goblets numerous and small...... *Dermacentor*

Scutum inornate. Festoons seven in number. Denticles of hypostome arranged in four longitudinal rows on each side of the median line. Spiracular plate prominently elevated above surface of body .... *Anocentor*

6. Festoons absent. Palpi very short and ridged dorsally and laterally. Coxa I with two very short spurs. Anal groove obsolete in female, indistinct in male. Male very small .... *Boophilus*

   Festoons present. Palpi not unusually short, not ridged. Coxa I with two long spurs. Anal groove distinct. Male moderate in size .... *Rhipicephalus*

Genus **Ixodes** Latreille, 1795

KEY TO PANAMANIAN SPECIES

Females

1. Hypostome with only files 1 and 2 extending the full length, files 3 never extending more than one-third the total length 2

   Hypostome with files 3 extending for half the length or more; files 4 may be present 4

2. Medium-sized tick of usual appearance; basis capituli subrectangular, not expanded laterally; coxa I with internal spur slender and much longer than the external .... *rubidus*

   Large ticks of unusual appearance: basis capituli expanded laterally; dorsally with a pair of anteriorly converging ridges; coxa I with spurs flattened and robust.. 3

3. Coxa I with spurs subequal in length .... *loricatus*

   Coxa I with external spur much longer than the internal .... *luciae*

4. Coxa II without spurs 5

   Coxa II with an external spur 7

5. Coxae III and IV without spurs. Auriculae mild ridge-like protuberances. Parasite of tapirs .... *tapirus*

   Coxae III and IV each with a short external spur. Auriculae long retrograde processes. Parasites of small mammals 6

6. Auriculae as sharply pointed curved horns. Hypostome situated on a conical base about as long as the hypostome itself. Punctations of scutum rather uniformly distributed .... *venezuelensis*

   Auriculae as long, straight, blunt, retrograde processes. Base of hypostome about half as long as the hypostome. Large punctations of scutum grouped near the posterior margin .... *lasallei*

7. Coxa I with a short internal spur, less than twice as long as the external spur. Trochanters I to III with small, but distinct, ventral spurs. Scutum, postscutal areas, and venter with numerous conspicuous long white hairs. Parasites of birds .... *brunneus*

   Coxa I with internal spur much longer than the external spur. Trochanters without spurs. Parasite of mammals 8

8. Cornua absent, posterior margin of basis capituli an even, concave, salient edge. Auriculae mild lateral saliences. Punctations near posterior margin of scutum conspicuous, deep circular .... *affinis*

   Cornua present 9

9. Palpal segment 1 with a long, sharp, ventral process. Auriculae long, thin curved horns. Parasite of *Sylvilagus* .... *pomerantzi*

   Palpal segment 1 with a suboval ventral plate or a short ventral spur similar to the external spurs of the coxae 10

10. Palpal segment 1 with a suboval ventral plate. Auriculae stout, curved, slightly longer than broad. Internal spur of coxa I long, slim, reaching nearly across coxa II in unfed specimens .... *boliviensis*

    Palpal segment 1 with a short ventral spur similar to the external spurs of the coxae. Auriculae mild, slightly pointed elevations. Internal spur of coxa I moderate, slightly overlapping coxa II. Parasite of squirrels (*Sciurus granatensis* so far as known) . . . . *tiptoni*

Males

(Males of *rubidus*, *tapirus*, and *venezuelensis* unknown)

1. Hypostome with large lateral denticles conspicuous and well differentiated from the small median denticles which are in diagonal or transverse crenulations . . . *affinis*
   Hypostome with smaller lateral denticles not well differentiated from the medians which may be in longitudinal files as in females or with small, mild teeth in indefinite files, or in diagonal transverse crenulations 2
2. Median denticles of hypostome in definite lineal files. Large ticks of unusual appearance: basis capituli expanded laterally, dorsally with a pair of anteriorly converging lateral ridges; lateral body folds wide; coxa I with spurs flattened and robust 3
   Median denticles in diagonal or transverse crenulations, or faint or indefinite lineal files. Smaller ticks of usual appearance 4
3. External spur of coxa I much longer than internal . . . . *luciae*
   External and internal spur of coxa I about equal . . . . *loricatus*
4. Hypostome distinctly notched apically 5
   Hypostome not notched apically 7
5. Coxae I and II without external spur, posterior margins broadly rounded and salient. Internal spur of coxa I long. Scutum with large punctations limited mainly to lateral and posterior areas . . . . *lasallei*
   Coxae I and II with external spur 6
6. Trochanters each with a small but distinct ventral spur. Spurs of coxa I short, subequal. Small tick, up to about 2 mm. long exclusive of capitulum. Parasite of birds . . . . *brunneus*
   Trochanters without ventral spurs. Coxa I with internal spur medium and much longer than external spur. Larger tick, up to at least 2.4 mm. long exclusive of capitulum. Parasite of squirrels (*Sciurus granatensis* so far as known) . . . . *tiptoni*
7. Cornua present, short, pointed. Posterointernal margin of coxa IV salient and spur-like. Hypostome slender, longitudinally grooved ventrally, with about 12 diagonal rows of crenulations. Parasite of *Sylvilagus* . . . . *pomerantzi*
   Cornua absent. Posterointernal margin of coxa IV smoothly rounded. Hypostome broad, heavy, with about eight transverse rows of crenulations plus a basal row of large irregular teeth which are well elevated above the smooth basal portion of the hypostome . . . . *boliviensis*

Ixodes affinis Neumann

Ixodes affinis Neumann, 1899, Mém. Soc. Zool. Fr., **12**: 120–121. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 583. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 29–34 (with *I. ricinus aragaoi* Fonseca, 1935 as synonym). Fonseca, 1960, Acarologia, 2, (1), pp. 9–10.

Ixodes ricinus aragaoi Fonseca, 1935, Mem. Inst. Butantan, **9**: 131–135.

Ixodes aragaoi Fonseca. Aragão and Fonseca, 1952, Mem. Inst. Oswaldo Cruz, **50**: 727–728. Fonseca, 1960, Acarologia, 2, (1), pp. 9–10.

Dunn (1923, 1934) recorded specimens, probably of this species, as *I. ricinus*, from near Camp Pital and from the Boqueron River area. Fairchild (1943) recorded adults from *Mazama* and *Odocoileus* from El Real (Darién) and Alhajuela (Canal Zone), while Cooley and Kohls (1945) recorded adults from *Felis concolor* (puma) from Almirante (Bocas del Toro). We have secured considerable material listed below, all collected by personnel of the Gorgas Memorial Laboratory unless otherwise stated, which indicates a wide distribution in Panama and considerable variety of hosts, though deer and the larger carnivores seem preferred.

Juan Mina (Canal Zone), 4 Sept. and 6 Jan. 1944, from *Odocoileus*, 4 females; Santa Rosa, Río Chagres, 24 Feb. 1944, from ocelot, 1 female; Moja Pollo, Río Chagres, 19 Feb. 1941, from dog, 1 female; Gamboa pipeline road (Canal Zone), 16 Oct. 1960, V. J. Tipton, from *Felis onca*, 1 female; Piña (Colón), 22 Dec. 1957, R. M. Altman, from *Didelphis marsupialis*, 1 male, 1 female; Tacarcuna Yellow Fever Station (Darién), 3 Sept. 1958, from *Mazama americana*, 1 female; Río Teribe (Bocas del Toro), 10 Aug. 1962, from *Mazama americana*, 3 males, 9 females; Cerro Pirre (Darién), 4 Feb. 1961, C. M. Keenan and C. E. Yunker, from ocelot, 1 female; Río Chucunaque (Darién), 17 Feb. 1958, from *Mazama*, 1 male, 1 female; Río Mandinga (San Blas), 30 May 1957, from *Felis onca*, 2 males, 1 female; Almirante (Bocas del Toro), 13 March 1961, from *Felis pardalis*, 2 males, 7 females.

The range of *I. affinis* extends from Georgia (Lund, Marshall and Hayes, 1962) and Florida (Kohls and Rogers, 1953) to Brazil. Cotype females of *aragaoi* (Brazil) have the punctations near the posterior margin of the scutum somewhat smaller than in *affinis* but we do not regard this and other minor differences noted by Aragão and Fonseca (1952) and Fonseca (1960) as sufficient to justify recognition of *aragaoi* as a separate species.

Ixodes boliviensis Neumann

Ixodes boliviensis Neumann, 1904, Arch. Parasit., 8: 457–458. Kohls, 1956, Proc. Ent. Soc. Wash., 58: 232–233 (with *I. bicornis* as synonym).

Ixodes bicornis Neumann, 1906, Arch. Parasit., **10**: 196–197. Fairchild, 1943, Amer. Jour. Trop. Med., **23**: 583. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 183–186. Kohls, 1956, Proc. Ent. Soc. Wash., 58: 232–233.

Fairchild (1943) and Cooley and Kohls (1945) reported this species as *I. bicornis*, from man, domestic cat and dog from several localities in Chiriquí Province. Since then we have secured 44 lots from the following hosts: jaguar (3 lots, 3 males, 51 females); dog (15 lots, 21 males, 143 females, 1 nymph); tapir (3 lots, 12 females); *Didelphis marsupialis* (3 lots, 4 females); *Procyon lotor* (1 lot, 3 males, 9 females, 8 nymphs, 15 larvae); cattle (4 lots, 1 male, 18 females); *Odocoileus* (1 lot, 4 females); mule (1 lot, 5 females); domestic cat (1 lot, 1 female); man (4 lots, 1 male, 4 females, only 1 female attached); *Coendou mexicanus* (4 lots, 10 females); *Nasua nasua* (3 lots, 15 females); in camp building (1 lot, 1 female). All were collected at elevations of over 2500 feet in Chiriquí Province or in neighboring Bocas del Toro Province. *I. boliviensis* appears to be the principal tick on dogs in this area, and on several occasions large numbers have been taken from a single dog. Its range extends from Mexico to Bolivia.

Ixodes brunneus Koch

Ixodes brunneus Koch, 1844, Arch. Naturg., **10**: 232. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 205–211. Anastos and Smith, 1957, Jour. Parasit., **43**: 535–541 (male, nymph, and larva described).

Ixodes californicus Banks, 1904, Proc. Cal. Acad. Sci., 3, (3), p. 369. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 215–216. *New synonymy.*

A single female from an undetermined species of tinamou, Bambito (Chiriquí), 6 Feb. 1960, collected by V. J. Tipton and C. M. Keenan, appears to be the first record of this bird tick from Panama. The specimen is somewhat larger than those from the United States, the scutal hairs are shorter, fewer and finer, and the median field of the scutum is glossy and has fewer and smaller punctations.

This species is known from several States in the United States (excluding Alaska and Hawaii) and from Venezuela. Boero (1945) identified as *I. brunneus* a female from the marsupial *Dromiciops australis australis* and a nymph from a supposed bat's roost, both from Victoria Island in Lake Nahuel (Neuquen), Argentina, but Ringuelet (1947) examined the specimens and described them as a new species, *Ixodes neuquenensis*. Boero's (1957) identification as *brunneus* of a female from a bird, *Turdus nigriceps*, Jujuy Province, Argentina, may be correct but his description and figures suggest that it may be another species.

Kohls has recently compared the syntype nymphs of *I. californicus* with authentic nymphs of *I. brunneus* and found them to be the same.

Ixodes lasallei Mendez and Ortiz

Ixodes lasallei Mendez and Ortiz, 1958, Mem. Soc. Cienc. Nat. LaSalle, 18: 198–202.

This species was described from females from Venezuela, taken from *Agouti paca*. We have secured 10 lots, including the undescribed male, 8 from *Dasyprocta punctata* and 2 from *Agouti paca:* Almirante (Bocas del Toro), 23 Jan. 1960, V. J. Tipton and C. M. Keenan, 1 female; same locality, 24 Jan. 1962, 1 female; same locality, 18 July 1960, GML, 1 female; Río Teribe (Bocas del Toro), 10 Aug. 1962, GML, 3 females; Cerro Hoya (Los Santos), 15 Feb. 1962, V. J. Tipton and C. M. Keenan, 7 nymphs, 2 larvae; same locality, 17 Feb. 1962, 1 female; same locality, 22 Feb. 1962, 2 nymphs; same locality, 23 Feb. 1962, 1 nymph; Timi de Boa, Río Teribe (Bocas del Toro), from *Agouti paca*, GML, May 1962, 1 male, 8 females, and 4 nymphs, and 10 Aug. 1962, 3 nymphs.

The salient morphological features of the male of this species are given in the key to *Ixodes* males.

Ixodes loricatus Neumann

Ixodes loricatus Neumann, 1899, Mém. Soc. Zool. Fr., 12: 139–142. Nuttall and Warburton, 1911, Ticks, pt. 2, pp. 266–269. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 187–193.

Although this species was erroneously reported from Panama as *I. loricatus spinosus* by Fairchild (1943), the following seems to be the first authentic record of the species from Panama: Tacarcuna Yellow Fever Station (Darién), 1 Sept. 1958, GML, from *Metachirus nudicaudatus*, 1 female.

The range of this species extends from Mexico to Argentina. Its principal hosts appear to be opossums (Family Didelphidae) but it has been recorded from a variety of other animals.

Ixodes didelphidis Fonseca and Aragão, 1952, described from adults taken on *Metachirus* sp. and *Didelphis paraguayensis* at Anápolis (Goiaz), Brazil, differs from *loricatus* in having somewhat larger spiracular plates with slightly smaller and more numerous goblets, and probably represents only a local population of that species. There are numerous lots from Anápolis in the Rocky Mountain Laboratory collection.

Ixodes luciae Senevet

Ixodes luciae Senevet, 1940, VI Cong. Intern. Ent., Madrid, (1935), pp. 896–898. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 175–180. Kohls, 1957, Proc. Ent. Soc. Wash., 59, (6), p. 259 (with *I. loricatus vogelsangi* Dias, 1954 as synonym).
Ixodes loricatus var. *spinosus* Nuttall, 1910, Parasitology, 3: 411–412, preoccupied by *I. spinosus* Neumann, 1899, Mém. Soc. Zool. Fr., 12: 146–147, = *I. fuscipes* Koch, 1844. Fairchild, 1943, Amer. Jour. Trop. Med., 23: 583.
Ixodes scuticrenatus Vazquez, 1946, An. Inst. Biol., 17: 237–245. *New synonymy.*

Aside from the specimens from *Didelphis marsupialis* from Alhajuela (Canal Zone), L. H. Dunn, reported by Fairchild (1943), and Cooley and Kohls (1945), we have secured the following additional material.

From *Didelphis marsupialis,* 20 lots totaling 33 males, 27 females, from the following localities: Tacarcuna Station (Darién), Aug.–Sept. 1958; Río Mandinga (San Blas), 27 May 1957; Cerro Azul (Panamá), May, Aug. 1955, Jan.–Apr. 1956; Cerro Campana (Panamá), March 1961; Camp Piña (Canal Zone), May, Aug. 1955, Jan., March 1956. From *Philander opossum,* 6 lots totaling 7 females, from Cerro Azul (Panamá), 21 Dec. 1955; Camp Piña (Canal Zone), 19 Jan., 9 March, 1956; Fort Gulick (Canal Zone), 21 March 1961. From *Marmosa robinsoni,* 1 nymph, Almirante (Bocas del Toro), 22 Feb. 1960. From *Zygodontomys microtinus,* 1 nymph, Tacarcuna Station (Darién), 3 Sept. 1958. From *Oryzomys* sp., 2 nymphs, Cerro Pirre, 1600 feet (Darién), 6 Feb. 1961.

The above records indicate that opossums are the favored hosts for the adults, but suggest that rodents are preferred by the earlier stages. The localities are all in areas of high rainfall, from sea level to about 2000 feet elevation.

In addition to Panama, this species has been recorded from southern Mexico, British Honduras, Guatemala, Colombia, Venezuela, Peru, French Guiana, Brazil and Argentina. The Rocky Mountain Laboratory has numerous lots, including many larvae and nymphs from rodents, that were collected in Trinidad by Dr. T. H. G. Aitken of the Trinidad Regional Virus Laboratory.

Ixodes pomerantzi Kohls

Ixodes pomerantzi Kohls, 1957, Jour. Parasit., 42, (6), pp. 639–642 (Dec. 1956).

Only three lots of this tick have been taken, all from *Sylvilagus brasiliensis,* as follows: Casa Tilley, Cerro Punta (Chiriquí), 1 May 1960, V. J. Tipton and C. M. Keenan, 2 males, 1 female, 13 nymphs; Bambito (Chiriquí), 5100 feet, 7 March 1962, V. J. Tipton, 1 male, 2 females, 17 nymphs; same locality, 13 March 1962, V. J. Tipton, 1 male, 1 female, 9 nymphs.

The species was described from adults from *Sylvilagus brasiliensis* in Peru and *S. floridanus chiapensis* in Guatemala.

Ixodes rubidus Neumann

Ixodes rubidus Neumann, 1901, Mém. Soc. Zool. Fr., 14: 282–283. Nuttall and Warburton, 1911, Ticks, pt. 2, pp. 175–176. Cooley and Kohls, 1945, Nat. Inst. Hlth. Bull., no. 184, pp. 153–156.

In addition to the 13 females from *Eira barbara* reported by Cooley and Kohls (1945) from Boquete (Chiriquí), we have secured five additional lots as follows: Nueva Colonia (Chiriquí), 30 Jan. 1960, V. J. Tipton and C. M. Keenan, from *Procyon lotor*, 7 females, 7 nymphs, 15 larvae; Bambito (Chiriquí), 15 Feb. 1960, V. J. Tipton and C. M. Keenan, from *Mustela frenata*, 1 female; Casa Tilley, Cerro Punta (Chiriquí), 5300 feet, 12 March 1962, V. J. Tipton, from *Conepatus semistriatus*, 9 females, 17 nymphs; Bambito (Chiriquí), 5100 feet, 12 March 1962, V. J. Tipton, from *Bassaricyon gabbii*, 3 females, 4 nymphs; and 13 March 1962, from *Nasua nasua*, 1 female. All of our material has come from small, wild carnivores of the families Procyonidae and Mustelidae, and from localities over 5000 feet in Chiriquí Province. The species was described from a female from *Bassariscus astutus*, Guanajuato, Mexico, and the Rocky Mountain Laboratory has 2 females from *Didelphis* sp., Yepocapa (Chimaltenango), Guatemala, 19 Jan. 1949, H. T. Dalmat. The male remains unknown.

Ixodes tapirus Kohls

Ixodes tapirus Kohls, 1957, Jour. Parasit., 42, (6), pp. 642–643, (Dec. 1956).

Two lots of this recently described species, both from tapir, *Tapirus bairdii*, have been secured. Upper Río Changuinola (Bocas del Toro), 10 May 1959, R. Hartmann, 1 female, and Río Candela (Chiriquí), 6600 feet, Oct. 1953, R. Hartmann, 5 females. This species was previously known from a female from the woolly, or mountain tapir, *Tapirus pinchaque*, Río Majuas, about 8600 feet, San Agustin (Huila), Colombia.

Ixodes tiptoni Kohls and Clifford

Ixodes tiptoni Kohls and Clifford, 1962, Jour. Parasit., 48, (2), pp. 182–184.

Records of this recently described species will be found listed in detail in the original description. Subsequent collections include larvae, nymphs, females and a single male, from *Sciurus granatensis* and from rodent and bird nests, the latter probably in use by mammals, possibly squirrels. One lot is from Río Changena (Bocas del Toro), 6000 feet, the others from the vicinity of Cerro Punta (Chiriquí).

The important morphological features of the male are given in the key to the males of this genus.

Ixodes venezuelensis Kohls

Ixodes venezuelensis Kohls, 1953, Jour. Parasit., 39, (3), pp. 300–303.

We have taken only females of this species and all but one lot came from a camp on the slopes of Mount Tacarcuna (Darién). Tacarcuna Yellow Fever Station, 31 Aug. 1958, GML, from *Zygodontomys microtinus*, 3 females; 1 Sept. 1958, same host, GML, 2 females; 2 Sept. 1958, same host, GML, 1 female; 7 Sept. 1958, same host, GML, 3 females; 20 March 1959, GML, from *Monodelphis adusta*, 1 female; Cerro Azul (Panamá), 14 March 1961, C. E. Yunker, from *Oryzomys* sp., 1 female.

Kohls (1953) recorded females and nymphs of this species from *Heteromys anomalus anomalus* and *Monodelphis brevicaudata palliolata*, State of Aragua, Venezuela, and females from *Oryzomys caliginosus* and *Nectomys alfari*, Antioquia, Colombia. Vogelsang and Dias (1953) recorded a female from *Mus musculus*, State of Aragua, Venezuela. The male is unknown.

Genus **Anocentor** Schulze, 1937

The one known species in this genus is widely distributed in the New World from southern Texas, Florida, and the West Indies southward to Brazil. It is commonly referred to as the "tropical horse tick."

Anocentor nitens (Neumann)

Dermacentor nitens Neumann, 1897, Mém. Soc. Zool. Fr., **10**: 376–378. Dunn, 1915, Ent. News, **26**: 214–219; 1923, Amer. Jour. Trop. Med., **3**, (2), pp. 93–94. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 583.

Otocentor nitens (Neumann), Cooley, 1938, Nat. Inst. Hlth. Bull., no. 171, pp. 65–68, figs.

Anocentor columbianus Schulze, 1937, Zool. Anz., **120**: 24–27, figs.

Dunn (1923, 1934) reports this tick as primarily a parasite of horses and mules in Panama; often all stages are found on the host simultaneously. He also indicates that the ticks seem to prefer the ears. Fairchild (1943) noted that it is often taken on cattle and that is was taken twice from deer. Subsequent records include thousands of specimens collected by Field in 1954–1955 from horses in horse-baited mosquito traps at Fort Davis, and lesser numbers from horses at Fort Clayton. It is a curious fact that this New World tick is now very largely confined to domestic animals of Old World origin. Observations on the biology of this tick in Panama are given by Dunn (1915).

Genus **Dermacentor** Koch, 1844

KEY TO PANAMANIAN SPECIES

Males and Females

1. Spurs of coxa I with proximal edges parallel or only slightly divergent.......... *latus*
   Spurs of coxa I widely divergent.. 2
2. Males ventrally with a short retrograde tubercle on some of the festoons. Female scutum with whitish ornamentation indistinct; tarsi II to IV each with strong, sharp, subterminal and apical ventral spurs.............................. *imitans*
   Males ventrally without tubercles on the festoons. Female scutum with distinct whitish ornamentation; tarsi II to IV each with the subterminal ventral spur blunt and much shorter than the apical ventral spur........................ *halli*

Only one species of this genus has been hitherto recorded from Panama, *D. latus* Cooley (Fairchild, 1943). Extensive collecting in the highlands of Chiriquí and Darién Provinces has added two species and has indicated that the species in the genus appear to prefer a cool environment.

Dermacentor latus Cooley

Dermacentor latus Cooley, 1937, Jour. Parasit., 23: 262–264, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Arthur, 1960, Ticks, pt. 5, pp. 102–103, figs. (fig. 185 is of scutum of *D. dispar*, not *D. latus* as stated). Clifford and Kohls, 1962, Jour. Parasit., 48: 486–488, figs.

This species was described from a single male from tapir in Costa Rica. Fairchild (1943) reported a male from dog, Boquete (Chiriquí). We have since secured additional material as follows: Río Candela (Chiriquí), >5000 feet, 20 Aug. 1954, R. Hartmann, from man, 1 male; Río Candela, >6000 feet, Dec. 1953, R. Hartmann, from tapir, 12 males, 12 females; Upper Río Changuinola (Bocas del Toro), >6000 feet, 10 May 1959, R. Hartmann, from tapir, 36 males, 12 females; Río Changena (Bocas del Toro), 2400 feet, 16 Sept. 1960, C. M. Keenan and C. E. Yunker, from tapir, 16 males, 12 females; Río Changena, >6000 feet, 8 Sept. 1961, V. J. Tipton, from man, 1 female. We feel that the tapir is probably the true host of this tick in the adult stage.

The female of the species was described by Clifford and Kohls from specimens from Río Candela and Río Changuinola.

Dermacentor halli McIntosh

Dermacentor halli McIntosh, 1931, Jour. Parasit., 18: 124 (brief description); 1932, Proc. U. S. Nat. Mus., 82, art. 4, pp. 1–6, figs. Cooley, 1938, Nat. Inst. Hlth. Bull., no. 171, pp. 55–58, figs. Arthur, 1960, Ticks, pt. 5, pp. 69–74, figs.

The previous range of this species was from Yucatan, Mexico, north to extreme southern Texas, and the hosts were peccary and skunk. Our records are all from the vicinity of Cerro Punta (Chiriquí), at about 5000 feet, collected by V. J. Tipton and C. M. Keenan (unless otherwise indicated), as follows: 3 May 1960, from rodent nest, 4 males, 1 female, 1 nymph; 4 May 1960, from rodent nest, 2 males; 10 Jan. 1961, C. E. Yunker, from mouse, 1 male reared from nymph; 6 March 1962, from *Coendou mexicanus,* 2 males, 1 female; 11 March 1962, same host, 1 male; 8 March 1962, same host, 7 males, 2 females; 6 March 1962 from *Myotis nigricans,* 1 nymph; Bambito (Chiriquí), 12 March 1962, from *Coendou mexicanus,* 1 male, 2 females; same data, 5 males, 1 nymph. The specimen from *Myotis* is possibly a stray.

The Rocky Mountain Laboratory has records of this species as follows: from peccary, Los Pozos (Sinaloa), Mexico, 26 Dec. 1937, 1 male; from man or vegetation, Taninul (San Luis Potosí), 24 Aug. 1961, 1 male, R. B. Eads; from *Coendou mexicanus,* San Pedro Yepocapa (Chimaltenango), Guatemala, April 1949, 5 males, 3 females, H. T. Dalmat; same host, locality and collector, 9 Feb. 1950, 1 female; and 15 April 1951, 8 males, 3 females; same host and collector, Acatenango (Chimaltenango), Guatemala, 8 Feb. 1951, 1 male, 2 females; from sloth, near San José, Costa Rica, March 1962, J. J. Shaw, 1 female.

The specimens from Panama, Costa Rica, and Guatemala differ somewhat from those from Texas and Mexico. They are more slender and narrowed anteriorly, the palpi are thinner, the porose areas tend to be larger, and the females from Panama have the cornua much reduced or absent. If these ticks are actually *D. halli* as we assume them to be, it is strange that there are no records of this species from peccaries in Panama or elsewhere in Central America.

Dermacentor imitans Warburton

Dermacentor imitans Warburton, 1933, Parasitology, 24: 559–560, figs. Cooley, 1937, Jour. Parasit., 23: 261, figs. Arthur, 1962, Ticks, pt. 5, pp. 97–98, figs.

This species, previously known only from the type lot consisting of 12 males and 1 female from peccary, *Tayassu tajacu,* (=*Pecari angulatus*), at Turrialba, Costa Rica, is now known from Panama, Guatemala and Mexico as detailed below.

Our Panama material consists of 6 lots as follows: Río Candela, (Chiriquí), 20 Aug. 1954, R. Hartmann, from man, 1 male; near Almirante (Bocas del Toro), 9 Feb. 1960, C. M. Keenan and V. J. Tipton, from collared peccary, *Tayassu tajacu,* 2 males; Timishik, Rio Teribe (Bocas del Toro), May 1962, from *Tayassu tajacu,* 10 males, 4 females; Cerro Pirre (Darién), 2 Feb. 1961, C. M. Keenan and C. E. Yunker, from *Tayassu tajacu,* 1 female; same locality, host and collectors, 5 Feb. 1961, 3 males; same locality, 6 Feb. 1961, C. E. Yunker and V. J. Tipton, from work table with animal skins, host unknown, 1 male. All the localities are in the highlands, over 3000 feet, except the collection from Bocas del Toro Province.

The collections of the Rocky Mountain Laboratory contain 1 male of this species from *Tayassu* sp. taken at Santa Clara near Cabanas (Zacapa), Guatemala, 1 Aug. 1948, at 5500 feet elevation by R. D. Mitchell and Luis de la Torre, Chicago Natural History Museum Guatemala Zoological Expedition. There are also 3 lots from El Ocote, Ocozocoautla (Chiapas), Mexico, 2000 feet elevation, collected by Miguel Alvarez del Toro, with data as follows: 1 male, 2 females from *Tayassu* sp., 4 May 1946; 1 male, same host and date; and 2 males from *Mazama americana,* 25 May 1950. The latter specimens are probably strays.

Genus **Rhipicephalus** Koch, 1844

Rhipicephalus sanguineus (Latreille)

Ixodes sanguineus Latreille, 1806, Gen. Crust. Ins., 1: 157.
Rhipicephalus sanguineus (Latreille), Dunn, 1923, Amer. Jour. Trop. Med., 3, (2), p. 94. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 583. Cooley, 1946, Nat. Inst. Hlth. Bull., no. 187, pp. 24–29, figs.

The common brown dog tick, is found on nearly all dogs throughout Panama. Fairchild removed nearly a pint of ticks from a stray mongrel several years ago. Infestation of houses by this tick is not uncommon, and often leads to excited inquiries on the part of the householders, though we have not encountered evidence of the ticks actually biting man. We have occasional records from animals in captivity, such as marmosets, capybara, and domestic rabbit, but these are no doubt accidental.

Genus **Boophilus** Curtice, 1891

Boophilus microplus (Canestrini)

Haemaphysalis micropla Canestrini, 1887, Atti Soc. Veneto Trent. Sci. Nat., **11**: 104.
Margaropus annulatus australis (Fuller), Dunn, 1923, Amer. Jour. Trop. Med., **3**, (2), p. 95.
Boophilus microplus (Canestrini), Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 586. Cooley, 1946, Nat. Inst. Hlth. Bull., no. 187, pp. 17–22, figs. (with *Uroboophilus cyclops* Minning as synonym).
Uroboophilus cyclops Minning, 1934, Zeitschr. Parasitenk., **7**: 33, figs.

This is the most abundant tick on cattle throughout Panama. We have records from as high as Cerro Punta, (5800 feet), in Chiriquí Province. Aside from twenty-three records from cattle, we have three records from horse, three from pig, and one each from goat and deer. Dunn (1923) recorded it, as *Margaropus annulatus australis* Fuller, from dogs as well. He also recorded the North American cattle tick, *B. annulatus*, from a recently imported bull, but it does not seem to have become established here.

Genus **Haemaphysalis** Koch, 1844

KEY TO PANAMANIAN SPECIES

Males and Females

Palpal segment 3 with a very short retrograde ventral spur; ventral cornua present; hypostome with dentition 3/3 .... *leporispalustris*
Palpal segment 3 with a long retrograde ventral spur; ventral cornua absent; hypostome with dentition 4/4 or 5/5 .... *juxtakochi*

Nymphs

Coxa I with a small external spur; palpal segment 2 ventrally with 4 or more stout hairs on the internal margin .... *leporispalustris*
Coxa I with external spur absent; palpal segment 2 ventrally with 2 fine hairs on the internal margin .... *juxtakochi*

Larvae

Cornua present on basis capituli dorsally; scutum relatively narrower (approximately 0.25 mm. long, 0.30 mm. wide) .... *leporispalustris*
Cornua absent; scutum relatively broader (approximately 0.24 mm. long, 0.37 mm. wide) .... *juxtakochi*

Haemaphysalis juxtakochi Cooley

Haemaphysalis kochi Aragão, 1908, Trab. Inst. Manguinhos, pp. 3–6 (reprint). Cooley, 1946, Nat. Inst. Hlth. Bull., no. 187, pp. 44–47, figs.
Haemaphysalis juxtakochi Cooley, 1946, loc. cit., no. 187, pp. 48–51, figs. Kohls, 1960, Jour. Parasit. 46, 3, pp. 356–358, figs. (*H. kochi* Aragão and *H. kohlsi* Aragão and Fonseca, 1951 reduced to synonyms of *H. juxtakochi*.)
Haemaphysalis kohlsi Aragão and Fonseca, 1951, Mem. Inst. Osw. Cruz, **49**: 574 (new name for *H. kochi* Aragão preoccupied by *H. concinna* var. *kochi* Neumann, 1905).

Dunn (1923) and Fairchild (1943) recorded this species (as *H. kochi*) from deer (*Odocoileus*) and tapir, and on vegetation, while Kohls (1960) recorded the species from *Odocoileus* and *Mazama*. Subsequent collections are all from the Canal Zone area, as follows: Gamboa road, 14 March 1961, N. B. Gale, from *Nasua nasua* dead on road, 3 nymphs; Juan Mina, 10 March 1944, GML, from peccary, 1 nymph; Río Casaya, 27 Feb. 1944, GML, from collared peccary, 1 nymph; Summit Gardens, 29 Aug. 1959, V. J. Tipton and C. M. Keenan, from *O. virginianus*, 24 males, 15 females; vicinity of Gamboa, 24 Oct. 1959, same collectors and host, 7 males, 6 females; Cerro Tigre, 4 July 1961, same collectors and host, 7 males, 3 females; Curundu, 10 March 1961, same collectors, from *Coendou rothschildi*, 1 nymph; Barro Colorado Island, 15 July 1960, same collectors, from *Tapirus bairdii*, 1 female.

Deer, especially *Odocoileus*, seem to be the preferred hosts of the adults, while nymphs have been secured from a variety of animals.

Haemaphysalis leporispalustris (Packard)

Ixodes leporis-palustris Packard, 1869, Ann. Rept. Peabody Acad. Sci., p. 67.

Haemaphysalis leporis-palustris (Packard), Dunn, 1923, Amer. Jour. Trop. Med., **3**, (2), p. 96. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 586. Cooley, 1946, Nat. Inst. Hlth. Bull., no. 187, pp. 31–36, figs. Kohls, 1960, Jour. Parasit., **46**, (3), pp. 355–361.

Dunn (1923) recorded specimens from domestic rabbit and *Dasyprocta* sp., while Kohls (1960) gave a number of records from *Sylvilagus* and birds. Nearly all of our specimens were taken from *Sylvilagus brasiliensis*, as follows: Cerro Punta (Chiriquí), 1 May 1960, V. J. Tipton and C. M. Keenan, 2 females; Río Mandinga (San Blas), 29 May 1957, P. Galindo, 6 males, 3 nymphs, 1 larva; 2 May 1957, same locality and collector, 2 females; Cerro Azul (Panamá), 15 March 1961, C. E. Yunker, 1 female held for oviposition, eggs and larvae secured; 22 March 1961, same locality and collector, 8 males, 2 females, 2 nymphs; Bambito (Chiriquí), 5100 feet elevation, 7 and 13 March 1962, V. J. Tipton, 1 male, 4 females, 4 nymphs, 1 larva; Cerro Punta (Chiriquí), 5300 feet elevation, 11 March 1962, V. J. Tipton, 2 males, 2 females, 2 nymphs; Las Palmitas (Los Santos), 19 and 28 Feb., and 1 March 1962, V. J. Tipton (4 lots), 47 males, 13 females, 40 nymphs, 2 larvae; El Hato (Chiriquí), 7 Jan. 1961, L. C. Wislocki and C. E. Yunker, from *Peromyscus* sp., 1 larva.

Genus **Amblyomma** Koch, 1844

KEY TO PANAMANIAN SPECIES

Males [5]

1. Marginal groove complete, limiting all festoons 2
   Marginal groove incomplete or absent 10
2. Coxa I with two long equal or subequal spurs, both spurs at least twice as long as broad 3
   Coxa I with one or both spurs short or medium 6

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[5] Excluding *crassum* Robinson, 1926. We have not seen males but we believe the description by Mendez and Ortiz (1957) may be that of another species, perhaps *sabanerae*.

3. Spurs on coxa I very long and acute, much longer than the spur on coxa IV, the external spur slightly curved outward near the tip. Body elongate oval..... *ovale*
   Spurs on coxa I as long as spur on coxa IV or shorter........ 4
4. Coxa I with broad stout spurs. Scutum with punctations numerous, large and deep .... *coelebs*
   Coxa I with slender acute spurs. Scutum with punctations few and fine.......... 5
5. Body broad oval. Elements of scutal pattern all of about equal intensity. Medium sized species .... *tapirellum*
   Body elongate oval, lateral margins subrectilinear. Longitudinal elements of scutal pattern accentuated, giving a more striped appearance. Very small species .... *oblongoguttatum*
6. Scutum with elongate, keel-like ridge in posteromedian area........ *pecarium*
   Scutum without keel-like ridge........ 7
7. Palpal segment 1 with a stout ventral retrograde spur. Trochanters I–IV each with a small ventral spur. Scutum inornate or very slightly ornate. Small species 8
   Palpal segment 1 without ventral spur. Trochanters without spurs. Scutum distinctly ornate 9
8. Coxa I with internal spur much shorter than the external. Scutum inornate........ *parvum*
   Coxa I with short sub-equal spurs. Scutal ornamentation indistinct or absent .... *auricularium*
9. Capitulum sub-rectangular. Coxae II and III each with spurs in the form of a broad salient ridge; a long stout spur on coxa IV........ *cajennense*
   Capitulum trapezoidal. Coxae II–IV each with a short triangular spur. Ventral plaques large .... *geayi*
10. Marginal groove incomplete, terminating posteriorly at the third festoon on each side. Body large, elongate oval. Ventral plaques large. Coxa I with two small unequal spurs; coxae II–IV each with a single short, pointed spur........ *longirostre*
    Marginal groove absent 11
11. Coxae II–IV each with two spurs (internal spur of IV sometimes absent). Parasites of reptiles and amphibians........12
    Coxae II-IV each with a single spur. Parasites of mammals........13
12. Dentition of hypostome 3/3. Coxal spurs pointed and not notably flattened; internal spurs much smaller than the externals. Scutum smooth; ornamentation not limited primarily to the anterolateral fields; punctations scattered, unequal in size, larger in the peripheral areas........ *dissimile*
    Dentition of hypostome 4/4. Coxal spurs broadly rounded, blunt, subequal. Scutum roughened by small areas of punctation-free elevations; ornamentation limited primarily to the anterolateral fields; punctations dense, coarse and deep .... *sabanerae*
13. Coxa I with two long contiguous equal or sub-equal spurs........14
    Coxa I with one or both spurs short or medium........15
14. Palpal segment 1 ventrally with a broad flattened expansion; segment 2 with a pronounced salient ridge surrounding the posterior border and forming dorsally a strong retrograde spine........ *nodosum*
    Palpal segment 1 ventrally without broad expansion; segment 2 without posterior salient ridge but posterodorsal margin pointed........ *calcaratum*
15. Coxa I with external spur long and pointed, the internal spur short and blunt. Festoons, except the first and median, each bearing a small posteriorly-directed tubercle. Scutum flat; punctations numerous, shallow. Small species.. *naponense*
    Coxa I with subequal spurs........16
16. Small species; scutum less than 4.5 mm. long, indistinctly ornate; punctations numerous, small. Parasite of pacas primarily........ *pacae*
    Large species, scutum more than 4.5 mm. long........17

17. Spurs of coxa I short, approximately as long as wide, well separated. Integument yellowish. Scutum with indistinct ornamentation and with numerous small deep punctations. Cornua very short and broad. Parasite of anteaters primarily .... *pictum*
Spurs of coxa I medium, approximately twice as long as broad, contiguous. Scutum with ornamentation much reduced but distinct. Punctation numerous, coarse, absent from three or four small isolated elevated areas on each side and a similar median area. Cornua long. Parasite of sloths primarily........ *varium*

Females

1. Coxa I with equal or subequal spurs........ 2
Coxa I with the external spur much longer than the internal........ 14
2. Coxa I with long spurs, more than twice as long as broad........ 3
Coxa I with medium or short spurs........ 6
3. Coxa I with slender spurs........ 4
Coxa I with stout spurs........ 11
4. Coxa I with very long acute spurs, the external slightly curved outward near its tip .... *ovale*
Coxa I with moderately long spurs, apical portion of external spur not curved.... 5
5. Genital apron overlaid on each side posterolaterally by a conspicuous, blunt, flattened projection darker in color than the apron and adjacent integument. Punctations not limited to anterior half of scutum........ *tapirellum*
Genital apron overlaid on each side with an inconspicuous, long, slender projection. Punctations very scant on posterior half scutum........ *oblongoguttatum*
6. Coxa II–IV with two spurs (internal spur of IV sometimes absent). Parasites of reptiles and amphibians 7
Coxa II–IV with one spur. Parasites of warm-blooded hosts........ 9
7. Hypostome dentition 3/3. Internal spur of coxa IV very small, sometimes absent .... *dissimile*
Hypostome dentition 4/4........ 8
8. Very large species; scutum over 4 mm. wide. Coxae II–IV each with a pair of short rounded plate-like spurs connected by a salient sharp-edged ridge...*crassum*
Smaller species; scutum less than 3.5 mm. wide. Spurs of coxae II–IV distinctly separated .... *sabanerae*
9. Large species; scutum approximately 3 mm. wide; punctations numerous, coarse or medium. Basis capituli with cornua. Hypostome dentition 4/4........ 10
Small species; scutum approximately 2 mm. wide; punctations numerous, fine. Cornua absent. Hypostome dentition 3/3........ *auricularium*
10. Spurs of coxa I short, about as long as wide. Scutum with punctations medium in size, uniformly distributed. Parasite of anteaters primarily........ *pictum*
Spurs of coxa I about twice as long as wide. Scutum with large deep punctations, these usually few or absent from median field near posterior margin. Parasite of sloths primarily........ *varium*
11. Scutum with extensive pale ornamentation. Palpal segment 1 ventrally with a large elongate flattened plate........ *coelebs*
Scutum extensively dark-colored........ 12
12. Scutum inornate or indistinctly ornate. Coxa I with external spur the longer..*pacae*
Scutum usually distinctly ornate. Coxa I with spurs equal........ 13
13. Scutum with ornamentation consisting of an irregular pale spot in the posterior angle and sometimes one also in each posterolateral field. Palpi slender and smooth .... *calcaratum*
Scutum with ornamentation in the form of a pale spot in the posterior angle and a Y-shaped figure in each lateral field. Palpi heavier and more rugose, segment 2 with an oblique ridge dorsally........ *nodosum*
14. Scutum ornate 15
Scutum inornate; small, about 1.5 mm. wide........ *parvum*

15. Coxae II and III with broad flat ridge-like spurs much broader than long........16
    Coxae II and III with spurs scarcely broader than long........................17
16. Palpal segment 2 about two and one-half times as long as segment 3. Festoons ventrally somewhat rugose and poorly defined, first four on each side of the median each with a well-developed tubercle at the posterointernal angle. Internal spur of coxa I broad, blunt .... *pecarium*
    Palpal segment 2 about twice as long as segment 3. Festoons ventrally smooth and clearly defined, each except the median, with a much smaller tubercle at the posterointernal angle. Internal spur of coxa I narrower and more sharply pointed .... *cajennense*
17. A small to medium-sized species. Coxa I with external spur long, slender, pointed; internal spur, short, blunt, stout. Scutum with extensive pale ornamentation .... *naponense*
    Large species. Coxa I with both spurs short, flat; internal spur very small. Scutum mostly dark colored..18
18. Scutum cordiform, about as long as wide, with irregular pale areas in the posteromedian field .... *geayi*
    Scutum elongate oval, indistinctly ornate with an irregular longitudinal pale area in the median field. Hypostome very long and sharply pointed. Legs, especially IV, notably long .... *longirostre*

Amblyomma auricularium (Conil)

Ixodes auricularius Conil, 1878, Act. Acad. Nac. Cienc. Exact., **3**: 99–110, figs.

Amblyomma concolor Neumann, 1899, Mém. Soc. Zool. Fr., **12**: 222. Robinson, 1926, Ticks, pt. 4, pp. 66–69, figs.

Amblyomma auricularium (Conil), Lahille, 1905, An. Minist. Agric., Secc. Zootec. Bact., Vet., Zool., **2**, (2), pp. 34, 145–148, figs. Aragão, 1935, Mem. Inst. Osw. Cruz, **30**, (3), p. 528 (with *A. concolor* as synonym). Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), pp. 583–584.

Amblyomma curruca Schulze, 1936, Zeitschr. Parasitenk., **8**, (6), pp. 621–622. *New synonymy.*

This is an abundant species whose chief hosts appear to be armadillos, although it has been taken in smaller numbers on a variety of other mammals, especially marsupials and edentates. It appears to range throughout the Republic, though most of our records are from the drier Pacific side and all are from elevations below 500 feet. We have specimens from the following hosts: *Dasypus novemcinctus* (22 lots, 164 males, 122 females, 28 nymphs, 7 larvae); *Cabassous centralis* (1 lot, 1 male, 2 nymphs); *Tamandua tetradactyla* (12 lots, 14 males, 13 females); *Didelphis marsupialis* (2 lots, 3 males, 1 female); *Philander opossum* (3 lots, 4 males, 4 females, 13 nymphs, 5 larvae); *Sigmodon hispidus* (2 lots, 2 females reared from 2 nymphs); *Hydrochaeris hydrochaeris* (1 lot, 1 male); *Nasua nasua* (1 lot, 2 males); domestic dog (1 lot, 1 male); animal burrows, probably dug by armadillos (2 lots, 1 male, 1 female, many nymphs). The three lots from *Philander* consisted, in part, of engorged nymphs from which adults were reared.

The range of this species extends from Mexico to Argentina.

Examination of the types of *A. curruca* by Kohls revealed that this species is a synonym of *A. auricularium*, not of *A. parvum* as stated by Aragão and Fonseca (1953).

Amblyomma cajennense (Fabricius)

Acarus cajennensis Fabricius, 1787, Mant. Insect., p. 372.
Amblyomma cajennense (Fabricius), Dunn, 1923, Amer. Jour. Trop. Med., 3, (2), p. 96; 1934, Psyche, 41, (3), p. 182; 1934, Jour. Parasit., 20, (5), p. 312. Robinson, 1926, Ticks, pt. 4, pp. 48–54, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 584. Cooley and Kohls, 1944, Jour. Parasit., 30, (2), pp. 83–87, figs. Aragão and Fonseca, 1953, Mem. Inst. Osw. Cruz, 51: 485–488. Kohls, 1958, Jour. Parasit., 44, (4), pp. 430–433, figs.

Although this is an abundant species, it is interesting that adults are not often taken from wild hosts. Our records, therefore, do not adequately indicate its abundance, since collections from domestic animals have been few and confined to small samples of the population of ticks on any one animal. For this reason no numbers of ticks collected are given below in the host list. The species seems to be present in most parts of the country up to elevations of over 5000 feet, but is most abundant in the drier areas and where cultivation has reduced the original forest cover. Our records are, as with most species of *Amblyomma,* confined almost wholly to adults, as nymphs and larvae are not yet identifiable with certainty: Horse (24 lots), cattle (20 lots), man (13 lots), dog (5 lots), horse-baited mosquito traps (3 lots), *Tamandua* (3 lots), *Didelphis* (2 lots), deer (2 lots), domestic hog (2 lots), chicken (2 lots), on vegetation and ground (2 lots), tapir, peccary, *Dasypus,* goat and a hawk, *Buteo magnirostris* (1 lot each). As can be seen by the above, horses and cattle seem to be the preferred hosts of the adults. Most of the collections from man consist of one or a few specimens taken crawling on the clothing, though the species will attack if given the opportunity. It is probably the larvae of this species which form the bulk of the seed ticks which attack man in enormous numbers during the dry season.

The range of *A. cajennense* extends from southern Texas and islands of the Caribbean to Argentina. In Panama, natural infection of this tick with the etiologic agent of Rocky Mountain spotted fever, *Rickettsia rickettsi,* has been demonstrated by Rodaniche (1953) and the species is believed to be a vector here as in Mexico, Colombia and Brazil.

Amblyomma calcaratum Neumann

Amblyomma calcaratum Neumann, 1899, Mém. Soc. Zool. Fr., 12: 226. Robinson, 1926, Ticks, pt. 4, pp. 191–194, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 584.

This large tick is almost restricted to anteaters; of 24 lots, 20 are from *Tamandua tetradactyla* and one from *Myrmecophaga tridactyla,* the latter a rare animal in Panama. Two of the remaining lots, collected by L. H. Dunn from *Choloepus hoffmanni,* include 5 adults, Panamá, and 1 female from Río Abajo (Panamá), 28 Sept. 1931. One lot is from *Mazama americana,* 1 male, Río Teribe (Bocas del Toro), 10 Aug. 1962. We have studied 62 males, 24 females, from localities on both coasts and from Darién to Bocas del Toro Provinces, but not from any elevations over 2500 feet. This species is often found together with *A. nodosum* on the same animal, and has a similar geographic range in Panama.

In addition to Panama, this species has been recorded from Venezuela, French Guiana, Ecuador, Brazil, and Paraguay. The Rocky Mountain Laboratory collection contains 1 male, San Rafael, Trinidad, 27 Feb. 1947, from *Tamandua tetradactyla longicauda,* Frank Wonder, Chicago Natural History Museum; 5 males, Río Guapaya, La Macarena (Meta), Colombia, 21 March 1957, from *Tamandua* sp., K. von Sneidern, Chicago Natural History Museum; 1 male, 1 female, San José, Costa Rica, 5 Feb. 1934, from "small anteater", F. Nevermann; 7 males, 2 females, Kate's Lagoon, British Honduras, 26 Feb. 1940, from "lesser anteater", I. T. Sanderson, Chicago Natural History Museum.

Amblyomma coelebs Neumann

Amblyomma coelebs Neumann, 1899, Mém. Soc. Zool. Fr., 12: 223. Robinson, 1926, Ticks, pt. 4, pp. 30–33. Dunn, 1934, Jour. Parasit., **20,** (5), p. 312; Psyche, **41,** (3), p. 182. Fairchild, 1943, Amer. Jour. Trop. Med., **23,** (6), p. 584. Dias, 1958, An. Inst. Med. Trop., **15,** (2), pp. 507–508 (with *A. bispinosum* Neumann as synonym).
Amblyomma bispinosum Neumann, 1906, Arch. Parasit., **10,** (2), p. 204.

Dunn (1934, 1934a) recorded this species from tapir and horse, Progreso (Chiriquí), and from three tapirs from Summit (Canal Zone), and Aguas Buenas (Panamá). Fairchild (1943) added records of single specimens from tapir and horse. Subsequent records, mostly from tapir, are as follows: Cerro Azul (Panamá), 12 May 1957, GML, from tapir, 1 female and 4 nymphs presumably this species; Río Chico Hydrographic Station, Upper Río Chagres (Panamá), 20 March 1948, GML, from tapir, 8 males, 2 females; Río Tuira at mouth of Río Paya (Darién), 25 Feb. 1958, P. Galindo, from *Agouti paca,* 1 female; same locality, 3 July 1958, P. Galindo, no host, free; Río Mandinga (San Blas), 18 May 1957, GML, no host, free; Río Changena (Bocas del Toro), 2400 feet, 2 Aug. 1961, R. Hartmann, from tapir, 5 males; same locality 16 Sept. 1961, C. M. Keenan and C. E. Yunker, from tapir, 1 male; Río Teribe (Bocas del Toro), 10 Aug. 1962, GML, 6 males, 6 females, from *Tapirus bairdii;* Porto Bello Trail, Continental Divide (Panamá), 30 May 1914, Hallinan, no host, 1 female; Barro Colorado Island (Canal Zone), 30 March 1924, in woods, no host, 3 females.

The range of this species extends from Mexico to Brazil and northern Argentina. In addition to hosts mentioned above, we have seen specimens from *Mazama americana* in Mexico and from cattle in Nicaragua.

Amblyomma crassum Robinson

Amblyomma crassum Robinson, 1926, Ticks, pt. 4, pp. 177–179, figs. Osorno-Mesa, 1941, An. Acad. Nac. Med., **1938–40,** pp. 413, 422, 425–426. Fairchild, 1943, Amer. Jour. Trop. Med., **23,** (6), p. 584. Mendez and Ortiz, 1957, Mem. Soc. Cienc. Nat. LaSalle, 17: 190–199, figs. Dias-Ungria, 1957, Rev. Sanid. Asist. Social, 22, (5–6), p. 459. Dias, 1958, An. Inst. Trop. Med., **15,** (3), pp. 496–497 (as synonym of *A. humerale* Koch).

Although we have not taken this species in Panama, we include it because it was described from "Darien Country, Colombia," which may have been within the present boundaries of Panama. The description was based on a female found on a "land-tortoise". Available specimens recorded by Fairchild (1943) as this species or *sabanerae* Stoll or *humerale* Koch prove to be *sabanerae*, and there are as yet no authentic records of the occurrence of either *crassum* or *humerale* in Panama.

Mendez and Ortiz (1957) described the male and redescribed the female which they believed to be *crassum* found on "land-tortoise (*Testudo* sp.)" from the territory of the Delta Amacuro in Venezuela but their descriptions and figures appear to be those of another species, perhaps *sabanerae*. Osorno-Mesa (1941) included both sexes in his key and recorded males from land turtles taken in two localities in Intendencia del Meta, Colombia. Dias-Ungria (1957) recorded specimens from *Testudo* sp. in Venezuela. The Rocky Mountain Laboratory collection contains a female taken from "*Testudo tabulata*" (=*Geochelone* sp.), Unguía, Golfo de Urabá, Chocó, Colombia, March, 1950, P. Hershkovitz, Chicago Natural History Museum; and a female found on a log, Sheshea River Basin at the headwaters of the Peruvian Amazon, Peru, 1960 or 1961, by G. E. Dickinson and received from Dr. R. E. Ryckman of Loma Linda University, Loma Linda, California.

Amblyomma dissimile Koch

Amblyomma dissimile Koch, 1844, Arch. Naturg., **10**: 225. Dunn, 1918, Jour. Parasit., 5, (1), pp. 1–10; 1923, Amer. Jour. Trop. Med., **3**, (2), p. 97. Robinson, 1926, Ticks, pt. 4, pp. 163–167. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 584. Cooley and Kohls, 1944, Jour. Parasit., **30**, (2), pp. 98–102, figs. Aragão and Fonseca, 1953, Mem. Inst. Osw. Cruz, **51**: 489 (with *A. deminutivum* Neumann, 1899 as synonym). Dias, 1958, An. Inst. Med. Trop., 15, (2), pp. 494–496 [as synonym of *A. bibroni* (Gervais), 1842].

This is the common reptile tick in Panama. Dunn (1923) found that over 60 percent of the snakes, 72 percent of the toads and 84 percent of the iguana lizards he examined were infested. Dunn (1918) also made a study of the life history of this tick. Fairchild (1943) noted that laboratory infestations on captive snakes were severe enough to kill the snakes. In one case, 190 ticks were removed from a single small fer-de-lance (*Bothrops atrox*). Tipton more recently secured 1800 ticks of all stages from a single snake. All stages are frequently found on a single host animal. The bulk of our material has come from the Canal Zone and vicinity, with no specimens from elevations over 800 feet. We have about 95 lots containing adults, mostly from snakes and iguanas, and an additional 22 lots of nymphs and/or larvae, mostly from lizards, which are probably this species. Two unusual records are 1 male, 1 nymph, 2 larvae from a hatchling aquatic turtle, *Pseudemys scripta*, Barro Colorado Island, Canal Zone, 20 Aug. 1961, J. M. Legler, and 1 male from boat-billed heron, *Cochlearius cochlearius*, Juan Mina, Chagres River, 5 April 1962, C. L. Hayward.

The range of this species extends from Florida, Mexico, and the West Indies, to Argentina.

Dias (1958) maintains that Neumann's (1899) summary of the Gervais (1842) and Packard (1869) descriptions of *Ixodes bibroni* applies to *A. dissimile* but we prefer to retain *dissimile* as the valid name of this species.

Amblyomma geayi Neumann

Amblyomma geayi Neumann, 1899, Mém. Soc. Zool. Fr., 12: 223–224; 1901, Mém. Soc. Zool. Fr., 14: 299. Robinson, 1926, Ticks, pt. 4, pp. 59–61, figs. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 584. Dias, 1961, An. Serv. Veter. Moçambique, 7: 240–242 [as synonym of *A. perpunctatum* (Packard), 1869].

We have secured some 60 lots of this species, practically all from our two species of sloth, *Bradypus infuscatus*, the three-toed sloth, and *Choloepus hoffmanni*, the two-toed sloth. The former is much more often seen, as it feeds on the foliage of the Guarumo (*Cecropia pentandra*) a common second-growth tree in the Canal Zone and elsewhere in the lowlands of Panama. Sloths are frequently encountered crossing highways and are then easily captured, or their corpses may be searched for ticks. However, they are seldom seen and difficult to secure in less inhabited areas, since they are hard to collect from the tree tops. This we believe accounts for the fact that with the exception of three lots from Bocas del Toro Province, all our material is from the Canal Zone or immediate vicinity. We have 35 lots from *Bradypus*, 227 males, 36 females, 8 nymphs; 12 lots from *Choloepus*, 36 males, 12 females; and 8 lots from unidentified sloths, 47 males, 8 females, 2 nymphs, 1 larva. In addition we have a single nymph from the woolly opossum, *Caluromys derbianus*, and 2 males, 1 female, said to be from "Eaton's opossum", which may refer to *Didelphis marsupialis etensis*. The remaining lots are without host, but are probably from sloths. Nymphs, possibly of this species, are occasionally taken with adults on sloths.

This species, originally described from specimens from Brazil and "Darien (Colombie)" which may have been within the present boundaries of Panama, is also recorded from British Guiana and French Guiana. In addition, the Rocky Mountain Laboratory collection contains specimens from *Choloepus*, Iquitos (Loreto), Peru, Sept. 3, 1956, C. Kalinowski, Chicago Natural History Museum.

After reviewing the literature, Dias (1961) concluded that *A. geayi* is the species that was very inadequately described by Packard (1869) as *Ixodes perpunctatus*. We cannot accept his conclusion and we regard *A. geayi* as the valid name of this species.

Amblyomma longirostre (Koch)

Haemalastor longirostris Koch, 1844, Arch. Naturg., 10, (1), p. 223.

Amblyomma longirostre (Koch), Robinson, 1926, Ticks, pt. 4, pp. 137–140, figs., synonymy. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 585.

Amblyomma avecolens Cooley and Kohls, 1944, Jour. Parasit., 30, (2), pp. 107–109, figs. *New synonymy.*

This species appears to be a specific parasite of porcupines, all our records of adults and those of Dunn (1923) being from *Coendou rothschildi*. The males are sometimes found attached to the spines of the host as noted by some earlier workers. Aragão (1936) says that the larvae and generally the nymphs are parasites of birds, and we have nymphs from seven species of birds in Panama. We have records only from the Canal Zone and Darién Province, listed below, but porcupines are uncommon or at least seldom taken, so that we know little of the distribution of either host or tick in Panama. It is noteworthy that a series of the highland porcupine, *Coendou mexicanus,* was not infested with this tick, but with *Dermacentor halli.*

From the Canal Zone: Gatún, 2 Jan. 1932, L. H. Dunn, 1 male, 1 nymph; Juan Mina, 24 April 1940, GML, 2 females; Fort Sherman, 30 July 1959, V. J. Tipton and C. M. Keenan, 1 male, 1 female; same locality and collectors, 29 July 1960, 1 female; same locality, F. S. Blanton, 29 June 1951, 1 male; Curundu, 10 March 1961, V. J. Tipton and C. M. Keenan, 5 males, 1 female; same locality, 19 April 1962, C. E. Yunker, 1 male; Pedro Miguel River, 28 Feb. 1962, V. J. Tipton, 9 males; Barro Colorado Island, 4 March 1955, C. Rettenmeyer, without host data, 1 female, Kansas University 955. Of nymphs, we have records from the following: *Saltator albicollis, Saltator maximus, Icterus chrysater, Xiphorhynchus* sp., *Malacoptila panamensis, Cymbilaimus lineatus, Cacicus microrhynchus* and *Querula purpurata,* all but one belonging to the Passeriformes. Five of the 12 lots of nymphs were from the vicinity of Cerro Pirre (Darién), at about 1600 feet, the rest from Canal Zone localities. Some of the undetermined nymphs and larvae from birds discussed elsewhere in this paper may also be *longirostre.*

The known breeding range of this species, as evidenced by collections of adults, extends from Panama to Brazil but nymphs are found occasionally on birds as far north as the United States. The Rocky Mountain Laboratory collection contains nymphs reported by Cooley and Kohls (1944) as *avecolens* from British Honduras and southern Texas, as well as a nymph taken off the base of the bill of a cardinal at Nashville, Tennessee, 17 July 1947, and several nymphs from birds in Chiapas, Mexico. Kohls has seen a nymph that was found on the throat of a white-eyed vireo in Leon County, Florida, 2 April 1957, L. J. Stannard, Illinois Natural History Survey.

Amblyomma naponense (Packard)

Ixodes naponensis Packard, 1869, Ann. Rept. Peabody Acad. Sci., p. 65.

Amblyomma naponense (Packard), Dunn, 1923, Amer. Jour. Trop. Med., **3**, (2), p. 99. Osorno-Mesa, 1941, An. Acad. Nac. Med., **1938–1940**: 426 (with *A. mantiquirense* Aragão, 1908 as synonym). Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 585.

Amblyomma mantiquirense Aragão, 1908, Brazil. Med., 22: 251–252. Robinson, 1926, Ticks, pt. 4, pp. 212–215, figs. Dunn, 1934, Psyche, 41, (3), p. 182.

Dunn (1923, 1934) records the species from *Tamandua* and collared peccary. Our collections, with few exceptions, are from collared peccary and are summarized as follows: *Tayassu tajacu* (13 lots, 11 males, 27 females); no host (3 lots, 6 males, 2 females); man (1 lot, 1 male, 1 female); *Tamandua tetradactyla* (1 lot, 1 female); *Nasua nasua* (1 lot, 2 females); raccoon (1 lot, 1 female). This species appears to prefer the wetter areas of Panama, as we have material only from the Provinces of Darién, San Blas, Colón, Bocas del Toro and the Canal Zone. Only two collections, from Balboa and Fort Clayton in the Canal Zone, are from relatively dry areas. Only one collection was made above 2000 feet.

This species has also been recorded (as *mantiquirense*) from British

Guiana, French Guiana, and Brazil. The Rocky Mountain Laboratory collection contains specimens from *Tayassu tajacu*, Socorré, Upper Río Sinú (Bolivar), Colombia, 12 March 1949, P. Hershkovitz, Chicago Natural History Museum; and from "wild pig", Sheshea River basin at the head of the Peruvian Amazon, Peru, 1960 or 1961, G. E. Dickinson, received from Dr. R. E. Ryckman, Loma Linda University, Loma Linda, Calif.

Amblyomma nodosum Neumann

Amblyomma nodosum Neumann, 1899, Mém. Soc. Zool. Fr., **12**: 224–225. Dunn, 1923, Amer. Jour. Trop. Med., **3**, (2), p. 98. Robinson, 1926, Ticks, pt. 4, pp. 196–199, figs. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 585.

This species is rather easily confused with *A. calcaratum*, as the two are quite similar in gross appearance and both occur on the same host, often together. We have 19 lots from *Tamandua tetradactyla*, one lot from *Myrmecophaga tridactyla*, and one lot from unknown host, totaling 207 males, 48 females, of which 95 males, 13 females came from one animal. It occurs throughout the lowlands, including at least San José Island in the Pearl Islands, but we have no records from elevations over 1000 feet.

This species, the adults of which are parasitic only on anteaters so far as known, was described from specimens from Costa Rica and besides Panama, it has also been recorded from Guatemala, Colombia, Venezuela, and Brazil. The Rocky Mountain Laboratory collection contains 1 male, 2 females from "lesser anteater", El Recreo, Nicaragua, 9 Feb. 1951, W. H. Dickinson.

Amblyomma oblongoguttatum Koch

Amblyomma oblongoguttatum Koch, 1844, Arch. Naturg., **10**: 228. Robinson, 1926, Ticks, pt. 4, pp. 33–36, figs. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), p. 585. Kohls, 1958, Jour. Parasit., **44**, (4), pp. 430–433.

This is probably the commonest and most ubiquitous tick in Panama, at least at lower elevations. Our records indicate that it prefers forested country, or at least areas of moderately high rainfall, since we have relatively few records of its occurrence in the drier areas of the Pacific coast. Dunn (1923) records it, as *darlingi*, from wild turkey, *Crax panamensis* (*Crax rubra*) from the Boquerón River region and from a black vulture, *Catharista urubu* (=*Coragyps atratus*), while Robinson (1926) records specimens from a turkey buzzard, *Catharista atratus* (=*Coragyps atratus*) from Empire (Canal Zone). We have examined 131 lots of adults from 21 different mammal hosts listed below.

Deer (*Odocoileus*) (18 lots); horse (17 lots); cattle (15 lots); dog (19 lots); peccary (13 lots); man (9 lots); *Nasua nasua* (10 lots); *Tamandua tetradactyla* (7 lots); tapir (7 lots); no host, free on vegetation, etc. (12 lots); domestic hog (3 lots); *Mazama* (2 lots); *Dasyprocta* (3 lots); sloth (*Choloepus*), *Myrmecophaga tridactyla*, goat, armadillo, *Procyon cancrivorus*, *Chironectes minimus*, *Cebus capuchinus*, *Eira barbara*, and domestic cat, (1 lot each).

According to Robinson (1926) and data of the Rocky Mountain Laboratory, *A. oblongoguttatum* occurs from Sinaloa, Mexico to Brazil. The species strongly resembles *A. cajennense* (Fabricius) and *A. tapirellum* Dunn but is separated by the characters given in the keys.

Amblyomma ovale Koch

Amblyomma ovale Koch, 1844, Arch. Naturg., **10**: 227. Robinson, 1926, Ticks, pt. 4, pp. 25–29, figs. (with synonyms including *A. fossum* Neumann, 1899, and *A. striatum* Koch, 1844). Vogelsang and Dias, 1953, Revista Med. Vet. Parasit., Caracas, 12, (1–4), pp. 70–74, figs. (with synonyms including *A. fossum*). Dias, 1958, An. Inst. Med. Trop., 15, (2), p. 507 (with *A. fossum* as synonym). Aragão and Fonseca, 1961, Mem. Inst. Osw. Cruz, 59, (2), pp. 131–148, figs. (detailed review of synonomy; redescribed).

This tick ranges throughout the wetter forested regions of Panama at lower elevations, and we have one record from San José Island in Panama Bay. Dunn (1923, 1934) records specimens from *Tamandua* and tapir, while Fairchild (1943) believed dogs to be the most common host. We have examined 39 lots of adults from 16 different hosts, listed below in order of their abundance. One of the largest single lots, consisting of 17 males and 9 females, was from *Nasua nasua,* which also seems to be a favorite wild host. Over 60 percent of the recorded lots and over 80 percent of the total ticks were from carnivores.

Nasua nasua (12 lots, 44 males, 15 females) ; dog (9 lots, 14 males, 10 females) ; man (7 lots, 5 males, 4 females) ; tapir (6 lots, 13 males, 11 females) ; *Felis pardalis* (3 lots, 1 male, 2 females) ; *Eira barbara* (3 lots, 11 males, 4 females) ; horse (2 lots, 1 male, 1 female) ; *Oryzomys* sp. (2 lots, 2 males) ; *Felis concolor* (1 lot, 25 males, 1 female) ; *Felis onca* (1 lot, 2 males, 1 female) ; sloth (1 lot, 2 males) ; *Felis yagouaroundi* (1 lot, 1 male, 1 female) ; *Procyon lotor* (1 lot, 1 male, 1 female) ; and one specimen each from *Procyon cancrivorus,* armadillo, *Galictis allamandi,* and a bird, *Arremonops conirostris.*

Engorged nymphs which subsequently molted to adults have been taken four times from *Proechimys semispinosus,* and once from *Zygodontomys microtinus,* so that rodents are perhaps important hosts for the earlier stages. Nymphs and larvae associated with adults on the same host, taken on several occasions, are not certainly *ovale.*

Several authors refer to this species as *A. fossum* Neumann, 1899, despite the fact that Robinson (1926) compared numerous specimens of *fossum* from various places in South America with the types of *ovale* and found them to be the same. Dias (1958) examined the types of *fossum* and, in accordance with Robinson and Vogelsang and Dias (1953), found that this species is the same as *ovale.* Although Robinson also reduced *striatum* Koch, 1844, to a synonym of *ovale,* he noted that *striatum* differed somewhat but attributed this to variation. Most subsequent authors have regarded *striatum* as distinct, the most recent of these being Aragão and Fonseca (1961) who include *fossum* among the synonyms of *ovale* and recognize *aureolatum* Pallas, 1772, as the valid name for *striatum.* We have not seen specimens referable to *aureolatum* in our Panama material but a male from an unspecified locality in Darién, possibly within the present boundaries of Panama, was doubtfully determined by Neumann (1899) as *striatum.*

The range of *ovale* extends from Mexico to Argentina. A single male was removed from a dog on the Tama Indian Reservation in Iowa (Eddy and Joyce, 1942) but there is no evidence to suggest that the species is established there or elsewhere in the United States.

Amblyomma pacae Aragão

Amblyomma pacae Aragão, 1911, Mem. Inst. Osw. Cruz, 3, (2), pp. 170–172, figs. Robinson, 1926, Ticks, pt. 4, pp. 209–211, figs. Aragão and Fonseca, 1953, Mem. Inst. Osw. Cruz, 51: 490 (with *A. nigrum* Tonelli Rondelli, 1939 as synonym).

Fairchild (1943) tentatively recorded this species from *Agouti paca,* a determination subsequently confirmed by Kohls. Since then, in spite of the ubiquity and abundance of its hosts, only a few additional collections of this species have been secured, as follows: Almirante (Bocas del Toro), 26 Jan. 1950, V. J. Tipton and C. M. Keenan, from *Agouti paca,* 1 female; Volcán (Chiriquí), 15 June 1959, V. J. Tipton and C. M. Keenan, from *Dasyprocta punctata,* 3 males, 3 females; vicinity of Juan Mina (Canal Zone), Jan. 1962, GML, from *Agouti paca,* 1 female; Fort Kobbe (Canal Zone), 18 Aug. 1955, G. Field, from paca, 1 female; Panamá, L. H. Dunn, T-12, no other data, 1 female; Timishik, Rio Teribe (Bocas del Toro), May 1962, GML, from *Agouti paca,* 1 female.

In addition to Panama this species is recorded from Brazil, Paraguay and Colombia, and the Rocky Mountain Laboratory collection contains a male from *Agouti paca,* Humming Bird Highway, British Honduras, 25 Dec. 1953, Dr. F. Manolson.

Amblyomma parvum Aragão

Amblyomma parvum Aragão, 1908, Trab. Inst. Manguinhos, pp. 18–19 (reprint). Robinson, 1926, Ticks, pt. 4, pp. 37–38. Aragão and Fonseca, 1953, Mem. Inst. Osw. Cruz, 51: 491 [with *A. curruca* Schulze, 1936, erroneously as synonym. Actually, *A. curruca* = *A. auricularium* (Conil), 1878].

This appears to be a rare species in Panama. Dunn (1923) recorded it from deer (*Odocoileus*) and cotton rats (*Sigmodon*) and Fairchild (1943) added a single record from cattle. Review of some old material of Dunn's and a few additional lots taken more recently suggests that the species occurs mainly on the drier Pacific coast and that we do not know its favored host. Our scanty records follow:

Parita (Herrera), 13 June 1931, L. H. Dunn, from cats, 3 females; Tumba Muerta (? Panamá), 13 Sept. 1932, L. H. Dunn, from *Tamandua,* 1 female; Coclé Province, 3 Dec. 1942, H. S. Eakins, from cattle, 1 male, 1 female; Balboa (Canal Zone), 8 Dec. 1914, no host, American Museum of Natural History, 1 female; Paraíso (Canal Zone), May 1955, G. Field, from sloth, 1 female; Fort Clayton (Canal Zone), 7 Nov. 1960, C. E. Yunker, from man, attached, feeding, 1 female.

Besides Panama, this species has been recorded from a wide variety of mammalian hosts from Venezuela, French Guiana, Brazil, and Argentina. In addition, the Rocky Mountain Laboratory collection contains a male and a female taken on man, Finca Santa Cristina (Escuintla), Guatemala, 10 Sept. 1948, H. T. Dalmat, and 3 males from *Urocyon cineroargenteus* *guatemalae,* Hacienda Miramar (Nentón), Guatemala, 18 Nov. 1948, L. de la Torre, Chicago Natural History Museum. Excellent illustrations of adults of this tick are given by Boero (1957).

Amblyomma pecarium Dunn

Amblyomma pecarium Dunn, 1933, Parasitology, 25, (3), pp. 356–358, figs.

Three male paratypes in bad condition remain at Gorgas Memorial Laboratory labeled Miraflores (Canal Zone), 11 Apr. 1932, R. Isaacs, Dunn no. 859, from *Pecari angulatus bangsi.* We have seen the following material, all from collared peccary, or wild pig, very probably collared peccary: Almirante (Bocas del Toro), 9 Feb. 1960, V. J. Tipton and C. M. Keenan, 1 male; Río Tuira, mouth of Río Paya (Darién), 28 Feb. 1958, GML, 1 male; Juan Mina (Canal Zone) 29 March 1946, many males, females, and nymphs; Almirante (Bocas del Toro), 1 March 1937, United Fruit Company Medical Department, 2 males; Fort Clayton (Canal Zone), 13 Sept. 1954, G. Field, 18 males, 1 female; Barro Colorado Island (Canal Zone), 2 Feb. 1961, C. E. Yunker, 7 males, 4 females.

The Rocky Mountain Laboratory collection contains a female from "peccary", Humming Bird Highway, British Honduras, 25 Dec. 1953, F. Manolson, and three lots from jungles of El Ocote, Ocozocautla (Chiapas), Mexico, Miguel Alvarez del Toro, with data as follows: 7 males, 1 female from *Tayassu tajacu,* 4 May 1946; about 40 adults from *Tayassu pecari,* 4 May 1946; and 19 males, 12 females from *Mazama americana,* 25 May 1950. Whether this last lot is actually from a deer seems questionable since all other collections of *pecarium* are from peccaries.

Amblyomma pictum Neumann

Amblyomma pictum Neumann, 1906, Arch. Parasit., 10, (2), pp. 204–206. Robinson, 1926, Ticks, pt. 4, pp. 238–240 (with *A. conspicuum* Aragão, 1913, as synonym).

A singe female which appears to be this little-known species was found on an anteater, *Myrmecophaga tridactyla,* Río Mandinga (San Blas), 25 May 1957, P. Galindo. This species has been previously reported from Brazil off *Myrmecophaga tridactyla* (=*Myrmecophaga jubata*) and dog; from Argentina off dog though not included in Boero's (1957) list; and from French Guiana off *Tamandua* sp. The Rocky Mountain Laboratory collection contains one of two males from giant anteater, upper New River (tributary of Courentyne), southern British Guiana, Sept. 1938, E. R. Blake, Chicago Natural History Museum. The dentition of the hypostome of these males is $3/3$, not $4/4$ as stated by Neumann for this species. Aragão (1913) gave it as $3/3$ in his description of *A. conspicuum;* Floch and Fauran (1958) gave it as $3/3$ for their single male from French Guiana.

Amblyomma sabanerae Stoll

Amblyomma sabanerae Stoll, 1890, Biol. Centr.-Amer., Arach., p. 23, figs. (female). Robinson, 1926, Ticks, pt. 4, pp. 182–183, figs. Schulze, 1937, Zeitsch. Parasitenk., 9, (6), pp. 692–694, fig. (male). Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 584. Dias, 1958, An. Inst. Trop. Med., 15, (2), pp. 496–497 (as synonym of *A. humerale* Koch).

Dunn (1923) recorded as *A. humerale* Koch, 2 males, 2 females taken from a tortoise (which he believed to be *Testudo tabulata*) on the Boqueron River (Panamá), H. C. Clark. Later (1934) he recorded as *humerale* a single adult, sex not stated, from a tapir. We have not seen Dunn's specimens from *Testudo* but we have a *sabanerae* male, without data, determined by Bishopp as *humerale*, which may well be the specimen Dunn reported from tapir. Recent examination of specimens of *Geochelone* (= *Testudo*) from the San Blas coast did not yield any ticks, though several *sabanerae* were taken from specimens of *Geoemyda* from the same area. Whether ticks from *Geochelone* in Panama will be *humerale, crassum* (q.v.), or *sabanerae*, must await re-examination of Dunn's specimens or the collection of new material.

We have taken *A. sabanerae* fairly frequently on turtles of the genus *Geoemyda*, less frequently on other turtles and on iguanas and once on an opossum. The ticks are often attached on the carapace around the margin where they leave characteristic pits in the shell, recognizable for a considerable period after the ticks have detached. Males outnumber females about three to one in our collections, perhaps due to their remaining attached longer. Adults may attach on the shell or on the skin of head and appendages. Dr. John M. Legler informs us that *Geoemyda annulata* is largely terrestrial, *G. funeria, Kinosternon* spp. and *Pseudemys scripta* are aquatic, at least as adults, although they come on land to lay their eggs or when moving from one body of water to another. Most of our material has come from the vicinity of the Canal Zone, though the species appears to range throughout the country at low elevations, as we have material from Darién and Bocas del Toro Provinces.

In the subjoined list, the lots under "turtle" and *Geoemyda* sp. probably are largely from *G. annulata*, the commonest terrestrial turtle in this area. *Geoemyda annulata* (6 lots, 23 males, 4 females, 1 larva); *Geoemyda funeria* (2 lots, 6 males, 3 females, 3 nymphs, 11 larvae); *Geoemyda* sp. (6 lots, 21 males, 3 females, 3 nymphs); turtle (12 lots, 40 males, 15 females, 4 nymphs, 76 larvae); *Pseudemys scripta* (juveniles, 2 lots, 2 males); *Kinosteron* sp. (4 nymphs); *Iguana iguana* (2 lots, 7 males, 1 female); *Marmosa robinsoni* (1 male); crawling on man (1 female).

We have also seen 1 female and 2 nymphs from Los Diamantes, vicinity of Guápiles (Limón), Costa Rica, 29 July 1961, J. M. Legler, from *Geoemyda funeria* (juvenile); 1 nymph, Río Sucio, Quezaltepeque, El Salvador, 4 July 1961, J. M. Legler, from *Geoemyda pulcherina;* and the Rocky Mountain Laboratory collection has 3 records from Mexico as follows: 1 male, 1 female from Island of Cozumal, Quintana Roo, 16 July 1951, L. J. Stannard, from *Geoemyda areolata;* 2 males from Chichen Itza (Yucatan), 24 July 1937, B. W. Andrews, from *Terrapene yucatana,* and 1 male, 1 female from Nayarit, Dec. 1955, J. Cook, from *Geoemyda* sp. The types, 2 females from Guatemala, were from "a small terrapin known to the natives by the name of la Sabanera." Schulze described the male from specimens from Colombia without further data.

Dias (1958) reduced *A. sabanerae* and *A. crassum* to synonyms of *A. humerale* but we regard them as valid species separable by characters given in the keys.

Amblyomma tapirellum Dunn

Amblyomma tapirellum Dunn, 1933, Parasitology, 25, (3), pp. 353–355, figs.; 1934, Jour. Parasit., 20, (5), p. 312. Fairchild, 1943, Amer. Jour. Trop. Med., 23, (6), p. 586. Kohls, 1958, Jour. Parasit., 44, (4), pp. 431–432.

This species was described from tapir, and we have taken it from collared peccary, giant anteater and horse as well. The bulk of our material, however, consists of specimens found crawling on man or on the ground. It appears to be quite strictly limited to forest areas below about 2500 feet, mostly from the Canal Zone eastward into Darién Province; we have only one record from western Panama (La Vaca, Chiriquí Province, 18 Feb. 1930, Dunn, from peccary, 3 males, 1 female). We did not take it on several tapirs examined in the highlands of Chiriquí and Bocas del Toro. To a certain extent it seems to replace *A. cajennense* as a human parasite in forested areas such as Barro Colorado Island, from which we have 27 lots of *tapirellum* totaling 101 specimens, but only 8 of *cajennense*, totaling 18 specimens. We have taken it only once from horse, in that case a pack animal used on a jungle field trip, and have secured no material from cattle or deer, in marked contrast to *cajennense*. We list our material below, by numbers of lots and specimens.

Free on ground or vegetation (11 lots, 11 males, 21 females); man, on clothing (14 lots, 22 males, 32 females); collared peccary (5 lots, 9 males, 5 females); tapir (5 lots, 180 males, 36 females, 1 nymph); man, attached (1 lot, 1 male); *Myrmecophaga tridactyla* (1 lot, 3 males, 2 females); horse (1 lot, 5 males, 6 females); bat (*Carollia perspicillata*) (1 lot, 1 male); no recorded host (16 lots, 20 males, 31 females plus two large lots not counted). The specimen from bat is probably a stray from the collector. One of the large lots with no host data is labeled simply "T-1", and is from Dunn's collecting. It may well be part of the paratype series. Dunn (1933) described the species from an adult tapir collected at Summit (Canal Zone) and mentions additional specimens from two young tapirs taken subsequently, but the dates of neither collection are given. Later (1934), he discusses the ticks taken from three tapirs, an adult killed at Summit (Canal Zone), and two young specimens from Aguas Buenas (Panamá), again with no dates given. In the later paper, *A. tapirellum* is listed, with a reference to the earlier paper. We suspect that both references allude to the same lots of ticks, and that T-1 refers to "Tapir No. 1" of the 1934 paper, the adult tapir from Summit.

Data of the Rocky Mountain Laboratory extend the range of *A. tapirellum* to Nicaragua, Colombia and Venezuela and add cattle to the list of hosts parasitized by this tick.

Amblyomma varium Koch

Amblyomma varium Koch, 1844, Arch. Naturg., **10**: 224 (male). Neumann, 1899, Mém. Soc. Zool. Fr., **12**: 246–247 (redescription of male and description of var. *albida*, Chile); 1901, Mém. Soc. Zool. Fr., **14**: 304–305 (female). Robinson, 1926, Ticks, pt. 4, pp. 205–209, figs.

Amblyomma gertschi Cooley and Kohls, 1942, Pub. Hlth. Rept., **57**, (46), pp. 1733–1735, figs. Fairchild, 1943, Amer. Jour. Trop. Med., **23**, (6), pp. 584–585. New synonymy.

Robinson (1926) records specimens from Panama off *Choloepus,* as does Dunn (1923). In the adult stage, this species, like *geayi,* appears to be restricted mainly to sloths but is less abundant. Both species appear to be slightly more abundant on *Bradypus* than on *Choloepus.*

All material we have seen, except one female from Isla Bastimentos (Bocas del Toro), has come from the Canal Zone or nearby Panamá, as follows: from *Choloepus hoffmanni,* two-toed sloth (16 lots, 30 males, 9 females); *Bradypus infuscatus,* three-toed sloth (12 lots, 30 males, 9 females); from sloth (4 lots, 10 males, 2 females); no host (1 lot, 5 males); from "Eaton's opossum," probably *Didelphis m. etensis* (1 female).

This species, originally described from specimens from Brazil, has been recorded from Nicaragua, Panama, Colombia, Venezuela, the Guianas, Argentina, and Chile (var. *albida*). Vargas (1955) included it in his list of species occurring in Mexico, but its principal hosts, *Bradypus* and *Choloepus,* do not range that far northward and we doubt its presence there. The Rocky Mountain Laboratory collection contains a male and female (and reared larvae) from a sloth from near San José, Costa Rica, March 1962, J. J. Shaw; and a male said to be from "wild pig", Sheshea River basin at the headwaters of the Peruvian Amazon, Peru, 1960 or 1961, G. E. Dickinson, received from Dr. R. E. Ryckman, Loma Linda University, Loma Linda, California.

Dunn (loc. cit.) noted an engorged female of *varium* that weighed over 5 grams, the largest tick he had seen from Panama. We have two engorged females which weigh 6.4 grams each. Floch and Fauran (1958) had a specimen from French Guiana measuring 32 mm. long, 30 mm. wide and weighing 7.5 grams.

All males of *A. varium* that we have seen differ from the type of var. *albida* (Robinson, 1926, fig. 100) in being more broadly oval and in having long stout cornua as shown in fig. 2 of Cooley and Kohls (1942). Some males also have a long rather than a short spur on coxa IV. The dentition of the female hypostome is usually arranged $\frac{4}{4}$ rather than $\frac{3}{3}$ as stated by Robinson. In all males that we have seen it is $\frac{3}{3}$ as given by all previous authors, except Floch and Fauran (1958) who stated that it is $\frac{4}{4}$.

Host-Parasite Relationships

We have secured ticks from most of the larger mammals that are known to occur in Panama, as well as from a number of birds and reptiles. Specific identifications of the larger host mammals are reasonably accurate; we have not attempted to identify subspecies. Many of the smaller rodents have been identified to species, but in some cases only a guess as to their generic identity has been possible. Many of the specimens of ticks have been accompanied by only the common name of the host. Names such as "tapir," "ocelot," "jaguar," and "armadillo" permit identification to species with fair certainty. Others such as "sloth," "wild boar," "wild turkey" pose difficulties, as two or more species are referable to these names. Names such as "bird," "lizard," "turtle," "wild rat" hardly permit conjecture.

A host-parasite list is given below. The scientific names of the mammals follow Charles O. Handley's checklist, which appears elsewhere in this volume. Most of the birds have been determined by Dr. Alexander Wetmore. The turtles were identified by Dr. John M. Legler, the other reptiles by various individuals.

In the list, following the scientific name of each host we have given: (1) the number of specimens of the host from which ticks have been taken; (2) the species of ticks in order of their frequency on the host, followed by a number in parentheses indicating the number of individual host specimens that were found infested with that species. Many lots of ticks either were not accompanied by host determinations or the host was merely listed as "mouse," "bird," "lizard," etc. These have not been listed below, but they are included under the discussion of each species of tick.

Table 5 summarizes the information in the host lists. The ticks are listed by genera, with the number of species in each genus. The mammalian hosts are listed by order. The number of genera from which ticks have been secured is indicated for each order. For birds and reptiles we have shown the number of orders and genera from which ticks have been taken. Data for ticks from Amphibia (*Bufo marinus*) are not shown. The numbers in table 5 indicate the number of determined species of tick in each genus that have been taken from hosts of each order or class of animal. "A" indicates adults, "NL" nymphs and/or larvae. A query (?) indicates that nymphs or larvae probably belonging to the indicated genus, but not determined specifically, were secured from the indicated order. In the case of nymphs and larvae, it is probable that many more species were taken than indicated, but in many cases larvae and nymphs are not determinable to species, and were not always determined to genus.

Certain associations are apparent from this table. The Marsupialia are hosts to but two genera of ticks, the Edentata to but one, yet both orders are well represented in species and individuals in Panama.

In Panama, the Chiroptera exceed all other orders of mammals in number of genera and species and yet they are true hosts to ticks of only two genera. The scattered records of other genera from bats probably represent strays or errors of association.

The Primates, with the exception of man, are rarely attacked by ticks. We have never found ticks on wild primates in Panama; all of our records are from animals in captivity.

The Lagomorpha are represented in Panama only by one species of *Sylvilagus*. These rabbits are infested by two species of ticks, *Ixodes pomerantzi* and *Haemaphysalis leporispalustris,* both apparently limited to *Sylvilagus* in Panama. Larvae of several other genera have been taken occasionally on

TABLE 5. HOST PREFERENCES OF PANAMANIAN TICKS (by genera)
(See text for detailed explanation.)

Host groups and numbers of genera from which ticks were collected:	Genera of ticks and number of species in each									
	Argas: 1	*Antricola*: 1	*Ornithodoros*: 7	*Ixodes*: 11	*Anocentor*: 1	*Dermacentor*: 3	*Rhipicephalus*: 1	*Boophilus*: 1	*Haemaphysalis*: 2	*Amblyomma*: 19
	A/NL	A/NL	A/NL	A/NL	A/NL	A/NL	A/NL	A/NL	A/NL	A/NL
Marsupialia: 6	..	..	..	5/1	..	..	..	..	..	6/2
Insectivora: 1	..	..	..	/?	..	..	..	..	..	..
Chiroptera: 14	..	1/1	3/4	/?	..	/1	..	..	..	2/?
Primates (man)	..	..	2/	1/	..	2/	..	..	..	6/?
Edentata: 7	..	..	..	/?	..	..	..	..	..	12/2
Lagomorpha: 2	..	..	/1	1/1	..	/?	1/	..	1/1	/?
Rodentia: 17	..	..	/1	5/2	..	1/1	1/	..	/2	6/3
Carnivora: 11	..	..	..	3/2	..	1/	1/1	..	/1	6/
Perissodactyla: 2	..	..	..	2/	1/1	1/	..	1/1	1/	5/2
Artiodactyla: 5	..	..	..	2/	1/1	1/	..	1/1	1/1	7/1
Reptilia: 15 (from 3 orders)	..	..	..	..	..	..	..	..	..	3/2
Aves: 26 (from 8 orders)	1/1	..	/1	1/	..	..	..	..	..	3/1

A = adults; NL = nymphs and/or larvae;
?=Probable members of indicated genus, but of undetermined species

these rabbits. The record for *Rhipicephalus* on Lagomorpha is based on the domestic rabbit and is doubtless due to a laboratory infestation.

The Insectivora are poorly represented in Panama. Only undetermined tick larvae were secured from the few specimens of shrews examined.

The Rodentia are hosts to thirteen species of ticks belonging to six genera. However, probably the only species whose adults regularly parasitize rodents are those of *Ixodes* and *Amblyomma,* while only the earlier instars of species of the other genera listed parasitize these hosts. Again, the record of *Rhipicephalus* refers to a rodent (capybara) kept in heavily infested quarters in the laboratory.

The Carnivora are hosts to adult ticks of eleven species belonging to four genera; an additional genus is recorded only from an early instar. *Rhipicephalus* has been taken only on domestic dogs and cats in Panama and does not belong to the native fauna.

The Perissodactyla in Panama include only the horse and tapir, but together these are hosts to eleven species of six genera of ticks. The horse is host to seven species representing three genera, the tapir to nine species belonging to four genera. Of these, *Dermacentor*, *Ixodes*, and *Haemaphysalis* have been taken only on the tapir, *Anocentor* and *Boophilus* only on the horse. The Artiodactyla, with five genera positive for ticks, have yielded thirteen species belonging to six genera. We have not had the opportunity to examine the white-lipped peccary (*Tayassu*), the only large terrestrial mammal from which we have not secured ticks.

The Reptilia, in Panama, are hosts to but two species of *Amblyomma* (three, if *A. crassum* actually occurs here), one on turtles and the other on a wide variety of lizards and snakes, as well as on the common toad, *Bufo marinus*. We have not examined any of the local Crocodilia. These are almost exclusively aquatic and not likely to be infested by ticks.

The Aves are rarely hosts to adult ticks. Probably only *Argas persicus* and *Ixodes brunneus* regularly infest birds in this stage. Birds are, however, frequently attacked by larval ticks of at least one and probably several species of *Amblyomma*. Search of a few nests of birds—such as woodpeckers and toucans, which utilize treeholes—has so far not yielded any ticks.

Host Specificity

It is exceptional to find adults of any Panamanian species of ticks (exclusive of Argasidae), parasitizing hosts of more than one class of vertebrates. *Amblyomma dissimile* apparently is the only tick to do so regularly, since it attacks species of both Amphibia and Reptilia. Adults of *A. dissimile* and *A. cajennense* have also been taken occasionally on birds. It is very doubtful that these hosts are satisfactory or that they are regularly parasitized by these ticks. Most Panamanian Ixodidae do not regularly parasitize hosts of more than one order of vertebrates, though there are exceptions. Among those species of which we have adequate material, two species of *Ixodes* regularly parasitize mammals of more than one order. Another species has been taken once on a small marsupial, but otherwise only on rodents, while the remaining species appear to be confined to hosts of a single order. *Anocentor nitens* and *Boophilus microplus* parasitize both Artiodactyla and Perissodactyla, while *Rhipicephalus sanguineus* is almost restricted to dogs. It is probable that all three species of *Dermacentor* regularly parasitize species of but a single order of mammals. However, all have been taken as strays on members of other orders. Each of the two species of *Haemaphysalis* also appear to be confined to hosts of a single order, though *H. leporispalustris*, which is normally restricted to Lagomorpha, has been secured once from a rodent.

In the dominant genus *Amblyomma*, with nineteen species in Panama, host selectivity varies greatly. Species such as *cajennense* and *oblongoguttatum* occur on hosts of seven or eight different orders, while *longirostre* and *pecarium* are known from only a single species of host. The six species parasitizing Edentata are of some interest. Two, *geayi* and *varium*, are practically confined to the almost entirely arboreal sloths. Three others—

calcaratum, pictum, and *nodosum*—parasitize the less arboreal anteaters. There are two records of *calcaratum* from sloths. The last species, *auricularium,* is primarily a parasite of the burrowing armadillos, though it is often taken on anteaters and occasionally on hosts of other orders.

Our information on the hosts of the early instars of Panamanian ticks is meager. Most species of *Ornithodoros* can now be determined in the larval stage, but our collections of larvae, other than of species that occur on bats, are limited. In the case of the latter, there is some indication of host preference, but whether this is due to the environmental necessities of the essentially free-living nymphs and adults, or to true host selection by the larvae is not clear from our scanty data. In the case of the Ixodidae, it has been possible to determine the larvae of *Haemaphysalis* and of a few species of *Amblyomma.* It is usually possible to place larvae of the other genera in the correct genus, though we have not critically studied all the numerous lots consisting only of nymphs and larvae.

We have secured adults from engorged nymphs of numerous species. In most cases these nymphs have been taken from hosts different from those generally favored by the adults. Thus, of five reared nymphs of *A. auricularium,* three were from *Philander* (a marsupial), and two from *Sigmodon* (a rodent). The adults are usually found on edentates (armadillos and anteaters). All but one of the adults of *H. juxtakochi* obtained were from deer (Artiodactyla) but no early stages were taken from this host. On the other hand, nymphs of this tick were taken from three other species of mammals, two of which belong to other orders (Rodentia, Carnivora). The case of *A. longirostre,* a specific parasite of the lowland porcupine, *Coendou rothschildi,* has been noted previously by others (Aragão, 1936). We also have secured nymphs of this species, but only from birds, mostly passerines. It is almost certain that the sloth ticks, and undoubtedly other species whose early instars are seldom or never taken on the host with adults, have larval and nymphal hosts far different from those of the adult. Work on the taxonomy of the early instars is an absolute prerequisite to the solving of these problems.

Abstract

Forty-seven species of ticks belonging to 10 genera are recorded from Panama. Keys to genera and species are given, and host and locality records for each species are detailed. Extensive host lists and comments on the apparent host preferences of the genera and species are given. The altitudinal and climatic preferences of the various species of Ixodoidea are also discussed and tabulated. No new species are reported, but the following 12 species are new for the fauna of Panama: *Antricola mexicanus* Hoffmann, *Ornithodoros puertoricensis* Fox, *O. viguerasi* Cooley and Kohls, *Ixodes brunneus* Koch, *I. lasallei* Mendez and Ortiz, *I. loricatus* Neumann, *I. pomerantzi* Kohls, *I. tapirus* Kohls, *I. venezuelensis* Kohls, *Dermacentor halli* McIntosh, *D. imitans* Warburton, and *Amblyomma pictum* Neumann.

Ixodes californicus Banks is synonymized under *I. brunneus* Koch, and *I. scuticrenatus* Vazquez under *I. luciae* Senevet. *Amblyomma avecolens* Cooley and Kohls and *A. curruca* Schulze are reduced to synonyms of *A. longirostre* Koch and *A. auricularium* (Conil), respectively. *A. gertschi* Cooley and Kohls is synonymized under *A. varium* Koch.

HOST-PARASITE LIST

(N = nymph; L = larva)

Class AMPHIBIA

Order SALIENTIA

Bufo marinus: 3
Amblyomma dissimile Koch (3)

Class REPTILIA

Order TESTUDINATA

Geoemyda annulata: 6
Amblyomma sabanerae Stoll (6)

Geoemyda funeria: 3
Amblyomma sabanerae Stoll (2)
" sp., NN and LL (2)

Pseudemys scripta: 3
Amblyomma sabanerae Stoll (2)
" *dissimile* Koch (1)

Kinosternon sp.: 1
Amblyomma sabanerae Stoll

Order SQUAMATA

Iguana iguana: 18
Amblyomma dissimile Koch (16)
" *sabanerae* Stoll (2)

Basiliscus basiliscus: 1
Amblyomma sp., LL

Ameiva ameiva: 7
Amblyomma dissimile Koch (1)
" sp., NN and/or LL (6)

lizards, probably Ameiva spp.: 17
Amblyomma sp., NN and/or LL (17)

Order SERPENTES

Constrictor constrictor: 3
Amblyomma dissimile Koch (3)

Epicrates sp.: 1
Amblyomma sp., NN and LL

Spilotes pullatus: 1
Amblyomma dissimile Koch

Pseustes poecilonotus: 1
Amblyomma dissimile Koch

Chironius carinatus: 1
Amblyomma dissimile Koch

Oxybelis sp.: 1
Amblyomma sp., N

Thalerophis richardi: 1
Amblyomma sp., LL

Bothrops atrox: 4
Amblyomma dissimile Koch (4)

Lachesis muta: 3
Amblyomma dissimile Koch (3)

Class AVES

In addition to the birds listed by name below, we have a considerable number of additional lots, all *Amblyomma* nymphs or larvae, from unidentified birds. Thus, birds seem to be important hosts for the early stages of *Amblyomma*. The few records of adult *Amblyomma* from birds appear to be strays.

Order TINAMIFORMES

Crypturellus soui: 1
Amblyomma sp., L

"Tinamou": 1
Ixodes brunneus Koch

Order CICONIIFORMES

Cochlearius cochlearius: 1
Amblyomma dissimile Koch

Order FALCONIFORMES

Buteo magnirostris: 1
Amblyomma cajennense (Fabricius)

Spizaetus tyrannus: 1
Amblyomma sp., N

Order GALLIFORMES

Crax rubra: 2
Amblyomma oblongoguttatum Koch
" sp., LL

Penelope purpurascens: 1
Amblyomma sp., LL

domestic fowl: 2
Amblyomma sp., NN and LL

chicken coops: 1
Argas persicus (Oken)

Order CUCULIFORMES

Neomorphus geoffroyi salvini: 1
Argas persicus (Oken), N

Order CORACIIFORMES

Chloroceryle americana: 1
Amblyomma sp., LL

Order PICIFORMES

Malacoptila panamensis: 2
Amblyomma longirostre (Koch), NN
Capito maculicoronatus: 1
Amblyomma sp., N
Ramphastos sp.: 1
Amblyomma sp., N

Order PASSERIFORMES

Xiphorhynchus sp.: 1
Amblyomma longirostre (Koch), N
Cymbilaimus lineatus: 1
Amblyomma longirostre (Koch), N
Thamnophilus nigriceps: 1
Amblyomma sp., N
Rhytipterna holerythra: 1
Amblyomma sp., N
Querula purpurata: 1
Amblyomma longirostre (Koch), N
Cacicus uropygialis microrhynchus: 2
Amblyomma longirostre (Koch), N
Icterus chrysater: 1
Amblyomma longirostre (Koch), N
Ramphocelus passerinii: 8
Amblyomma sp., NN
Tachyphonus rufus: 1
Amblyomma sp., N
Eucometis penicillata: 1
Amblyomma sp., L
Saltator maximus: 1
Amblyomma longirostre (Koch), N
Saltator albicollis: 1
Amblyomma longirostre (Koch), N
Sporophila aurita corvina: 9
Amblyomma sp., NN
Arremonops conirostris: 1
Amblyomma ovale Koch, ♀, engorged

Class MAMMALIA

Order MARSUPIALIA
Family Didelphidae

Caluromys derbianus: 4
Amblyomma geayi Neumann (1)
" sp., NN and/or LL (3)
Monodelphis adusta: 1
Ixodes venezuelensis Kohls
Marmosa robinsoni: 2
Ixodes luciae Senevet, N (1)
Amblyomma sabanerae Stoll (1)
Philander opossum: 24
(Early records from "*Philander*" generally refer to *Caluromys derbianus*, q.v.)
Ixodes luciae Senevet (6)
Amblyomma auricularium (Conil) (3)
" *geayi* Neumann (1)
" sp., NN and/or LL (22)
Metachirus nudicaudatus: 2
Ixodes loricatus Neumann (1)
" sp., NN (1)
Didelphis marsupialis: 43
Ixodes luciae Senevet (20)
" *boliviensis* Neumann (3)
" *affinis* Neumann (2)
" sp., NN and/or LL (3)
Amblyomma auricularium (Conil) (2)
Amblyomma cajennense (Fabricius) (2)
" *geayi* Neumann (1)
" *varium* Koch (1)
" sp., NN and/or LL (20)
Chironectes minimus: 1
Amblyomma oblongoguttatum Koch

Order INSECTIVORA
Family Soricidae

Cryptotis nigrescens: 2
Dermacentor sp., L
? *Ixodes* sp., L

Order CHIROPTERA

Infestations of bats with ticks other than *Ornithodoros* were probably accidental. Many of the bats were caught in mist nets and rested on or near the ground for some time. Here they could easily be infested with larval ticks of other genera. In addition to the following, we have a number of records of ticks from unidentified bats.

Family Emballonuridae

Peropteryx macrotis: 2
Ornithodoros azteci Matheson, LL

Family Noctilionidae

Noctilio labialis: 7
Ornithodoros hasei (Schulze), NN and LL (7)

Noctilio leporinus: 3
Ornithodoros hasei (Schulze), LL (3)

Family Phyllostomidae

Pteronotus parnellii: 1
Ornithodoros viguerasi Cooley and Kohls, LL

Pteronotus psilotis: 1
Antricola mexicanus Hoffmann, LL
Amblyomma sp., L

Pteronotus sp.: 1
Ornithodoros viguerasi Cooley and Kohls, L

Lonchorhina aurita: 2
Ornithodoros azteci Matheson, LL

Tonatia silvicola: 1
Ornithodoros hasei (Schulze), L

Trachops cirrhosus: 3
Ornithodoros brodyi Matheson, LL (3)
" *hasei* (Schulze), L (1)

Carollia perspicillata: 4
Ornithodoros brodyi Matheson, LL (3)
Amblyomma tapirellum Dunn (1)

Uroderma bilobatum: 1
Ornithodoros hasei (Schulze), LL

Vampyrops helleri: 2
Amblyomma cajennense (Fabricius), ♂
" sp., N
Ornithodoros hasei (Schulze), LL

Chiroderma salvini: 1
Amblyomma sp., N

Artibeus sp.: 1
Ixodes sp., L

Family Desmodidae

Desmodus rotundus: 2
Ornithodoros azteci Matheson, LL (1)
" *brodyi* Matheson, L (1)

Family Vespertilionidae

Myotis nigricans: 3
Dermacentor halli McIntosh, N
Antricola mexicanus Hoffmann, LL (3)

Family Molossidae

Molossus sp.: 1
Ornithodoros hasei (Schulze), L

Order PRIMATES

With the exception of man, ticks are very seldom found on Primates in Panama. We have records of *Amblyomma* nymphs and/or larvae from one individual each of *Alouatta villosa, Cebus capuchinus,* and *Aotus trivirgatus.* Two *Saguinus geoffroyi* have yielded ticks, *Rhipicephalus sanguineus* (Latreille) in one case, and *Amblyomma* larva in the other.

Family Hominidae

Homo sapiens: 54

Our records do not generally indicate whether the ticks were attached or merely crawling on the skin or clothing. Larvae of *Amblyomma* species are a great pest in many areas, especially during the dry season.

Amblyomma tapirellum Dunn (15)
" *cajennense* (Fabricius) (13)
" *naponense* (Packard) (1)
" *oblongoguttatum* Koch (9)
" *ovale* Koch (7)
" *parvum* Aragão (1)
" *sabanerae* Stoll (1)
" sp., NN (11)
Ixodes boliviensis Neumann (4)
Rhipicephalus sanguineus (Latreille) (2)
Dermacentor latus Cooley (2)
" *imitans* Warburton (1)

Order EDENTATA

Family Myrmecophagidae

Myrmecophaga tridactyla: 1
Amblyomma calcaratum Neumann
" *nodosum* Neumann
" *oblongoguttatum* Koch
" *tapirellum* Dunn
" *pictum* Neumann
" sp., NN

Tamandua tetradactyla: 30
Amblyomma calcaratum Neumann (20)
" *nodosum Neumann* (19)
" *auricularium* (Conil) (12)
" *oblongoguttatum* Koch (7)
" *cajennense* (Fabricius) (3)
" *naponense* (Packard) (1)
" *parvum* Aragão (1)
" sp., NN and/or LL (1)

Cyclopes didactylus: 2
Amblyomma sp., NN and/or LL (2)

Family Bradypodidae

Bradypus infuscatus: 35
Amblyomma geayi Neumann (35)
" *varium* Koch (12)
" sp., NN and/or LL (7)
Choloepus hoffmanni: 25
Amblyomma varium Koch (16)
" *geayi* Neumann (12)
" *calcaratum* Neumann (2)
" *oblongoguttatum* Koch (1)

Family Dasypodidae

Cabassous centralis: 1
Amblyomma auricularium (Conil)
Dasypus novemcinctus: 25
Amblyomma auricularium (Conil) (22)
" *cajennense* (Fabricius) (1)
" *oblongoguttatum* Koch (1)
" *ovale* Koch (1)
" sp., NN and/or LL (2)
Ixodes sp., L (1)

Order Lagomorpha

Sylvilagus brasiliensis: 14
Haemaphysalis leporispalustris (Packard) (14)
Ixodes pomerantzi Kohls (3)
Dermacentor sp., N (1)
Amblyomma sp., N (1)
Ornithodoros puertoricensis Fox, L (1)
Oryctolagus cuniculus: 3
Rhipicephalus sanguineus (Latreille) (3)

Order Rodentia

Family Sciuridae

Sciurus granatensis: 23
Ixodes tiptoni Kohls and Clifford (14)
" sp., probably *tiptoni*, LL (3)
Amblyomma sp., NN and/or LL (6)

Family Heteromyidae

Liomys adspersus: 20
Amblyomma sp., LL (20)
Heteromys sp.: 5
Amblyomma sp., NN and/or LL (3)
Dermacentor sp., NN (2)

Family Cricetidae

Oryzomys spp.: 21
Amblyomma ovale Koch (2)
" sp., NN and/or LL (13)
Ixodes luciae Senevet (1)
Ixodes venezuelensis Kohls (1)
" sp., NN and/or LL (4)
Dermacentor sp., LL (1)
Reithrodontomys creper and spp.: 12
Dermacentor sp., NN and/or LL (8)
Amblyomma sp., LL (3)
Ixodes sp., N (1)
Peromyscus spp.: 23
Dermacentor sp., NN and/or LL (11)
Amblyomma sp., NN and/or LL (7)
Ixodes sp., NN and/or LL (5)
Haemaphysalis leporispalustris (Packard), L (1)
Zygodontomys microtinus: 16
Ixodes venezuelensis Kohls (4)
" *luciae* Senevet, N
Amblyomma ovale Koch, N (1)
" sp., NN and/or LL (11)
Scotinomys xerampelinus: 4
Ixodes sp., LL (2)
Dermacentor sp., L (1)
?*Amblyomma* sp., L (1)
Sigmodon hispidus: 40
Amblyomma auricularium (Conil), N (2)
" sp., N and/or LL (38)
?*Ixodes* sp., L (1)

Family Muridae

Rattus sp.: 1
Ornithodoros puertoricensis Fox, LL

Family Erethizontidae

Coendou mexicanus: 5
Dermacentor halli McIntosh (5)
Ixodes boliviensis Neumann (4)
" sp., N and LL (2)
Coendou rothschildi: 10
Amblyomma longirostre (Koch) (8)
" sp., NN and/or LL (5)
Haemaphysalis juxtakochi Cooley, N (1)

Family Hydrochaeridae

Hydrochaeris hydrochaeris: 2
Amblyomma auricularium (Conil) (1)
Rhipicephalus sanguineus (Latreille) (1)

Family Dasyproctidae

Agouti paca: 10
Amblyomma pacae Aragão (6)
" *coelebs* Neumann (1)
" sp., NN (3)
Ixodes lasallei Mendez and Ortiz (2)
" sp., NN and/or LL (3)

Dasyprocta punctata: 14
Ixodes lasallei Mendez and Ortiz (8)
" sp., NN (1)
Amblyomma oblongoguttatum Koch (3)
" *pacae* Aragão (1)
" sp., NN and/or LL (5)

Family Echimyidae

Proechimys semispinosus: 52
Amblyomma ovale Koch, NN (4)
" sp., NN and/or LL (48)
Ixodes sp., N (1)
Haemaphysalis juxtakochi Cooley, N (1)
Hoplomys gymnurus: 1
Amblyomma sp., L

Order CARNIVORA
Family Canidae

Canis familiaris: 38
Rhipicephalus sanguineus (Latreille) (20)
Amblyomma oblongoguttatum Koch (19)
" *ovale* Koch (9)
" *cajennense* (Fabricius) (5)
" *auricularium* (Conil) (1)
" sp., NN and/or LL (5)
Ixodes affinis Neumann (1)
" *boliviensis* Neumann (15)

Family Procyonidae

Procyon lotor: 1
Amblyomma ovale Koch
Ixodes boliviensis Neumann
" *rubidus* Neumann
Procyon cancrivorus: 3
Amblyomma ovale Koch (1)
" *oblongoguttatum* Koch (1)
" *naponense* (Packard) (1)
" sp., NN and/or LL (2)
Nasua nasua: 30
Amblyomma ovale Koch (12)
" *oblongoguttatum* Koch (10)
" *auricularium* (Conil) (1)
" *cajennense* (Fabricius) (1)
" *naponense* (Packard) (1)
" sp., NN and/or LL (8)
Ixodes rubidus Neumann (1)
" *boliviensis* Neumann (3)
" sp., NN and/or LL (2)
Haemaphysalis juxtakochi Cooley (2)

Potos flavus: 1
Amblyomma sp., N
Bassaricyon gabbii: 1
Ixodes rubidus Neumann

Family Mustelidae

Mustela frenata: 1
Ixodes rubidus Neumann
Eira barbara: 4
Amblyomma ovale Koch (3)
" *oblongoguttatum* Koch (1)
Ixodes rubidus Neumann (1)
Galictis allamandi: 1
Amblyomma ovale Koch
" sp., N
Conepatus semistriatus: 1
Ixodes rubidus Neumann
Lutra annectens: 1
Ixodes sp., L

Family Felidae

Felis concolor: 1
Amblyomma ovale Koch
Felis onca: 5
Ixodes boliviensis Neumann (3)
" *affinis* Neumann (2)
Amblyomma ovale Koch (1)
" sp., NN
Felis pardalis: 4
Ixodes affinis Neumann (3)
Amblyomma ovale Koch (3)
" sp., NN and LL (1)
Felis yagouaroundi: 1
Amblyomma ovale Koch
Felis cattus: 4
Amblyomma parvum Aragão (2)
" *oblongoguttatum* Koch (1)
" sp., NN and/or LL (2)
Rhipicephalus sanguineus (Latreille) (1)
Ixodes boliviensis Neumann (1)

Order PERISSODACTYLA
Family Tapiridae

Tapirus bairdii: 11
Amblyomma oblongoguttatum Koch (7)
" *ovale* Koch (6)
" *coelebs* Neumann (5)
" *tapirellum* Dunn (5)
" *cajennense* (Fabricius) (1)
" sp., NN (2)
Dermacentor latus Cooley (3)
Ixodes boliviensis Neumann (3)
" *tapirus* Kohls (2)
Haemaphysalis juxtakochi Cooley (1)

Family Equidae

Equus caballus: 43
Amblyomma cajennense (Fabricius) (24)
" *oblongoguttatum* Koch (17)
" *ovale* Koch (2)
" *tapirellum* Dunn (1)
" *coelebs* Neumann (1)
" sp., NN (1)
Anocentor nitens (Neumann) (7)
Boophilus microplus (Canestrini) (3)
(Numerous specimens of *A. nitens* collected by Field not included)

Order ARTIODACTYLA

Family Tayassuidae

Tayassu tajacu: 19
Amblyomma naponense (Packard) (13)
" *oblongoguttatum* Koch (13)
" *pecarium* Dunn (7)
" *tapirellum* Dunn (5)
" *cajennense* (Fabricius) (1)
" sp., NN and/or LL (7)
Dermacentor imitans Warburton (4)
Haemaphysalis juxtakochi Cooley (3)

Family Suidae

Sus scrofa: 7
Anocentor nitens (Neumann) (7)
Boophilus microplus (Canestrini) (3)
Amblyomma oblongoguttatum Koch (3)
" *cajennense* (Fabricius) (2)
" *ovale* Koch (2)
Amblyomma tapirellum Dunn (2)
" *coelebs* Neumann (1)
" sp., NN (1)

Family Cervidae

Odocoileus virginianus: 21
Amblyomma oblongoguttatum Koch (18)
" *cajennense* (Fabricius) (1)
Haemaphysalis juxtakochi Cooley (6)
Ixodes affinis Neumann (4)
" *boliviensis* Neumann (1)
Anocentor nitens (Neumann) (2)
Mazama americana: 5
Ixodes affinis Neumann (3)
Amblyomma oblongoguttatum Koch (2)
" *calcaratum* Neumann (1)
" sp., NN (1)
Haemaphysalis juxtakochi Cooley (1)

Family Bovidae

Bos taurus: 33
Boophilus microplus (Canestrini) (23)
Amblyomma cajennense (Fabricius) (20)
" *oblongoguttatum* Koch (15)
" *parvum* Aragão (1)
" sp., NN and/or LL (4)
Anocentor nitens (Neumann) (5)
Ixodes boliviensis Neumann (4)
Capra hircus: 3
Amblyomma cajennense (Fabricius) (1)
" *oblongoguttatum* Koch (1)
Boophilus microplus (Canestrini) (1)

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The Chiggers of Panama
(Acarina : Trombiculidae)

JAMES M. BRENNAN [1] AND CONRAD E. YUNKER [2]

Ewing (1925) described the first chigger from Panama. Fairchild (1943) prepared the first list in which he recorded eight species and was followed by Wharton and Fuller (1952) who recorded 12 species. Both included *Trombicula cavernarum* Ewing, 1933 and *T. trifurca* Ewing, 1933, known only as adults and therefore not further considered here. Brennan and Jones (1961a) added 17 new species and three new genera.

The present report concerns large numbers of chiggers collected in Panama (most after 1954 and the great majority from 1960 to 1962), from nearly 5000 vertebrate hosts of about 70 mammalian, 50 avian and a few reptilian species. Seventy-six species of chiggers, distributed among 29 genera, are recorded. Five of these genera and 16 species are described as new. Several other undescribed species and new genera have been recognized, but are not included because of inadequate material.

The active support and cooperation of the following individuals and their organizations are acknowledged: Major Vernon J. Tipton and Mr. Charles M. Keenan, Preventive Medicine Division, United States Army Caribbean; Dr. Graham B. Fairchild and Mr. Pedro Galindo, Gorgas Memorial Laboratory; Dr. Nathan Gale, Veterinary Division, Canal Zone Government. They assisted the authors, either directly or indirectly, in obtaining permission to collect in the Canal Zone and the Republic of Panama, by arranging field trips, by providing transportation via land, air, and water, by providing various items of essential supplies and equipment, by generously lending laboratory and field personnel, and by collecting many vertebrate hosts and their parasites.

For specimens collected after May 1960, identifications of Panamanian

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[1, 2] U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana, and Middle America Research Unit, Ancon, Canal Zone.

reptiles were by Mr. Hymen Marx, Chicago Natural History Museum; of birds by Dr. Alexander Wetmore, Smithsonian Institution; of mammals by Dr. Charles O. Handley, United States National Museum. We are unable to credit accurately host determinations prior to 1960, although Dr. Handley identified many of the mammals collected since 1957.

Holotypes of all new species are deposited in the Rocky Mountain Laboratory (RML). Paratypes are deposited there and in the United States National Museum, the British Museum (Natural History), and the Chicago Natural History Museum, as indicated.

If not otherwise indicated, collecting of new forms is credited to organizations: Environmental Health Branch, Preventive Medicine Division, United States Army Caribbean (EHB); Middle America Research Unit (MARU).

KEY TO PANAMANIAN GENERA

1. Leg I with six segments; coxa I with two setae; spiracles and tracheae present; scutum with six setae (Leeuwenhoekiinae) 2
   Leg I with seven segments; coxa I with one seta; spiracles and tracheae absent; scutum with three, four, five, or seven setae 3
2. Scutum with anteromedian projection; cheliceral blade with series of teeth .... *Odontacarus* Ewing
   Scutum without anteromedian projection; cheliceral blade with tricuspid cap only .... *Sasacarus* Brennan and Jones
3(1). Scutum with a pair of anterosubmedian setae (Apoloniinae) .. *Vargatula* n. gen.
   Scutum with a single anteromedian seta (Trombiculinae) 4
4. Sensillae expanded 5
   Sensillae flagelliform 18
5. With dorsal platelets in addition to scutum .. *Polylopadium* Brennan and Jones
   Without additional dorsal platelets 6
6. PL's and most dorsal setae broad-foliate .... *Cordiseta* Hoffmann
   PL's and dorsal setae not foliate 7
7. Sensillae with elongate flagelliform setules, parasitic on bats .... *Perissopalla* Brennan and White
   Sensillae without flagelliform setules 8
8. Cheliceral blades with tricuspid cap only or a single minute subapical dorsal tooth or hook 9
   Cheliceral blades with one or a series of dorsal teeth plus tricuspid cap 16
9. Posterior margin of scutum obsolescent or absent; coxa II with two setae; intranasal habitat .... *Kymocta* Yunker and Brennan
   Posterior margin of scutum present; coxa II with one seta; habitat not intranasal 10
10. Tarsi with nude subapical setae; sensillae slightly expanded, but with large swollen setules, parasitic on bats .... *Speleocola* Lipovsky
   Tarsi without nude subapical setae; sensillae greatly expanded; setules not swollen 11
11. Integumental striae encroaching on posterior half of scutum .... *Neoschoengastia* Ewing
   Scutum without striae 12
12. Leg segmentation 7-7-7; ventral humeral setae absent 13
   Leg segmentation usually 7-6-6, rarely 7-7-6 or 7-7-7 in which cases ventral humeral setae are always present, but may be present or absent if leg segmentation is 7-6-6 14
13. PL's extrascutal .... *Ascoschoengastia* Ewing
   PL's on scutum .... *Euschoengastia* Ewing

14(12). Ventral humeral setae and parasubterminala present....................
......................................*Pseudoschoengastia* Lipovsky
Ventral humeral setae and parasubterminala absent.................... 15
15. PL's on scutum; genualae II and III absent; intradermal habitat............
....*Intercutestrix* n. gen.
PL's off scutum; genualae II and III present; habitat not intradermal......
....*Vanidicus* Brennan and Jones
16(8). Cheliceral blade with one dorsal tooth in addition to tricuspid cap; genualae II and III present; habitat intranasal........................*Blix* n. gen.
Cheliceral blade with a series of dorsal teeth; genualae II and III absent.... 17
17. Ventral humeral setae present; cheliceral blade sharply curved; palpal tibial claw bifurcate; scutum subquadrate; intranasal habitat...*Myxacarus* n. gen.
Ventral humeral setae absent; cheliceral blade nearly straight; palpal tibial claw trifurcate; scutum much wider than deep; habitat not intranasal....
....*Aniatrus* Brennan and Jones
18(4). With seven scutal setae....................*Hoffmannina* Brennan and Jones
With five scutal setae.. 19
19. PL's off scutum...................................*Tecomatlana* Hoffmann
PL's on scutum.. 20
20. Palpal tibial claw with a single prong.............................. 21
Palpal tibial claw with two or three prongs........................... 23
21. Eyes large, 2/2, in a plate; anterior scutal setae branched; sensillae branched; a mastitarsala III; habitat not intranasal.................*Crotiscus* Ewing
Eyes absent or only a single reduced pair; anterior scutal setae nude; sensillae nude or with few vestigial barbs; no mastitarsala III; intranasal habitat, on bats 22
22. Scutum cuneiform; eyes absent; all leg segments with one or more elongate nude setae; palpal femur greatly enlarged......*Alexfainia* Yunker and Jones
Scutum subquadrate; eyes 1/1; leg segments without nude setae; palpal femur not enlarged ....*Vergrandia* Yunker and Jones
23(20). With a mastifemorala I; basifemora and telofemora semi-fused to fused; intranasal, on bats..........................*Perates* Brennan and Dalmat
Without a mastifemorala I; basifemora and telofemora not fused, but distinctly articulated 24
24. Cheliceral blade with hood-like serrate distal expansion; posterior margin of scutum with a sharp median tip; on bats..............*Beamerella* Brennan
Cheliceral blade otherwise, usually with a subapical dorsal tooth or a tricuspid cap; posterior margin of scutum without a tip, although it may be angulate. 25
25. Scutum cuneiform with a medially cleft posterior margin; all scutal setae nude; coxae II and III multisetose; intranasal habitat; on rodents.......
....*Crotonasis* n. gen.
Scutum not cuneiform and without a cleft posterior margin; all scutal setae branched; coxae II and III unisetose; habitat not intranasal............ 26
26. Palpal claw bifurcate, accessory prong inner and ventral..*Eutrombicula* Ewing
Palpal claw normally trifurcate, but if bifurcate, accessory prong outer and dorsal 27
27. Mastitarsala III present; three genualae I; scutum deep, frequently pentagonal, the AL's never in anterolateral angles and usually set considerably behind margin; sensillae branched; palpal femoral seta branched; on birds
....*Blankaartia* Oudemans
Without the above combination of characters.......................... 28
28. Mastitarsala III absent; two genualae I; scutum roughly rectangular, the AL's always in anterolateral angles; sensillae branched; palpal femoral, genual, and tibial setae nude; galeal seta branched...................
......................................*Leptotrombidium* Nagayo et al.
Without the above combination of characters.............*Trombicula* Berlese

Genus **Odontacarus** Ewing

Odontacarus Ewing, 1929, Man. Ext. Parasites, p. 188.
Type-species: *Trombicula dentata* Ewing, 1925.

KEY TO PANAMANIAN SPECIES

Tarsus III with a tarsala................................*chiapanensis* (Hoffmann)
Tarsus III without a tarsala...............................*fieldi* Brennan and Jones

Odontacarus chiapanensis (Hoffmann)

Acomatacarus chiapanensis Hoffmann, 1948, Rev. Inst. Salub. Enferm. Trop., 9, (3), pp. 179–182, figs. 6–11.

Twenty-nine specimens off (5) *Proechimys semispinosus,* Almirante (Bocas del Toro), 22 to 27 January and 16 July 1960. First Panamanian records.

Odontacarus fieldi Brennan and Jones

Odontacarus fieldi Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 105–106, fig. 1.

Seventy specimens identified from 28 lots. Hosts: BIRDS, *Neomorphus geoffroyi salvini, Odontophorus erythrops;* MAMMALS, *Didelphis marsupialis, Proechimys semispinosus, Liomys adspersus, Sciurus granatensis, Sigmodon hispidus, Zygodontomys microtinus, Felis pardalis.* Localities: Cacao Plantation, Summit, and Miraflores (Canal Zone) ; Cerro Pirre (Darién) ; Cerro Campana (Panamá) ; Isla Bastimentos (Bocas del Toro) ; Cerro Hoya (Los Santos). Active throughout the year. See Brennan and Jones (1961a) for other Panamanian records.

Genus **Sasacarus** Brennan and Jones

Sasacarus Brennan and Jones, 1959, Ann. Ent. Soc. Amer., 52, (1), p. 8.
Type-species: *Chatia furmani* Hoffmann, 1954.

Sasacarus furmani (Hoffmann)

Chatia furmani Hoffmann, 1954, Ann. Esc. Nac. Cienc. Biol. Mex., 8, (1–2), pp. 17–20, figs. 1–4.

Sixty-eight specimens identified from 30 lots. Hosts: *Didelphis marsupialis, Proechimys semispinosus, Heteromys desmarestianus.* Localities: Piña, Gamboa Road, Fort Gulick, and France Field, (Canal Zone) ; Cerro Azul (Panamá) ; Bocas del Toro Province. First records for Panama.

Sporadic collections, 1954 to 1962, November to April, suggest peak activity during the dry season. The Panamanian form differs from the typical form in that tarsala II is noticeably thicker and not longer than tarsala I.

Vargatula, new genus

Type-species: *Vargatula hispida,* new species.

DIAGNOSIS: Apoloniine larvae with anterolateral, paired submedian, and displaced posterolateral scutal setae; sensillae flagelliform, branched. Cheliceral blades with minute dorsal tooth. Palpal tarsus with five branched setae, a subterminala, and a tarsala; tibial claw trifurcate. Eyes absent. No genuala II and no specialized setae on leg III.

Differs from the other three genera of the subfamily Apoloniinae (Wharton and Fuller, 1952) in lacking an anteromedian scutal projection.

Vargatula hispida, new species. Figure 12.

DIAGNOSIS: Scutum cuneiform, apex posterior, sensillae branched. One genuala I, no genualae II and III, no tibiala III, no parasubterminala. Coxal setae 1-2-1. Palpal setae branched. Dorsal, sternal, and ventral setae numerous.

DESCRIPTION: *Idiosoma.*—Ellipsoidal. Length and width of holotype, nearly engorged, 515 by 290 μ. Eyes absent. Anus at about the eighth row of ventral setae. *Scutum.*—As figured, cuneiform, moderately punctate, two pairs of pores at lateral margins in posterior half of scutum. Setae with long coarse branches. Sensillae branched to base. Measure-

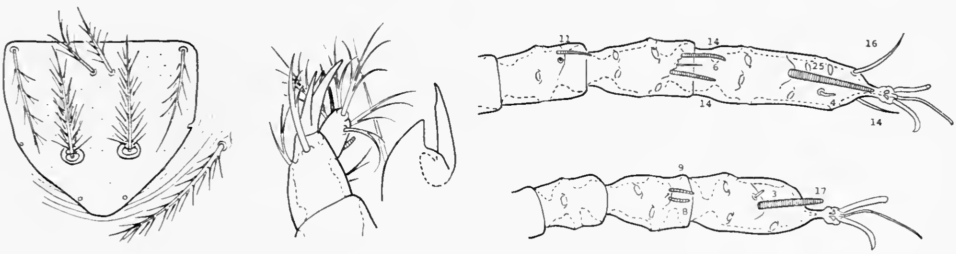

FIG. 12. *Vargatula hispida*, new species. Scutum. Palpal tarsus and tibia. Cheliceral blade. Specialized setae of legs I and II, with measurements in microns.

ments of holotype: AW 41, SB 13, ASB 29, PSB 15, AM 12, AL 17, PL 32, S 24 μ. *Gnathosoma.*—Punctate. Capitular sternum transversely rugose. Cheliceral blade nearly straight, with minute dorsal tooth. Galeal seta nude. Palpal setae B/B/BBB; claw trifurcate; tarsus with five branched setae, a subterminala, and a tarsala. *Legs.*—Punctate. Specialized setae as figured. No pretarsala II. Non-specialized setae coarsely branched. Coxa I with one, II with two, and III with one branched setae. Empodia elongate, nearly filiform. *Body setae.*—Dorsal setae thickened and becoming thicker and longer posteriorly, heavily branched, 17 to 40 μ, four or five humerals on each side plus about 110 dorsals. Ventral setae, 12 to 16 sternals arranged 2-2 plus a fairly uniform group at the level of coxae III, and about 150 ventrals. Postanals similar to dorsals.

TYPE MATERIAL: Holotype and 10 paratypes, RML no. 44425, off *Dasypus novemcinctus*, Paraíso (Canal Zone), 12 February 1962; 4 paratypes, same host and locality, 27 February and 26 March 1962, MARU. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, Chicago Natural History Museum, British Museum (Natural History).

Genus **Alexfainia** Yunker and Jones

Alexfainia Yunker and Jones, 1961, Jour. Parasit., 47, (6), p. 995.

Type-species: *Alexfainia chilonycteris* Yunker and Jones, 1961.

KEY TO PANAMANIAN SPECIES

Palpal femur with hamuli.......................... *chilonycteris* Yunker and Jones
Palpal femur without hamuli.. *munozi* n. sp.

Alexfainia chilonycteris Yunker and Jones

Alexfainia chilonycteris Yunker and Jones, loc. cit., pp. 995–996, pl. I.

More than 100 specimens (22 lots) from intranasal passages of (21) *Pteronotus parnellii,* Paraíso (Canal Zone), 18 August 1960, 4 January and

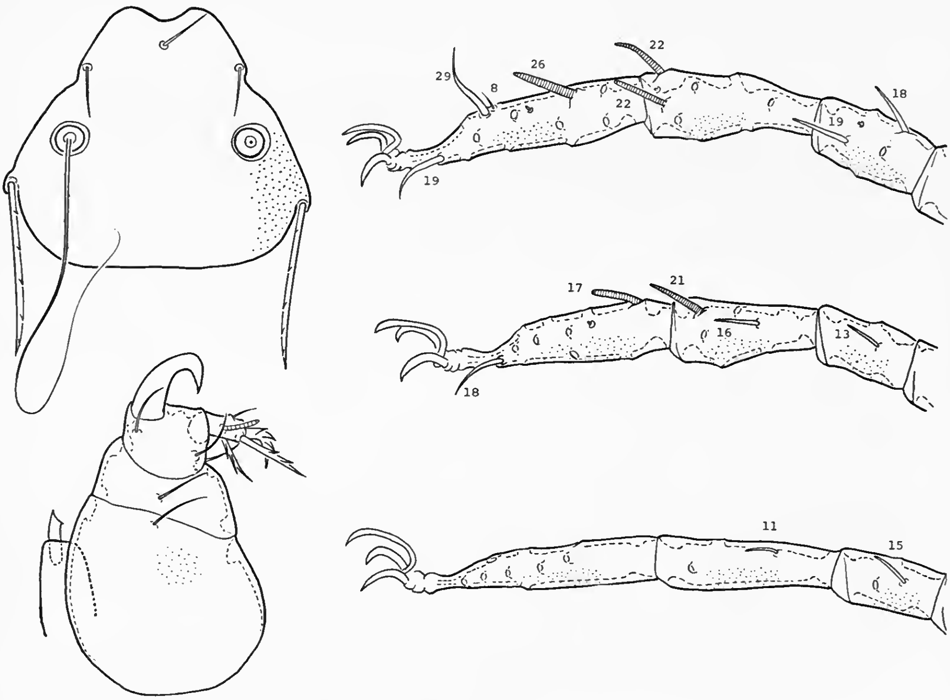

FIG. 13. *Alexfainia munozi,* new species. Scutum. Cheliceral blade and palp. Specialized setae of legs.

2 March 1962, Madden Field (Canal Zone), 7 July and 3 October 1961; 1 off *Carollia perspicillata,* Pacora (Panamá), 31 October 1960. See Yunker and Jones (1961) for other Panamanian records.

Alexfainia munozi, new species. Figure 13.

DIAGNOSIS: A large intranasal chigger, separated from *A. chilonycteris* Yunker and Jones by palpal femur lacking hamuli and scutum with more emarginate and narrow anterior margin.

DESCRIPTION: *Idiosoma.*—Ellipsoidal, mildly constricted when engorged. Length and width of holotype, unengorged, 310 by 165 μ, of an engorged paratype, 1463 by 793 μ. Eyes absent. Anus at third row of ventral setae. *Scutum.*—As figured, densely punctate, cuneiform with a pronounced emarginate and narrow anterior margin. Anterior setae short, nude, the holotype anomalous in that the AM is absent; posterior setae much longer, with tiny barbs. Sensillae slender, elongate, with few minute barbs. Measurements of holotype: AW 44, PW 86, SB 54, ASB 39, PSB 38, AP 42, AM–, AL 8, PL 53, S 96 μ. *Gnathosoma.*—Densely punctate. As in *A. chilonycteris*, a marked disparity in size between the greatly reduced chelicerae and the exceedingly enlarged palpi, as figured. Palpal setae N/N/NNN; claw large, simple, recurved; tarsus with three heavily barbed thick setae, four small nude setae, and a tarsala. Galeal seta nude. *Legs.*—Punctate. Specialized setae as figured. Non-specialized setae sparsely branched, some with few barbs, others apparently nude, a thick seta ventrally on telofemur and genu of leg III, much longer than homologous setae in *chilonycteris*. Coxal setae II much shorter than I and III. *Body setae.*—Dorsal setae with tightly appressed barbs, some appearing nude, 47 to 54 μ, arranged 2-6-6-8-6-6-4-2. Ventral setae, 2-2 sternals plus 34; sternals apparently nude, others minutely barbed.

TYPE MATERIAL: Holotype, RML no. 44413, off *Pteronotus psilotis*, Penonomé (Coclé), 8 February 1962; 8 paratypes, same host and locality, 30 January and 8 February 1962, V. J. Tipton, collector. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, Chicago Natural History Museum, and the British Museum (Natural History).

Named for Mr. Angel Muñoz, Acarology Group, Middle America Research Unit.

Genus **Aniatrus** Brennan and Jones

Aniatrus Brennan and Jones, 1961, Jour. Parasit., 47, (1), p. 105.

Type-species: *Aniatrus bifax* Brennan and Jones, 1961.

Aniatrus bifax Brennan and Jones

Aniatrus bifax Brennan and Jones, loc. cit., pp. 106–107, fig. 2.

Five specimens off (2) *Dasypus novemcinctus* near Pedro Miguel River and Paraíso, El Rallo (Canal Zone), 15 and 27 February 1962. *A. bifax* was described from a single specimen off *Dasypus novemcinctus*, Albrook Air Force Base (Canal Zone), 17 March 1959.

Genus **Ascoschoengastia** Ewing

Ascoschoengastia Ewing, 1946, Proc. Biol. Soc. Wash., 59: 71.

Type-species: *Neoschoengastia malayensis* Gater, 1932.

Ascoschoengastia dyscrita Brennan and Jones

Ascoschoengastia dyscrita Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 107–108, fig. 3.

Twenty-eight specimens identified from 12 lots. Hosts: *Didelphis marsupialis, Heteromys desmarestianus, Hoplomys gymnurus, Liomys adspersus, Oryzomys capito, Tylomys watsoni.*

Localities: Piña, Cacao Plantation, Miraflores, Summit, and Corte Culebra Road (Canal Zone); Cerro Azul (Panamá). From 1959 to 1962, collections were made from September to March with none from April to August. Brennan and Jones (1961a) record the following additional hosts: *Oryzomys caliginosus, Sigmodon hispidus,* and *Proechimys semispinosus,* the last from Bocas del Toro Province.

Genus **Beamerella** Brennan

Beamerella Brennan, 1958, Jour. Kans. Ent. Soc., 31, (2), p. 71.

Type-species: *Beamerella acutascuta* Brennan, 1958.

Beamerella acutascuta Brennan

Beamerella acutascuta Brennan, loc. cit., pp. 72–73, fig. 1.

Six specimens off *Micronycteris megalotis,* Pacora (Panamá), 31 October 1960; 3 off *Saccopteryx bilineata,* Pacora, 31 October 1960; 7 off *Carollia perspicillata,* Los Santos Province, 27 January 1962. First Panamanian records.

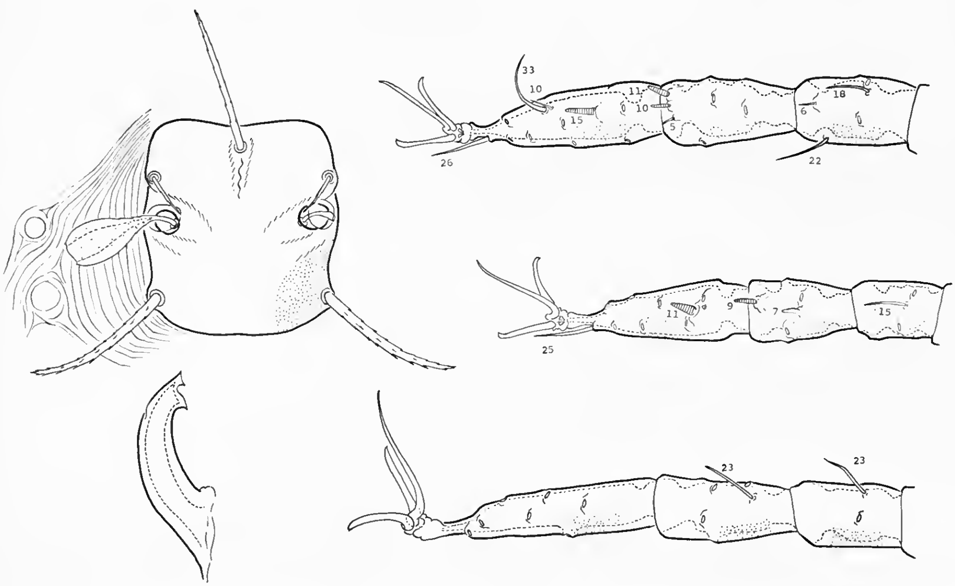

FIG. 14. *Blix cabassoi,* new species. Scutum and eyes. Cheliceral blade. Specialized setae of legs.

Blix, new genus

Type-species: *Blix cabassoi,* new species.

DIAGNOSIS: Intranasal trombiculine larvae with leg segmentation 7-7-7. Legs without mastisetae, but with genualae II and III and a tibiala III. Scutum subquadrate, with five setae and expanded sensillae. Eyes present. Cheliceral blades with tricuspid cap and a prominent dorsal tooth. Palpal tarsus with five branched setae, a subterminala, and a tarsala; tibial claw trifurcate.

This genus has affinities with *Schoutedenichia* from which it differs in the palpal tarsal setation, a tibiala III, unique form of scutum, etc.

Blix cabassoi, new species. Figure 14.

DIAGNOSIS: Fairly large intranasal species. Rectangular scutum deeper than wide, sensillae arising just within lateral margins. Cheliceral blades with large dorsal tooth in addition to tricuspid cap. Two genualae I and a tibiala III. Gnathosoma, scutum, and legs densely and conspicuously punctate.

DESCRIPTION: *Idiosoma.*—Ellipsoidal, slightly constricted. Length and width of holotype, slightly engorged, 885 by 390 μ. Eyes 2/2, no plate. Anus at sixth row of ventral setae. *Scutum.*—Approximately rectangular, with mildly convex posterior margin and lateral margins bulging opposite sensillary bases which they nearly touch. Puncta conspicuous and compact. AL's reduced, with barbs suggested; AM and PL's with appressed barbs. Sensillae oblanceolate, apparently lacking setules. Measurements of holotype: AW 88, PW 76, SB 70, ASB 51, PSB 47, AP 60, AM 74, AL 18, PL 75, S 57 μ. *Gnathosoma.*—Densely punctate. Chelicerae elongate, blades with tricuspid cap and prominent dorsal tooth. Palpi densely punctate, all setae barbed; tarsus with five branched setae, a subterminala, and short tarsala; claw trifurcate, one accessory prong smaller than the other. Galeal seta nude. *Legs.*—Densely punctate. Specialized setae as figured. Non-specialized setae long, with few appressed barbs. *Body setae.*—Dorsal setae barbed, 48 to 62 μ, arranged 2-6-8-8-4-2-2. Ventral setae, 2-2 sternals plus about 70.

TYPE MATERIAL: Holotype and 16 paratypes, RML no. 40076, from nasal mucosa of *Cabassous centralis*, Gamboa (Canal Zone), 29 November 1960, Dr. Nathan Gale, collector. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, Chicago Natural History Museum, and the British Museum (Natural History).

Genus **Cordiseta** Hoffmann

Cordiseta Hoffmann, 1954, An. Esc. Nac. Cienc. Biol. Mex., 8: 26.

Type-species: *Walchiella* (*Cordiseta*) *mexicana* Hoffmann, 1954.

Cordiseta mexicana (Hoffmann)

Walchiella (*Cordiseta*) *mexicana* Hoffmann, loc. cit., pp. 27–30, figs. 15–20.

One specimen off *Scotinomys teguina,* Cerro Punta (Chiriquí), 4 May 1960; one off *Peromyscus nudipes,* same locality, 18 January 1961. First records for Panama.

Genus **Crotiscus** Ewing

Crotiscus Ewing, 1944, Proc. Biol. Soc. Wash., 57: 102.

Type-species: *Trombicula desdentata* Boshell and Kerr, 1942.

Crotiscus desdentatus (Boshell and Kerr)

Trombicula desdentata Boshell and Kerr, 1942, Rev. Acad. Colomb. Cienc. Exacta, Fisico-Quim. y Nat., 5, (17), pp. 11–12 (in reprint), figs. 15–17.

About 230 specimens identified from 35 lots. Hosts: *Didelphis marsupialis, Philander opossum, Proechimys semispinosus, Hoplomys gymnurus, Heteromys desmarestianus, Nectomys alfari, Sigmodon hispidus.* Localities: Piña, Road K-9, and Fort Gulick (Canal Zone); Almirante, Cayo Agua, and Isla Bastimentos (Bocas del Toro); Cerro Campana (Panamá). Taken throughout the year, from 1954 to 1962. First Panamanian records.

This polymorphic species is widely distributed in the American tropics. A form common to Panama is *C. desdentatus tissoti* Fauran (1960), described as a variety. Another similar form known from Cerro Campana has a much longer and strongly curved tarsala I.

Crotonasis, new genus

Type-species: *Crotonasis fissa,* new species.

DIAGNOSIS: Intranasal trombiculine larvae with leg segmentation 7-7-7; coxae II and III multisetose. Scutum cuneiform, with five nude setae and short, nude, flagelliform sensillae. Eyes absent. Cheliceral blades short, recurved, with a single dorsal hook. Palpal tarsus with four branched setae and a tarsala; tibial claw trifurcate.

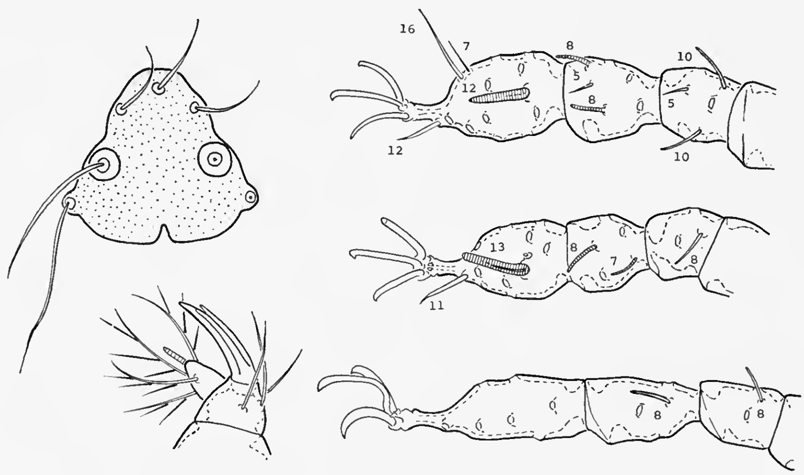

FIG. 15. *Crotonasis fissa,* new species. Scutum. Palpal tarsus and tibia. Specialized setae of legs.

Distinguished from other American genera of intranasal chiggers with flagelliform sensillae, by the multisetose coxae II and III, trifurcate palpal tibial claw, and all scutal setae nude.

Crotonasis fissa, new species. Figure 15.

DIAGNOSIS: Two genualae I, genualae II and III, tibiala III. Coxae II and III multisetose. Three pairs of sternal setae. Palpal, genual, and tibial setae nude. Posterior margin of scutum with a median cleft.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Length and width of holotype, engorged, 405 by 278 μ. Eyes absent. Anus at third row of ventral setae. *Scutum.*—As figured, cuneiform, with numerous fine puncta. All setae nude. Sensillary bases nearly touching lateral margins. Sensillae short, flagelliform, nude. Measurements of holotype: AW 14, PW 39, SB 20, ASB 21, PSB 17, AP 25, AM 15, AL 15, PL 27, S 24 μ. *Gnathosoma.*—Finely punctate. Blades small, recurved, with a subapical dorsal hook. Galeal seta nude. Palpal setae B/N/NNN; tarsus with four branched setae and a tarsala; claw trifurcate. *Legs.*—Finely punctate. Specialized setae as figured, tarsala II thicker than tarsala I. Non-specialized setae sparsely branched. Coxa I with one, II with two, and III with seven to nine branched setae. *Body setae.*—Dorsal setae bare, or with barbs merely suggested, 22 to 30 μ, arranged 2-6-6-4-2. Ventral setae, 2-2-2 sternals plus 32. Sternals and preanals barbed, postanals similar to dorsals.

TYPE MATERIAL: Holotype and 7 paratypes, RML no. 43471, from nasal mucosa of *Liomys adspersus,* Summit (Canal Zone), 28 August 1961; 3 paratypes, same host and locality, 27 and 28 December 1961, MARU. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, Chicago Natural History Museum, and the British Museum (Natural History).

Genus **Doloisia** Oudemans

Doloisia Oudemans, 1910, Ent. Ber., 3: 87.

Type-species: *Doloisia synoti* Oudemans, 1910.

Subgenus **Kymocta** Yunker and Brennan

Kymocta Yunker and Brennan, 1962, Acarologia, 4, (4), p. 572.

Type-species: *Kymocta teratarsalis* Yunker and Brennan, 1962.

KEY TO PANAMANIAN SPECIES

Genuala III present .... *teratarsalis* Yunker and Brennan
Genuala III absent .... *chironectes* Yunker and Brennan

Doloisia (Kymocta) chironectes Yunker and Brennan

Doloisia (Kymocta) chironectes Yunker and Brennan, 1962, Acarologia, 4, (4), pp. 574–576, fig. 3.

No records other than of the original description: 2 specimens off *Chironectes minimus,* Pedro Miguel (Canal Zone), 19 February 1962.

Doloisia (Kymocta) teratarsalis Yunker and Brennan

Doloisia (Kymocta) teratarsalis Yunker and Brennan, loc. cit., p. 574, fig. 2.

Described from 6 specimens off *Heteromys desmarestianus,* Piña (Canal Zone), 7 to 15 December 1960; 1 off *Hoplomys gymnurus,* Piña, 6 December 1960; 7 off *Tylomys watsoni,* Piña, 8 August 1961. No further records.

Genus **Euschoengastia** Ewing

Euschoengastia Ewing, 1938, Jour. Wash. Acad. Sci., 28: 293.

Type-species: *Euschoengastia americana* Ewing, 1938 (=*Schoengastia sciuricola* Ewing, 1925).

KEY TO PANAMANIAN SPECIES

1. With a mastitarsala III 2
   Without a mastitarsala III 3
2. Palpal genual and ventrotibial setae branched; scutum deep, with narrow lanceolate sensillae .... *tragulata* Brennan and Jones
   Palpal genual and ventrotibial setae nude; scutum shallow, with broad obovate sensillae .... *nunezi* (Hoffmann)

3(1). Palpal tibial claw with five prongs; tibiala III absent; coxa III with three setae .... *libertatis* Brennan and Dalmat

Palpal tibial claw with three prongs; tibiala III present; coxa III usually unisetose, rarely multisetose 4

4. With two genualae I 5

With three genualae I 7

5. Coxa III with two to four setae; ventral setae extend into area of sternals . . . . *cunctata* Brennan and Jones

Coxa III with one seta; ventral setae not extending to sternals 6

6. Galeal seta branched; palpal dorso- and laterotibial setae branched; dorsal formula begins 2-10; on rodents . . . . *enhebra* n. sp.

Galeal seta nude; palpal dorso- and laterotibial setae nude; dorsal formula begins 2-6; on bats . . . . *desmodus* Brennan and Dalmat

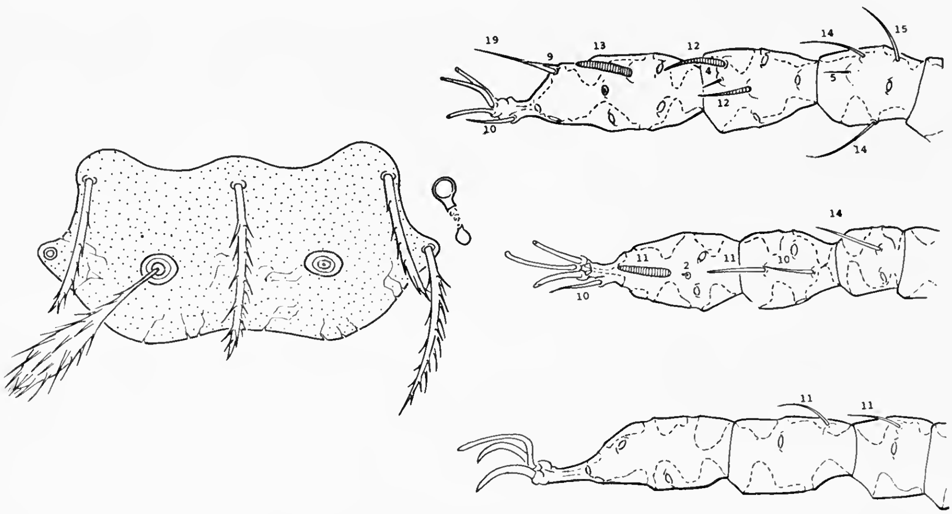

FIG. 16. *Euschoengastia belgicae,* new species. Scutum and eyes. Specialized setae of legs.

7(4). A single pair of eyes; palpal tarsala unusually long (25 μ); on bats . . . . *megastyrax* Brennan and Jones

Two pairs of eyes; palpal tarsala normal 8

8. Scutum subquadrate; sensillae broad, oblanceolate; palpal genual seta branched; on bats . . . . *colombiae* (Boshell and Kerr)

Scutum much wider than deep; sensillae fusiform; palpal genual seta nude; on rodents 9

9. Eyes large; dorsal setae 32, more than 55 μ long; setules of sensillae long and densely distributed . . . . *spissa* Brennan and Jones

Eyes reduced; dorsal setae 24, less than 50 μ long; setules of sensillae long, but moderately distributed . . . . *belgicae* n. sp.

Euschoengastia belgicae, new species. Figure 16.

DIAGNOSIS: Distinguished from *E. lipoglena* Brennan and Jones (off bat, Trinidad) by presence of eyes; palpal genual and tibial setae nude; sensillary bases at level of PL's; and about half as many dorsal setae; from *E. spissa* Brennan and Jones by greatly reduced eyes, dorsal formula, and the much smaller size of all setae.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Dimensions of fully engorged specimen cannot be accurately determined because of crushed mount; approximate length and width, 475 by 390 μ. Eyes 2/2, small, in obscure plate. Anus at fourth row of ventral setae. *Scutum.*—As figured, densely punctate, with sinuous margins. Sensillae fusiform, with elongate setules. Measurements: AW 66, PW 78, SB 33, ASB 24, PSB 17, AP 18, AM 34, AL 28, PL 48, S 41 μ. *Gnathosoma.*—Moderately punctate. Blades with tricuspid cap. Galeal seta nude. Palpal setae B/N/NNN; tarsus with at least five branched setae and a tarsala; tibial claw trifurcate. *Legs.*—Punctate. Specialized setae as figured. Nonspecialized setae moderately branched. *Idiosomal setae.*—Dorsal setae with semi-appressed branches, 38 to 42 μ, arranged 2-6-6-4-4-2. Ventral setae, 2-2 sternals plus 18.

TYPE MATERIAL: Holotype, RML no. 40556, off *Heteromys desmarestianus,* Cerro Azul (Panamá), 17 March 1961, MARU. In the collection of the Rocky Mountain Laboratory.

Named for Miss Belgica Rodriguez, Acarology Group, Middle America Research Unit.

Euschoengastia colombiae (Boshell and Kerr)

Neoschoengastia colombiae Boshell and Kerr, 1942, Rev. Acad. Colomb. Cienc. Exacta, Fisico-Quim. y Nat., 5, (17), pp. 16–18 (in reprint), figs. 6–8.

One specimen off *Carollia subrufa,* Cerro Pirre (Darién), 31 January 1961; 1 off same host, Río Changena (Bocas del Toro), 24 September 1961. First records for Panama.

Euschoengastia cunctata Brennan and Jones

Euschoengastia cunctata Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 108–109, fig. 4.

Known only from the type series, 8 specimens off *Oryzomys capito* (= *talamancae*), Cerro Azul (Panamá), 8 to 14 February 1956.

Euschoengastia desmodus Brennan and Dalmat

Euschoengastia desmodus Brennan and Dalmat, 1960, Ann. Ent. Soc. Amer., 53, (2), pp. 188–189, fig. 7.

One specimen off *Saccopteryx bilineata,* Chepo (Panamá), 8 October 1959; 4 off bat, El Valle (Coclé), 30 May 1961; 4 off *Glossophaga soricina,* Río Changena (Bocas del Toro), 19 September 1961; 3 off *Carollia subrufa,* Río Changena, 26 September 1961; 2 off *Carollia castanea,* Cerro Hoya (Los Santos), 9 February 1962; 2 off *Micronycteris megalotis,* Fort Kobbe (Canal Zone), 2 February 1962. First Panamanian records.

Euschoengastia enhebra, new species. Figure 17.

DIAGNOSIS: Two genualae I, no genualae II and III, tibiala III. Distinguished from *E. utahensis* Brennan and Beck by the widely separated sensillae, longer scutal setae, more body setae, branched galeal seta, and longer tarsala I than tarsala II.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Length and width engorged, 463 by 288 μ. Eyes large, 2/2, in a plate. Anus at about fourth row of ventral setae. *Scutum.*—As figured, trapezoidal with mildly sinuous margins, punctate. Sensillae obovate, anterior surface densely setulose, posterior surface with a denuded median area, stems barbed nearly to base. Setae with semi-appressed branches. Measurements: AW 64, PW 95, SB 51, ASB 31, PSB 24, AP 42, AM 38, AL 34, PL 45, S 37 μ. *Gnathosoma.*—Densely punctate.

Cheliceral bases broad, blades with tricuspid cap. Galeal setae branched. Palpal setae B/B/BBB; tarsus with five branched setae, a subterminala and a tarsala; tibial claw trifurcate. *Legs.*—Punctate. Specialized setae as figured. Non-specialized setae sparsely to moderately branched. *Body setae.*—Dorsal setae similar to scutals, 32 to 46 μ, arranged 2-10-2-6-6-6-6-2-2. Ventral setae, 2-2 sternals plus about 50, postanals similar to dorsals.

TYPE MATERIAL: Holotype, RML no. 44401, off *Tylomys watsoni,* Piña (Canal Zone), 7 February 1962, EHB. In the collection of the Rocky Mountain Laboratory.

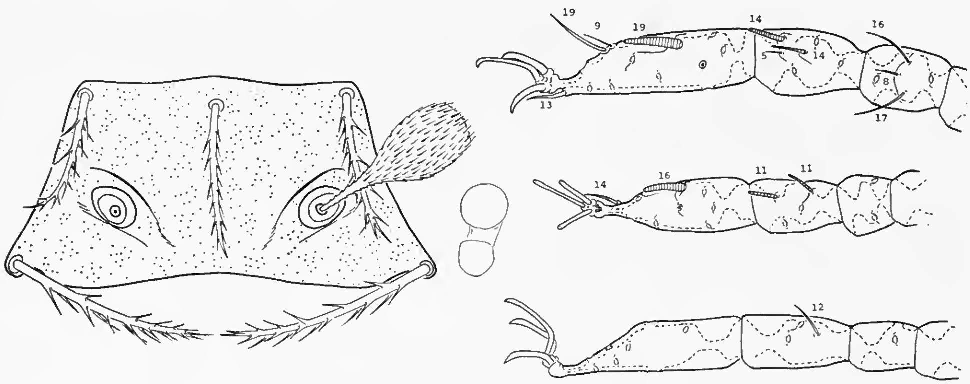

FIG. 17. *Euschoengastia enhebra,* new species. Scutum and eyes. Specialized setae of legs.

Euschoengastia libertatis Brennan and Dalmat

Euschoengastia libertatis Brennan and Dalmat, 1960, Ann. Ent. Soc. Amer., 53, (2), pp. 189–190, fig. 8.

Four specimens off *Peromyscus nudipes,* Highlands of Chiriquí, 12 February 1960. First Panamanian record.

Euschoengastia megastyrax Brennan and Jones

Euschoengastia megastyrax Brennan and Jones, 1960, Acarologia, 2, (4), pp. 506–507, fig. 7.

Seven specimens off unidentified bat, Los Santos, 26 January 1962; 1 off *Carollia perspicillata,* Cacao Plantation (Canal Zone), 12 December 1961; 1 off *Didelphis marsupialis,* Piña (Canal Zone), 18 December 1959. First records for Panama.

Euschoengastia nunezi (Hoffmann)

Neoschoengastia nunezi Hoffmann, 1944, Rev. Inst. Salub. Enferm. Trop., 9, (3), pp. 221–225, figs. 1–4.

One specimen off *Didelphis marsupialis,* Madden Forest (Canal Zone), 24 February 1955; 15 off *Philander opossum,* Canal Zone, 16 and 17 March 1955. First records for Panama.

Euschoengastia spissa Brennan and Jones

Euschoengastia spissa Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 109–110, fig. 5.

Known only from the holotype, off *Peromyscus nudipes,* Highlands of Chiriquí, 4 May 1960.

Euschoengastia tragulata Brennan and Jones

Euschoengastia tragulata Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 110–111, fig. 6.

One specimen off *Didelphis marsupialis,* Piña (Canal Zone), 16 February 1962; 33 off (5) *Coendou rothschildi,* vicinity of Pedro Miguel River (Canal Zone), 21 February to March 1962. Described from 5 specimens off *Nasua nasua,* Barro Colorado Island (Canal Zone), November 1956.

Genus **Eutrombicula** Ewing

Eutrombicula Ewing, 1938, Jour. Wash. Acad. Sci., 28: 293.
Type-species: *Microthrombidium alfreddugesi* Oudemans, 1910.

KEY TO PANAMANIAN SPECIES

1. With three mastitarsalae III and two mastitibialae III; dorsal formula begins 2-8 .... *batatas* (Linnaeus)
   With one mastitarsala III and no mastitibialae III; dorsal formula begins 2-6......2
2. Accessory prong of palpal claw arises at distal three-fourths of axial prong...... .... *alfreddugesi* (Oudemans)
   Accessory prong of palpal claw arises at distal one-half of axial prong........... .... *goeldii* (Oudemans)

Eutrombicula alfreddugesi (Oudemans)

Microthrombidium alfreddugesi Oudemans, 1910, Ent. Ber., 3: 84.

Some 1000 specimens identified from 245 lots. Hosts: REPTILES, *Oxybelis* sp., *Pseustes poecilonotus, Spilotes pullatus, Ameiva bifrontata, A. undulata, Anolis* sp., *Sceloporus* sp., unidentified lizards; BIRDS, *Odontophorus erythrops, Taraba major;* MAMMALS, *Didelphis marsupialis, Marmosa robinsoni, Philander opossum, Aotus trivirgatus, Saguinus geoffroyi, Proechimys semispinosus, Heteromys desmarestianus, Coendou rothschildi, Agouti paca, Hydrochaeris hydrochaeris, Sciurus granatensis, Sigmodon hispidus, Zygodontomys microtinus, Reithrodontomys mexicanus, Oryzomys alfaroi, O. capito, Oryzomys* sp., *Peromyscus flavidus, P. nudipes, Scotinomys teguina, S. xerampelinus,* mouse, *Sylvilagus brasiliensis, Nasua nasua, Tayassu tajacu.*

Localities: Galeta Point, Fort Gulick, France Field, Piña, Cacao Plantation, Summit, Madden Forest, Juan Mina, Pedro Miguel, Fort Clayton, Miraflores, Curundu, Roads K-9 and K-10, Corte Culebra Road, and Nuevo Emperador (Canal Zone); Cerro Azul, Cerro Campana, and Pacora (Panamá); Parita (Herrera); Cerro Pirre (Darién); Achiote (Colón); Almirante and Río Changena (Bocas del Toro); Cerro Hoya (Los Santos); Boquete Trail, El Hato, Bambito, and Cerro Punta (Chiriquí). This common pest chigger is more or less active throughout the year, with peak activity during the wet season, especially in the lowlands, according to collections from 1954 to 1962.

Both the *"lipovskyana"* and *"tropica"* forms are included in the above records. The former, from the Highlands of Chiriquí, is distinguished by a longer than usual tarsala I, and the latter, principally from lowlands, is distinguished by nude genual and ventrotibial palpal setae.

Eutrombicula batatas (Linnaeus)

Acarus batatas Linnaeus, 1758, Syst. Nat. (10th ed.), p. 617.

About 225 specimens identified from 95 lots. Hosts: BIRDS, *Gallus gallus, Hypomorphnus urubitinga, Caracara plancus, Catharus mexicanus, Crotophaga ani, Nyctidromus albicollis, Myiozetetes* sp.; MAMMALS, *Homo sapiens, Hydrochaeris hydrochaeris, Sigmodon hispidus, Zygodontomys microtinus, Reithrodontomys* sp., *Mazama americana.*

Localities: Fort Gulick, France Field, Fort Davis, Gatun, Nuevo Emperador, Fort Clayton, Fort Kobbe, and Curundu (Canal Zone); Tocumen and Pacora (Panamá); Achiote (Colón); Almirante and Río Changena (Bocas del Toro); El Hato (Chiriquí). Active during the wet season; no records available for January, February, or March.

Eutrombicula goeldii (Oudemans)

Microthrombidium goeldii Oudemans, 1910, Ent. Ber., 3: 84.

Some 1000 specimens identified from 280 lots. Hosts: REPTILES, *Pseustes poecilonotus, Ameiva bifrontata, A. festiva, A. undulata;* BIRDS, *Momotus momota, Neomorphus geoffroyi salvini, Malacoptila panamensis, Cyphorhinus aradus phaeocephalus;* MAMMALS, *Didelphis marsupialis, Marmosa mexicana, M. robinsoni, Metachirus nudicaudatus, Philander opossum,* unidentified bats, *Aotus trivirgatus, Saguinus geoffroyi, Dasypus novemcinctus, Proechimys semispinosus, Hoplomys gymnurus, Coendou rothschildi, Liomys adspersus, Heteromys australis, H. desmarestianus, Sciurus granatensis, Microsciurus alfari, Dasyprocta punctata, Rattus rattus, Sigmodon hispidus, Oryzomys caliginosus, O. capito, Nectomys alfari, Zygodontomys microtinus, Sylvilagus brasiliensis, Nasua nasua, Felis pardalis.*

Localities: Barro Colorado Island, Piña, Galeta Point, Fort Gulick, France Field, Fort Sherman, Fort Davis, Cacao Plantation, Summit, Madden Forest, Juan Mina, Miraflores, Pedro Miguel, Fort Clayton, Nuevo Emperador, Road K-9, Corte Culebra Road, Fort Kobbe, and Ancón Hill (Canal Zone); Coiba Island; Cerro Azul, Cerro Campana, Capira, Guayabito, and Madden Airstrip (Panamá); Cerro Pirre (Darién); Divisa and Parita (Herrera); Achiote (Colón); Cerro Hoya (Los Santos); Almirante, Río Changena, Cayo Agua, Escudo de Veraguas, and Isla Bastimentos (Bocas del Toro); Chiriquí Province. Common throughout the year, as suggested by miscellaneous collections made from 1954 to 1962.

Genus **Hoffmannina** Brennan and Jones

Hoffmannina Brennan and Jones, 1959, Ann. Ent. Soc. Amer., 52: 8.
Type-species: *Novotrombicula suriana* Hoffmann, 1954.

KEY TO PANAMANIAN SPECIES

With two genualae I . . . . *handleyi* Brennan and Jones
With three genualae I . . . . *suriana* (Hoffmann)

Hoffmannina handleyi Brennan and Jones

Hoffmannina handleyi Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 111–112, fig. 7.

Thirty-two specimens in 16 lots off *Didelphis marsupialis, Peromyscus nudipes, Reithrodontomys* sp., El Hato, Bambito, and Cerro Punta (Chiriquí), 7 to 31 January, 26 April to May 1961. Brennan and Jones (1961a) report this species also from *Scotinomys teguina, Reithrodontomys mexicanus,* and *Heteromys desmarestianus,* all from the same general area in the Chiriquí Highlands.

Hoffmannina suriana (Hoffmann)

Novotrombicula suriana Hoffmann, 1954, Ann. Esc. Nac. Cienc. Biol. Mex., 8, (1–2), pp. 23–26, figs. 9–12.

Nine specimens identified off *Reithrodontomys sumichrasti,* Cerro Barú, 10500 feet (Chiriquí), 2 May 1960; 1 off *Scotinomys xerampelinus,* 7 off *Peromyscus nudipes,* 9 off *Reithrodontomys creper,* Boquete Trail (Chiriquí), 3 to 5 May 1961. First Panamanian records.

Intercutestrix, new genus

Type-species: *Euschoengastia tryssa* Brennan and Jones, 1961.

DIAGNOSIS: Intradermal trombiculine larvae with leg segmentation 7-6-6; legs without mastisetae, parasubterminala, and genualae II and III. Scutum much wider than deep, with five setae and expanded sensillae. Eyes present. Cheliceral blades with tricuspid cap. Palpal tarsus with four branched setae and a tarsala.

Intercutestrix tryssa (Brennan and Jones), *new combination.* Figure 18.

Euschoengastia tryssa Brennan and Jones, 1961, Acarologia, 3, (2), pp. 189–190, fig. 9.

Additional material from Panama has indicated the need for erecting a genus to receive this species which was described from a single Peruvian specimen off *Proechimys hendeei.* The conspecificity of this and the Panamanian form is evident, although as might be expected, the latter exhibits geographic variation and may be a subspecies. Here, as figured, the scutum is somewhat deeper and AM < AL. The dorsal setae are longer. Engorged specimens of both forms are circular in outline.

Forty-five specimens off (15) *Proechimys semispinosus,* all from Canal Zone: Fort Gulick, 9 March 1954, 7 December 1960, 14 and 15 December 1961; France Field, 8 September to 21 December 1961; Piña, 29 November and 29 August, 1961, 9 February 1962; Summit, 1 December 1960. One off

Oryzomys caliginosus, Cerro Azul (Panamá), 26 January 1956. Two off *Tylomys watsoni,* Piña (Canal Zone), 7 February 1962, and 4 off *Oryzomys capito,* Piña, 20 December 1960. First records for Panama.

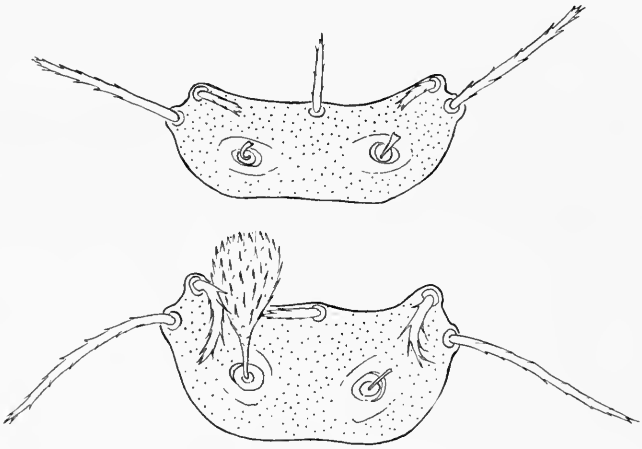

FIG. 18. *Intercutestrix tryssa* (Brennan and Jones). Scutum of holotype (Peru), above, and Panamanian form, below.

Genus **Leptotrombidium** Nagayo et al.

Leptotrombidium Nagayo et al., 1916, Dobutsugaku Zasshi, 28: 392.
Type-species: *Trombidium akamushi* Brumpt, 1910.

Leptotrombidium panamensis (Ewing)

Trombicula panamensis Ewing, 1925, Amer. Jour. Trop. Med., 5, (3), pp. 259–260.

About 160 specimens from 36 lots. Hosts: *Didelphis marsupialis, Marmosa robinsoni, Artibeus toltecus* (one specimen, Bocas del Toro), *Proechimys semispinosus, Hoplomys gymnurus, Heteromys australis, Liomys adspersus, Coendou rothschildi, Sigmodon hispidus, Oryzomys bombycinus, O. caliginosus, O. capito, Zygodontomys microtinus.*

Localities: Fort Sherman, Gamboa Road, Summit, Madden Forest, Pedro Miguel River, and Fort Kobbe (Canal Zone); Almirante and Río Changena (Bocas del Toro). Irregular collections from 1954 to 1962 suggest that peak activity of this species is during the dry season, January to April, although a few collections were made in June and September.

Myxacarus, new genus

Type-species: *Myxacarus oscillatus,* new species.

DIAGNOSIS: Intranasal trombiculine larvae with leg segmentation 7-7-7; legs without mastisetae and genualae II and III, but with tibiala III. Scutum subquadrate, with five setae and expanded sensillae. Eyes apparently absent. Cheliceral blades with a series of dorsal teeth of which the proximal is enlarged. Palpal tarsus with five branched setae and a tarsala; tibial claw bifurcate. Ventral humeral setae present.

Distinguished from *Blix* n. gen. by armature of cheliceral blades, specialized setation of legs, bifurcate palpaltibial claw, and ventral humeral setae.

Myxacarus oscillatus, new species. Figure 19.

DIAGNOSIS: Intranasal habitat. Scutum subquadrate with concave posterior margin and PL's arising from tubercles. Cheliceral blades with series of dorsal teeth. Two genualae I, no genualae II or III.

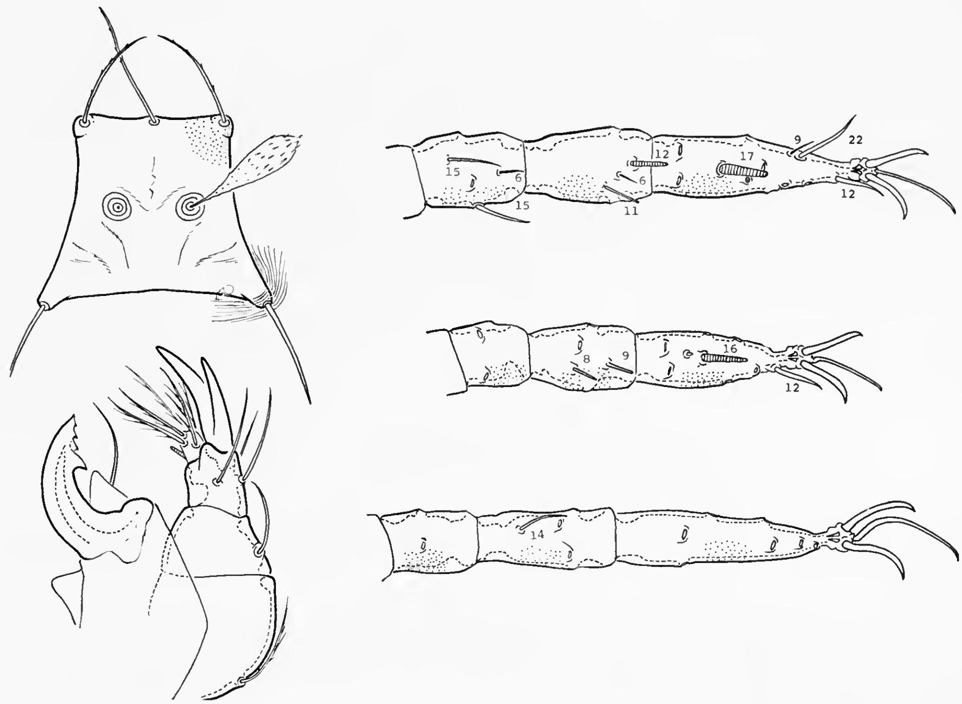

FIG. 19. *Myxacarus oscillatus,* new species. Scutum. Half of gnathosoma. Specialized setae of legs.

DESCRIPTION: *Idiosoma.*—Broad-ellipsoidal, slightly constricted. Length and width of holotype 610 by 390 μ. Eyes not seen. Anus at fourth row of ventral setae. *Scutum.*—Subquadrate with straight to concave posterior margin, densely punctate. Posterolateral angles produced and tuberculate. Anterior setae with distinct barbs, posterior setae apparently nude. Sensillae broadlanceolate, with minute setules. Measurements of holotype: AW 47, PW 76, SB 26, ASB 30, PSB 29, AP 57, AM 40, AL 40, PL 40, S 40 μ. *Gnathosoma.*—Densely punctate. Blades strong, with a large dorsal tooth on apical third, in front of which is a series of four or five smaller teeth. Galeal seta nude. Palpal setae B/N/NNN: tarsus with five branched setae and a tarsala; claw bifurcate. *Legs.*—Densely punctate. Specialized setae as figured. Non-specialized setae barbed to branched. Empodium long and slender. *Body setae.*—Dorsal setae with short barbs, 29 to 46 μ, arranged 2-6-6-4-2. Ventral setae, 2-2 sternals and three to four ventral humerals on each side between coxae II and III, plus 30. Postanals similar to dorsals.

TYPE MATERIAL: Holotype and a paratype, RML no. 44241, from nasal mucosa of *Proechimys semispinosus,* Summit (Canal Zone), 20 December

1961, MARU. Paratypes: 3, same host, Piña (Canal Zone), 20 December 1960, and Fort Gulick (Canal Zone), 6 January 1961, EHB; 11 off *Hoplomys gymnurus*, Piña, 6 December 1960, EHB; 1 off *Oryzomys capito*, Piña, 7 December 1960, EHB; 6 off *Dasypus novemcinctus*, Paraíso (Canal Zone), 15 February 1962, MARU; 1 off *Metachirus nudicaudatus*, Cerro Azul (Panamá), 16 March 1961, MARU. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, Chicago Natural History Museum, and the British Museum (Natural History).

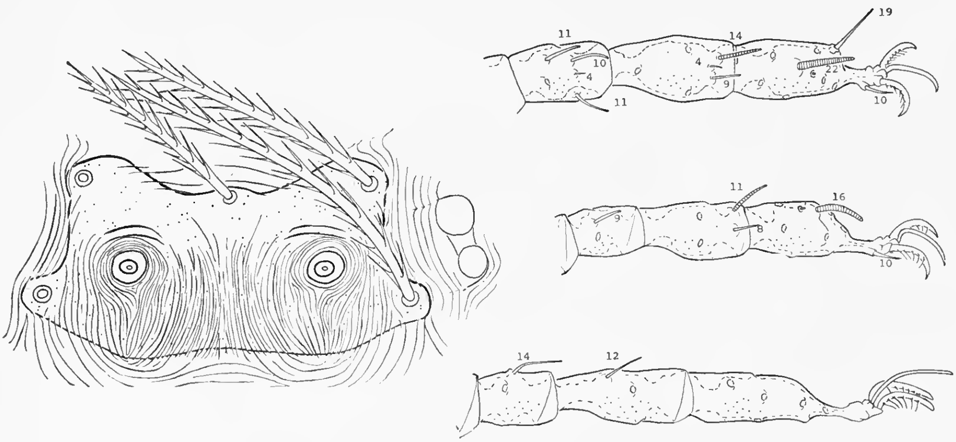

FIG. 20. *Neoschoengastia electron*, new species. Scutum and eyes. Specialized setae of legs.

Genus **Neoschoengastia** Ewing

Neoschoengastia Ewing, 1929, Man. Ext. Parasites, p. 187.

Type-species: *Schoengastia americana* Hirst, 1921.

Neoschoengastia electron, new species. Figure 20.

DIAGNOSIS: Three pairs of humeral setae, sternal setae 2-4, three genualae I, parasubterminala absent, coxa III with three setae.

DESCRIPTION: *Idiosoma.*—Broad-ellipsoidal. Eyes 2/2, in a plate. Length and width of holotype, 587 by 400 μ. Anus at sixth row of ventral setae. *Scutum.*—Wider than long, with sinuous margins, puncta large, whorls of cuticular striations cover posterior two-thirds of scutum. Setae long, with semi-appressed branches. Sensillae missing. Measurements of holotype: AW 62, PW 83, SB 44, ASB 24, PSB 20, AP 27, AM 39, AL 57, PL 78, S– μ. *Gnathosoma.*—Punctate. Blades with tricuspid cap. Palpal setae B/B/NNB; tarsus with five branched setae, a subterminala, and a tarsala; claw trifurcate. Galeal seta branched. *Legs.*—Punctate. Specialized setae as figured. No parasubterminala. Non-specialized setae moderately branched. Coxa III with three setae. Tarsal claws with tenent hairs. *Body setae.*—Dorsal setae 50 to 75 μ, arranged approximately 6-9-8-2-7-5-4-4. Ventral setae, 2-4 sternals plus 52, postanals like dorsals.

TYPE MATERIAL: Holotype, RML no. 44332, off *Electron platyrhynchum*, Cacao Plantation Road (Canal Zone), 2 February 1962, MARU. In the collection of the Rocky Mountain Laboratory.

Genus **Perates** Brennan and Dalmat

Perates Brennan and Dalmat, 1960, Ann. Ent. Soc. Amer., 53: 186.
Type-species: *Perates insessus* Brennan and Dalmat, 1960.

Perates insessus Brennan and Dalmat

Perates insessus Brennan and Dalmat, loc. cit., p. 187, fig. 5.

Eleven specimens off (3) *Pteronotus psilotis*, Penonomé (Coclé), 30 January and 8 February 1962. First Panamanian records.

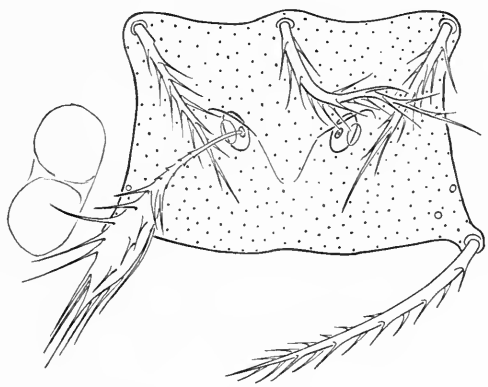

FIG. 21. *Perissopalla precaria* (Brennan and Dalmat). Scutum and eyes.

Genus **Perissopalla** Brennan and White

Perissopalla Brennan and White, 1960, Jour. Parasit., 46: 346.
Type-species: *Perissopalla flagellisetula* Brennan and White, 1960.

Perissopalla precaria (Brennan and Dalmat), *new combination.* Figure 21.

Euschoengastia precaria Brennan and Dalmat, 1960, Ann. Ent. Soc. Amer., 53, (2), p. 190, fig. 9.

Eighteen specimens off *Micronycteris megalotis*, Pacora (Panamá), 31 October 1960. This species is transferred to the genus *Perissopalla* Brennan and White on the basis of a specimen in the above series that bears sensillae. Previous specimens lacked these structures. First record for Panama.

Genus **Polylopadium** Brennan and Jones

Polylopadium Brennan and Jones, 1961, Jour. Parasit., 47: 112.
Type-species: *Polylopadium kramisi* Brennan and Jones, 1961.

The discovery of a second species of *Polylopadium, P. confirmatum* n. sp., permits a revision of the generic diagnosis as follows:

Trombiculine larvae with dorsal pattern of platelets in addition to scutum. Scutum with five short inconspicuously barbed setae, sensillae expanded. Eyes present or absent. Dorsal setae short and barbed, similar to scutals. Cheliceral blades with tricuspid cap. Palpal tibial claw trifurcate. Leg segmentation 7-6-6.

FIG. 22. *Polylopadium confirmatum*, new species. Dorsum, showing scutum and platelets. Oblique lighting photomicrograph by N. J. Kramis.

KEY TO PANAMANIAN SPECIES

With 11 dorsal platelets; eyes absent; genualae II and III absent..................
....*kramisi* Brennan and Jones
With 16 dorsal platelets; eyes present; genualae II and III present................
....*confirmatum* n. sp.

Polylopadium confirmatum, new species. Figures 22, 23.

DIAGNOSIS: Dorsum with 16 platelets, two genualae I and a genuala II and III, eyes present.

DESCRIPTION: *Idiosoma.*—Ovate. Eyes 2/2, in a plate, posterior pair obsolescent. Dorsum with 16 small platelets arranged as figured. Length and width of holotype, partly engorged, 315 by 235 μ. Anus at seventh row of ventral setae. *Scutum.*—Trapezoidal, with anteromedian and posteromedian extensions, as figured. Setae short and barbed. Sensillae oblanceolate, setules conspicuous. Measurements of holotype: AW 46, PW 59, SB 30, ASB 23, PSB 33, AP 21, AM 7, AL 8, PL 10, S 28 μ. *Gnathosoma.*—Cheliceral blade with tricuspid cap and small ventral notch. Palpal setae B/B/BBB; claw trifurcate; tarsus with five branched setae and a tarsala. Galeal seta nude. *Legs.*—With fine puncta. Specialized setae as figured. Non-specialized setae sparsely branched. *Body setae.*—Dorsal setae short, barbed, 14 to 18 μ, arranged in the holotype 4-6-6-2-6-4-4-2. Ventral setae, 2-2 sternals plus 38, sternals with few pronounced branches similar to coxal setae, postanals similar to dorsals.

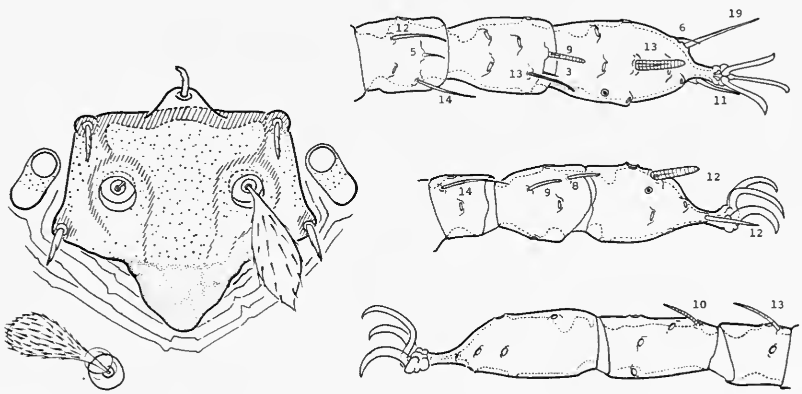

FIG. 23. *Polylopadium* species. Scutum and eyes of *P. confirmatum*, new species. Sensilla of *P. kramisi* Brennan and Jones. Specialized setae of legs of *P. confirmatum*.

TYPE MATERIAL: Holotype, RML no. 43719, off *Oryzomys caliginosus*, near Río Changena (Bocas del Toro), 21 September 1961. Two paratypes, same host and locality, 26 and 27 September 1961, EHB. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory and the United States National Museum.

Polylopadium kramisi Brennan and Jones. Figure 23.

Polylopadium kramisi Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 112–113, figs. 8, 9.

Off (4) *Liomys adspersus* in the Canal Zone: 2 specimens, Curundu, 3 October 1961; 8 specimens, Summit, 27 and 28 December 1961; 3 specimens, Cacao Plantation, 31 January 1962. Also reported by Brennan and Jones (1961a) from *Proechimys semispinosus*, Canal Zone, and from *Peromyscus* sp., Chiriquí Province.

A specimen bearing sensillae permits us to illustrate this structure.

Genus **Pseudoschoengastia** Lipovsky

Pseudoschoengastia Lipovsky, 1951, Jour. Kans. Ent. Soc., 24: 95.

Type-species: *Pseudoschoengastia hungerfordi* Lipovsky, 1951.

KEY TO PANAMANIAN SPECIES

1. With one genuala I; genualae II and III absent .... *mermeriza* n. sp.
   With two or three genualae I; genualae II and III present 2

2. PL's on scutum; parasubterminala branched; one pair of humeral setae...*apista* n. sp.
PL's off scutum; parasubterminala nude; two pairs of humeral setae.............. 3
3. Eyes absent ....*finitima* n. sp.
Eyes present 4
4. With two genualae I; idiosomal setae arise from deep, wide pits..........*dasypi* n. sp.
With three genualae I; idiosomal setal bases normal......................... 5
5. Sensillae capitate, a small bulb at base; palpal genual and tibial setae branched; AL's much longer than PL's..................................*bulbifera* Brennan
Sensillae obovate, no bulb at base; palpal genual tibial and setae nude; AL's shorter than PL's 6
6. About 48 short dorsal setae; SB = 18 μ..........................*abditiva* Brennan
About 60 longer dorsal setae; SB = 28 μ............................*zona* Brennan

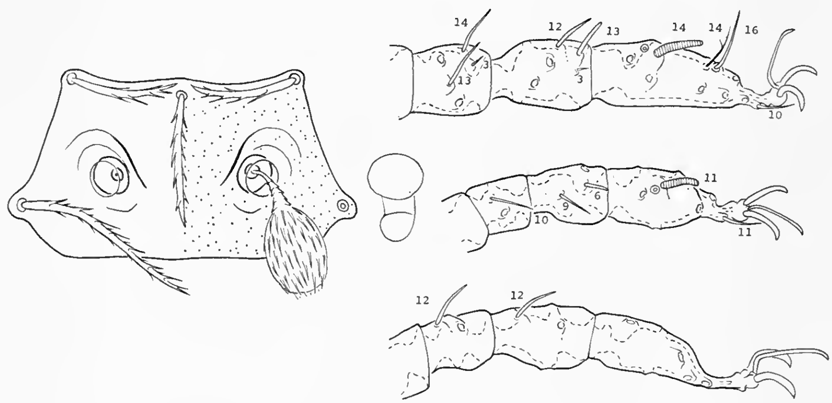

FIG. 24. *Pseudoschoengastia apista,* new species. Scutum and eyes. Specialized setae of legs.

Pseudoschoengastia abditiva Brennan

Pseudoschoengastia abditiva Brennan, 1960, Acarologia, 2, (4), pp. 482-483, fig. 1.

Known only from the type series, 4 specimens off *Oryzomys capito,* Cerro Azul (Panamá), 8 February 1956.

Pseudoschoengastia apista, new species. Figure 24.

DIAGNOSIS: Related to *P. inevicta* Brennan from which it differs by nude dorsotibial palpal seta, branched parsubterminala, leg segmentation 7-7-7, and tarsala I longer than tarsala II. Distinguished from all other members of the genus by having only one pair of humeral setae.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Length and width of holotype, engorged, 345 by 255 μ. Eyes large, 2/2, in a plate. Anus at fourth row of ventral setae. *Scutum.*—As figured, with sinuous margins, moderately punctate. Posterolateral setae on scutum. Sensillae obovate, densely setulose on anterior surface, fewer and larger setules on posterior surface, stems barbed nearly to base. Measurements of holotype: AW 46, PW 64, SB 29, ASB 21, PSB 16, AP 28, AM 25, AL 19, PL 30, S 30 μ. *Gnathosoma.*—Moderately punctate. Cheliceral blades with tricuspid cap and dorsal and ventral tooth. Galeal seta nude, sometimes forked. Palpal setae B/B/NNB; tarsus with five branched setae and a tarsala; claw trifurcate. *Legs.*—Punctate. Segmentation 7-7-7. Specialized setae as figured, parasubterminala forked or branched. Non-specialized setae moderately and conspicuously branched. *Body setae.*—Dorsal setae short, with conspicuous branches, 24 to 32 μ, arranged 2-8-2-8-2-6-6-4. Ventral setae, 2-2 sternals plus 40, postanals similar to dorsals, two or three ventral humerals on each side between coxae II and III.

TYPE MATERIAL: Holotype and 8 paratypes, RML no. 44654, off *Dasypus novemcinctus*, Paraíso (Canal Zone), 26 March 1962, MARU. Holotype, in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, British Museum (Natural History), and the Chicago Natural History Museum.

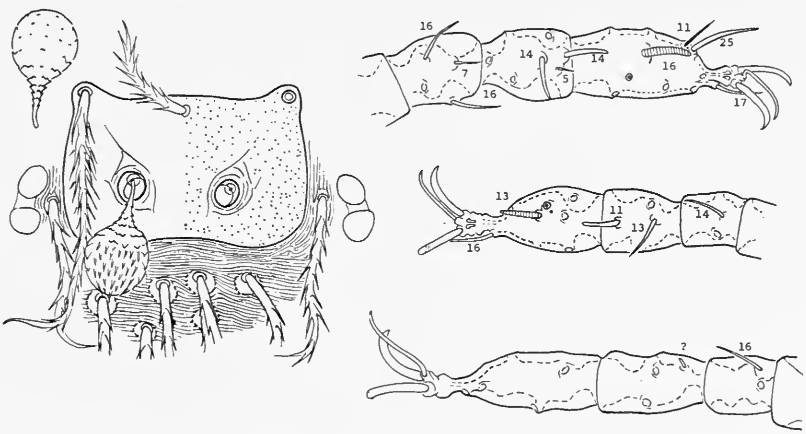

FIG. 25. *Pseudoschoengastia dasypi*, new species. Posterior aspect of sensilla. Scutum and eyes; bases of dorsal setae; sensilla, anterior surface. Specialized setae of legs.

Pseudoschoengastia bulbifera Brennan

Pseudoschoengastia bulbifera Brennan, 1960, Acarologia, 2, (4), pp. 483–484, fig. 2.

About 425 specimens identified from 135 lots. Hosts: REPTILES, *Sceloporus* sp.; MAMMALS, *Didelphis marsupialis, Marmosa mexicana, M. robinsoni, Philander opossum, Cryptotis* sp., *Sturnira ludovici, Saguinus geoffroyi, Proechimys semispinosus, Heteromys australis, H. desmarestianus, Liomys adspersus, Hoplomys gymnurus, Sigmodon hispidus, Oryzomys alfaroi, O. bombycinus, O. caliginosus, O. albigularis, O. capito, Oryzomys* sp., *Peromyscus nudipes, Peromyscus* sp., *Reithrodontomys* sp., *Scotinomys xerampelinus, Zygodontomys microtinus, Nectomys alfari.*

Localities: Piña, Miraflores, Summit, and Corte Culebra Road (Canal Zone); Cerro Azul (Panamá); Isla Bastimentos and Río Changena (Bocas del Toro); Cerro Pirre (Darién); Boquete Trail, Cerro Punta, Bambito, and El Hato (Chiriquí). See Brennan (1960) for other Panamanian records. In miscellaneous collections made from 1954 to 1962, this species was found in all months except June, July and August.

Pseudoschoengastia dasypi, new species. Figure 25.

DIAGNOSIS: Separated from other species of the genus by coarsely branched idiosomal setae arising from deep, wide pits. It is related to

P. guatemalensis Brennan from which it differs by wider scutum in proportion to depth, more widely separated sensillary bases, and more and larger idiosomal setae.

DESCRIPTION: *Idiosoma.*—Ovate. Length and width of holotype, slightly engorged, 237 by 165 μ. Eyes large, 2/2, in a plate. Anus at fourth row of ventral setae. *Scutum.*—Conspicuously punctate, as figured; extrascutal PL'S coarsely branched setae. Sensillate capitate, anterior surface moderately setulose and with small setules sparsely distributed on posterior surface. Measurements of holotype: AW 55, SB 29, ASB 29, PSB 19, AM 32, AL 73, PL 53, S 32 μ. *Gnathosoma.*—Conspicuously punctate. Cheliceral blades

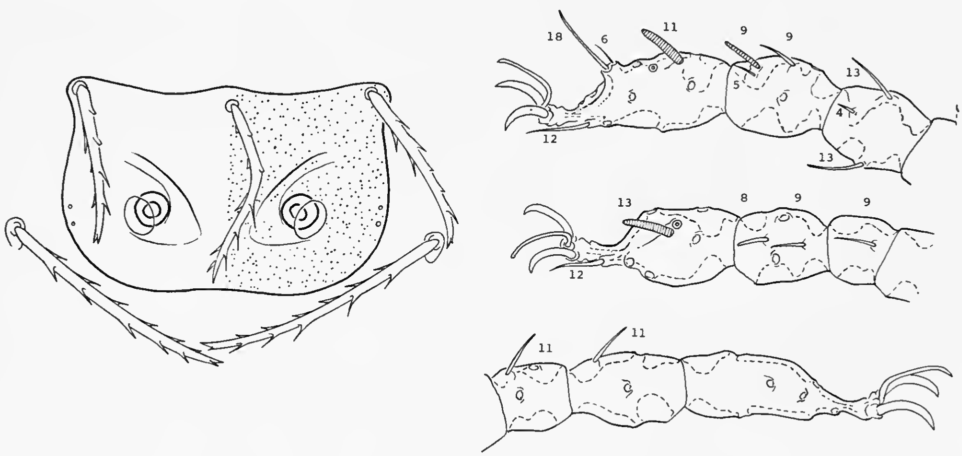

FIG. 26. *Pseudoschoengastia finitima*, new species. Scutum. Specialized setae of legs.

with tricuspid cap and minute subapical dorsal and ventral teeth. Galeal seta nude. Palpal setate B/B/BNB; tarsus with five branched setae and a tarsala; claw trifurcate. *Legs.*—Punctate. Leg segmentation 7-6-6. Specialized setae as figured. Non-specialized setae coarsely branched. *Body setae.*—Dorsal setae coarsely branched, arising from deep, wide pits, 33 to 50 μ, 2-2 humerals plus about 70. Ventral setae, 2-2 sternals, 2-2 ventral humerals, plus about 60. These also arise from wide pits.

TYPE MATERIAL: Holotype and 4 paratypes, RML no. 44654, off *Dasypus novemcinctus,* Paraíso (Canal Zone), 26 March 1962, MARU. In the collection of the Rocky Mountain Laboratory. All specimens in fair to poor condition.

Pseudoschoengastia finitima, new species. Figure 26.

DIAGNOSIS: Distinguished from all other species of the genus by the absence of eyes, and from *P. farneri* Lipovsky by the more appressed branches of branched setae, wider scutum in proportion to depth, and smaller tarsalae I and II.

DESCRIPTION: *Idiosoma.*—Broad-ovate, slightly constricted. Length and width of holotype, engorged, 400 by 260 μ. Eyes absent. Anus at about fifth row of ventral setae. *Scutum.*—As figured, PL's extrascutal, sensillae broken off throughout the series. Measurements of holotype: AW 47, SB 25, ASB 21, PSB 10, AM 33, AL 24, PL 42, S– μ. *Gnathosoma.*—Punctate. Cheliceral blades with tricuspid cap, and apparently without additional teeth. Galeal seta nude. Palpal setae B/N/BNB; tarsus with five branched setae and a tarsala; claw trifurcate. *Legs.*—Leg segmentation 7-6-6. Specialized setae as figured. Non-specialized setae moderately branched. *Body setae.*—Dorsal setae 32 to 40 μ, 2-2 humerals plus about 50. Ventral setae, 2-2 sternals, 2-2 humerals, plus 60.

TYPE MATERIAL: Holotype and 7 paratypes, RML no. 40112, off *Heteromys desmarestianus*, Piña (Canal Zone), 7 December 1960. Two paratypes, same host and locality, 29 December 1961, EHB. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Laboratory, United States National Museum, British Museum (Natural History), and the Chicago Natural History Museum.

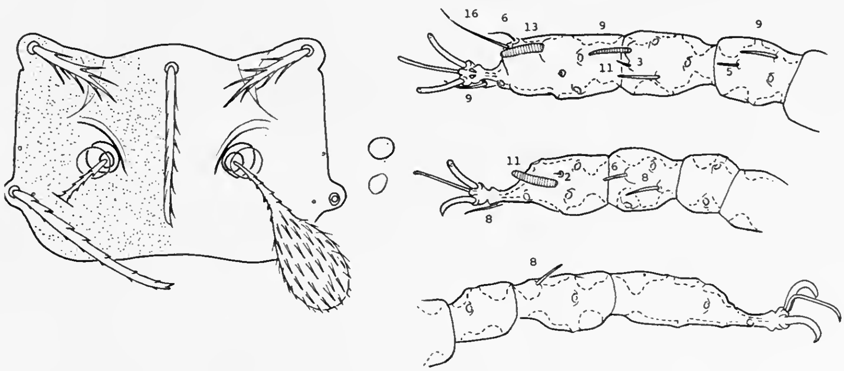

FIG. 27. *Pseudoschoengastia mermeriza*, new species. Scutum and eyes. Specialized setae of legs.

Pseudoschoengastia mermeriza, new species. Figure 27.

DIAGNOSIS: Similar to *P. aberrans* Brennan and Jones (PL's on deep-narrow scutum, palpal setation, one genuala I, no genualae II and III, and small eyes) but a distinct form with leg segmentation apparently 7-7-6, all branched setae with more appressed and shorter branches and different arrangement of dorsal setae.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Length and width, partly engorged, 285 by 206 μ. Eyes small, 2/2, posterior pair obsolescent. Anus at fourth row of ventral setae. *Scutum.*—As figured, punctate, deep-narrow. Posterolateral setae on scutum. Sensillae obovate, with large setules, anterior surface completely covered, posterior surface with a denuded median area, stems barbed nearly to their bases. Measurements: AW 41, PW 50, SB 19, ASB 20, PSB 17, AP 23, AM 24, AL 12, PL 31, S 29 μ. *Gnathosoma.*—Moderately punctate. Cheliceral blades with tricuspid cap and a ventral tooth. Galeal seta nude. Palpal setate B/N/NNB; tarsus with five branched setae and a tarsala; tibal claw trifurcate. *Legs.*—Punctate. Segmentation 7-7-6. Specialized setae as figured. Non-specialized setae moderately branched. *Body setae.*—Dorsal setae similar to PL's with short appressed branches, 19 to 28 μ arranged 4-4-6-8-2-8-6-4-2. Ventral setae, 2-3 (can be interpreted as 2-2 or 2-4) plus 32, postanals similar to dorsals, two ventral humerals on each side between coxae II and III.

TYPE MATERIAL: Holotype, RML no. 44508, off *Coendou rothschildi*, Paraíso (Canal Zone), 26 February 1962, MARU. In the collection of the Rocky Mountain Laboratory.

Pseudoschoengastia zona Brennan

Pseudoschoengastia zona Brennan, 1960, Acarologia, 2, (4), pp. 490–492, fig. 8.

Five specimens off *Liomys adspersus,* Nuevo Emperador (Canal Zone), 7 August 1961; 3 off same host, Summit (Canal Zone), 27 and 28 December 1961; 1 off *Heteromys australis,* Cerro Pirre (Darién), 3 February 1961; 1 off *Oryzomys caliginosus,* Río Changena (Bocas del Toro), 23 September 1961. In addition, reported by Brennan (1960) from *Sigmodon hispidus* and *Tylomys panamensis.*

Genus **Speleocola** Lipovsky

Speleocola Lipovsky, 1952, Jour. Kans. Ent. Soc., 25: 132.

Type-species: *Speleocola tadaridae* Lipovsky, 1952.

Speleocola secunda Brennan and Jones

Speleocola secunda Brennan and Jones, 1960, Acarologia, 2, (4), pp. 509-510, fig. 8.

Three specimens off *Coendou rothschildi,* along Pedro Miguel River (Canal Zone), 20 March 1962. First record for Panama.

Genus **Tecomatlana** Hoffmann

Tecomatlana Hoffmann, 1947, An. Esc. Nac. Cienc. Biol. Mex., 4, (4), p. 451.

Type-species: *Tecomatlana sandovali* Hoffmann, 1947.

Tecomatlana sandovali Hoffmann

Tecomatlana sandovali Hoffmann, loc. cit., pp. 452–457, figs. 1–6.

Six specimens off *Peropteryx macrotis,* Buena Vista (Colón), 29 October 1959; 5 off undetermined bats, cave near Quebrada Bonita (Panamá), 16 February 1962. First records for Panama.

Genus **Blankaartia** Oudemans

Blankaartia Oudemans, 1911, Ent. Ber., 3: 123.

Type-species: *Trombidium niloticum* Trägårdh, 1905.

KEY TO PANAMANIAN SPECIES

1. Sensillae nude; all setae of palpal tarsus nude .... *marui* n. sp.
   Sensillae branched, at least some setae of palpal tarsus branched 2
2. Palpal tibial claw bifurcate; palpal genual seta nude: galeal seta nude; tarsala I extremely long ($>50\ \mu$) .... *wetmorei* n. sp.
   Palpal tibial claw trifurcate; palpal genual seta branched; galeal seta forked or branched; tarsala I not unusually long 3
3. Scutum not pentagonal, its posterior margin broadly curved .... *arremonops* (Brennan and Jones)
   Scutum pentagonal 4
4. Posterior angle of scutum acute .... *attenuata* (Michener)
   Posterior angle of scutum not acute 5
5. Length of tarsala I about 20 μ .... *allcei* (Ewing)
   Length of tarsala I about 15 μ 6
6. Large, heart-shaped species (length, engorged, may exceed 1 mm.) .... *sinnamaryi* (Floch and Fauran)
   Smaller species, not heart-shaped .... *velascoi* (Boshell and Kerr)

Blankaartia alleei (Ewing)

Trombicula alleei Ewing, 1926, Ent. News, 37: 111–112.

Ten specimens off *Hydrochaeris hydrochaeris,* Cerro Pirre (Darién), 7 February 1961. This species was described from a single adult from Barro Colorado Island. For additional information, including larval records from Panama, see Michener (1946) who gives biologic data and shows that the larvae are characteristically parasitic on birds.

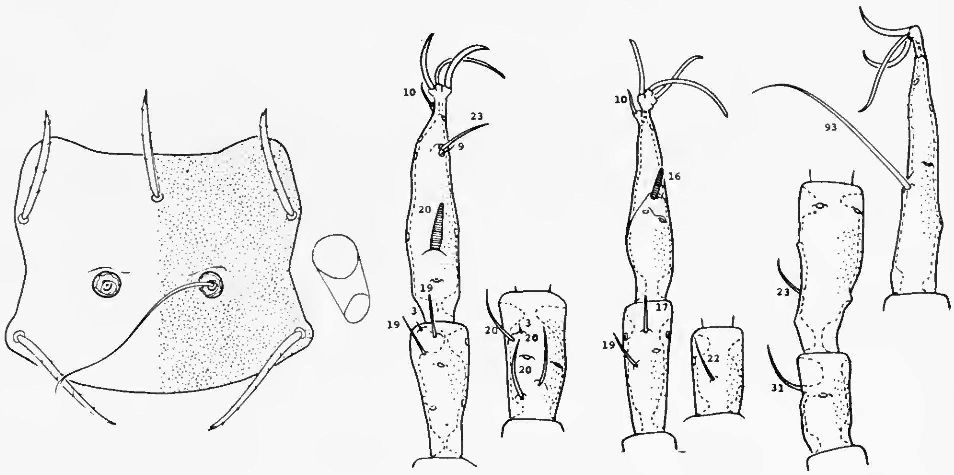

FIG. 28. *Blankaartia marui,* new species. Scutum and eyes. Specialized setae of legs.

Blankaartia arremonops (Brennan and Jones), *new combination.*

Trombicula arremonops Brennan and Jones, 1961, Jour. Parasit., 47, (2), pp. 114–115, fig. 10.

Known only from the holotype off *Arremonops conirostris,* Cacao Plantation (Canal Zone), 4 May 1955.

Blankaartia attenuata (Michener)

Trombicula (*Megatrombicula*) *attenuata* Michener, 1946, Ann. Ent. Soc. Amer., 39, (3), pp. 440–444, figs. 12–17, 22.

The description of this species is based principally on adults of both sexes, found only on floating plants of water lettuce (*Pistia stratiotes*), Juan Mina (Canal Zone), September and October 1945. Larvae, obtained by rearing, were briefly described. The holotype is a male, the allotype a female. Hosts are unknown. No additional records.

Blankaartia marui, new species. Figure 28.

DIAGNOSIS: Distinguished from all other species by the nude sensillae and nude setae of palpal tarsus; in addition, distinguished from *wetmorei* n. sp. by the greater number of body setae and much shorter tarsala I.

DESCRIPTION: *Idiosoma.*—Ellipsoidal. Length and width of holotype 885 by 463 μ.

Eyes prominent, 2/2, in a plate, the anterior larger. Anus at fourth row of ventral setae. *Gnathosoma.*—Densely and conspicuously punctate. Chelicerae long and narrow, blades long, with tricuspid cap. Palpal setae B/N/NNN; tarsus with six nude setae, a subterminala and a tarsala; claw bifurcate. Galeal seta nude. *Scutum.*—As figured, nearly quadrate, with shallow curving posterior margin, densely punctate. Setae with appressed branches, AM and AL'S considerably removed from anterior margin. Sensillae thread-like, nude. Measurements of holotype: AW 99, PW 100, SB 36, ASB 52, PSB 41, AP 44, AM 40, AL 40, PL 51, S 88 μ. *Legs.*—Long, conspicuously punctate. Specialized setae as figured. Non-specialized setae long, sparsely branched, some seemingly nude. *Body setae.*—Dorsal setae with appressed branches, 42 to 55 μ, arranged 2-6-6-6-4-2-2. Ventral setae, 2-2 sternals plus 36.

TYPE MATERIAL: Holotype and a paratype, RML no. 40982, off *Nycticorax nycticorax*, Cerro Azul (Panamá), 29 May 1961; one paratype, same collecting data, MARU. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory and the United States National Museum.

Blankaartia sinnamaryi (Floch and Fauran)

Trombicula (*Tragardula*) ! *sinnamaryi* Floch and Fauran, 1956, Arch. Inst. Pasteur Guyane Franç. et Inini, no. 405, pp. 3–7, figs. 1–5.

About 200 specimens identified from 47 lots. Hosts: BIRDS, *Anhinga anhinga, Aramides cajanea, Ciccaba virgata, Otus guatemalae, Caprimulgus rufus, Nyctidromus albicollis, Trogon massena, Baryphthengus ruficapillus,* Bucconidae sp., *Monasa morphoeus, Catharus mexicanus, Dendrocincla homochroa, Dumetella carolinensis, Dysithamnus mentalis, Geothlypis semiflava, Hylocichla ustulata, Icterus mesomelas, Microbates cinereiventris, Myiarchus ferox, Myiozetetes* sp., *Oporornis formosus, Piranga rubra, Sclerurus guatemalensis, Sporophila aurita corvina, Taraba major, Xiphorhynchus guttatus;* MAMMALS, *Phyllostomus hastatus.*

Localities: Juan Mina, Nuevo Emperador, Cacao Plantation, and Rodman Naval Base (Canal Zone); Madden Airstrip and Pacora (Panamá); Almirante and Río Changena (Bocas del Toro); Coiba Island. From 1956 to 1962, taken in all months of the year except March, April, May, and July.

Blankaartia velascoi (Boshell and Kerr)

Trombicula velascoi Boshell and Kerr, 1942, Rev. Acad. Colomb. Cienc. Exacta, Fisico-Quim. y Nat., 5, (17), pp. 9–10 (in reprint).

Described from 8 adults from Colombia. The only known larval records of this species are those of Michener (1946) from Panama. Michener also gives interesting biologic findings, e.g., the collecting of 4 larvae from the branches of a mango tree, and lists numerous bird hosts.

Blankaartia wetmorei, new species. Figure 29.

DIAGNOSIS: Distinguished from all other species of *Blankaartia* by the extremely long tarsala I (about 60 μ), and from all except *marui* n. sp. by the nude palpal genual and tibial setae and the bifurcate palpal tibial claw.

DESCRIPTION: *Idiosoma.*—Elliptical, red in life. Length and width of holotype 650 by 425 μ. Eyes 2/2, in a plate. Anus at fourth row of ventral setae. *Gnathosoma.*—Punctate. Chelicerae and cheliceral blades elongate, the latter with tricuspid cap. Galeal seta nude. Palpal setae B/N/NNN: tarsus with six setae (four branched and two apparently nude) a subterminala and a tarsala; claw bifurcate. *Scutum.*—Densely punctate, with broadly curved posterior angle. Setae with appressed barbs, AM and AL's posterior to margin. Sensillae branched. Measurements of holotype: AW 93, PW 100, SB 37, ASB 42, PSB 36, AP 35, AM 42, AL 40, PL 57, S 50 μ. *Legs.*—Punctate. Specialized setae as figured, tarsala I extremely long. Non-specialized setae long and with few branches. *Body setae.*—Dorsal setae with appressed barbs, 40 to 55 μ, arranged 2-6-6-4-2. Ventral setae, 2-2 sternals plus 16.

TYPE MATERIAL: Holotype and 3 paratypes, RML no. 43234, off *Nyctanassa violacea,* Fort Kobbe (Canal Zone), 20 July 1961, Frank Todd, collector. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory and the United States National Museum.

Named for Dr. Alexander Wetmore, who graciously identified all bird hosts.

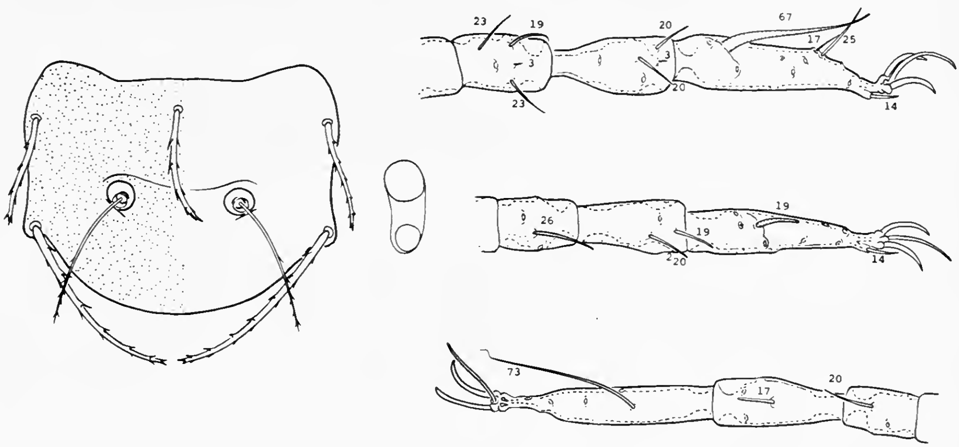

FIG. 29. *Blankaartia wetmorei,* new species. Scutum and eyes. Specialized setae of legs.

Genus **Trombicula** Berlese (*sensu lato*)

Trombicula Berlese, 1905, Redia, 2: 155.

Type-species: *Trombicula minor* Berlese, 1905.

KEY TO PANAMANIAN SPECIES

1. Palpal tibial claw bifurcate; parasubterminala branched .... *dicrura* Brennan and Jones
   Palpal tibial claw trifurcate; parasubterminala nude 2
2. Mastitarsala III present 3
   Mastitarsala III absent 13
3. With five genualae I; on bats .... *saccopteryx* Brennan and Jones
   With two or three genualae I 4
4. Galeal seta branched .... *pecari* Brennan and Jones
   Galeal seta nude 5
5. With two genualae I 6
   With three genualae I 8
6. Eyes absent, palpal femur and genu flattened and with pronounced lateral angles .... *anophthalma* Hoffmann

Eyes present; palpal femur and genu normal 7

7. Dorsal formula begins 2-6 .... *dunni* Ewing

Dorsal formula begins 2-8 .... *cribanus* Brennan and Jones

8(5). All palpal tibial setae nude; genuala III unusually long; on bats .... *vesperuginis* Brennan and Jones

Not all palpal tibial setae nude; genuala III of normal length 9

9. Dorsal formula begins 2-4 or 4-4 .... *keenani* Brennan and Jones

Dorsal formula begins 2-6 10

10. Palpal tarsus with five branched setae; sensillae with two long branches; eyes not in a plate; on bats .... *carmenae* Brennan and Jones

Palpal tarsus with seven branched setae; sensillae with several branches of moderate length; eyes in a plate 11

11. Posterior scutal margin sinuous; AL's considerably behind margin of scutum; on bats .... *soucouyanti* n. sp.

Posterior scutal margin broadly rounded; AL's not set far behind scutal margin; on rodents 12

12. Palpal laterotibial seta branched; scutum sparsely punctate; scutal setae slender, with semi-appressed branches; AM < AL .... *chiriquensis* Brennan and Jones

Palpal laterotibial seta nude; scutum densely punctate; scutal setae thick, with appressed barbs; AM > AL .... *caccabulus* Brennan and Jones

13(2). With three pairs of sternal setae .... *liomys* Brennan and Jones

With two pairs of sternal setae 14

14. Palpal femoral seta nude; two genualae I .... *tiptoni* Brennan and Jones

Palpal femoral seta branched, or at least delicately barbed; three genualae I .. 15

15. Galeal seta branched; eyes absent; palpal femur and genu with prominent lateral angles; on bats .... *tibbettsi* Brennan and White

Galeal seta nude; eyes present; palpal femur and genu without lateral angles. 16

16. With a single pair of eyes 17

With two pairs of eyes in plates 18

17. Sensillae nude; posterior margin of scutum nearly straight; palpal genual seta nude; on bats .... *monops* Brennan and Jones

Sensillae branched; posterior margin of scutum sharply angulate; palpal genual seta branched; on rodents .... *punctata* Boshell and Kerr

18(16). Palpal ventrotibial seta branched; posterior scutal margin broadly rounded; AL's set in anterolateral angles .... *dasyproctae* Ewing

Palpal ventrotibial seta nude; posterior scutal margin sinuous; AL's set behind margin 19

19. Palpal tarsala extremely long; on tree-frequenting animals .... *longicalcar* Brennan and Jones

Palpal tarsala of normal length; on various animals .. *manueli* Brennan and Jones

Trombicula anophthalma Hoffmann

Trombicula anophthalma Hoffmann, 1960, Ciencia (Mex.), **20**, (3–4), pp. 102–103, figs. 11–13.

Euschoengastia anops Brennan and Jones, 1960, Acarologia, **2**, (4), pp. 498–500, fig. 2. *New synonymy.*

Two specimens identified off *Pteronotus parnellii,* Chilibrillo Caves, Chilibre (Panamá), 2 August 1960. First Panamanian record.

Trombicula caccabulus Brennan and Jones

Trombicula caccabulus Brennan and Jones, 1961, Jour. Parasit., **47**, (1), pp. 115–116, fig. 11.

Forty-seven specimens identified from 13 lots. Hosts: *Peromyscus* *nudipes, Scotinomys teguina.* Localities: Bambito and Cerro Punta (Chiriquí). Active during the dry season, January to May. In addition, Brennan and Jones (1961a) report *T. caccabulus* from *Oryzomys fulvescens* and *Reithrodontomys mexicanus.*

Trombicula carmenae Brennan and Jones

Trombicula carmenae Brennan and Jones, 1960, Acarologia, 2, (4), p. 513, fig. 10.

Ten specimens off *Phyllostomus hastatus,* Pacora (Panamá), 6 June 1961; 1 off *Sturnira ludovici,* Bambito (Chiriquí), 24 April 1961; 1 off *S. ludovici* and 4 off *Artibeus jamaicencis,* Río Changena (Bocas del Toro), 19 September 1961. First records for Panama.

Trombicula chiriquensis Brennan and Jones

Trombicula chiriquensis Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 116–117, fig. 12.

Two specimens off *Scotinomys teguina,* Cerro Punta (Chiriquí), 26 and 28 April 1961. Brennan and Jones (1961a) also record this species from *Peromyscus* sp. and *Reithrodontomys* sp.

Trombicula cribanus Brennan and Jones

Trombicula cribanus Brennan and Jones, 1961, loc. cit., pp. 117–118, fig. 13.

Known only from the holotype off *Proechimys semispinosus,* Cerro Azul (Panamá), 24 January 1956.

Trombicula dasyproctae Ewing

Trombicula dasyproctae Ewing, 1937, Proc. Biol. Soc. Wash., **50**: 172.

In spite of additional examinations of the type host-species from the type locality, this chigger is still known only from the type series, 8 specimens off *Dasyprocta punctata,* Capira (Panamá), 28 August 1931.

Trombicula dicrura Brennan and Jones

Trombicula dicrura Brennan and Jones, 1961, loc. cit., pp. 118–119, fig. 14.

About 125 specimens identified from 32 lots. Hosts: *Coendou rothschildi, Heteromys desmarestianus, Reithrodontomys creper, R. mexicanus, Sciurus granatensis, Peromyscus nudipes, Scotinomys teguina, S. xerampelinus,* and mouse.

Localities: Pedro Miguel River (Canal Zone); Cerro Punta and Boquete Trail (Chiriquí). Taken in the dry season, January to May. For additional Panamanian records, see Brennan and Jones (1961a).

Trombicula dunni Ewing

Trombicula dunni Ewing, 1931, Proc. U. S. Nat. Mus., **80**: 12–13, fig. 2.
Trombicula (Trombicula) agutii Floch and Fauran, 1957, Arch. Inst. Pasteur Guyane Franç. et Inini, no. 426, pp. 4–6, fig. 2. *New synonymy.*
Trombicula paragoga Brennan and Jones, 1960, Acarologia, 2, (4), pp. 524–527, fig. 18. *New synonymy.*

About 900 specimens identified from 165 lots. Hosts: BIRDS, *Odonto-*

phorus erythrops, Leptotila cassinii, Neomorphus geoffroyi salvini, Microbates cinereiventris; MAMMALS, *Didelphis marsupialis, Marmosa robinsoni, Metachirus nudicaudatus, Philander opossum, Vampyressa pusilla, Dasypus novemcinctus, Bradypus infuscatus, Proechimys semispinosus, Hoplomys gymnurus, Heteromys desmarestianus, H. australis, Dasyprocta punctata, Sciurus granatensis, Microsciurus alfari, Sigmodon hispidus, Oryzomys caliginosus, O. capito, Peromyscus flavidus, P. nudipes, Sylvilagus brasiliensis, Nasua nasua, Felis pardalis, Tayassu tajacu.*

Localities: Barro Colorado Island, Fort Davis, Fort Gulick, Fort Sherman, France Field, Galeta Point, Piña, Paraíso, Summit, Madden Forest, Cacao Plantation, Miraflores, Fort Kobbe, Quarry Heights, and Corte Culebra Road (Canal Zone); Cerro Azul and Cerro Campana (Panamá); Cerro Pirre (Darién); Río Changena, etc. (Bocas del Toro); Camp Pital, etc. (Chiriquí); Cerro Hoya (Los Santos). Active in the dry season. From 1953 to 1963, 95 percent of all collections made were from December to April, the remaining 5 percent sporadically during June, September, October, and November.

T. dunni is a very common polymorphic species parasitizing a wide variety of vertebrates in the American tropics. At least three forms are apparent, but because of intergradation observed in large series and the relative absence of biologic data, any consideration of this taxon other than in terms of population variants is not feasible. Principal differences among the forms are in length, and structure and number of idiosomal setae. Brennan and Jones (1960) redescribed the species, included new synonymy and designated a lectotype.

Trombicula keenani Brennan and Jones

Trombicula keenani Brennan and Jones, 1961, Jour. Parasit., 47, (1), pp. 119–120, fig. 15.

One hundred and thirty-five specimens identified from 38 lots. Hosts: *Didelphis marsupialis, Philander opossum, Heteromys australis, H. desmarestianus, Proechimys semispinosus, Coendou mexicanus, Peromyscus nudipes, Reithrodontomys creper, R. mexicanus, Scotinomys teguina, Oryzomys capito.*

Localities: Piña (Canal Zone); Cerro Pirre (Darién); Boquete Trail, Cerro Punta, Bambito, and El Hato (Chiriquí). From 1954 to 1962, taken principally during the dry season, November to May. In addition, Brennan and Jones (1961a) report *T. keenani* from *Hoplomys gymnurus* and *Sciurus granatensis.*

Trombicula liomys Brennan and Jones

Trombicula liomys Brennan and Jones, 1961, loc. cit., p. 121, fig. 16.

Two specimens off *Liomys adspersus*, Corte Culebra Road (Canal Zone), 28 September 1961. Described from 4 specimens off same host, Curundu (Canal Zone), 8 July 1954 and Corozal (Canal Zone), 21 October 1954. No other records.

Trombicula longicalcar Brennan and Jones

Trombicula longicalcar Brennan and Jones, 1960, Acarologia, 2, (4), pp. 517–518, fig. 13.

Five specimens off *Didelphis marsupialis*, Summit (Canal Zone), 23 January 1962; 17 off (4) *Coendou rothschildi*, along Pedro Miguel River (Canal Zone), 21 February to 20 March 1962; 9 off unidentified bat, Las Palmitas (Los Santos), 27 January 1962; 6 off *Vampyrum spectrum*, Río Changena (Bocas del Toro), 23 September 1961. First records for Panama.

Trombicula manueli Brennan and Jones

Trombicula manueli Brennan and Jones, 1960, loc. cit., pp. 520–522, fig. 15.

Three specimens off *Marmosa robinsoni*, Fort Gulick (Canal Zone), 24 March 1961; 2 off *Didelphis marsupialis*, Piña (Canal Zone), 28 December 1961; 12 off *Sciurus granatensis*, Cerro Punta (Chiriquí), 2 May 1961. First Panamanian records.

The form from the Chiriquí highlands is a variant and may be a subspecies. It differs from the typical form in having a branched palpal ventrotibial seta and more dorsal setae.

Trombicula monops Brennan and Jones

Trombicula monops Brennan and Jones, 1960, loc. cit., pp. 524–525, fig. 17.

One specimen off *Myotis nigricans*, from a cave, Cerro Punta (Chiriquí), 3 May 1961; 3 off undetermined bat, Penonomé (Coclé), 30 January 1962; 1 off *Pteronotus psilotis*, Penonomé, 8 February 1962. First Panamanian records.

Trombicula pecari Brennan and Jones

Trombicula pecari Brennan and Jones, 1960, loc. cit., pp. 527–528, fig. 19.

No additional records since described from 21 specimens off *Tayassu tajacu*, Chiriquí Province, no date, and 1 specimen (not of the type series) off *Bradypus griseus* (= *B. infuscatus*), Chilibre (Panamá), no date.

Trombicula punctata Boshell and Kerr

Trombicula (*s.l.*) *punctata* Boshell and Kerr, 1942, Rev. Acad. Colomb. Cienc. Exacta, Fisico-Quim. y Nat., 5, (17), pp. 15–16 (in reprint), figs. 23, 24.

Twenty-one specimens off *Hoplomys gymnurus*, Piña (Canal Zone), 6 December 1960; 1 off same host, Río Changena (Bocas del Toro), 23 September 1961. First records for Panama.

Fauran (1959) described a very closely related species, *tuberculata*, which in all likelihood is a form of *punctata*. On the basis of a pentagonal scutum with a very sharp posterior angle, a single pair of eyes, and body setae arising from tubercles, he also erected a subgenus, *Boshkerria*—type-species, *Trombicula* (*Boshkerria*) *tuberculata*—to receive these two forms.

Trombicula saccopteryx Brennan and Jones

Trombicula saccopteryx Brennan and Jones, 1960, loc. cit., pp. 530–531, fig. 21.

Ten specimens off *Saccopteryx bilineata*, Pacora (Panamá), 24 April 1957; 27 specimens, same host and locality, 31 October 1960; 13 off same host, Bocas del Toro Province, 24 January 1960; 10 off same host, Cacao Plantation (Canal Zone), 5 February 1962. First Panamanian records.

Trombicula soucouyanti, new species. Figure 30.

DIAGNOSIS: Superficially resembles *T. manueli* Brennan and Jones, a common Caribbean species not known from bats, from which it is separated by a mastitarsala III and branched palpal dorso- and ventrotibial setae.

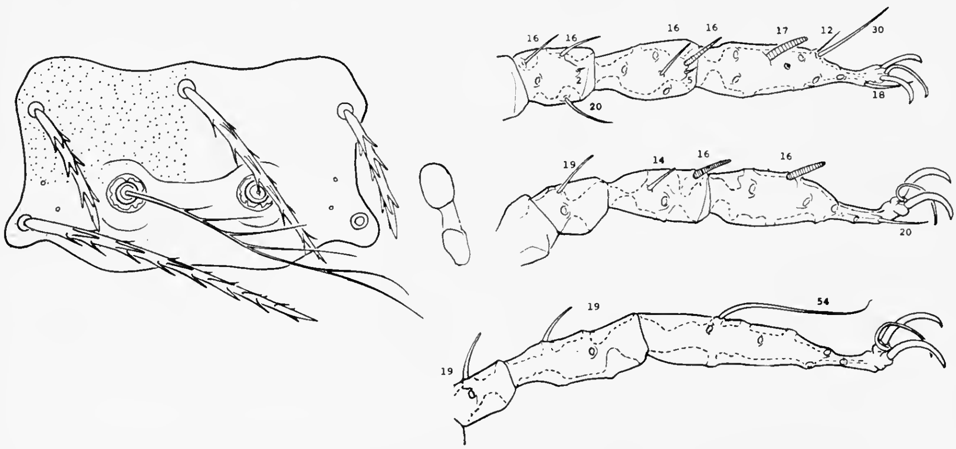

FIG. 30. *Trombicula soucouyanti*, new species. Scutum and eyes. Specialized setae of legs.

DESCRIPTION: *Idiosoma.*—Broad-ovate. Length and width of holotype, engorged, 635 by 450 μ. Eyes 2/2, in an obscure plate, the posterior pair obsolescent. Anus at about fourth row of ventral setae. *Scutum.*—As figured, densely punctate with sinuous margins. Sensillae with several long branches. Measurements of holotype: AW 72, PW 84, SB 30, ASB 33, PSB 19, AP 24, AM 53, AL 33, PL 75, S 73 μ. *Gnathosoma.*—Densely punctate. Cheliceral blades with tricuspid cap. Galeal seta nude. Palpal setae B/B/BNB (laterotibial may be forked); tarsus with seven branched setae, a subterminala, and a tarsala; claw trifurcate. *Legs.*—Densely punctate. Specialized setae as figured. Non-specialized setae with long conspicuous branches. *Body setae.*—Dorsal setae similar to scutals, with semi-appressed branches, 44 to 66 μ, arranged 2-6-6-4-2-2-2. Ventral setae, 2-2 plus 20 to 26.

TYPE MATERIAL: Holotype and 7 paratypes, RML no. 40711, off *Sturnira ludovici*, Cerro Punta (Chiriquí), 24 April 1961, MARU. Holotype in the collection of the Rocky Mountain Laboratory. Paratypes in the Rocky Mountain Laboratory, United States National Museum, British Museum (Natural History), and the Chicago Natural History Museum.

ADDITIONAL MATERIAL: Two specimens from *Myotis* sp., same general locality as type series, 5 May 1961, obviously conspecific, but with posterior area of scutum less densely punctate, anterior angles of scutum less abrupt, and reduced AP (17 μ).

Trombicula tibbettsi Brennan and White

Trombicula tibbettsi Brennan and White, 1960, Jour. Parasit., 46, (3), pp. 348–350, fig. 3.

A single specimen off *Pteronotus suapurensis,* Chilibrillo Caves, Chilibre (Panamá), 2 August 1960. First Panamanian record.

Trombicula tiptoni Brennan and Jones

Trombicula tiptoni Brennan and Jones, 1961, Jour. Parasit., 47, (1), p. 122, fig. 17.

One specimen off *Peromyscus nudipes,* Boquete Trail (Chiriquí), 3 May 1961. Otherwise known only from the holotype, off the same host species from the same general locality, 12 February 1960.

Trombicula vesperuginis Brennan and Jones

Trombicula vesperuginis Brennan and Jones, 1960, Acarologia, 2, (4) pp. 533–535, fig 23.

One specimen off *Carollia perspicillata,* Sardanillo Caves, Summit (Canal Zone), 12 August 1961; 11 off same host, Barro Colorado Island, (Canal Zone), 13 February 1957; 1 off *Glossophaga soricina,* Río Changena (Bocas del Toro), 17 September 1961; 3 off *Vampyrum spectrum,* Río Changena, 23 September 1961; 10 off *G. soricina,* Cerro Hoya (Los Santos), 10 February 1962; 32 off (7) unidentified bats, Los Santos Province, 16 February 1962.

Genus **Vanidicus** Brennan and Jones

Vanidicus Brennan and Jones, 1961, Jour. Parasit., 47, (1), p. 123.

Type-species: *Vanidicus tricosus* Brennan and Jones, 1961.

Vanidicus tricosus Brennan and Jones

Vanidicus tricosus Brennan and Jones, 1961, loc. cit., p. 123, fig. 18.

One specimen off *Heteromys desmarestianus,* Piña (Canal Zone), 7 December 1960. Described from 4 specimens off *Liomys adspersus,* Curundu and Summit Garden (Canal Zone), 8 July and 21 September 1954.

Genus **Vergrandia** Yunker and Jones

Vergrandia Yunker and Jones, 1961, Jour. Parasit., 47, (6), p. 996.

Type-species: *Vergrandia galei* Yunker and Jones, 1961.

Vergrandia galei Yunker and Jones

Vergrandia galei Yunker and Jones, 1961, loc. cit., pp. 997–998, pl. II.

Described from 3 specimens off *Pteronotus parnellii* (= *Chilonycteris rubiginosa*), Chilibrillo Caves, Chilibre (Panamá), 2 August 1960. No additional records.

Abstract

Seventy-six species of chiggers (16 new), distributed among 29 genera (5 new) are recorded. New genera are: *Blix, Crotonasis, Intercutestrix, Myxacarus,* and *Vargatula.* New species and their type hosts are: *Vargatula hispida* off *Dasypus novemcinctus; Euschoengastia belgicae* off *Heteromys desmarestianus; Euschoengastia enhebra* off *Tylomys watsoni; Pseudoschoengastia apista* off *Dasypus novemcinctus; Pseudoschoengastia dasypi* off *Dasypus novemcinctus; Pseudoschoengastia finitima* off *Heteromys*

desmarestianus; Pseudoschoengastia mermeriza off *Coendou rothschildi, Neoschoengastia electron* off *Electron platyrhynchum; Polylopadium confirmatum* off *Oryzomys caliginosus; Blix cabassoi,* intranasal, off *Cabassous centralis; Myxacarus oscillatus,* intranasal, off *Proechimys semispinosus; Alexfainia munozi,* intranasal, off *Pteronotus psilotis; Crotonasis fissa,* intranasal, off *Liomys adspersus; Blankaartia marui* off *Nycticorax nycticorax; Blankaartia wetmorei* off *Nyctanassa violacea; Trombicula soucouyanti* off *Sturnira ludovici.* Keys to the genera and species and a classified host list are given.

Euschoengastia anops Brennan and Jones is synonymized under *Trombicula anophthalma* Hoffmann; *Trombicula agutii* Floch and Fauran and *T. paragoga* Brennan and Jones are synonymized under *T. dunni* Ewing.

New combinations are the transfer of *Trombicula arremonops* Brennan and Jones to *Blankaartia, Euschoengastia precaria* Brennan and Dalmat to *Perissopalla,* and *Euschoengastia tryssa* Brennan and Jones to *Intercutestrix.*

The description of the genus *Polylopadium* Brennan and Jones has been expanded and additional descriptions and/or illustrations are given for *Polylopadium kramisi* Brennan and Jones and *Perissopalla precaria* (Brennan and Dalmat).

HOST-PARASITE LIST

Class Reptilia

Order Squamata

Suborder Iguanidae

Ameiva bifrontata
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)

Ameiva festiva
Eutrombicula goeldii (Oudemans)

Ameiva undulata
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)

Anolis sp.
Eutrombicula alfreddugesi (Oudemans)

Sceloporus sp.
Eutrombicula alfreddugesi (Oudemans)
Pseudoschoengastia bulbifera Brennan

Spilotes pullatus
Eutrombicula alfreddugesi (Oudemans)

lizards
Eutrombicula alfreddugesi (Oudemans)

Suborder Serpentes

Oxybelis sp.
Eutrombicula alfreddugesi (Oudemans)

Pseustes poecilonotus
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)

Class Aves

Order Pelecaniformes

Anhinga anhinga
Blankaartia sinnamaryi (Floch and Fauran)

Order Ciconiiformes

Nyctanassa violacea
Blankaartia wetmorei n. sp.

Nycticorax nycticorax
Blankaartia marui n. sp.

Order Falconiformes

Caracara plancus
Eutrombicula batatas (Linnaeus)

Hypomorphnus urubitinga
Eutrombicula batatas (Linnaeus)

Order Galliformes

Gallus gallus
Eutrombicula batatas (Linnaeus)

Odontophorus erythrops
Eutrombicula alfreddugesi (Oudemans)
Odontacarus fieldi Brennan and Jones
Trombicula dunni Ewing

Order Gruiformes

Aramides cajanea
Blankaartia sinnamaryi (Floch and Fauran)

Order Columbiformes

Leptotila cassinii
Trombicula dunni Ewing

Order Cuculiformes

Crotophaga ani
Eutrombicula batatas (Linnaeus)
Neomorphus geoffroyi salvini
Eutrombicula goeldii (Oudemans)
Odontacarus fieldi B. & J.
Trombicula dunni Ewing

Order Strigiformes

Ciccaba virgata
Blankaartia sinnamaryi (Floch and Fauran)
Otus guatemalae
Blankaartia sinnamaryi (Floch and Fauran)

Order Caprimulgiformes

Caprimulgus rufus
Blankaartia sinnamaryi (Floch and Fauran)
Nyctidromus albicollis
Eutrombicula batatas (Linnaeus)
Blankaartia sinnamaryi (Floch and Fauran)

Order Trogoniformes

Trogon massena
Blankaartia sinnamaryi (Floch and Fauran)

Order Coraciiformes

Electron platyrhynchum
Neoschoengastia electron n. sp.
Baryphthengus ruficapillus
Blankaartia sinnamaryi (Floch and Fauran)
Momotus momota
Eutrombicula goeldii (Oudemans)

Order Piciformes

Bucconidae, undet. sp.
Blankaartia sinnamaryi (Floch and Fauran)
Malacoptila panamensis
Eutrombicula goeldii (Oudemans)
Monasa morphoeus
Blankaartia sinnamaryi (Floch and Fauran)

Order Passeriformes

Dendrocincla homochroa
Blankaartia sinnamaryi (Floch and Fauran)
Xiphorhynchus guttatus
Blankaartia sinnamaryi (Floch and Fauran)
Sclerurus guatemalensis
Blankaartia sinnamaryi (Floch and Fauran)
Taraba major
Eutrombicula alfreddugesi (Oudemans)
Blankaartia sinnamaryi (Floch and Fauran)
Dysithamnus mentalis
Blankaartia sinnamaryi (Floch and Fauran)
Myiozetetes sp.
Eutrombicula batatas (Linnaeus)
Blankaartia sinnamaryi (Floch and Fauran)
Myiarchus ferox
Blankaartia sinnamaryi (Floch and Fauran)
Cyphorhinus aradus phaeocephalus
Eutrombicula goeldii (Oudemans)
Dumetella carolinensis
Blankaartia sinnamaryi (Floch and Fauran)
Hylocichla ustulata
Blankaartia sinnamaryi (Floch and Fauran)
Catharus mexicanus
Eutrombicula batatas (Linnaeus)
Blankaartia sinnamaryi (Floch and Fauran)
Microbates cinereiventris
Trombicula dunni Ewing
Blankaartia sinnamaryi (Floch and Fauran)
Oporornis formosus
Blankaartia sinnamaryi (Floch and Fauran)
Geothlypis semiflava
Blankaartia sinnamaryi (Floch and Fauran)
Icterus mesomelas
Blankaartia sinnamaryi (Floch and Fauran)
Piranga rubra
Blankaartia sinnamaryi (Floch and Fauran)
Sporophila aurita corvina
Blankaartia sinnamaryi (Floch and Fauran)
Arremonops conirostris
Blankaartia arremonops (B. & J.)

Class Mammalia

Order Marsupialia
Family Didelphidae

Marmosa mexicana
Eutrombicula goeldii (Oudemans)
Pseudoschoengastia bulbifera Brennan

Marmosa robinsoni
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *manueli* B. & J.

Philander opossum
Crotiscus desdentatus (Boshell and Kerr)
Euschoengastia nunezi (Hoffmann)
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *keenani* B. & J.

Metachirus nudicaudatus
Eutrombicula goeldii (Oudemans)
Myxacarus oscillatus n. sp.
Trombicula dunni Ewing

Didelphis marsupialis
Ascoschoengastia dyscrita B. & J.
Crotiscus desdentatus (Boshell and Kerr)
Euschoengastia megastyrax B. & J.
" *nunezi* (Hoffmann)
" *tragulata* B. & J.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Hoffmannina handleyi B. & J.
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi B. & J.
Pseudoschoengastia bulbifera Brennan
Sasacarus furmani (Hoffmann)
Trombicula dunni Ewing
" *keenani* B. & J.
" *longicalcar* B. & J.
" *manueli* B. & J.

Chironectes minimus
Doloisia (*Kymocta*) *chironectes* Yunker and Brennan

Order Insectivora
Family Soricidae

Cryptotis sp.
Pseudoschoengastia bulbifera Brennan

Order Chiroptera
Family Emballonuridae

Saccopteryx bilineata
Beamerella acutascuta Brennan
Euschoengastia desmodus Brennan and Dalmat
Trombicula saccopteryx B. & J.

Peropteryx macrotis
Tecomatlana sandovali Hoffmann

Family Phyllostomidae

Pteronotus parnellii
Alexfainia chilonycteris Yunker and Jones
Trombicula anophthalma Hoffmann
Vergrandia galei Yunker and Jones

Pteronotus psilotis
Alexfainia munozi n. sp.
Perates insessus Brennan and Dalmat
Trombicula monops B. & J.

Pteronotus suapurensis
Trombicula tibbettsi Brennan and White

Micronycteris megalotis
Beamerella acutascuta Brennan
Euschoengastia desmodus Brennan and Dalmat
Perissopalla precaria (Brennan and Dalmat)

Phyllostomus hastatus
Blankaartia sinnamaryi (Floch and Fauran)
Trombicula carmenae B. & J.

Vampyrum spectrum
Trombicula longicalcar B. & J.
" *vesperuginis* B. & J.

Glossophaga soricina
Euschoengastia desmodus Brennan and Dalmat
Trombicula vesperuginis B. & J.

Carollia castanea
Euschoengastia desmodus Brennan and Dalmat

Carollia perspicillata
Alexfainia chilonycteris Yunker and Jones
Beamerella acutascuta Brennan
Euschoengastia megastyrax B. & J.
Trombicula vesperuginis B. & J.

Carollia subrufa
Euschoengastia colombiae (Boshell and Kerr)

Euschoengastia desmodus Brennan and Dalmat

Sturnira ludovici

Pseudoschoengastia bulbifera Brennan
Trombicula carmenae B. & J.
" *soucouyanti* n. sp.

Vampyressa pusilla

Trombicula dunni Ewing

Artibeus toltecus

Leptotrombidium panamensis (Ewing)

Artibeus jamaicensis

Trombicula carmenae B. & J.

Family Vespertilionidae

Myotis nigricans

Trombicula monops B. & J.

Myotis sp.

Trombicula soucouyanti n. sp.

Family unknown

Alexfainia munozi n. sp.
Euschoengastia desmodus Brennan and Dalmat
Euschoengastia megastyrax B. & J.
Eutrombicula goeldii (Oudemans)
Tecomatlana sandovali Hoffmann
Trombicula longicalcar B. & J.
" *monops* B. & J.
" *vesperuginis* B. & J.

Order PRIMATES
Family Cebidae

Aotus trivirgatus

Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)

Family Callithricidae

Saguinus geoffroyi

Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Pseudoschoengastia bulbifera Brennan

Family Hominidae

Homo sapiens

Eutrombicula batatas (Linnaeus)

Order EDENTATA
Family Bradypodidae

Bradypus infuscatus

Trombicula pecari B. & J.
" *dunni* Ewing

Family Dasypodidae

Cabassous centralis

Blix cabassoi n. sp.

Dasypus novemcinctus

Aniatrus bifax B. & J.
Eutrombicula goeldii (Oudemans)
Myxacarus oscillatus n. sp.
Pseudoschoengastia apista n. sp.
" *dasypi* n. sp.
Trombicula dunni Ewing
Vargatula hispida n. sp.

Order LAGOMORPHA
Family Leporidae

Sylvilagus brasiliensis

Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Trombicula dunni Ewing

Order RODENTIA
Family Sciuridae

Sciurus granatensis

Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Odontacarus fieldi B. & J.
Trombicula dicrura B. & J.
" *dunni* Ewing
" *keenani* B. & J.
" *manueli* B. & J.

Microsciurus alfari

Eutrombicula goeldii (Oudemans)
Trombicula dunni Ewing

Family Heteromyidae

Liomys adspersus

Ascoschoengastia dyscrita B. & J.
Crotonasis fissa n. sp.
Eutrombicula goeldii (Oudemans)
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi B. & J.
Polylopadium kramisi B. & J.
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula liomys B. & J.
Vanidicus tricosus B. & J.

Heteromys australis

Eutrombicula goeldii (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula dunni Ewing
" *keenani* B. & J.

Heteromys desmarestianus

Ascoschoengastia dyscrita B. & J.
Crotiscus desdentatus (Boshell and Kerr)
Euschoengastia belgicae n. sp.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Hoffmannina handleyi B. & J.

Doloisia (Kymocta) teratarsalis Yunker and Brennan
Pseudoschoengastia bulbifera Brennan
" *finitima* n. sp.
Sasacarus furmani (Hoffmann)
Trombicula dicrura B. & J.
" *dunni* Ewing
" *keenani* B. & J.
Vanidicus tricosus B. & J.

Family Cricetidae

Oryzomys albigularis
Pseudoschoengastia bulbifera Brennan

Oryzomys alfaroi
Eutrombicula alfreddugesi (Oudemans)
Pseudoschoengastia bulbifera Brennan

Oryzomys bombycinus
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia bulbifera Brennan

Oryzomys caliginosus
Ascoschoengastia dyscrita B. & J.
Eutrombicula goeldii (Oudemans)
Intercutestrix tryssa (B. & J.)
Leptotrombidium panamensis (Ewing)
Polylopadium confirmatum n. sp.
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula dunni Ewing

Oryzomys capito
Ascoschoengastia dyscrita B. & J.
Euschoengastia cunctata B. & J.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Intercutestrix tryssa (B. & J.)
Myxacarus oscillatus n. sp.
Pseudoschoengastia abditiva Brennan
" *bulbifera* Brennan
Trombicula dunni Ewing
" *keenani* B. & J.
Leptotrombidium panamensis (Ewing)

Oryzomys fulvescens
Trombicula caccabulus B. & J.

Oryzomys sp.
Eutrombicula alfreddugesi (Oudemans)
Pseudoschoengastia bulbifera Brennan

Nectomys alfari
Crotiscus desdentatus (Boshell and Kerr)
Eutrombicula goeldii (Oudemans)
Pseudoschoengastia bulbifera Brennan

Tylomys watsoni
Ascoschoengastia dyscrita B. & J.
Euschoengastia enhebra n. sp.
Intercutestrix tryssa (B. & J.)
Kymocta teratarsalis Yunker and Brennan
Pseudoschoengastia zona Brennan
Sasacarus furmani (Hoffmann)

Reithrodontomys creper
Hoffmannina suriana (Hoffmann)
Trombicula dicrura B. & J.
" *keenani* B. & J.

Reithrodontomys mexicanus
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi B. & J.
Trombicula caccabulus B. & J.
" *dicrura* B. & J.
" *keenani* B. & J.

Reithrodontomys sumichrasti
Hoffmannina suriana (Hoffmann)

Reithrodontomys sp.
Eutrombicula batatas (Linnaeus)
Hoffmannina handleyi B. & J.
Pseudoschoengastia bulbifera Brennan
Trombicula chiriquensis B. & J.

Peromyscus flavidus
Eutrombicula alfreddugesi (Oudemans)
Trombicula dunni Ewing

Peromyscus nudipes
Cordiseta mexicana (Hoffmann)
Euschoengastia libertatis Brennan and Dalmat
" *spissa* B. & J.
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi B. & J.
" *suriana* (Hoffman)
Pseudoschoengastia bulbifera Brennan
Trombicula caccabulus B. & J.
" *dicrura* B. & J.
" *dunni* Ewing
" *keenani* B. & J.
" *tiptoni* B. & J.

Peromyscus sp.
Polylopadium kramisi B. & J.
Pseudoschoengastia bulbifera Brennan
Trombicula chiriquensis B. & J.

Zygodontomys microtinus
Eutrombicula alfreddugesi (Oudemans)
" *batatas* (Linnaeus)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi B. & J.
Pseudoschoengastia bulbifera Brennan

Scotinomys teguina
Cordiseta mexicana (Hoffmann)
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi B. & J.
Trombicula caccabulus B. & J.
" *chiriquensis* B. & J.
" *dicrura* B. & J.
" *keenani* B. & J.

Scotinomys xerampelinus
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina suriana (Hoffmann)
Pseudoschoengastia bulbifera Brennan
Trombicula dicrura B. & J.

Sigmodon hispidus
Ascoschoengastia dyscrita B. & J.
Crotiscus desdentatus (Boshell and Kerr)
Eutrombicula alfreddugesi (Oudemans)
" *batatas* (Linnaeus)
" *goeldii* (Oudemans)
Intercutestrix tryssa (B. & J.)
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi B. & J.
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula dunni Ewing

Family Muridae

Rattus rattus
Eutrombicula goeldii (Oudemans)

Family Erethizontidae

Coendou mexicanus
Trombicula keenani B. & J.

Coendou rothschildi
Euschoengastia tragulata B. & J.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia mermeriza n. sp.
Speleocola secunda B. & J.
Trombicula dicrura B. & J.
" *longicalcar* B. & J.

Family Hydrochaeridae

Hydrochaeris hydrochaeris
Blankaartia alleei (Ewing)
Eutrombicula alfreddugesi (Oudemans)
" *batatas* (Linnaeus)

Family Dasyproctidae

Agouti paca
Eutrombicula alfreddugesi (Oudemans)

Dasyprocta punctata
Eutrombicula goeldii (Oudemans)
Trombicula dasyproctae Ewing
" *dunni* Ewing

Proechimys semispinosus
Ascoschoengastia dyscrita B. & J.
Crotiscus desdentatus (Boshell and Kerr)
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Intercutestrix tryssa (B. & J.)
Leptotrombidium panamensis (Ewing)
Myxacarus oscillatus n. sp.
Odontacarus chiapanensis (Hoffmann)
" *fieldi* B. & J.
Polylopadium kramisi B. & J.
Pseudoschoengastia bulbifera Brennan
Sasacarus furmani (Hoffmann)
Trombicula cribanus B. & J.
" *dunni* Ewing
" *keenani* B. & J.

Hoplomys gymnurus
Ascoschoengastia dyscrita B. & J.
Crotiscus desdentatus (Boshell and Kerr)
Eutrombicula goeldii (Oudemans)
Doloisia (*Kymocta*) *teratarsalis* Yunker and Brennan
Leptotrombidium panamensis (Ewing)
Myxacarus oscillatus n. sp.
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *keenani* B. & J.
" *punctata* Boshell and Kerr

mouse
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi B. & J.
Trombicula dicrura B. & J.

Order Carnivora

Family Procyonidae

Nasua nasua
Euschoengastia tragulata B. & J.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Trombicula dunni Ewing

Family Felidae

Felis pardalis
Eutrombicula goeldii (Oudemans)
Odontacarus fieldi B. & J.
Trombicula dunni Ewing

Order Artiodactyla

Family Tayassuidae

Tayassu tajacu
Eutrombicula alfreddugesi (Oudemans)
Trombicula dunni Ewing
" *pecari* B. & J.

Family Cervidae

Mazama americana
Eutrombicula batatas (Linnaeus)

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Mallophaga of the Mammals of Panama

K. C. Emerson[1]

Mallophaga are obligatory external parasites and host-specific; therefore, their distribution is dependent entirely upon distribution of the hosts. Some species of Mallophaga are restricted to a single host species, and others are restricted to a host genus or closely related genera. With few exceptions, the same species of Mallophaga are found on a mammal species throughout its range without regard to host subspecies. In addition, many groups of mammals do not harbor Mallophaga. These factors have been considered in the compilation of this list.

Species collected in Panama are marked with an asterisk. Species are also listed which should be found in Panama, but to date have not been collected in that country. If a host is found in Costa Rica, Panama and Colombia, and a parasite has been recorded from Costa Rica or Colombia, it can be found in Panama with adequate collecting.

Specimens examined are in collections of the author, United States National Museum, Gorgas Memorial Laboratory, and the Chicago Natural History Museum. Collections were made by John H. Paine, Alexander Wetmore, Robert M. Altman, Charles M. Keenan, Vernon J. Tipton, Eustorgio Mendez, Phyllis T. Johnson, Lloyd E. Rozeboom, William H. Komp, Lawrence H. Dunn, and others not recorded.

Detailed taxonomic discussions are not included since these are available in *Os Malófagos de Mamíferos* published by the late Dr. F. L. Werneck in 1948 and 1950 (see References).

Family **Trimenoponidae**

Cummingsia intermedia Werneck

Cummingsia intermedia Werneck, 1937, Mem. Inst. Oswaldo Cruz, 32: 70, figs. 1–6.

This species is found on hosts of the genus *Marmosa.*

Cummingsia peramydis Ferris

Cummingsia peramydis Ferris, 1922, Parasitology, 14: 85, figs. 2d, 3e, 4e, 8.

This species is found on hosts of the genus *Monodelphis.*

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* **Harrisonia uncinata** Ferris

Harrisonia uncinata Ferris, 1922, loc. cit., p. 81, figs. 2c, 3c, 4d, 6.

Collected from *Proechimys semispinosus* at Gamboa, Fort Clayton, Fort Davis, Fort Kobbe, Madden Dam, Summit, Cocoli, Camp Piña, and Curundu (Canal Zone); Almirante (Bocas del Toro); and Cerro Azul (Panamá).

* **Trimenopon hispidum** (Burmeister)

Gyropus hispidus Burmeister, 1838, Handb. Ent., 2: 443.

Collected from laboratory guinea pigs, *Cavia porcellus*, at Corozal (Canal Zone) and Panama City.

Family Boopidae

* **Heterodoxus spiniger** (Enderlein)

Menopon spiniger Enderlein, 1909, Denkschr. Med. Nat. Ges., Jena, 14: 80, pl. 8, figs. 4–5.

Collected off dogs in Panama City.

Family Gyropidae

* **Gliricola panamensis** Werneck

Gliricola panamensis Werneck, 1944, Rev. Brasil. Biol., 4: 391, figs. 1–4.

Collected from *Proechimys semispinosus* at Madden Dam, Camp Piña, Fort Kobbe, Gamboa, Fort Clayton, Fort Davis, Curundu, and Cocoli (Canal Zone); and Almirante (Bocas del Toro). Previously recorded from Bugaba (Chiriquí) off *"Proechimys centralis chiriquinus"* (*P. semispinosus chiriquinus*) by Werneck (1948, p. 46) and from the type locality, Camp Pital (Chiriquí) off *Sigmodon hispidus chiriquensis* which is probably a contamination from *P. semispinosus*.

* **Gliricola porcelli** (Schrank)

Pediculus porcelli Schrank, 1781, Enum. Ins. Austr. Indig., p. 500, pl. 1, fig. 1.

Collected from laboratory guinea pigs, *Cavia porcellus*, at Corozal (Canal Zone) and Panama City.

* **Gliricola** sp. (near **panamensis**)

Collected from *Hoplomys gymnurus* at Almirante and Cayo Agua (Bocas del Toro), and Tacarcuna (Darién).

Gyropus aotophilus Ewing

Gyropus aotophilus Ewing, 1924, Proc. U. S. Nat. Mus., 63: 23, fig. 1.

This species is found on hosts of the genus *Aotus*, and has been collected off *A. trivirgatus* elsewhere.

* **Gyropus ovalis** Burmeister

Gyropus ovalis Burmeister, 1838, Handb. Ent., 2: 443.

Collected from laboratory guinea pigs, *Cavia porcellus*, at Corozal (Canal Zone) and Panama City.

* **Gyropus setifer** Ewing

Gyropus setifer Ewing, 1924, loc. cit., p. 22, fig. 10.

Collected off *Proechimys semispinosus* at Fort Clayton, Fort Davis, Fort Kobbe, Cocoli, Madden Dam, Gamboa, Camp Piña, Summit, Fort Gulick and Curundu (Canal Zone); and Almirante (Bocas del Toro). Collected off *Hoplomys gymnurus* at Tacarcuna (Darién), Curundu (Canal Zone), Almirante (Bocas del Toro), Salinas Place, Aguadulce (Coclé), and Cerro Azul (Panamá).

* **Macrogyropus costalimai** (Werneck)

Heterogyropus costalimai Werneck, 1931, Bol. Biol. Fac. Med. São Paulo, 18: 21, figs. 1–3.

A slide in the E. W. Stafford Collection has one specimen from *Agouti paca* in Panama. No specific locality is given.

* **Macrogyropus dicotylis** (Macalister)

Gyropus dicotylis Macalister, 1869, Proc. Zool. Soc. London, 1869: 420, fig.

Collected from *Tayassu tajacu* at Gamboa (Canal Zone). It was recorded by Werneck (1948, p. 89) off *Tayassu angulatus bangsi* (*T. tajacu bangsi*) from Porto Belo (Colón).

Family **Trichodectidae**

* **Bovicola bovis** (Linnaeus)

Pediculus bovis Linnaeus, 1758, Syst. Nat., ed. 10, p. 611.

This species has been collected off cows, in dairy herd in the Canal Zone.

Bovicola caprae (Gurlt)

Trichodectes caprae Gurlt, 1843, Mag. ges. Thierheilk., 9: 3, pl. 1, fig. 2.

This species should be found on the goat in Panama, as it is world-wide in distribution.

* **Bovicola equi** (Denny)

Trichodectes equi Denny, 1842, Mon. Anopl. Brit., pp. 61, 191, pl. 17, fig. 7.

Prior to 1941, this species was common on horses and mules maintained by the United States Army in the Canal Zone.

* **Bovicola limbatus** (Gervais)

Trichodectes limbatus Gervais, 1844, Walck. Hist. Nat. Ins., Apteres, 3: 313, pl. 48, fig. 4.

Recorded by Werneck (1950, p. 62) from *Capra hircus*, "Mona Island" (Mono Island, Darién).

Bovicola ovis (Schrank)

Pediculus ovis Schrank, 1781, Enum. Ins. Austr. Indig., p. 502, pl. 1, figs. 8–9.

This is a common parasite of sheep and is world-wide in distribution.

Cebidicola semiarmatus (Neumann)

Trichodectes semiarmatus Neumann, 1913, Arch. Parasit., 15: 611, fig. 5.

This species is found on hosts of the genus *Alouatta.*

* **Eutrichophilus maximus** Bedford

Eutrichophilus maximus Bedford, 1939, Onderstepoort Jour. Vet. Sci., 12: 118, fig. 24.

This species was described from a specimen off *Coendou rothschildi* taken at Gamboa (Canal Zone).

Eutrichophilus mexicanus (Rudow)

Trichodectes mexicanus Rudow, 1866, Zeitschr. ges. Naturw., 27: 109, pl. 5, fig. 1.

This species is found on *Coendou mexicanus.*

Felicola felis (Werneck)

Trichodectes felis Werneck, 1934, Mem. Inst. Oswaldo Cruz, 28: 282, figs. 11–14.

This species has been reported from *Felis concolor, Felis pardalis* and *Felis yagouaroundi* which are found in Panama, and some other hosts of the genus *Felis* found elsewhere. Specimens are rarely collected, so an adequate evaluation of distribution on the hosts has not been made.

* **Felicola subrostratus** (Burmeister)

Trichodectes subrostratus Burmeister, 1838, Handb. Ent., 2: 436.

This species was collected off the domestic cat in the Canal Zone and Panama City.

* **Geomydoecus** species

A large series from *Macrogeomys cavator,* taken at Casa Pitty, Cerro Punta (Chiriquí), represents a new species which will be described by Dr. Ronald Ward in his revision of the genus.

Lymeon cummingsi Eichler

Lymeon cummingsi Eichler, 1943, Mitt. Deutsch. Ent. Ges., 11: 111.

This species is probably found on *Bradypus infuscatus.*

Lymeon gastrodes (Cummings)

Trichodectes gastrodes Cummings, 1916, Ann. Mag. Nat. Hist., (8), 17: 94, figs. 2–4.

This species is probably found on *Choloepus hoffmanni.*

? **Neotrichodectes minutus** (Paine)

Trichodectes minutus Paine, 1912, Ent. News, 23: 439, pl. 20, fig. 4.

This species is found on *Mustela frenata.* A specimen collected at La Amenaza, Bambito (Chiriquí) is probably this species.

* **Neotrichodectes pallidus** (Piaget)

Trichodectes pallidus Piaget, 1880, Les Pediculines, p. 405, pl. 42, fig. 9.

Collected from *Nasua nasua* at Almirante (Bocas del Toro).

Trichodectes barbarae Neumann

Trichodectes barbarae Neumann, 1913, Arch. Parasit., 15: 616, fig. 9.

This species is found on *Eira barbara.*

* **Trichodectes canis** (De Geer)

Ricinus canis De Geer, 1778, Mem. Hist. Ins., 7: 81, pl. 4, fig. 16.

Found on dogs in the Canal Zone.

Trichodectes fallax Werneck

Trichodectes fallax Werneck, 1948, Malóf. Mamíf., 1: 122, figs. 159–165.

This species is found on *Procyon cancrivorus.*

* **Trichodectes galictidis** Werneck

Trichodectes galictidis Werneck, 1934, Mem. Inst. Oswaldo Cruz, 28: 161, figs. 1–5.

Recorded by Werneck (1948, p. 119) off *Galictis allamandi* (=*"Grisonia canaster"*) from Pacora (Panamá).

* **Trichodectes octomaculatus** Paine

Trichodectes octomaculatus Paine, 1912, Ent. News, 23: 438, pl. 20, fig. 1.

Collected off *Procyon lotor* at Finca de P. H., Cerro Punta (Chiriquí) and from Panama without specific locality.

* **Trichodectes potus** Werneck

Trichodectes potus Werneck, 1934, Mem. Inst. Oswaldo Cruz, 28: 171, figs. 7–10.

Collected off *Potos flavus chiriquensis,* at Camp Piña (Canal Zone).

Tricholipeurus albimarginatus (Werneck)

Trichodectes albimarginatus Werneck, 1936, Mem. Inst. Oswaldo Cruz, 31: 570, figs. 205–212.

This species is found on hosts of the genus *Mazama.*

Tricholipeurus lipeuroides (Megnin)

Trichodectes lipeuroides Megnin, 1884, Naturaliste, no. 62, p. 494.

This species is found on *Odocoileus virginianus.*

Tricholipeurus parallelus (Osborn)

Trichodectes parallelus Osborn, 1896, Bull. U. S. Bur. Ent., (n.s.), 5: 240, fig. 148.

This species is found on *Odocoileus virginianus.*

Suricatoecus quadraticeps (Chapman)

Trichodectes quadraticeps Chapman, 1897, Ent. News, 8: 185, pl. 9, fig.

This species is found on *Urocyon cinereoargenteus.*

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Checklist of the Sucking Lice of Panama
(Anoplura)

RUPERT L. WENZEL [1] AND PHYLLIS T. JOHNSON [2]

Fairchild (1943, p. 581) reported four species of sucking lice from Panama. Since then, five others have been recorded. Eighteen are listed in the present paper, based largely on specimens collected by Lt. Colonel Robert M. Altman, Major Vernon J. Tipton, Charles M. Keenan, and other personnel of the Environmental Health Group, Dr. Conrad E. Yunker, Dr. Charles O. Handley, and personnel of the Gorgas Memorial Laboratory. The junior author, who received this material for identification and study, described two new species in an earlier paper (Johnson, 1962) on the Genus *Fahrenholzia*. Unfortunately, other commitments made it impossible for her to study all of the specimens collected or to prepare a critical review of the Panamanian species. The following treatment is, therefore, incomplete.

Additional species will undoubtedly be obtained through further collecting from both wild and domesticated animals. For example, *Enderleinellus hondurensis* Werneck, which has been taken on various species of *Sciurus* in Colombia, Honduras, and Mexico, will probably be found in Panama. Likewise, *Linognathus pedalis* (Osborn) and *L. setosus* (van Olfers) may occur in Panama on dogs, and *Haematopinus asini* on horses.

The junior author is responsible for identifications of the species preceded by an asterisk (*). The senior author collated the data and information on other species and prepared the manuscript.

Original citations and selected references are given, but one should refer to Ferris (1919–35, 1951) and Johnson (1962) for additional synonymies, references, discussions, and more comprehensive keys.

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Family **Haematopinidae**

Haematopinus eurysternus (Nitsch)

Pediculus eurysternus Nitsch, 1818, Germar's Mag. Ent., 3: 305.
Haematopinus eurysternus Ferris, 1933, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (6), p. 448, figs. 263, 264; 1951, Mem. Pac. Coast Ent. Soc., 1: 88, figs. 39, 40.

Lice from cattle in Coclé Province were identified as *H. eurysternus* by Fairchild (1943, p. 581). They may actually have been *H. quadripertusus* Fahrenholz.

* **Haematopinus suis** (Linnaeus)

Pediculus suis Linnaeus, 1758, Syst. Nat., 10th ed., p. 611.
Haematopinus suis Ferris, 1933, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (6), p. 425, figs. 252A, 253A, 254; 1951, Mem. Pac. Coast Ent. Soc., 1: 91, figs. 41, 42.

From *Sus scrofa:* 1 male, 2 females, Santa Rita, Antón (Coclé), 14 March 1961; 3 males, 3 nymphs, Río Indio, Arraiján (Panamá), 13 June 1960, V. Barria, collector; 2 males, 1 female, and 1 nymph, Guánico (Los Santos), 25 February 1962 (no. 004) and 2 males, 3 females, and 4 nymphs, same data (no. 007).

Family **Hoplopleuridae**
Subfamily Enderleinellinae

* **Enderleinellus** sp. (**longiceps** group)

One female from *Sciurus granatensis,* Cacao Plantation, Gamboa (Canal Zone), 26 April 1957, R. M. Altman, collector.

Subfamily Hoplopleurinae

***Hoplopleura hesperomydis** (Osborn)

Haematopinus hesperomydis Osborn, Bull. Div. Ent., U. S. Dept. Agric., (old series), 7: 26, fig. 14.
Hoplopleura hesperomydis Ferris, 1921, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (2), p. 70, figs. 38, 39; 1951, Mem. Pac. Coast Ent. Soc., 1: 136.

From *Peromyscus nudipes:* 18 males and 4 females, Lava Flow, El Hato (Chiriquí), 5000 feet elevation, 7–9 January, 1961; 13 females, Martinz Dairy, Cerro Punta (Chiriquí), 5800 feet elevation, 7–8 January 1961. From *Scotinomys teguina,* 1 female, Martinz Dairy, 8 January 1961. From *Reithrodontomys* sp., 1 female, Lava Flow, El Hato, 7–9 January 1961. Collected by C. M. Keenan and V. J. Tipton. Additional specimens, probably of this species, from *Scotinomys* and *Peromyscus,* have not yet been studied.

* **Hoplopleura hirsuta** Ferris

Hoplopleura hirsuta Ferris, 1916, Psyche, 23: 122, figs. 8, 9A, 10, 11B; 1921, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (2), p. 117, figs. 75, 76; 1951, Mem. Pac. Coast Ent. Soc., 1: 137.

From *Sigmodon hispidus:* 1 nymph, probably this species, Camp Piña (Canal Zone), 30 August 1960; 2 males, 1 female, Curundu (Canal Zone), 9 December 1959; 1 male, 2 females, and 4 nymphs, Almirante (Bocas del

Toro), 26 and 29 January, 1960, collected by C. M. Keenan and V. J. Tipton; 1 male, 1 female, Cocoli (Canal Zone), 10 January 1957, by R. M. Altman.

* **Hoplopleura oryzomydis** Pratt and Lane

Hoplopleura oryzomydis Pratt and Lane, 1951, Jour. Parasit., 37: 141, figs. 1–3, 5. Ferris, 1951, Mem. Pac. Coast Ent. Soc., 1: 139.

From *Oryzomys caliginosus*, 1 male, 1 female, El Valle (Coclé), March 1957, R. M. Altman, collector.

* **Hoplopleura nesoryzomydis** Ferris

Hoplopleura nesoryzomydis Ferris, 1921, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (2), p. 90, fig. 53A; 1951, Mem. Pac. Coast Ent. Soc., 1: 138.

From "rat" (Altman K-14), Barro Colorado Island (Canal Zone), 4 November 1956, C. Koford, collector.

* **Pterophthirus audax** (Ferris)

Hoplopleura audax Ferris, 1921, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2 (2), p. 125, figs. 82, 83.
Pterophthirus audax (Ferris), 1951, Mem. Pac. Coast Ent. Soc., 1: 147.

From *Hoplomys gymnurus*, 1 male and 1 female, Cerro Azul (Panamá), 29 January 1958, R. M. Altman, collector.

Subfamily Polyplacinae

* **Fahrenholzia fairchildi** Johnson

Fahrenholzia fairchildi Johnson, 1962, Ann. Ent. Soc. Amer., 55, (4), p. 419, figs. 18–21, 32, 39.

The original description of this species was based on specimens from Panama and Guatemala. The holotype, allotype, and 18 paratypes are from *Heteromys desmarestianus*, Santa Fé (Veraguas). Other paratypes from the same host in Panama are from Fort Kobbe and Summit Road (Canal Zone). Numerous additional specimens were collected from the type host at Cerro Punta (Chiriquí) and from *Liomys adspersus* at Guánico (Los Santos).

***Fahrenholzia hertigi** Johnson

Fahrenholzia hertigi Johnson, loc. cit., p. 421, figs. 22, 23, 34, 40.

The holotype female and 6 paratype females of this species are from *Heteromys desmarestianus*, Cerro Azul (Panamá). An additional female paratype was taken on *Zygodontomys microtinus* (=*cherriei*), Camp Piña (Canal Zone).

* **Neohaematopinus** sp. (**sciurinus** group)

From *Sciurus granatensis:* 1 male, 7 January 1961, and 2 females, 2 May 1961, and 2 males, 26 April, 1961, Martinz Dairy, near Cerro Punta (Chiriquí); 2 males, 10 females, and 4 nymphs, Cerro Hoya (Los Santos), 10 February 1962. From *S. variegatoides:* 5 males, 13 females, Guánico (Los Santos), February 1962.

* Polyplax spinulosa (Burmeister)

Pediculus spinulosus Burmeister, 1839, Gen. Insect., Rhynchota, no. 8.
Polyplax spinulosa Ferris, 1923, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (4), p. 187, figs. 119, 120A, D, F, H; 1951, Mem. Pac. Coast Ent., Soc., 1: 211, figs. 90, 91.

From *Rattus rattus,* 6 males, 6 females, and 5 nymphs, Guánico (Los Santos), 5 February 1961, C. O. Handley, collector.

Family Linognathidae

Solenopotes binipilosus (Fahrenholz)

Linognathus binipilosus Fahrenholz, 1916, Arch. Naturg., A, 81, Heft 11, p. 11, plate, figs. 11–13.
Solenopotes binipilosus Ferris, 1932, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2, (5), p. 131, figs. 245, 246; 1951, Mem. Pac. Coast Ent. Soc., 1: 252. Johnson, 1958, Proc. U. S. Nat. Mus., 108: 49.

Recorded by Ferris (1932) from *Odocoileus chiriquiensis* (sic!) from the Canal Zone, L. H. Dunn, collector. Ferris (loc. cit.) regarded *Linognathus panamensis* Ewing as a synonym.

Solenopotes panamensis (Ewing)

Linognathus panamensis Ewing, 1927, Proc. Ent. Soc. Wash., 29: 119.
Solenopotes panamensis Johnson, 1958, loc. cit., pp. 48–49.

Ferris (1932, p. 131) placed *L. panamensis* Ewing as a synonym of *S. bipinilosus* (Fahrenholz). Johnson (loc. cit.), after re-examining the types of *panamensis,* concluded that they represented a distinct species and gave characters for separating the females from those of *bipinilosus.* The male of *panamensis* is unknown. Johnson also pointed out that there is some doubt about the true host of *panamensis,* since the type specimens were "from *Odocoileus chiriquensis* [*Odocoileus virginianus chiriquensis*] (origin, Panama) which died at the National Zoological Park. . . ." [Washington, D.C.], and "it is highly possible that the occurrence of *panamensis* on *Odocoileus virginianus chiriquensis* was accidental, the true host being some other ungulate with which the deer had come in contact while in the zoo."

Family Pediculidae

Pediculus atelophilus Ewing

Pediculus (*Parapediculus*) *atelophilus* Ewing, 1926, Proc. U. S. Nat. Mus., 68: 9, figs. 4A, 5; 1938, Jour. Parasit., 24: 26, figs. 2, 5b, 6b. Johnson, 1958, Proc. U. S. Nat. Mus., 108: 44.
Pediculus atelophilus Ferris, 1951, Mem. Pac. Coast Ent. Soc., 1: 273.
Pediculus mjobergi Ferris (part.), 1935, Stanford Univ. Publ., Univ. Ser., Biol. Sci., 2: (8), pp. 588–598, figs. 318E, 319E, 322F, 323I, 328–332.

Reported by Ewing (1938) from *Ateles dariensis* from Panama and by Hinman (1931, p. 488) from material determined by Ewing from *Ateles geoffroyi* from Panama.

The nomenclatorial status of *P. atelophilus, P. chapini* (see below) and *P. lobatus* Fahrenholz, 1916, is still in doubt. In 1935, Ferris placed these names as synonyms of *P. mjobergi* Ferris, 1916 (= *P. affinis* Mjöberg, 1910 nec Burmeister, 1839). However, in 1951, though he still presumed them to be conspecific, he treated them separately and assigned to *atelophilus* specimens "from *Ateles dariensis, Cebus capuchinus,* and *Alouatta palliata,* all from Panama from monkeys in captivity." He left the question of synonymy open until the types of *affinis* Mjöberg could be examined, though in his key he employed the name *mjobergi* to cover all of the forms involved.

Pediculus chapini Ewing

Pediculus (*Parapediculus*) *chapini* Ewing, 1926, Proc. U. S. Nat. Mus., **68**: 13, figs. 2, 4b, 5 and pl. 1, figs. 3, 4; 1938, Jour. Parasit., **24**: 28, figs. 4a, 5c, 6c. Johnson, 1958, loc. cit., p. 44.

Pediculus mjobergi Ferris (part.), 1935, Stanford Univ. Publ., Univ. Ser., Biol. Sci., **2**, (8), pp. 588–598.

Ewing (1938) reported this species from Panama from *Cebus capuchinus.* Ferris (see above) considered *chapini* to be a synonym of *mjobergi* Ferris. Johnson (loc. cit.), considered that *chapini* "probably is the same as *Pediculus atelophilus* Ewing, 1926.

Pediculus humanus Linnaeus

Pediculus humanus Linnaeus, 1758, Syst. Nat., 10th ed., p. 610. Ferris, 1935, Stanford Univ. Publ., Univ. Ser., Biol. Sci., **2**, (8), pp. 17–62, plates 1–3, text figs. 306–327; 1951, Mem. Pac. Coast Ent. Soc., **1**: 261–271, figs. 116, 117, 118, 119.

Phthirus pubis (Linnaeus)

Pediculus pubis Linnaeus, 1758, loc. cit., p. 611.

Phthirus pubis Ferris, 1935, Stanford Univ. Publ., Univ. Ser., Biol. Sci., **2**, (8), p. 603, figs. 335–337; 1951, Mem. Pac. Coast. Ent. Soc., **1**: 281, figs. 122–124.

Fairchild (loc. cit.) reported that physicians had observed head, body, and crab lice on humans in Panama.

Because the lice of Panama are incompletely known, the following key should be used with caution, preferably in conjunction with the works cited above.

KEY TO PANAMANIAN ANOPLURA

[Largely adapted from Ferris, 1951]

1. Paratergal plates absent, abdomen entirely membranous except for plates associated with terminal and genital segments and rarely tergal plates in male (Linognathidae) 2
   Paratergal plates on at least some abdominal segments 3
2. Apical lobes of female abdomen with a short, slender terminal portion .... *Solenopotes panamensis* (Ewing)
   Apical lobes of female abdomen gradually constricted into long, tapering lobes .... *Solenopotes binipilosus* (Fahrenholz)
3. Venter of abdominal segment II with a pair of small, strongly sclerotized plates .... *Enderleinellus* Fahrenholz
   Without such plates 4

4. Paratergal plates free, at least in part, from the body and not simply forming a cap over the lateral lobes of the abdomen (Hoplopleuridae) 5
   Paratergal plates never with any part free from the body wall 12
5. Second abdominal segment with its sternal plate extended laterally on each side to articulate with the corresponding paratergal plate (Hoplopleurinae) 6
   Second abdominal segment with its sternal plate never thus extended laterally (Polyplacinae) 10
6. Paratergal plates of second abdominal segment each prolonged into a blade-like process which projects from the body wall .... *Pterophthirus audax* (Ferris)
   Paratergal plates not thus (*Hoplopleura*) 7
7. Ventral lobe of paratergal plates of third abdominal segment divided into two apically rounded, equal lobes 8
   Not thus 9
8. Ventral lobe of paratergal plates of sixth abdominal segment divided into two equal lobes .... *Hoplopleura oryzomydis* Pratt and Lane
   Ventral lobe of paratergal plates of sixth abdominal segment forming a single, acute point .... *Hoplopleura nesoryzomydis* Ferris
9. Posterior apex of thoracic sternal plate sharply pointed, no setae laterally off the tergal and sternal abdominal plates .... *Hoplopleura hesperomydis* (Osborn)
   Posterior apex of thoracic sternal plate rounded, many setae present laterally off the abdominal plates .... *Hoplopleura hirsuta* Ferris
   At least one of the lobes apically acute .... *Hoplopleura hirsuta* Ferris
10. Paratergal plates of second abdominal segment definitely divided longitudinally into two plates, one of which is flat on the dorsum and one on the venter, the ventral portion with a flat, raised apical free point (*Fahrenholzia*) 11
    Paratergal plates of second abdominal segment not thus divided .... *Polyplax spinulosa* (Burmeister)
11. Antennal segments 3–5 completely coalesced; thorax not broader than head; thoracic sternal plate with a small detached portion . . *Fahrenholzia hertigi* Johnson
    Antennal segments not completely coalesced; thorax obviously broader than head; sternal plate of thorax without a detached apical portion .... *Fahrenholzia fairchildi* Johnson
12. Eyes conspicuous as a pair of distinct lenses accompanied by pigmentation (visible in uncleared specimens); derm of dorsum of abdomen not wrinkled (Pediculidae) 14
    Eyes not visible, though represented by vestiges; derm of dorsum of abdomen wrinkled (Haematopinidae) 13
13. Head very short and broad, length only very slightly shorter than width; penis of male strongly asymmetrical, strongly sclerotized and forming a large hook or barb at its base .... *Haematopinus eurysternus* (Nitsch)
    Head elongate, about as long as broad; penis V- or Y-shaped .... *Haematopinus suis* (Linnaeus)
14. All legs of essentially the same size, claws slender; thorax with a distinct notal pit, sternal plate sclerotized, though its margins are not free from body; abdomen narrower at base than at middle; spiracle enclosed within borders of paratergal plates (*Pediculus*) 15
    Anterior legs slender, with slender claws, middle and posterior legs very large and stout, with stout claws; thorax very wide occupying the greater part of the body, without notal pit or sternal plate; abdomen widest basally, tapering apically, with prominent segmentally arranged sclerotized lateral tubercles, the spiracles borne slightly removed from the base of the tubercles .... *Phthirus pubis* (Linnaeus)
15. Paratergal plates throughout clearly without evidence of lateral lobes .... *Pediculus humanus* Linnaeus
    Paratergal plates of fifth to sixth abdominal segments bearing strong lateral lobes, both dorsally and ventrally .... *Pediculus mjobergi* Ferris
    (? = *P. atelophilus* Ewing, *P. chapini* Ewing)

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New Species of the Genus *Amblyopinus* Solsky from Panama and Mexico
(Coleoptera: Staphylinidae)

Alfredo Barrera [1]

This paper includes descriptions of *Amblyopinus tiptoni* n. sp. from Northern Panama, *A. isabelae* n. sp. from Southern Mexico, and records of *A. emarginatus* Seevers, 1954, from Northern Panama. These species are interesting additions to the primitive "Andean" elements of the highlands of Southern Mexico and Central America. All were found in association with cricetine rodents, like the two closely allied species previously described from that area, namely, *A. schmidti* Seevers, 1944, and *A. bolivari* Barrera, Machado and Muñiz, 1960.

The single male of *A. isabelae* n. sp. which represents the second species known from Mexico, was collected some years ago by Professor Dionisio Pelaez and myself at Omiltemi, Guerrero, Mexico (Barrera, 1958). I am very much indebted to Dr. Candido Bolivar for the gift of this specimen which had previously been deposited in his laboratory at the Escuela Nacional de Ciencias Biológicas, México, D.F.

The Panamanian species constitute the first records of the genus for that country. The description of *A. tiptoni* n. sp. is based on a large number of specimens collected in Chiriquí Province near the Costa Rican border. I am very grateful to Lt. Col. Vernon J. Tipton, formerly Chief, Environmental Health Branch, Preventive Medicine Division, United States Army Caribbean, Canal Zone, for making the Panamanian collection available to me.

It is difficult to even attempt to assess my debt to Mr. Carlos Machado, Biologist, now at the Departmento de Zoología, Secretaría da Agricultura, São Paulo, Brazil. Mr. Machado has been extremely kind in devoting his valuable time to checking specimens for me. His criticism about the designation of abdominal sterna is greatly appreciated.

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The abdomen of *Amblyopinus* is of the haplogastrous type with a complete second sternum; thus, the first externally visible sternum is actually the second. When Barrera *et al.* (1960) described *A. bolivari,* they named the abdominal sterna following a simple ordinal criterion. However, in this paper, descriptions are made using the terminology of morphologists. The first externally visible abdominal sternum is designated as the second, and so forth.

Seevers (1955) says that "considerable reliance must be placed on the aedeagus and the terminal segments of the male abdomen for distinguishing closely allied species." I agree entirely with his point of view. Some members of the *jelskii* group are not easily recognizable without a careful examination of the apex of the aedeagus. For this reason, the genital armatures were dissected with fine needles, then mounted in Canadian balsam and drawn with the aid of a camera lucida.

I prepared the illustrations of the aedeagus. All other drawings were made by Maria A. Vulcano, of the above-mentioned Departmento de Zoología, to whom I am very much indebted for her kind cooperation.

Amblyopinus tiptoni, new species. Figures 31A, B; 32.

Near *A. bolivari* (figs. 31E, F; 33B) but readily separated as follows: eyes visible from above; mentum with two very small marginal bristles on each side; metasternal process with more than six bristles on the anterior surface; eighth sternum of male with one or two bristles. Ventral margin of apex of aedeagus (fig. 31A) forming a well sclerotized lobe followed proximally by a wide sinus. Marginal row of spiniform microsetae extending from behind the fourth to the first submarginal apical bristles of the aedeagus.

DESCRIPTION, MALE: *Head.*—Clypeal margin straight, with one very short, blunt seta on each frontolateral angle. Labrum bilobed; each lobe with two very long thin submarginal setae on the internal side. Lateral margins divergent, convergent behind the eyes. Lateral lobes separated from the posterolateral or occipital lobes by a relatively wide sinus. Seven eye facets visible from above, just in front of the supraocular bristle. Occipital region with two very well-developed lateral setae, these longer than the postantennal bristles. Mentum with two very small marginal bristles on each side.

Thorax.—Prosternum with two large median bristles. Mesosternum with about 25 bristles arranged as in fig. 31B. Characteristically six small bristles of the 25 are arranged in two apical rows. In *A. isabelae* n. sp. there are three large apical bristles (fig. 31D). Metasternum as in *A. isabelae* n. sp.

Abdomen and genitalia.—Caudal margin of terga I to VI with a long, pigmented lateral bristle. Margin of tergum VII almost rounded. Tergum VIII relatively slender, with a fringe of thin long setae along the caudal margin. Margin of sternum VI with three conspicuously long, pigmented bristles on each side. Sternum VII bilobed, with two large bristles on the left lobe and four on the right. Apex of sternum VIII entire, rounded, with many slender marginal setae (fig. 32A, *VIII*). Urostyli with many thin setae on the anterior half of the external margin, and with the large bristles arranged as in fig. 32A.

Dorsal apodeme of aedeagus relatively wide, with numerous spiniform microsetae well-developed from near the apex, behind fourth submarginal to the first submarginal bristle. A wide ventral sinus forms a conspicuous isthmus between apex and the anterior part of the aedeagal apodeme. Apical sclerite of internal tube of aedeagus long, slender, dorsally convex, the caudal apex flat, constricted, the proximal end rounded (fig. 31A).

FEMALE: *Abdomen and genitalia.*—Caudal margin of sternum VI with two large pigmented bristles on the right side, three on the left. Same condition is found in sternum VII, the bristles arranged as in fig. 32B, *VII*. Apex of urostyli with four long bristles. Two very long bristles on the apex of styliform appendages of segment VIII arranged as in fig. 32B.

TYPE MATERIAL: Holotype male from *Peromyscus nudipes nudipes* (host no. 5967), Bambito (Chiriquí), 5800 feet elevation, collected 9 February 1960 by V. J. Tipton. In the collection of Chicago Natural History Museum.

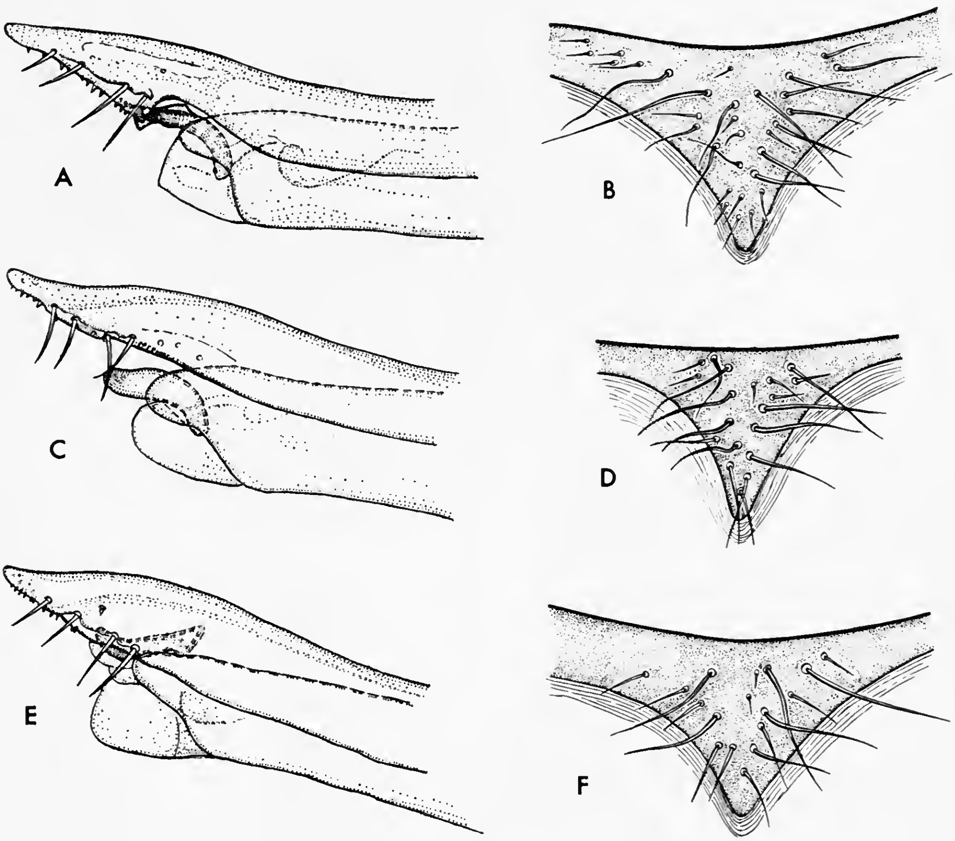

Fig. 31. Apex of aedeagus (A,C,E) and mesosternal plate (B,D,F) of male. A,B, *Amblyopinus tiptoni* n. sp. C,D, *Amblyopinus isabelae* n. sp. E,F, *Amblyopinus bolivari* Barrera, Machado, and Muñiz.

Allotype female, same host and repository as the holotype, from Lava Flow (Chiriquí), 5000 feet elevation, collected 5 February 1960 by V. J. Tipton. The following paratypes, collected by V. J. Tipton and C. M. Keenan, are all from *Peromyscus n. nudipes*, with the one exception indicated.

A male from Finca Martinz (Chiriquí), 6800 feet elevation, 13 February 1960 (host no. 6004). In the collection of the Escuela de Biología of the Universidad Central de Venezuela, Caracas, Venezuela.

Several males and females from Lava Flow and Finca Martinz, 7 January 1961 (host nos. 6813, 6815, 6820, 6827, 6836). In the collection of the Laboratorio de Entomologia Económica y Experimental, Escuela Nacional de Ciencias Biológicas, I.P.N., México. Also deposited here is the unique material collected from *Reithrodontomys creper* (host no. 6309), Cerro Barú, 10500 feet elevation, 2 May 1960.

A male and female (host nos. 6844, 6875) both from Lava Flow, 5000 feet elevation, 8 and 9 January 1961, respectively. In the collection of the Departmento de Zoología, Secretaría da Agricultura, São Paulo, Brazil.

From Lava Flow a long series, 27–29 January, 7–9 February, 1960 (host nos. 5794, 5806, 5807, 5935, 5936, 5965) and several males and females, 27 January 1960 and 5 February 1960 (host nos. 5781 and 5906). In the collection of V. J. Tipton.

A long series from: Finca Martinz, 30 January 1960 (host no. 5827), 1 February 1960 (host no. 5847), 14 February 1960 (host nos. 6012 and 6022); and Casa Lewis (Chiriquí), 5700 feet elevation, 31 January 1960 (host no. 5838). In the collection of Gorgas Memorial Laboratory.

This species is named for Lt. Col. Vernon J. Tipton, who has contributed much to the study of ectoparasites of the mammals of Panama.

It is important to note that the modified abdominal segments of many paratypes of *A. tiptoni* n. sp. have been separately mounted. These specimens were dissected for examination of gastro-intestinal contents. Dissection was always carefully made to avoid damage of important sclerotized parts used for descriptive purposes.

Amblyopinus emarginatus Seevers

Amblyopinus emarginatus Seevers, 1955, Fieldiana, Zoology, 37: 239, figs. 37m, 38f.

I have examined three specimens of this species from Rancho Mojica (Bocas del Toro), elevation 5000 feet, from *Peromyscus flavidus* (host no. 8042), 10 September 1961, and from *Oryzomys albigularis* (host no. 8098), 12 September 1961, collected by V. J. Tipton and C. M. Keenan. The type specimens are from Huila, Colombia, from *Thomasomys laniger*. The species probably also occurs in Venezuela.

Amblyopinus isabelae, new species. Figures 31C, D; 33A.

Near *A. bolivari* (figs. 31E, F; 33B) but readily separated as follows: eyes visible from above; mentum without marginal bristles; metasternal process with more than six bristles on the anterior surface; eighth sternum of male with two or three bristles. Ventral margin of apex of aedeagus (fig. 31C) with a sclerotized flat extension between fourth and second submarginal apical bristles; marginal row of spiniform microsetae well developed only from behind the fourth submarginal bristle toward the apex.

DESCRIPTION, MALE: *Head.*—Clypeal margin nearly straight, with one very short and blunt seta on each frontolateral angle. Labrum bilobed; each lobe with three setae on the external side and three on the internal side of the margin. Lateral margins very divergent, but convergent behind the eyes, forming conspicuous lateral lobes separated from the posterolateral or occipital lobes by a short sinus. Five or six eye facets are visible from above just in front of the supraocular bristle. Occipital region with two

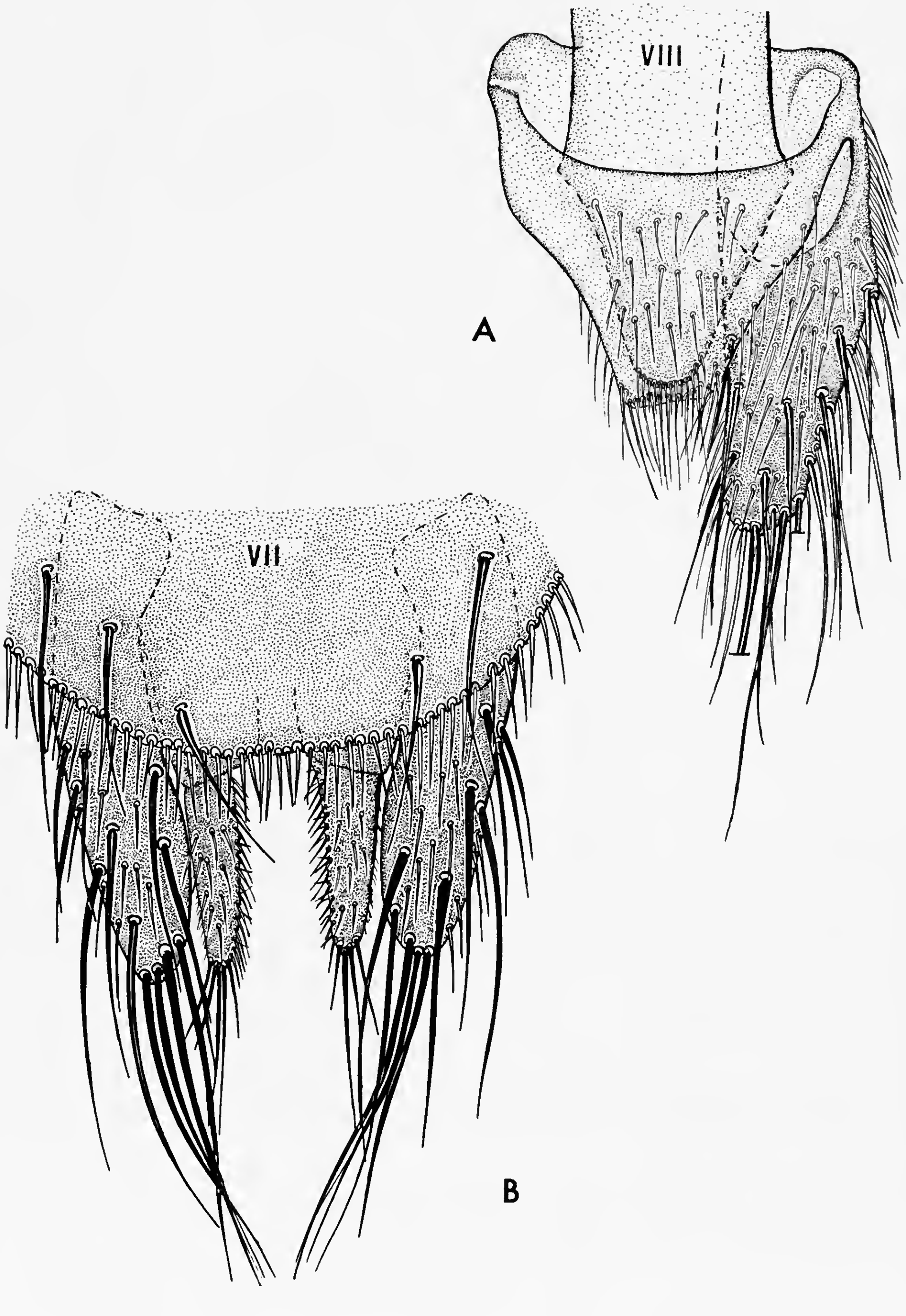

Fig. 32. *Amblyopinus tiptoni* n. sp., modified abdominal segments. A, eighth sternum (*VIII*), male. B, seventh sternum (*VII*), female.

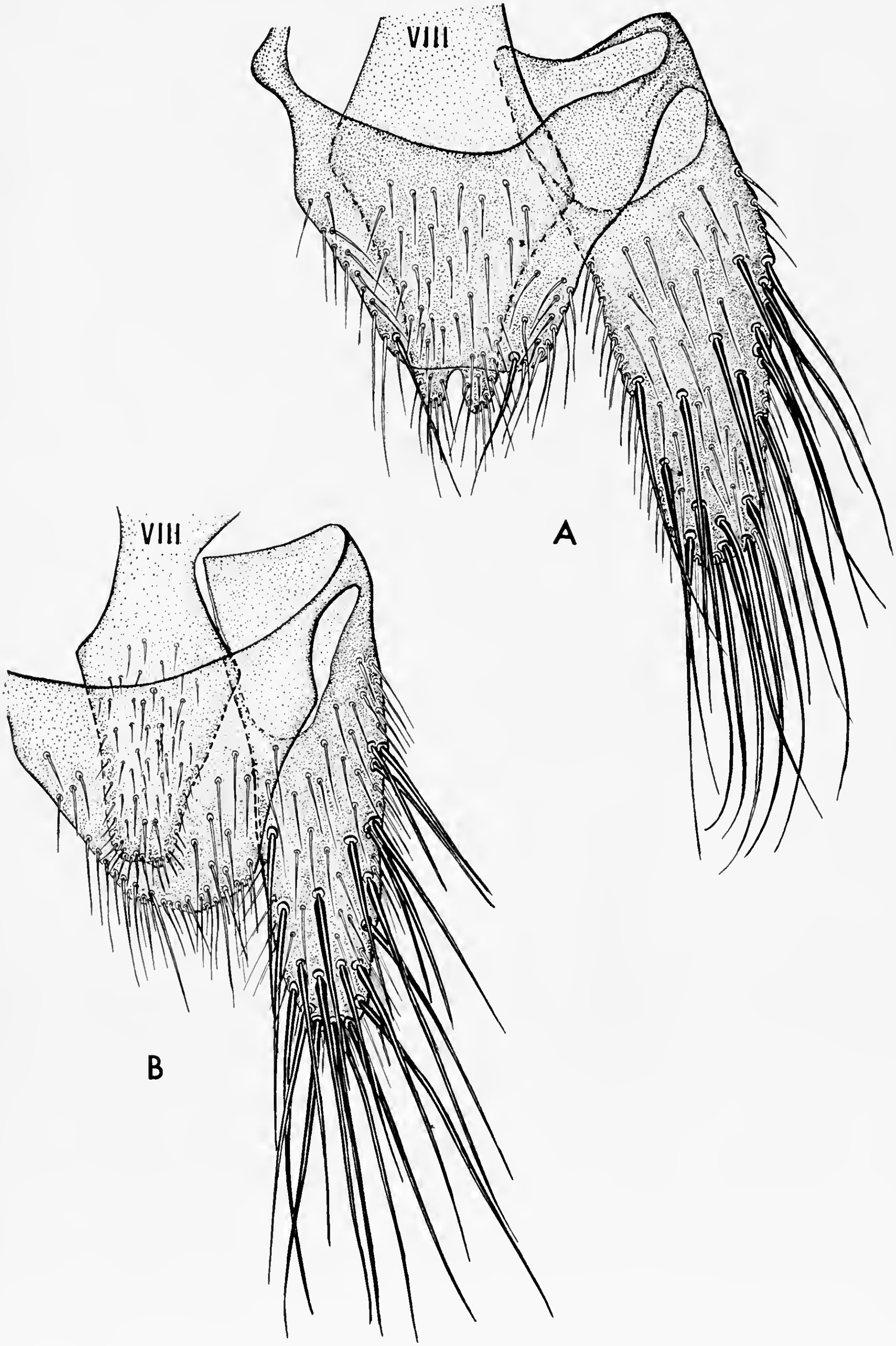

Fig. 33. Modified abdominal segments, male. A, *Amblyopinus isabelae* n. sp. B, *Amblyopinus bolivari* Barrera, Machado and Muniz.

abortive lateral setae, very much shorter than the postantennal ones. Mentum without marginal bristles.

Thorax.—Prosternum with two large median bristles. Mesosternum (fig. 31D) with about 14 large bristles arranged in two irregular longitudinal rows. Metasternum clothed with several relatively small bristles arranged in eight irregular rows; apex of metasternal process emarginate, nearly pentagonal.

Abdomen and genitalia.—Caudal margin of terga I to VI with a long pigmented lateral bristle. Margin of tergum VII evenly rounded. Tergum VIII trapezoidal, with several long, slender marginal bristles; near the posterolateral angles one of these bristles is longer and more pigmented than the others. Margin of sternum V with one long pigmented bristle on each side. Margin of sternum VI with two long pigmented bristles each side. Sternum VII bilobed, with two large submarginal bristles on the left lobe and three on the right. Sternum VIII rhomboidal, but with the apex bilobed (fig. 33A).

Urostyli with very few setae on the anterior half of the external margin and with the large bristles arranged as in fig. 33A. Dorsal apodeme of the aedeagus (fig. 31C) relatively slender, with spiniform microsetae well developed only at apex, behind fourth submarginal bristle. One spiniform microseta under each submarginal bristle. A flat extension runs between the second and fourth submarginal bristles. Lateral lobes wide, rounded. Apical sclerite of internal tube of aedeagus dorsally convex, smooth, with both proximal and distal ends rounded. Female unknown.

TYPE MATERIAL: Holotype a male from Omiltemi, State of Guerrero, Mexico; collected 29 December 1954 by A. Barrera and D. Pelaez. In the collection of the Laboratorio de Entomología Económica y Experimental, Escuela Nacional de Ciencias Biológicas, I.P.N., México, D.F.

REMARKS: This species is named for my wife, the entomologist Isabel Bassols de Barrera, who has often helped me in collecting rodents and ectoparasites. Other ectoparasites collected at Omiltemi were described by Barrera (1958) in a previous paper.

There is considerable agreement that the Amblyopinini are obligate ectoparasites. However, neither the literature nor field notes contain conclusive reports on their feeding habits. Although Zikan (1939) concluded that *Amblyopinus henseli* Kolbe is a blood-sucking parasite, he offered no positive evidence.

By means of the benzidine test for occult blood, I obtained a strong positive reaction for blood in some specimens of the large series of *Amblyopinus tiptoni* n. sp. I have come to the conclusion that, as far as the species tested is concerned, *Amblyopinus* do parasitize their hosts primarily for food. Normally, however, they feed on skin exudates or on other products that do not contain haemoglobin, although they may occasionally draw peripheral blood when embedding their mandibles deeply into the skin as they usually do.

A forthcoming paper will specifically report the results of the examination of gastro-intestinal contents of this and other *Amblyopinus*.

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The Fleas (Siphonaptera) of Panama

VERNON J. TIPTON [1] AND EUSTORGIO MÉNDEZ [2]

Published records of fleas from Panama are fragmentary. Jennings (1910) surveyed the two terminal cities of Colon and Panama City for rats and fleas in an attempt to assess the plague potential resident within these two cities. Dunn (1923) listed the fleas known from the more common animals collected in and near the Canal Zone and admitted that his list was incomplete. He later (1934) listed additional species as a result of a general entomological investigation in Chiriquí Province and Fuller (1943) reported on still other material collected by Dunn. Collections made by Dunn in the vicinity of the Canal Zone and J. H. Batty in Chiriquí Province provided new material for taxonomic papers by Jordan and Rothschild (1922, 1923), Jordan (1926) and Kohls (1942). Fairchild (1943) brought together the existing records which included 12 common species and gave additional host data. Mendez and Altman (1960) described a new species of the genus *Kohlsia*. Tipton and Mendez (1961) described four new species and listed four species not previously known in Panama.

This study is based on material in our possession, for the most part collected by us. It attempts to provide data on host-parasite relationships and supplies keys and illustrations to facilitate the identification of the 37 species and subspecies of fleas known to occur in Panama. Six new species are described and seven species are recorded for the first time from Panama. In addition, the male of *Rhynchopsyllus megastigmata* Traub and Gammons, 1950, and the female of *Strepsylla dalmati* Traub and Barrera, 1955, are described.

We wish to express our appreciation to several people whose cooperation has made this study possible. We are especially grateful to Lt. Col. Robert M. Altman who initiated the field work on which much of this study is based. It was intended originally that he be a co-author of the publica-

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[1] Lieutenant Colonel, Medical Service Corps, United States Army.
[2] Gorgas Memorial Laboratory, Panamá, Panamá.

tion resulting from our joint study. However, it has been impractical for us to continue the work as a joint project. Colonel Altman has been very cooperative and kindly allowed us to use material collected during his tour of duty in Panama. Colonel Robert Traub (Ret.), formerly with the United States Army Medical Research and Development Command, Office of the Surgeon General, and Mr. F. G. A. M. Smit, British Museum (Natural History), have compared many of our specimens with type material and have given helpful suggestions. We are grateful to Dr. Phyllis T. Johnson, Gorgas Memorial Laboratory, for her suggestions and permission to use illustrations contained in her outstanding study, *Fleas of South America.* Major Wallace P. Murdoch and Lt. Col. Gordon Field and their staff of illustrators at the 406th Medical General Laboratory in Tokyo prepared many of the figures contained herein and we are grateful for their cooperation and assistance. Charles M. Keenan has been most helpful with preparations for field trips as well as with collecting of host animals. Dr. Charles O. Handley has identified our host animals and has been very helpful in obtaining specimens, especially during a joint venture into the Chiriquí area during March, 1962. We wish also to acknowledge with gratitude the assistance rendered by field workers and laboratory technicians. Prodigious feats of strength and endurance in the field were equaled only by patience and painstaking care in the laboratory.

KEY TO THE PANAMANIAN GENERA OF FLEAS[3]

1. Sword-like ridge of mesocoxa usually present, mesonotum with or without pseudosetae; metanotum much broader dorsally than ventrally 2
   Sword-like ridge of mesocoxa absent; metanotum lacking pseudosetae; metanotum rectangular, not especially broader dorsally than ventrally; never with more than one row of bristles on abdominal terga 3
2. With a combination of the following characters: anterior tentorial arm present, always inserting in front of eye; mesopleural rod not bifurcate dorsally; lacking head, thoracic and abdominal combs; ventral margin of pronotum never bilobed; fifth tarsal segment always with four lateral plantar bristles 10
   Not with above combination of characters 11
3. Inside of metacoxae with spiniform bristles; sensillium with 14 or more pits on a side; female with anal stylet 5
   Inside of metacoxae without spiniform bristles; sensillium with eight pits on a side; female without anal stylet 4
4. Anterior apical corner of hind coxa projecting downward as a broad tooth; no tooth at base of hind femur .... *Tunga* Jarocki
   Hind coxa without apical tooth; hind femur with a large basal tooth .... *Rhynchopsyllus* Haller
5. Thorax compressed; measured dorsally, meso- and metathorax together shorter than first abdominal tergum .... *Echidnophaga* Olliff
   Thorax normal; measured dorsally, meso- and metathorax together longer than first abdominal tergum 6
6. With both genal and pronotal combs .... *Ctenocephalides* Stiles and Collins
   With only pronotal comb or no combs 7
7. With pronotal comb .... *Hoplopsyllus* Baker
   Without pronotal comb 8

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[3] Partially adapted from Hopkins and Rothschild (1953) and Johnson (1957).

8. Dorsal sulcus above antennae absent or poorly sclerotized; mesopleural rod present; vestigial genal comb absent........................*Xenopsylla* Glinkiewicz
   Dorsal sulcus above antennae well sclerotized; mesopleural rod absent; vestigial genal comb present...9
9. Frons smoothly rounded, without a tubercle......................*Pulex* Linnaeus
   Frons angulate, with small tubercle.........................*Juxtapulex* Wagner
10. Prosternosome projecting downward between the coxae; mesocoxa rectangular, margins parallel ....*Rhopalopsyllus* Baker
    Prosternosome not projecting downward between coxae; mesocoxa not rectangular, obviously broadest basally................................*Polygenis* Jordan
11. Head with helmet...*Plocopsylla* Jordan
    Head without helmet...12
12. Pronotal comb present...13
    Pronotal comb absent...*Wenzella* Traub
13. Genal comb present; male with third aedeagal rod arising from aedeagal pouch....14
    Genal comb absent; male with third aedeagal rod arising from ninth sternum......18
14. Genal comb of two spines..15
    Genal comb of four spines................................*Adoratopsylla* Ewing
15. Genal comb of two overlapping spines (on rodents)..............*Strepsylla* Traub
    Genal comb of two large spines which do not overlap (on bats)..................16
16. First abdominal tergum with well developed comb.............................17
    First abdominal tergum without comb..........*Sternopsylla* Jordan and Rothschild
17. Metanotum and terga I through IV with combs...*Hormopsylla* Jordan and Rothschild
    Only first abdominal tergum with comb...........*Ptilopsylla* Jordan and Rothschild
18. Pronotal comb with 24 or more spines..19
    Pronotal comb with fewer than 24 spines.....................................20
19. Fifth segment of all tarsi with third pair of plantar bristles ventrally displaced.. ....*Dasypsyllus* Baker
    Fifth segment of all tarsi with third pair of plantar bristles not ventrally displaced ....*Ceratophyllus* Curtis
20. Males 21
    Females 23
21. Distal arm of ninth sternum with stout, cephalad directed bristle; without apical or subapical spiniform bristles...............................*Jellisonia* Traub
    Distal arm of ninth sternum without stout cephalad directed bristle.............22
22. Distal arm of ninth sternum with distinct notch, lacking spiniform bristles...... ....*Pleochaetis* Jordan
    Distal arm of ninth sternum without notch, with spiniform bristles....*Kohlsia* Traub
23. Female anal stylet with dorsomarginal bristle.................*Pleochaetis* Jordan
    Female anal stylet without dorsomarginal bristle............................24
24. Tail of spermatheca almost twice length of head; head of spermatheca subglobular; bursa copulatrix lying in a horizontal plane.................*Kohlsia* Traub
    Tail of spermatheca only slightly longer than head; head of spermatheca ovoid; bursa copulatrix lying in a vertical plane......................*Jellisonia* Traub

Superfamily PULICOIDEA
Family **Pulicidae**
Subfamily Pulicinae
Genus **Ctenocephalides** Stiles and Collins

Ctenocephalides Stiles and Collins, 1930, U.S. Publ. Hlth. Repts., Wash., 45: 1308.
Type-species: *Pulex canis* Curtis, 1826.

Ctenocephalides felis felis (Bouché). Plate 47.

Pulex felis Bouché, 1835, Nova Acta Leop.—Carol., 17: 505.
Ctenocephalides felis felis, Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas, 1: 145, figs. 14, 152, 155, 157, 161, 162; pls. 25E, 27A, B, D. Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 228, pls. 100, 101.

MATERIAL EXAMINED: 346 males and 742 females collected from several hosts including *Canis familiaris, Felis cattus, Didelphis marsupialis caucae, Nasua nasua narica, Eira barbara biologiae, Conepatus semistriatus trichurus, Liomys adspersus, Coendou mexicanus laenatus, Peromyscus nudipes nudipes, Felis onca centralis* and *Oryzomys caliginosus* from various localities throughout Panama. In addition, several hundred specimens in alcohol, from July 1956 to March 1962, collected by R. M. Altman, C. M. Keenan and V. J. Tipton.

REMARKS: Perhaps the most ubiquitous flea in Panama, *C. felis felis,* has been taken in all of our collecting localities and from a wide variety of hosts.

Ctenocephalides canis (Curtis)

Pulex canis Curtis, 1826, Brit. Ent., 3: 114, figs. A-E, 8.
Ctenocephalides canis, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 227–228.

MATERIAL EXAMINED: None.

REMARKS: We have not collected this species in Panama. However, Dunn (1923) reports a collection taken from a dog shortly after it had been brought to Panama from an island off the coast of Honduras.

Genus **Echidnophaga** Olliff

Echidnophaga Olliff, 1886, Proc. Linn. Soc. N. S. Wales, (2), 1: 171.
Type-species: *Echidnophaga ambulans* Olliff, 1886.

Echidnophaga gallinacea (Westwood). Plates 48 (fig. 2), 49 (figs. 3, 4).

Sarcopsylla gallinaceus Westwood, 1875, Ent. Month. Mag., 11: 246.
Echidnophaga gallinacea, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 232, pls. 108, 109.

MATERIAL EXAMINED: None.

REMARKS: We have not collected this species although it is likely quite common throughout Panama. Dunn (1923) made several collections from such hosts as poultry, dogs, cats, rats, and man.

Genus **Pulex** Linnaeus

Pulex Linnaeus, 1758, Syst. Nat., 10th ed., 1: 614.
Type-species: *Pulex irritans* Linnaeus, 1758.

Pulex irritans Linnaeus

Pulex irritans Linnaeus, 1758, Syst. Nat., 10th ed., p. 614. Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas, 1: 105, figs. 3–6, 18A, 20B, 75, 124, 125; pls. 1, 4A, 21B, 22A–G. Smit, 1958, Jour. Parasit., 44, (5), pp. 523–526, fig. 2.

MATERIAL EXAMINED: 2 females from *Conepatus semistriatus trichurus,* Cerro Punta (Chiriquí), 12 March 1962, collected by C. O. Handley and V. J. Tipton.

REMARKS: *Pulex irritans* has been collected in Panama on a number of occasions but Hopla and Smit (personal communications, 1960) have indicated that these records are in error. Smit has kindly examined the Panamanian specimens labeled *P. irritans* in the British Museum. According to him, only one lot of 4 males and 4 females from Ancón are *P. simulans* Baker. An additional lot of 3 females from Bugaba is in alcohol and could be of either species. We have examined all specimens labeled as *irritans* in the United States National Museum and are of the opinion that they fit Smit's (loc. cit.) figures of *simulans*. There is one lot of 1 male and 4 females, which are regarded as *irritans*, but the origin of these specimens is doubtful, because they were removed from an airplane employed on the Balboa-New Orleans route.

We were unable to collect *P. irritans* in the Chiriquí area where Champion (Hopkins and Rothschild, 1953) found it at elevations from 4000 to 6000 feet, nor has it been found during several years of collecting in the Canal Zone. However, we have 2 females from skunk (*Conepatus semistriatus*) collected in Cerro Punta (Chiriquí) which are probably *irritans*.

Pulex simulans Baker. Plates 48 (fig. 4), 51 (figs. 6, 7).

Pulex simulans Baker, 1895, Can. Ent., 27: 65, 67. Smit, 1958, Jour. Parasit., 44, (5), pp. 523–526, fig. 1.

MATERIAL EXAMINED: 31 males and 53 females collected by Wilbur Lowe from man in Colón (Panamá), March, September and November, 1958. Also 1 male and 4 females from *Rattus norvegicus*, Panama City, May 1957, collected by E. Mendez.

REMARKS: Dunn (1923) reported a heavy infestation of *P. irritans* in a labor camp (Camp Maru) near the Chagres River on the Atlantic side of the Isthmus. Fuller (1942) lists one male collected from a dog in Panama City and Fairchild (1943) adds data on two lots from man at Moja Pollo, Chagres River area. We do not know whether these records refer to *P. irritans* or to the closely related species, *P. simulans*. We are not yet convinced that *simulans* is a distinct species but for the present we choose to retain it as valid, in view of the paucity of our material from hosts other than man. Assuming that the two species are morphologically distinguishable, we suggest that *simulans* occurs in the lowlands of Panama and that *irritans* is restricted to elevations of over 5000 feet.

Smit (loc. cit.) indicates that *irritans* has a predilection for man and large carnivores while *simulans* occurs on rodents which live in colonies. Our records do not bear this out since most of our specimens (31 males and 53 females) of *simulans* were collected from man and the remaining specimens (1 male and 4 females) were collected from *Rattus norvegicus*.

Genus **Juxtapulex** Wagner

Juxtapulex Wagner, 1933, Mitt. Berlin Zool. Mus., 18: 431.

Type-species: *Juxtapulex echidnophagoides* Wagner, 1933.

Juxtapulex echidnophagoides Wagner. Plates 48 (fig. 3), 49 (figs. 5, 6).

Juxtapulex echidnophagoides Wagner, 1933, Mitteil. Mus. Berlin, 18: 343, figs. 1A, 2–6. Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas, 1: 100–102, fig. 120. Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 255–256.

MATERIAL EXAMINED: 273 males and 326 females from *Dasypus novemcinctus fenestratus;* 78 males and 138 females from *Didelphis marsupialis caucae;* 19 males and 19 females from *Felis onca concolor;* 1 male and 1 female from *Canis familiaris;* 1 male from *Sciurus granatensis chiriquensis;* 1 female from man. All, except *F. onca concolor* from El Volcán, were collected at Cerro Punta (Chiriquí) during July 1959, January and February 1960, January, April and May 1961, and March 1962, by C. O. Handley, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: Of 859 fleas of this species collected from 23 hosts, 599 (about 70 percent) were collected from 7 (34 percent) of the hosts, *Dasypus novemcinctus fenestratus,* at a rate of 85 fleas per host. Twelve specimens of *Didelphis marsupialis caucae* were collected at elevations above 5000 feet. From 11 of these, 216 fleas were removed at a rate of approximately 20 fleas per host. Even though *J. echidnophagoides* may live quite successfully in association with marsupials, it is likely that edentates are true hosts.

Genus **Hoplopsyllus** Baker

Hoplopsyllus Baker, 1905, Proc. U. S. Nat. Mus., 29: 130.

Type-species: *Pulex anomalus* Baker, 1904.

Hoplopsyllus glacialis exoticus Jordan and Rothschild. Plates 50, 51 (figs. 1–5).

Hoplopsyllus exoticus Jordan and Rothschild, 1923a, Ectoparasites, 1: 311–312, fig. 314. Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas, 1: 192–193, fig. 181.

Hoplopsyllus glacialis exoticus, Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 256–259, pls. 1, 2.

MATERIAL EXAMINED: 24 males and 47 females from *Sylvilagus brasiliensis gabbi,* 5 males and 3 females from *Didelphis marsupialis caucae,* 1 male from *Nasua nasua narica;* Cerro Punta (Chiriquí), January 1960, January 1961 and March 1962, collected by C. O. Handley, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: *H. glacialis exoticus* is found most commonly, although not exclusively, on rabbits. Apparently it does not occur on rabbits in the lowlands.

Genus **Xenopsylla** Glinkiewicz

Xenopsylla Glinkiewicz, 1907, Sitzber. Akad. Wiss. Wien, Abt. 1, 116: 385.

Type-species: *Xenopsylla pachyuromyidis* Glinkiewicz, 1907.

Xenopsylla cheopis Rothschild. Plates 52, 53.

Pulex cheopis Rothschild, 1903, Ent. Month. Mag., (2), 14: 85, pl. 1 (figs. 3, 9), 2 (figs. 12, 19).

Xenopsylla cheopis Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas 1: 248–260, figs. 20A, 76, 199, 220, 246, 255, 259, 266, 286, 305–308, 310, 391; pls. 2, 22D–F, 39A, 40E. Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 226–227, pls. 98, 99.

MATERIAL EXAMINED: 3 males and 5 females *Rattus rattus;* Arraiján and Santa Fé; February and April 1959, collected by R. M. Altman and C. M. Keenan.

REMARKS: The distal arm of the ninth sternum is considerably more setose in our specimens than in those of Hopkins and Rothschild (1953). The shape of the spermatheca also differs but within the range of intraspecific variation.

Jennings (1910) collected 3022 fleas from 2394 rats (presumably of the genus *Rattus*), an average of 1.26 fleas per rat. Most of the fleas (2966 or 97.9 percent) were *X. cheopis.* In a later survey in Colón and Panama City in 1920–21, he collected 505 fleas from 1225 rats and mice. However, 1020 of the hosts were mice, from which only 29 fleas were removed. There were 476 fleas on 205 rats or an average of 2.33 fleas per rat. The rats captured on the drier Pacific side of the Isthmus were more heavily infested than those from the Atlantic side.

In recent years there have been very few specimens of *X. cheopis* collected in the Canal Zone. Only eight specimens of *X. cheopis* were collected from 119 rats in Arraiján just outside of the Canal Zone. The widespread use of insecticides for the control of mosquitoes may be partially responsible for the paucity of fleas on domestic rats.

Subfamily Tunginae

Genus **Tunga** Jarocki

Tunga Jarocki, 1838, Zoologiia, **6**: 50.
Type-species: *Pulex penetrans* Linnaeus, 1758.

Tunga penetrans (Linnaeus). Plates 48 (fig. 1), 49 (figs. 1, 2).

Pulex penetrans Linnaeus, 1758, Syst. Nat., 10th ed., p. 614.
Tunga penetrans, Hopkins and Rothschild, 1953, Cat. Rothschild Coll. Fleas, **1**: 39–43, figs. 21, 22A, 23, 26A, 28, 37; pls. 6A, B, 7A–C, 8B.

MATERIAL EXAMINED: 31 males and 9 females from *Sus scrofa;* Santa Fé (Veraguas) and Las Palmitas (Los Santos); January 1956, February 1957 and January 1962, collected by R. M. Altman, C. O. Handley and C. M. Keenan.

REMARKS: This species does not appear to be highly variable. Hopkins and Rothschild (loc. cit.) compare the claspers of males from Brazil and Nyasaland and as expected, our specimens agree more closely with those from Brazil. *T. penetrans* is widespread throughout Panama according to those who have visited villages of the interior. Residents of these villages are familiar with the "nigua," and in some areas of western Panama, it is a common pest of man and domestic pigs.

Genus **Rhynchopsyllus** Haller

Rhynchopsyllus Haller, 1880, Arch. Naturg., **46**, Bd. 1, p. 72.
Type-species: *Rhynchopsyllus pulex* Haller, 1880.

Rhynchopsyllus megastigmata Traub and Gammons. Plate 54.

Rhynchopsyllus megastigmata Traub and Gammons, 1950, Jour. Parasit., **36**, (3), pp. 271–272, figs. 6, 7.

MATERIAL EXAMINED: 4 males and 3 females from bat guano under tile on church at Pacora, 20 June 1961 and 12 January 1961; 1 female from *Tadarida yucatanica,* same locality, 20 June 1961; collected by C. M. Keenan and V. J. Tipton.

REMARKS: We are not certain that all of our specimens should be called *R. megastigmata.* Traub (personal communication, 1962) has pointed out that if the sexes are conspecific, there is extreme sexual dimorphism in this species. However, it seems unlikely that males of one species would be found occupying the same ecological niche as females of a closely related species. On the other hand, our series is small and it is possible that we have collected four male specimens of one species and three female specimens of another species in the same guano deposit. Perhaps at a later date, when male specimens of *R. pulex* have been collected, it will be possible to determine the extent of sexual dimorphism in this genus.

Our female specimens differ from the description and illustrations given by Traub and Gammons (loc. cit.) in several details. In our specimens, the spermatheca is extremely large, the abdominal spiracles are not quite as large, the lateral process of the prosternum and the maxillary lobe are longer and somewhat more acuminate, and the postoral process is broader basally. There also appear to be some differences in the arrangement of the bristles on the eighth tergum.

The type material, consisting of two females, and our four specimens make a total of six female specimens available for study. Such a short series does not allow a proper evaluation of intraspecific variation. Despite the possibility that our specimens may represent two distinct species, we choose to refer them to *R. megastigmata.*

DESCRIPTION, MALE: *Head* (pl. 54, fig. 1).—Dorsal margin of head shallow arc; anterior margin well rounded; ventral margin almost straight, terminating in small postoral process. One large preantennal bristle cephalad of eye; 10–11 minute spiniforms scattered over preantennal area. Eye well developed, subovate; with small ventral sinus. Genal process long, subacuminate. Maxillary lobe short, reaches to apex of first segment of maxillary palpus; broad basally, suddenly reduced to subacuminate apex. Stilettos broad, serrations not prominent; reach slightly beyond apex of maxillary palpus. Labial palpus three-segmented; reach almost to apex of forecoxa. Antenna oblong; bristles of second segment reach beyond middle of club. Postantennal area with four long bristles plus five or six spiniforms.

Thorax (pl. 54, fig. 2).—Pronotum with single row of four bristles. Prosternum broad, without lateral process. Mesonotum (*MSN.*) with row of five bristles. Mesosternum (*MST.*) undivided; with one long bristle. Metanotum (*MTN.*) with two or three bristles. Lateral metanotal area (*L.M.*) well developed. Metepisternum (*MTS.*) with long dorsal bristle immediately ventrad of prominent, strongly sclerotized pleural arch (*PL.A.*). Metasternum (*MTT.*) fairly well developed; saber-like. Metepimere (*MTM.*) large; with five bristles.

Legs.—Metafemur with basal spur. Tibia and first three tarsal segments much broader apically than basally. Third tarsal segment with two bristles which reach beyond apex of fifth segment.

Modified Abdominal Segments (pl. 54, figs. 3–5).—Eighth tergum (8*T*.) reduced. Tergum 9 with broad, cephalad-directed apodeme (*T. AP.* 9); rod-like dorsal apodeme. Manubrium much reduced, thumb-like; directed caudad. Immovable process of clasper (*P*.) large; with several small bristles scattered over surface. Movable process of clasper divided (F_1, F_2); apical half of F_1 broad, somewhat truncate; basal half with deep lateral sinus to accommodate ventral spur on F_2; caudal margin of F_2 strongly arched; anterior margin with truncate recess to receive apical portion of F_1. Distal arm of ninth sternum (*D.A.*9) roughly foot-like; with three small bristles on ventral margin, about 18 lateral bristles.

Aedeagus (pl. 54, fig. 6).—Aedeagal apodeme short, broad; with prominent middle plate (*MI.P.*) strongly hooked apically. Proximal spur absent. Crescent sclerite (*C.S.*) inconspicuous. Medial dorsal lobe (*M.D.L.*) rounded subapically; apex hook-like. Sclerotized inner tube (*S.I.T.*) long, straight; with prominent lateral process. Lateral lobe of adeagus (*L.L.*) broadly nipple-like. Crochet (*CR.*) broad basally; with short apical hook. Pseudocrochet (*PS.C.*) on broad stalk projecting from wall of aedeagal pouch; apex slightly rugose.

Superfamily RHOPALOPSYLLOIDEA
Family **Rhopalopsyllidae**
Subfamily Rhopalopsyllinae
Genus **Polygenis** Jordan

Polygenis Jordan, 1939, Novit. Zool. 41: 444.

Type-species: *Pulex roberti* Rothschild, 1905.

Polygenis atopus (Jordan and Rothschild). Plate 55.

Rhopalopsyllus atopus Jordan and Rothschild, 1922, Ectoparasites, 1: 267, figs. 259, 260.

Polygenis atopus, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 158–159.

MATERIAL EXAMINED: 2 males and 3 females from *Peromyscus nudipes nudipes* and 1 male from *Oryzomys albigularis,* Rancho Mojica (Bocas del Toro), September 1961, collected by V. J. Tipton.

REMARKS: In a comparison with the original description and figures we note that in our specimens the distal arm of the ninth sternum of the male is more setose and the apex not quite so truncate. The sinus in the process of the clasper is almost absent and P_1 is very short in our specimens.

As mentioned elsewhere, the flea fauna of *Peromyscus nudipes nudipes* captured on the Pacific slope was quite different from that of the Atlantic slope although the two localities were separated by only a few miles and at essentially the same elevation. *P. atopus* was not found on any of the more than 200 specimens of *P. nudipes nudipes* collected on the pacific slope but was found only on the Atlantic slope above 5000 feet elevation. The occurrence of *atopus* at this locality lends credence to the statement by Fairchild (personal communication, 1961) that it is not uncommon to find South American species of insects in Atlantic drainage localities on the Isthmus and that species of the Pacific drainage are characteristically North American.

Polygenis dunni (Jordan and Rothschild). Plates 56 (fig. 1), 57 (figs. 1, 2).

Rhopalopsyllus dunni Jordan and Rothschild, 1922, Ectoparasites, 1, (4), p. 269, figs. 261, 262. Jordan and Rothschild, 1923b, Ectoparasites, 1, (5), pp. 336, 351.
Rhopalopsyllus (*Polygenis*) *dunni*, Ewing and Fox, 1943, Fleas N. Am., p. 22.
Polygenis dunni, Costa Lima and Hathaway, 1946, Pulgas, p. 144.
Polygenis ambersoni Traub and Johnson, 1952, Bol. Of. Sanit. Panam., 32: 112, figs. 1–4, 6, 9, 10, 12–14, 16.
Polygenis dunni, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 160–161 (synonymizes *ambersoni*).

MATERIAL EXAMINED: 19 males and 19 females from *Liomys adspersus*, 2 males and 1 female from *Proechimys semispinosus panamensis*, 1 male and 1 female from *Zygodontomys microtinus*, 1 male from *Sigmodon hispidus chiriquensis*, 2 females from *Metachirus nudicaudatus dentaneus*, 1 female from *Oryzomys capito*, 1 female from *Sciurus granatensis chiriquensis;* Canal Zone, Cerro Azul, Río Seteganti, Chiriquí Lagoon; September–December 1956, July 1958, February 1960, January and March 1961, collected by R. M. Altman, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: Our specimens conform closely to the original description and show very little variation. However, we have a rather short series (23 males and 25 females).

Polygenis klagesi (Rothschild). Plates 56 (fig. 3), 57 (figs. 5, 5a, 6, 6a, 6b).

Pulex klagesi Rothschild, 1904, Novit. Zool., 11: 620, pls. 9 (fig. 28), 10 (figs. 35, 39).
Rhopalopsyllus klagesi samuelis Jordan and Rothschild, 1923b, Ectoparasites, 1: 331, figs. 342, 345.
Polygenis klagesi samuelis Johnson, 1957, Mem. Ent. Soc. Wash., no. 5: 164.
Rhopalopsyllus klagesi klagesi Jordan and Rothschild, loc. cit., p. 332, figs. 343, 344.
Polygenis klagesi klagesi Johnson, loc. cit., p. 163.

MATERIAL EXAMINED: 966 males and 1347 females from *Proechimys semispinosus panamensis*, 30 males and 51 females from *Hoplomys gymnurus*, 13 males and 18 females from *Tylomys panamensis*, 19 males and 24 females from *Nasua nasua narica*, 3 males and 8 females from *Zygodontomys microtinus*, 3 males and 7 females from *Didelphis marsupialis caucae*, 2 males and 2 females from *Oryzomys capito*, 2 females from *O. bombycinus*, 1 male and 3 females from *Dasyprocta punctata isthmica*, 2 males and 1 female from *Marmosa robinsoni*, 2 females from *Liomys adspersus*, 1 female from *Heteromys australis*, 1 female from *Sigmodon hispidus chiriquensis* and several hundred specimens in alcohol; from all collecting localities at 2500 feet elevation and below. In addition 8 males and 25 females from *Coendou mexicanus laenatus*, Cerro Punta (Chiriquí), collected by R. M. Altman, C. O. Handley, C. M. Keenan, V. J. Tipton, and Gorgas Memorial Laboratory.

REMARKS: Jordan and Rothschild (1923) referred Panamanian specimens of *P. klagesi* (Rothschild, 1904) to a new subspecies, *P. klagesi samuelis*, based on the shape of the spermatheca and the apical width of the movable process of the clasper compared with the immovable process of the clasper. It is our opinion that the figures and description given by Jordan and Rothschild are not adequate for an accurate assignment of our specimens to either subspecies. Furthermore, there is an unusual amount of variation in this species as expressed in the length of the distal arm of the ninth sternum. In specimens from the Canal Zone, the length of *D.A.*9 is 94 μ; from Cerro Azul, 140 μ; from Río Changena, 156 μ; and from Cerro Punta, 187 μ. The spermatheca of our specimens resembles the figure by Jordan and Rothschild for *P. klagesi klagesi,* while the male claspers more closely resemble their figures of *P. klagesi samuelis.* The width and length of the movable process of the clasper and the shape of the spermatheca are highly variable. Specimens from *Coendou mexicanus laenatus* (pl. 57, figs. 5a, 6a, 6b) collected in Chiriquí represent a distinct population and may be even a distinct species. Smit (personal communication, 1962) pointed out that the abdominal spiracles are larger and the seta below the eye is positioned differently than in *P. klagesi samuelis.* The shape of the spermatheca, the setal pattern of the clasper and the length of the distal arm differ from lowland specimens. It will be necessary to obtain specimens from the entire range of *P. klagesi* and a detailed study of the aedeagus will be required to determine the status of subspecific populations of this species.

Almost 99 percent of the fleas collected from *Proechimys semispinosus panamensis* were *Polygenis klagesi* and 51 percent of the specimens of *P. s. panamensis* harbored this flea. Over 92 percent of all the specimens of *klagesi* collected were from this host and 96 percent from hystricomorph rodents.

Records maintained over a period of four years indicate there is a seasonal fluctuation in the population of *P. klagesi.* It appears that the numbers increase at the onset of the wet season but drop off sharply as the rainfall increases. As will be noted in the table below, the dry season corresponds roughly with the first quarter of the calendar year. Rainfall is expressed as an average of both the Atlantic and Pacific sides of the Isthmus.

Quarter	*Average Rainfall per Month in Inches*	*Fleas per Rat (Positive Rats Only)*
1	1.7	2.8
2	7.3	14.4
3	10.7	4.0
4	11.7	1.7

Polygenis roberti beebei (I. Fox). Plates 56 (fig. 2), 57 (figs. 3, 4).

Rhopalopsyllus beebei I. Fox, 1947, Zoologica, 32: 117, fig. 2.
Polygenis roberti beebei, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 168–169.

MATERIAL EXAMINED: 13 males and 17 females from *Oryzomys capito,* 14 males and 29 females from *O. caliginosus chrysomelas,* 5 males and 5 females from *O. bombycinus,* 3 males and 7 females from *Didelphis marsupialis caucae,* 2 males and 4 females from *Nectomys alfari,* 2 males and 5 females from *Proechimys semispinosus panamensis,* 1 male and 2 females from *Philander opossum fuscogriseus,* 1 male and 2 females from *Zygodontomys microtinus,* 1 male from *Metachirus nudicaudatus dentaneus,* 3 females from *Marmosa robinsoni,* 1 female from *Peromyscus nudipes nudipes,* 1 female from *Heteromys desmarestianus;* all collecting localities between 2000 and 3000 feet elevation plus a few specimens from the Canal Zone; July–August 1956, May–June 1957, January–February 1958 and September 1961, collected by R. M. Altman, C. M. Keenan, V. J. Tipton, C. E. Yunker, and Gorgas Memorial Laboratory.

REMARKS: Most of our specimens were collected at 2550 to 3000 feet elevation. Although they are associated with a wide range of hosts they appear to have a predilection for oryzomine rodents.

KEY TO THE PANAMANIAN SPECIES OF *POLYGENIS* JORDAN

1. Immovable process of clasper (*P.*) divided by shallow sinus; spermatheca without sharp distinction between head and tail........*P. atopus* (Jordan and Rothschild)
   Immovable process of clasper (*P.*) not divided by sinus; spermatheca with sharp distinction between head and tail..2
2. Apex of movable process of clasper (*F.*) reaches to or beyond antero-dorsal margin of immovable process (*P.*); head of spermatheca roughly ovoid, tail narrow and not recurved back over head........................*P. klagesi* (Rothschild)
   Apex of movable process of clasper (*F.*) does not reach to antero-dorsal margin of immovable process (*P.*); head of spermatheca roughly triangular, tail broad and recurved back over head..3
3. Bristles of distal arm of ninth sternum short, approximately as long as width of distal arm of ninth sternum. Labial palpus does not reach trochanter I........ ....*P. roberti beebei* (I. Fox)
   Bristles of distal arm of ninth sternum long, approximately four times as long as width of distal arm; labial palpus reaches to trochanter I.................. ....*P. dunni* (Jordan and Rothschild)

Genus **Rhopalopsyllus** Baker

Rhopalopsyllus Baker, 1905, Proc. U. S. Nat. Mus., 29: 128, 129, 143.

Type-species: *Pulex lutzi* Baker, 1904.

Rhopalopsyllus australis tupinus Jordan and Rothschild. Plates 58 (fig. 1), 59 (figs. 1, 2).

Pulex australis Rothschild, 1904, Novit. Zool., 11: 613, pls. 9 (fig. 29), 10 (figs. 34, 36), partim.

Rhopalopsyllus australis tupinus Jordan and Rothschild, 1923b, Ectoparasites, 1: 328, figs. 339. Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 176.

MATERIAL EXAMINED: 96 males and 130 females from *Dasyprocta punctata,* 24 males and 39 females from *Nasua nasua narica,* 2 males and 5 females from *Didelphis marsupialis caucae,* 3 males and 3 females from *Chironectes minimus,* 2 males and 2 females from *Tamandua tetradactyla,* 3 males and 11 females from *Proechimys semispinosus panamensis,* 8 males and 11 females from *Agouti paca virgatus,* 1 male and 1 female from *Zygodontomys microtinus,* 1 male from *Sciurus granatensis chiriquensis,* 1 female from *Philander opossum fuscogriseus,* 1 female from *Eira barbara biologiae,* 1 female from *Galictis allamandi,* 1 female from *Canis familiaris,* 1 female from man, 10 males and 20 females from *Tayassu tajacu;* mostly from Canal Zone but also from Chiriquí, Bocas del Toro, Los Santos, and Darién Provinces; November 1956 to March 1962, collected by R. M. Altman, C. O. Handley, C. M. Keenan, V. J. Tipton, C. E. Yunker, and Gorgas Memorial Laboratory.

REMARKS: Fuller (1942) lists *R. australis australis* from *D. marsupialis etensis,* Alhajuela; *R. australis tupinus* from *Tayassu tajacu,* Alhajuela; and *R. australis tamoyus* taken from *D. marsupialis etensis,* Ancón and Chilibrillo Caves. The morphological differences in these subspecies are based on the position of a notch of the movable process and a groove in the immovable clasper in relation to the acetabulum. With few exceptions our specimens fit the figures given by Jordan and Rothschild (1923) for *R. australis tupinus.* However, there is an unusual amount of variation in our series. For example, a male from *Dasyprocta punctata isthmica* is easily referrable to *R. australis tupinus* while another male from the same host specimen more closely approaches *R. a. tamoyus.* We prefer to refer all of our specimens to a single subspecies in view of the variation found in a series from a single host specimen. Further, it is very easy to confuse *R. lugubris* with subspecies of *R. australis;* this may have happened in the past.

The subspecies of *R. australis* are most frequently associated with agoutis, pacas and other hystricomorph rodents, and the carnivores which prey upon them. Most of our specimens were collected during the dry season but this may be due to the more favorable collecting conditions.

Rhopalopsyllus cacicus saevus Jordan and Rothschild. Plates 58 (fig. 3), 59 (figs. 5, 6).

Rhopalopsyllus cacicus saevus Jordan and Rothschild, 1923b, Ectoparasites, 1: 325, fig. 332. Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pp. 176–177.

MATERIAL EXAMINED: 77 males and 104 females from *Dasypus novemcinctus fenestratus,* 6 males and 12 females from *Didelphis marsupialis caucae,* 2 males and 3 females from *Proechimys semispinosus panamensis,* 5 females from *Philander opossum fuscogriseus,* 1 male and 1 female from *Nasua nasua narica,* 1 male from *Agouti paca virgatus,* 1 female from *Metachirus nudicaudatus dentaneus,* 2 females from *Dasyprocta punctata,* 105 males and 159 females from animal burrows (presumably *Dasypus novemcinctus fenestratus*) ; mostly from the Canal Zone, but a few from other sea level localities in Panama; July 1956 to March 1961, collected by R. M. Altman, C. M. Keenan and V. J. Tipton.

REMARKS: Fuller (1942) lists this species from *Dasypus novemcinctus* and *Didelphis marsupialis* from several localities in and near the Canal Zone. The variation due to orientation of specimens on microscope slides is frequently great enough to constitute what appear to be morphological differences. However, all of our specimens fit fairly closely the description and figures for *R. cacicus saevus.*

In many of the animal burrows listed above we found the host present. We have collected leaves and soil from the burrows in which we found *Dasypus novemcinctus fenestratus;* from this debris we have removed large numbers of *R. cacicus saevus.* We surmise that *D. novemcinctus fenestratus* is the true host of this flea at low elevations while *J. echidnophagoides* replaces *R. cacicus saevus* on the same host at high elevations.

Rhopalopsyllus lugubris cryptoctenes (Enderlein). Plate 59 (fig. 3a).

Rhopalopsyllus lugubris Jordan and Rothschild, 1908, Parasitology, 1: 74; pls. 3 (fig. 12), 6, (fig. 9).
Rothschildella cryptoctenes Enderlein, 1912, Zool. Anz., 40: 72, figs. 1–5, 7.
Rhopalopsyllus lugubris cryptoctenes, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 177, pls. 92 (figs. 1–3, 5), 93 (figs. 1, 2, 5).

MATERIAL EXAMINED: 51 males and 64 females from *Agouti paca virgatus* and 17 males and 19 females from *Dasyprocta punctata isthmica;* El Volcán and Cerro Punta (Chiriquí); July 1958, June–July 1959, January 1960 and March 1962, collected by C. M. Keenan, V. J. Tipton, and Gorgas Memorial Laboratory.

REMARKS: All of our specimens of *R. lugubris* from paca and agouti in Chiriquí are *R. l. cryptoctenes.* Dunn (1934) reports this species from agoutis collected in the lowlands in Chiriquí Province but they were probably *R. l. lugubris.* Johnson (loc. cit.) lists a single male "ex human" collected by H. C. Mathes in Volcán (Chiriquí).

There is considerable variation in the characters used to separate *R. lugubris cryptoctenes* from the nominate subspecies. This is especially true of the incrassation which separates the lateral groove on the caudal margin of the process of the clasper from the acetabulum. In general, however, this incrassation is very broad in *cryptoctenes,* and it extends at least two-thirds of the distance from the acetabulum to the apex of the finger of the clasper. In the nominate subspecies the incrassation extends less than one-half this distance. The notch on the finger of the clasper opposite the lateral groove of the process of the clasper is subapical in *cryptoctenes* and is roughly at the midpoint in *lugubris.* There are no demonstrable differences in the females.

Rhopalopsyllus lugubris lugubris Jordan and Rothschild. Plates 58 (fig. 2), 59 (figs. 3, 4).

Rhopalopsyllus lugubris Jordan and Rothschild, 1908, Parasitology, 1: 74, pls. 3 (fig. 12), 6 (fig. 9).
Rhopalopsyllus lugubris lugubris, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 177, pls. 92 (fig. 4), 93 (fig. 4).

MATERIAL EXAMINED: 15 males and 16 females from *Agouti paca virgatus,* 1 male and 3 females from *Dasyprocta punctata isthmica,* 7 males and 3 females from *Didelphis marsupialis caucae,* 1 female from *Zygodontomys microtinus,* 1 female from *Proechimys semispinosus panamensis* and 1 male and 2 females from man; Canal Zone, Darién, San Blas, Bocas del Toro Provinces and other sea level collecting localities; October 1957 through July 1958, April–October 1959, March, September 1961 and February 1962, collected by R. M. Altman, C. M. Keenan, V. J. Tipton, and Gorgas Memorial Laboratory.

REMARKS: All specimens of *R. lugubris* collected at elevations below 4000 feet are probably *R. l. lugubris.* In addition, 1 male and 1 female from man, Rancho Mojica (Bocas del Toro), elevation 5600 feet, have been assigned to this subspecies. None of our specimens of *R. lugubris* conform exactly to figures given by Jordan and Rothschild (1923b) or Johnson (loc. cit.) which makes clear the need for a revision of the genus *Rhopalopsyllus.*

Rhopalopsyllus species, near **mesus** Wagner

MATERIAL EXAMINED: 1 female from *Sciurus granatensis chiriquensis,* Cerro Punta (Chiriquí), January 1960, collected by C. M. Keenan and V. J. Tipton.

REMARKS: This single specimen has a rather unique spermatheca and probably represents an undescribed species. Its description, however, will await the collection of additional material.

KEY TO THE PANAMANIAN SPECIES OF *RHOPALOPSYLLUS* BAKER

1. Spiracle of metepimere oblong, prolonged dorsally; head of spermatheca globular.. .... *R. lugubris* (Rothschild)
   Spiracle of metepimere rounded or subrounded; head of spermatheca not globular....2
2. Labial palpus reaching to apex of coxa I or beyond; movable process of clasper longer than distal arm of ninth sternum; spermatheca not strongly S-shaped.... .... *R. cacicus saevus* Jordan and Rothschild
   Labial palpus not reaching apex of coxa I; movable process of clasper about as long as distal arm of ninth sternum; spermatheca strongly S-shaped.......... .... *R. australis tupinus* Jordan and Rothschild

Superfamily CERATOPHYLLOIDEA
Family **Ischnopsyllidae**
Genus **Hormopsylla** Jordan and Rothschild

Hormopsylla Jordan and Rothschild, 1921, Ectoparasites, 1, (3), p. 158.

Type-species: *Ceratopsylla fosteri* Rothschild, 1903.

Hormopsylla kyriophila, new species. Plates 60, 61.

DIAGNOSIS: *H. kyriophila* is more heavily sclerotized than the other species of the genus. In chaeotaxy of the frons and dorsal incrassations of the occiput it closely resembles *H. fosteri* (Rothschild). It may be separated from the latter species in that the male eighth sternum is subacuminate and bears about 16 regularly spaced bristles on the ventral margin to form a comb whereas in *fosteri* there are only eight to ten bristles and the apex is rounded; the distal arm of ninth sternum is not globular as in *fosteri;* the apical portion of the crochet is only slightly sinuate but is S-shaped in *fosteri* and the immovable process of the clasper is almost twice as wide as the movable process of the clasper while it is only slightly wider in *fosteri.* In the female the apex of the tail of the spermatheca almost touches the head of the spermatheca resulting in virtually a closed circle while the angle between the head and the tail of the spermatheca in *fosteri* is 30 to 40 degrees.

DESCRIPTION: *Head, Male* (pl. 60, fig. 1).—Anterior margin evenly rounded; preantennal area covered with 62–64 short, spiniform bristles plus four longer bristles; prominent mesal sclerotization running parallel with anterior margin of head; vertical incrassation extending from dorsal region. Two genal teeth; anterior tooth broad, about two-thirds length of narrower tooth; preoral tuber distinct. Genal process long, extends well beyond apex of antenna; apex rounded. Eye small, lightly pigmented. Postantennal area with five rows of marginal bristles of two bristles each; four vertical incrassations between rows of bristles, middle two most pronounced; diagonal row of bristles along antennal fossa; pale, mesal, triangular area with four short, three moderately long and three long bristles.

Thorax (pl. 60, fig. 2).—Pronotum with approximately nine bristles (three short, three moderately long, three long); about 24 teeth in pronotal comb which curves cephalad on ventral end. Mesonotum (*MSN.*) with six long bristles, four or five shorter bristles; two broad thickened areas extending ventrad from dorsal margin. Mesepimere (*MPM.*) with three long, six shorter bristles. Mesepisternum (*MPS.*) divided by broad horizontal band; two long, four shorter bristles above band; lower portion devoid of setae. Metanotum (*MTN.*) with four dorsal incrassations; seven long, two short bristles; apex with comb of ten teeth. Lateral metanotal area (*L.M.*) elongate, with single long bristle. Metepisternum (*MTS.*) with one long bristle; squamulum well developed. Metepimere (*MTM.*) with five bristles.

Legs.—Procoxa with about 36 bristles plus marginals; profemur with two short, one longer bristle on outer lateral surface. Meso-, metacoxae with heavily, sclerotized internal rods. Meso-, metafemora with single lateral bristle. Hind tibia with eight dorsocaudal notches with bristles arranged 2-2-1-2-2-1-2-2; single bristles between last five notches. Tarsal segment lengths (in μ) 156, 140, 104, 68, 125; four pairs lateral plantar bristles.

Abdomen.—Terga 1–4 with well developed combs with teeth numbering 18, 14, 14, 14; each tergum with globular sclerotization extending from dorsal margin; two bristles per segment with bases near dorsal margin plus two additional bristles more ventrad with spiracle between them. Minute bristle at base of single, long antesensillial bristle. Sterna with darkened, heavily sclerotized areas near ventral margins; one bristle per sternum.

Modified Abdominal Segments, Male (plate 61, figures 4, 5, 6, and 7).—Tergum 8 (8*T.*) with four stout bristles caudad of sensillium; caudal margin rounded. Sternum 8 (8*S.*) with broad, subacuminate process bearing 15–16 small bristles on ventral margin resembling comb. Distal arm of ninth sternum (*D.A.* 9) with pronounced lobe on caudoventral margin bearing one short, one long setae; apex shaped like head of bird with prominent cephalad-directed beak; small marginal seta proximad of throat; two longer setae on back of neck. Immovable process of clasper (*P.*) membranous; outline indistinct; apex reaches to approximately midpoint on movable process of clasper (*F.*). *F.* prominent; with five or six lateral bristles distad of *P.*; point of articulation with *P.* medial.

Aedeagus (pl. 60, fig. 3).—Aedeagal apodeme (*AE.A.*) long, slender; with upturned, acuminate apex; proximal spur (*P.S.*) prominent; apex angular. Accessory lateral lobe (*A.L.L.*) with prominent dorsal hump. Crescent sclerite (*C.S.*) small, rod-like. Median dorsal lobe (*M.D.L.*) a membranous flap with distal half doubled. Lateral lobes (*L.L.*) with caudal margin subtruncate. Crochet (*CR.*) very broad basally; apex slightly sinuous, acuminate.

Modified Abdominal Segments, Female (pl. 61, figs. 1–3).—Seventh sternum (7*S.*) with sloping, almost straight caudal margin; bearing six or seven lateroventral bristles. Eighth tergum (8*T.*) with two long, lateral bristles plus several marginals. Eighth sternum (8*S.*) indistinct, broadly rounded caudal margin. Dorsal anal lobe of proctiger with five or six bristles. Anal stylet about twice as long as wide; long apical bristle plus minute subapical bristle. Ventral anal lobe of proctiger with shallow sinus in caudal margin; with two long submarginal, four or five marginal bristles. Spermatheca swollen slightly on head-end, otherwise little distinction between head and tail; curved so that apex of tail almost touches head. Bursa copulatrix club-shaped; with slightly sinuous handle.

TYPE MATERIAL: Holotype male (host no. 7583) from *Tadarida yucatanica*, collected under roof tile on belfry of church at Pacora, about 25 miles northeast of Panama City (Panamá), elevation sea level, 21 June 1961, collected by C. M. Keenan and V. J. Tipton. Allotype female (host no. 7284), same locality and collectors, 20 June 1961. Paratypes: 2 males and 9 females, same host, locality, and collectors, 6 June 1961 (host no. 7231), 20 June 1961 (host nos. 7291, 7504, 7509), 21 June 1961 (host nos. 7563, 7566, 7589); 3 females, same locality and collectors, from *Molossus coibensis* (host nos. 7297, 7501), 20 June 1961; 11 males and 6 females, same locality and collectors, from bat guano (coll. no. 8824) 12 January 1962.

Holotype male and allotype female in the collection of the United States National Museum. Paratypes (1 pair each) deposited in the British Museum (Natural History); Chicago Natural History Museum; Gorgas Memorial Laboratory in Panama City; Environmental Health Branch, Corozal, Canal Zone; private collections of Robert Traub and the senior author.

Genus **Ptilopsylla** Jordan and Rothschild

Ptilopsylla Jordan and Rothschild, 1921, Ectoparasites, 1, (3), p. 158.

Type-species: *Ptilopsylla leptina* Jordan and Rothschild, 1921.

Ptilopsylla dunni Kohls. Plates 62, 63. Figure 34.

Ptilopsylla dunni Kohls, 1942, Jour. Parasit., 28, (5), pp. 361–362, 1 fig. Hopkins and Rothschild, 1956, Cat. Rothschild Coll. Fleas, 2: 207–208, figs. 301, 335, 357, 358, pls. 19A, 23A, 25A. Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, pls. 44–46.

MATERIAL EXAMINED: 83 males and 163 females from *Tadarida yucatanica*, 66 males and 129 females from *Molossus coibensis* and 2667 males and 5305 females from bat guano. Bats were collected in mist nets, or, like bat guano, were collected from under roof tile on the belfry of the church at Pacora about 25 miles northeast of Panama City (Panamá), elevation sea level, by C. M. Keenan, C. E. Yunker and V. J. Tipton in June and July of 1961 and January of 1962.

REMARKS: *P. dunni* is represented by a series of several thousand specimens. They conform quite well to the figures given by Johnson (1957) except for the crochet. We have a few specimens with crochets like those in Johnson's drawings but the majority of them are oriented so that the crochet resembles an inverted high-heeled boot or a raised thumb and pointing index finger with a membrane between (pl. 63, figs. 2, 3). In some of our male specimens, the length of *P* is greater than in specimens shown by Johnson, and the spicules on the base of the eighth sternum are shorter and more numerous. There is some variation in the shape of *F*, especially in the dorsocaudal margin. There is no apparent difference in specimens taken from hosts and reared specimens taken from bat guano.

P. dunni is extremely rare in collections and we had been unable to obtain it during two years of intensive collecting. There were no fleas on hundreds of specimens of *M. coibensis* collected in various localities throughout Panama. This may indicate that *T. yucatanica* is the true host and *M. coibensis* was infested only because of close association with *T. yucatanica*.

We can only speculate about the length of time the bat colony has inhabited the Pacora church where we obtained the hosts and guano. Bat guano was six inches deep in places when Bloedel (1955) observed the colony in 1953. Residents of the town claim that the church is very old. This is substantiated by a 1785 date inscribed on a silver incense burner which was made in Mexico especially for the church. However, it is reported that the church was rebuilt in 1941 or 1942.

The estimated 1000 specimens of *Tadarida yucatanica* observed by Bloedel were said to constitute the major portion of the bat population. There were also small colonies of *Myotis nigricans nigricans* and *Noctilio labialis minor*. Bloedel observed no immatures or pregnant females.

In June and July of 1961 when we made our collections, small numbers of *Molossops p. planirostris* and *Noctilio l. labialis* and several hundred *Tadarida yucatanica* were living under the tile on the roof of the belfry of

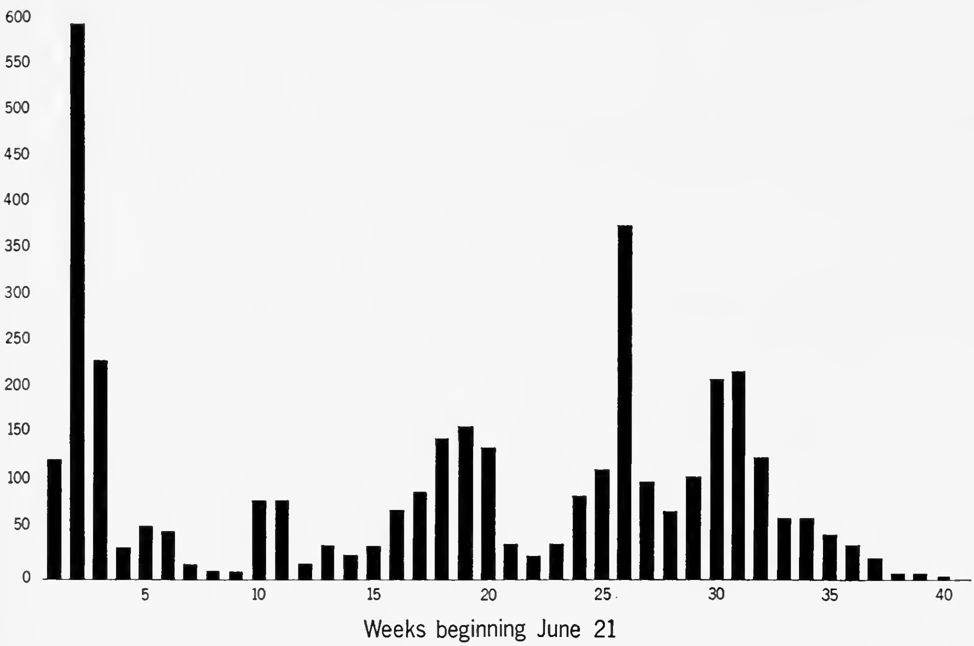

Fig. 34. Numbers of *Ptilopsylla dunni* which emerged from bat guano over a 40 week period (see text).

the church. Bloedel had observed the latter two species hanging from the floor joists in the attic. We observed many immature specimens of *T. yucatanica*. We also captured many specimens of *Molossus coibensis*, a few *Glossophaga soricina leachii*, and one *Phyllostomus hastatus panamensis* in a mist net near the church. We presume they came from the attic of the church where we had observed bats earlier.

Bat guano was abundant under the tile on the belfry of the church and we removed approximately 45 pounds during the June collecting trip and an additional 32 pounds on a subsequent trip in July. Guano was divided into three-pound lots and placed in paper bag containers. The tops of the bags were fastened with paper clips. As the adult fleas emerged they moved to the surface of the guano and jumped on the sides of the paper bags. The bags were examined daily or every other day and the fleas were removed with applicator sticks, the tips of which had been dipped in 70 percent alcohol. As the guano began to dry out, wet paper towels were added to each bag after the adult fleas had been removed.

At first, it appeared that this was a pure colony of *Ptilopsylla dunni* Kohls and during the first month over 3000 specimens were removed from the guano. Eventually three male specimens of *Rhynchopsyllus megastigmata* Traub and Gammons emerged. The latter species was somewhat smaller and moved more sluggishly, so perhaps other specimens were present but were not observed earlier in the collecting. By late April 1962, it appeared that the guano would produce no more specimens. Over the 9-month period, 3634 adult fleas had emerged continuously from the 45-pound batch of guano. This suggests that development is arrested by unfavorable conditions or that some mechanism insures survival of the species during times when the host species is absent from the roosting place. After a small amount of guano had been sterilized in an autoclave, 16 adult fleas of both sexes were introduced into this material. Although it was examined at frequent intervals during the subsequent two months, no adult fleas were recovered.

Additional bat guano was collected during the dry season (January 1962) and adult fleas (*P. dunni*) emerged at about the same rate as from the wet season material. This was also apparently true for *Hormopsylla kyriophila* and *R. megastigmata*.

Figure 34 shows the number of fleas (*P. dunni* only) removed from the bat guano collected in June. The erratic emergence rate may be due to humidity variations. Wet paper towels were not added to the paper bags until after the first month when the guano had begun to dry out.

Genus **Sternopsylla** Jordan and Rothschild

Sternopsylla Jordan and Rothschild, 1921, Ectoparasites, 1, (3), p. 158.
Type-species: *Ischnopsyllus texanus* C. Fox, 1914.

Sternopsylla distincta speciosa Johnson. Plates 64, 65.

Sternopsylla distincta speciosa Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 100, pls. 48 (figs. 3, 4), 50 (figs. 3, 8).

MATERIAL EXAMINED: 11 males and 12 females from *Myotis nigricans nigricans*, 1 male and 3 females from mixed collection of *M. nigricans nigricans* and *M. chiloensis*, 2 males and 1 female from *Tadarida brasiliensis*, 1 male and 1 female from *Tadarida yucatanica*, 313 males and 250 females from bat guano from cave where both species of *Myotis* and *T. brasiliensis* were roosting; all from Cerro Punta (Chiriquí) except specimens from *Tadarida yucatanica* from Rancho Mojica (Bocas del Toro); April, May and September 1961 and March 1962, collected by C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: Johnson (1957) indicates there is some variation in the shape of the crochet of *S. distincta distincta*. Some variation in this character is found in *S. distincta speciosa* too. Compared with her figures, the bases of the crochets of our specimens tend to be broader and to taper less abruptly. Our material agrees closely with her figures of the eighth and ninth sterna and the clasper. However, in the female, she shows the bursa copulatrix straight and lying in a vertical plane (*S. d. distincta*), whereas in our specimens only the apical portion lies in a vertical plane and there is an abrupt bend.

Species of the genus *Sternopsylla* are most frequently found on molossid bats and various species of *Myotis*. The cave from which our host bats were collected was inhabited by *Tadarida brasiliensis, Myotis nigricans nigricans* and *Myotis chiloensis*. We have not collected specimens of *S. d. speciosa* below 5000 feet elevation.

Family **Ceratophyllidae**

Genus **Ceratophyllus** Curtis

Ceratophyllus Curtis, 1832, British Ent., 9: pl. 417, text.
Type-species: *Ceratophyllus hirundinis* Curtis, 1832.

Ceratophyllus altus, new species. Plate 66.

DIAGNOSIS: *C. altus* is near *C. idius* Jordan and Rothschild but may be distinguished from that species as follows: the membranous apical flap of the eighth sternum has a narrow, saber-like, horizontal lobe without a fringe, while in *idius* this lobe is broad and fringed at the base; the vertical lobe of the apical flap of the eighth sternum is fringed in both species but the pseudosetae are more prominent in *altus* (pl. 66, fig. 7); the movable process of the clasper extends beyond the apex of the immovable process of the clasper for about one-half its length in *altus* but much less than one-fourth its length in *idius*.

DESCRIPTION, MALE: *Head* (pl. 66, fig. 1).—Frontoclypeal margin rounded; with moderately well developed frontal tubercle; presetal area pitted; with two rows of three bristles each. Eye ovate, well pigmented. Genal process subacuminate. Maxillary lobe extends to distal end of penultimate segment of maxillary palpus. Apical setae of second antennal segment about one-half length of club. Postantennal area with row of fine bristles on margin of antennal fossa; two long bristles; posterior row of five or six bristles interspersed with fine setae.

Thorax (pl. 66, fig. 2).—Pronotum with five or six long bristles interspersed with fine setae; pronotal comb of 28–29 spines. Mesonotum (*MSN.*) with three rows of bristles arranged 5-5-5. Mesepisternum (*MPS.*) with two small medial bristles plus one minute seta near caudal margin. Mesepimere (*MPM.*) with three long bristles. Metanotum (*MTN.*) with two rows of bristles arranged 5-3; intercalary setae between bases of bristles of second row. Lateral metanotal area (*L.M.*) with one long bristle. Metepisternum (*MTS.*) with single long bristle. Metepimere (*MTM.*) with three long bristles.

Legs.—Procoxa with 24–25 bristles on lateral surface. Meso-metacoxae with strongly sclerotized internal rods; several long bristles in distal angle. Profemur with two bristles on outer surface plus five or six bristles on inner surface. Meso-metafemora with single bristle on outer surface; four or six bristles on inner surface. Metatibia with about 13–15 medial bristles on outer surface. Length of metatarsal segments 270.4, 156, 104, 62.4, 124.8 μ. No tarsal bristles reach beyond apex of next segment. Fifth tarsal segment of all legs covered with microsetae.

Abdomen.—Apical spinelets on terga 1–4 paired; single on terga 5, 6. Terga with two rows bristles of about five bristles per row with intercalary microsetae between bases of second row. Basal sternum with submarginal bristles; sterna 3–7 with row of three stout bristles. Single antesensillial bristle between two minute bristles.

Modified Abdominal Segments (pl. 66, figs. 3–7).—Tergum 8 large, membranous flap, almost entirely covering genitalia; with four stout bristles on dorsal margin. Eighth sternum triangular basally; punctate; becoming long, moderately narrow apically, with three apical bristles; six marginal bristles; sword-like apical flap bearing caudally directed spiculose membranous process. Immovable process of clasper (*P.*) with broadly rounded apex bearing three short bristles; two long acetabular bristles midway on caudal margin between apex and base. Movable finger of clasper (*F.*) ham-like; broad medially, tapering somewhat to broadly rounded apex; extending for almost one-half its length beyond apex of *P.*; with one long apical bristle surrounded by three or four smaller bristles; three additional bristles on caudal margin. Proximal arm of ninth sternum curved caudad subapically. Distal arm of ninth sternum very narrow basally, abruptly swollen into proximal lobe bearing 17–18 marginal or submarginal bristles; narrower distal lobe resting on proximal lobe bears 12–15 marginal to submarginal bristles; apex rounded, with 15–18 small setae scattered on medial surface plus three or four larger marginal setae.

Aedeagus (pl. 66, fig. 4).—Aedeagal apodeme long, narrow; with long coiled apical appendage; neck short. Lateral lobe (*L.L.*) narrow, inapparent; median dorsal lobe (*M.D.L.*) bifid, open apically. Crochet (*CR.*) swollen ventrally; apex subacuminate, beak-shaped.

TYPE MATERIAL: Holotype male (host no. 7477) from *Glaucidium jardinii*, about five miles beyond Cerro Punta on the Boquete Trail (Chiriquí), elevation 7800 feet, 3 May 1961, collected by C. E. Yunker and C. M. Keenan. Deposited in the collection of the United States National Museum.

Genus **Dasypsyllus** Baker

Dasypsyllus Baker, 1905, Proc. U. S. Nat. Mus., 29: 129.

Type-species: *Ceratophyllus perpinnatus* Baker, 1904.

Dasypsyllus gallinulae perpinnatus (Baker). Plate 67.

Ceratopsyllus gallinulae Dale, 1878, Hist. Glanville's Woot., pp. 291, 292.
Ceratophyllus gallinulae, Rothschild, 1903, Ent. Month. Mag., (2), 14: 145, 146.
Dasypsyllus gallinulae, Wagner, 1927, Konowia, 7: 104, 106, figs. 2, 4B.
Ceratophyllus perpinnatus Baker, 1904, Proc. U. S. Nat. Mus., 27: 386, 391, 445, figs. 1–6.
Dasypsyllus perpinnatus, Baker, 1905, loc. cit., 29: 129, 146.
Ceratophyllus gallinulae perpinnatus, Jordan, 1926, Novit. Zool., 33: 386.
Dasypsyllus gallinulae perpinnatus, Wagner, 1930, Kat. Siphonap., p. 14.

MATERIAL EXAMINED: 2 males and 6 females from *Sciurus granatensis chiriquensis*, 5 males and 7 females from nest of *Zonotrichia capensis costaricensis*, 3 males and 7 females from nest of *Vireo leucophrys chiriquensis;* near Cerro Punta (Chiriquí), January and May 1960, April 1961 and March 1962, collected by C. L. Hayward, C. M. Keenan, V. J. Tipton, and C. E. Yunker.

REMARKS: We have examined many birds and bird nests for fleas but have found this species only at high elevations. It is probably much more common than our records would indicate since we have concentrated on mammal collecting in the Chiriquí mountains.

Dasypsyllus lasius venezuelensis (I. Fox and Anduze). Plates 68, 69.

Ceratophyllus lasius Rothschild, 1909, Novit. Zool., **16**: 63, fig. 10.
Dasypsyllus lasius, Jordan, 1933, Novit. Zool., **39**: 76.
Avesopsylla venezuelensis I. Fox and Anduze, 1947, Bol. Ent. Venez., **6**: 108, pl. 1, figs. 1–3.
Dasypsyllus lasius venezuelensis, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 117, pls. 53–55.

MATERIAL EXAMINED: 193 males and 242 females from nests of *Notiochelidon cyanoleuca*, 1 male and 5 females from nest of unknown host which contained both bird and rodent fleas and ticks, 1 female from *N. cyanoleuca;* near Cerro Punta (Chiriquí), March 1962, collected by C. L. Hayward and V. J. Tipton.

REMARKS: This species was very abundant in swallow nests, both in buildings as well as earth banks. In one hole in an earth bank the fleas were very numerous in the sand below the scanty nesting material.

Genus **Jellisonia** Traub

Jellisonia Traub, 1944, Field Mus. Nat. Hist., Zool. Ser., **29**: 211.
Type-species: *Jellisonia klotsi* Traub, 1944.

Jellisonia johnsonae Tipton and Mendez. Plates 70, 71.

Jellisonia johnsonae Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 259–262, pls. 3, 4.

MATERIAL EXAMINED: 14 males and 27 females from *Scotinomys teguina*, 4 males from *S. xerampelinus*, 6 males and 3 females from *Peromyscus nudipes nudipes*, 3 males and 10 females from *Reithrodontomys sumichrasti vulcanius*, 1 male from *R. creper*, 1 female from *R. mexicanus garichensis*, 1 female from *Bassaricyon gabbii gabbii*, and 5 males and 5 females from nest; near Cerro Punta (Chiriquí), January, February and May 1960, January and April 1961, March 1962, collected by C. O. Handley, C. M. Keenan, V. J. Tipton, and C. E. Yunker.

REMARKS: Specimens collected subsequent to the type material do not vary greatly from the original figures and description. Some two years after the type material was obtained, about 500 small animals were collected in the same general area but at a little higher elevation. There was a decided paucity of *J. johnsonae* on this group of hosts. There is much to be learned about host preferences and seasonal and altitudinal distribution of fleas in this area.

Jellisonia species

One female from *Reithrodontomys mexicanus*, Rancho Mojica (Bocas del Toro), collected by V. J. Tipton, 10 September 1961, may be *J. johnsonae* but the dorsal lobe of the female seventh sternum is more pronounced. Another female from *Oryzomys capito*, Cerro Hoya (Los Santos), collected by C. O. Handley, 12 February 1962, is quite distinct and undoubtedly represents an undescribed species. The dorsal lobe of the female seventh sternum is pronounced and the ventral margin is concave.

Genus **Pleochaetis Jordan**

Pleochaetis Jordan, 1933, Novit. Zool., 39: 77.
Type-species: *Ceratophyllus mundus* Jordan and Rothschild, 1922.

Pleochaetis altmani Tipton and Mendez. Plates 72, 73.

Pleochaetis altmani Tipton and Mendez, 1960, Ann. Ent. Soc. Amer., 54, (2), pp. 262–263, pls. 5, 6.

MATERIAL EXAMINED: A total of 58 males and 58 females as follows: 28 males and 29 females from *Reithrodontomys creper,* 2 males from *R. sumichrasti vulcanius,* 4 males and 1 female from *R. mexicanus garichensis,* 16 males and 12 females from *Scotinomys xerampelinus,* 5 males and 12 females from *Peromyscus nudipes nudipes,* 2 males and 2 females from *Oryzomys fulvescens vegetus,* 1 male and 2 females from *O. albigularis* near Cerro Punta (Chiriquí), collected by C. M. Keenan, V. J. Tipton, and C. E. Yunker, between January 1960 and March 1962.

REMARKS: In addition to the type material collected in 1960, an additional lot of 6 males and 7 females was collected in May of 1961 and a long series of 49 males and 50 females was collected in March of 1962. We have a relatively long series of specimens of this species and it is remarkable for its lack of variation. In some male specimens the dorsal margin of the crochet is straighter than in the type material and the dorsal and apical margins are slightly serrate. The outline of the female seventh sternum is quite constant.

Pleochaetis dolens dolens (Jordan and Rothschild). Plates 74, 75.

Ceratophyllus dolens Jordan and Rothschild, 1914, Novit. Zool., 21: 257, figs. 1, 2.
Pleochaetis dolens, Jordan, 1923, Novit. Zool., 29: 27.
Pleochaetis dolens dolens, Traub, 1950, Fieldiana, Zool. Mem., 1: 34–36, pls. 18, 19. Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 263–264.

MATERIAL EXAMINED: A total of 194 males and 285 females as follows: 104 males and 140 females from *Sciurus granatensis chiriquensis,* 47 males and 58 females from *Peromyscus nudipes nudipes,* 8 males and 6 females from *Reithrodontomys sumichrasti vulcanius,* 4 males and 8 females from *R. mexicanus garichensis,* 2 males and 4 females from *R. creper,* 4 males and 5 females from *Scotinomys xerampelinus,* 1 male and 3 females from *S. teguina,* 1 male and 6 females from *Oryzomys fulvescens vegetus,* 1 male and 3 females from *O. alfaroi alfaroi,* 3 females from *O. albigularis,* 3 females from *Nyctomys sumichrasti,* 1 male from *Mus musculus,* 1 male from *Heteromys desmarestianus,* 4 males and 8 females from *Didelphis marsupialis caucae,* 5 males and 9 females from *Bassaricyon gabbii gabbii,* 1 female from *Procyon lotor,* 1 female from *Nasua nasua,* 1 female from *Mustela frenata,* 11 males and 23 females from nests; all collected near Cerro Punta (Chiriquí) and Rancho Mojica (Bocas del Toro) by C. M. Keenan, V. J. Tipton, and C. E. Yunker, from January 1960 to March 1962.

REMARKS: This is a highly variable species but the aedeagal structures, especially the crochet, are rather constant. Fifty-one per cent of all the specimens of *P. dolens dolens* collected in Panama have been taken from *Sciurus* *granatensis chiriquensis* and 22 per cent have been collected from *Peromyscus nudipes nudipes*. The table below indicates the distribution of this flea on *Sciurus granatensis* according to elevation:

Elevation	*Specimens of Sciurus granatensis*	*Total P. dolens dolens*	*Number of P. dolens dolens per host*
Below 4000 ft.	63	0	0
4000–5000 ft.	2	0	0
5000–6000 ft.	10	18	2
Over 6000 ft.	48	227	5

There may be some seasonal variation in the number of fleas per host since there were eight specimens of *P. dolens dolens* per host collected during the latter part of April and early part of May at elevations in excess of 6000 feet.

Genus **Kohlsia** Traub

Kohlsia Traub, 1950, Fieldiana, Zool. Mem., 1: 45.

Type-species: *Kohlsia osgoodi* Traub, 1950.

Kohlsia azuerensis, new species. Plates 76, 77.

DIAGNOSIS: *K. azuerensis* n. sp. resembles *K. uniseta* Traub (1950) and *K. graphis graphis* (Rothschild). It is easily distinguished from *uniseta* in possessing two acetabular bristles. It may be separated from *graphis graphis* in that there is a single, long, apical bristle on the reduced male eighth sternum and the distal arm of the ninth sternum is broader and more setose. In addition, the caudal margin of the female seventh sternum has a deep sinus not present in the other two species.

DESCRIPTION: *Head, Male* (pl. 76, fig. 1).—Small frontal tubercle on broadly rounded anterior margin of head; micropunctate preantennal area with large ovate pores cephalad of 15–16 bristles. Eye subovate, not heavily pigmented. Ovate trabecula centralis. Apex of genal process subrounded. Maxillary lobe reaches slightly beyond distal end of second segment of five-segmented labial palpus. Maxillary palpus four-segmented. Postantennal area with about 11–13 bristles arranged in three rows.

Thorax (pl. 76, fig. 2).—Pronotal comb of about 18 spines caudad of row of five or six bristles. Mesonotum (*MSN.*) with row of three thin bristles, row of five or six slightly longer bristles, then row of three or four long bristles; about six microsetae on flange; two or three subapical pseudosetae. Mesepisternum (*MPS.*) with patch of four small, thin setae in cephalodorsal angle plus two or three bristles in caudoventral area. Mesepimere (*MPM.*) with five bristles; does not cover lateral metanotal area. Metanotum (*MTN.*) with six or seven bristles arranged in two irregular rows. Lateral metanotal area (*L.M.*) broader than long; with two long bristles. Metepisternum (*MTS.*) with single long bristle. Pleural arch well defined. Metepimere (*MTM.*) with six or seven long bristles.

Legs.—Coxae and femora not unusual. Metatibia with nine dorsomarginal notches bearing bristles arranged 2-2-1-2-2-1-1-2-3. Last segment of metatarsus with six pairs plantar bristles with sixth pair medially displaced.

Abdomen.—Terga 1–4 with apical spinelets; paired on terga 2–3; two rows of bristles on all terga ranging from three to five bristles per row. Bristles on sterna 2–7 arranged 1-3(4)-3-3(4)-3-3. Dorsal antesensillial bristle about three times longer than ventral bristle.

Modified Abdominal Segments, Male (pl. 77).—Tergum 8 indistinct but appears to cover most of genitalia. Sternum 8 with short, thin process bearing long apical bristle plus short, thin, subapical bristle. Distal arm of ninth sternum broad, with well sclerotized rod reaching almost to apex; ventral lobe bearing 11–12 marginal or submarginal bristles; patch of 11 medial bristles which becomes diagonal row of additional nine or ten bristles terminating in two subapical spiniform bristles; small apical bristle plus three more small bristles on dorsal margin; apex not produced caudad into lobe. Immovable process of clasper (*P.*) with slightly concave caudal margin bearing two long acetabular bristles near base. Movable process of clasper (*F.*) reaches apex of *P.;* caudal margin bears three heavy marginal bristles plus two or three small marginal bristles; several medial microsetae.

Aedeagus (pl. 77, fig. 1).—Aedeagal apodeme more than twice as long as aedeagus proper; prominent proximal spur (*P.S.*) arising near base of blade-like accessory lateral lobe (*A.L.L.*) Median dorsal lobe (*M.D.L.*) with smoothly rounded anterior margin; convoluted to form handle-like paradorsal lobe (*P.D.L.*); primary medial dorsal lobe (*P.M.D.*) with flared, hyaline apex. Lateral lobes (*L.L.*) well developed; ventral margin bulbous. Crochet (*CR.*) well developed but lightly sclerotized; triangular, with apex, dorsal and caudoventral margins tufted. Sclerotized inner tube (*S.I.T.*) rod-like, heavily sclerotized; with prominent, lateral, "seed-cluster" sclerite. Subacuminate, curved caudal process (*A.M.S.*) arising mesad of hooked anterior process of armature of inner tube (*A.I.T.*). Crescent sclerite (*C.S.*) prominent. Penis rods strongly recurved but not coiled.

Modified Abdominal Segments, Female (pl. 76, figs. 3–5).—Caudal margin of seventh sternum (7*S.*) with acuminate dorsal lobe followed by deep sinus; ventral lobe broadly rounded; with medial row of six bristles. Eighth tergum (8*T.*) with nine or ten long, three or four short medial bristles plus three or four marginals. Eighth sternum (8*S.*) not clearly defined. Anal stylet more than twice as long as broad. Head of spermatheca subglobular; tail more than twice as long as head; bent at right angle to head. Bursa copulatrix lying in diagonal plane with cephalad end inflated; bent slightly to lie in horizontal plane.

TYPE MATERIAL: Holotype male (host no. 9955) from *Peromyscus* species near *P. pirrensis,* about ten airline miles west of Las Palmitas (Los Santos), elevation 3000 feet, 20 February 1962, collected by C. O. Handley. Allotype female (host no. 9934) same data as above except 17 February 1962. Paratypes: 3 males and 2 females, same data as holotype; 1 female, same data as allotype; 2 females (host no. 9855), same data as holotype but 11 February 1962; 1 male and 1 female (host no. 9915), same data as holotype but 15 February 1962; 1 male (host no. 10040), same data as holotype but 26 February 1962. Holotype and allotype deposited in the United States National Museum; 1 pair of paratypes deposited with each of the following named institutions and individuals: British Museum (Natural History), Chicago Natural History Museum, Gorgas Memorial Laboratory, and private collections of Robert Traub and the senior author.

Kohlsia graphis graphis (Rothschild). Plate 78.

Ceratophyllus graphis Rothschild, 1909, Novit, Zool., **16**: 62, pl. 10, figs. 3, 4.
Kohlsia graphis graphis, Traub, 1950, Fieldiana, Zool. Mem., **1**: 50–51, pls. 29 (fig. 6), 30 (figs. 5–7). Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 272.

MATERIAL EXAMINED: 5 males and 11 females from *Sciurus granatensis chiriquensis,* near Cerro Punta (Chiriquí), collected by C. M. Keenan, V. J. Tipton, and C. E. Yunker from January 1960 to March 1962.

REMARKS: Our specimens differ slightly from Traub's (1950) figures. In our males the distal arm of the ninth sternum is more setose and the dorsal margin distad of the sharp angle is shorter. The proximal hump on the latero-ventral, curved lobe of the apodemal strut of the aedeagus is similar to that figured for *K. g. erana* Traub but the apex is like *K. g. graphis* (Rothschild). The caudal margin of the seventh sternum of the female has a nipple-like bump suggesting a dorsal lobe and the ventral portion of the margin is concave while Traub shows this margin to be straight. The spermatheca also has some slight differences such as the concavity in the ventral margin of the head.

Our failure to collect a longer series of this species is probably related to season and altitude. A total of 60 specimens of *Sciurus granatensis chiriquensis* was collected from localities that are above 5000 feet and fleas were removed from 47 of the specimens. All of the 60 specimens were collected during the dry season or the early part of the wet season and none were collected above 7000 feet elevation. The majority of our specimens of *K. g. graphis* were collected late in the dry season or early wet season. Nests from which squirrel ticks and *Pleochaetis d. dolens* were collected contained no specimens of *K. g. graphis.*

Kohlsia keenani Tipton and Mendez. Plates 79, 80.

Kohlsia keenani Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 265–269, pls. 7, 8.

MATERIAL EXAMINED: A total of 5 males and 13 females as follows: 2 males and 3 females from *Peromyscus nudipes nudipes,* 2 males and 4 females from *Oryzomys fulvescens vegetus,* 1 male and 1 female from *O. albigularis,* 2 females from *O. alfaroi alfaroi,* 2 females from *Scotinomys xerampelinus,* 1 female from *S. teguina,* all collected by C. M. Keenan, V. J. Tipton, and C. E. Yunker near Cerro Punta (Chiriquí), January 1960 to March 1962.

REMARKS: The majority of the specimens (three males and eight females) were collected during the first collecting trip in May, 1960. Although hundreds of small rodents were collected during subsequent trips in a much wider variety of ecological situations, only two additional males and five females were obtained. All specimens conform closely to figures given.

Kohlsia mojica, new species. Plates 81, 82.

DIAGNOSIS: *Kohlsia mojica* n. sp. is very close to *K. traubi* Tipton and Mendez in size, shape and setation of the processes of the clasper; in the general structure of the aedeagus; in the outline of the seventh sternum and shape of the spermatheca of the female. *K. mojica* differs from *traubi* in that the distal arm of ninth sternum of the male is bilobed, somewhat as in *keenani* Tipton and Mendez, while there is a single ventral lobe in *traubi;* the caudal process of eighth sternum of the male is much broader and while the crochet is roughly conical as in *traubi,* the top of the cone is rectangular and the bottom portion of the cone is contiguous with the proximal corner of the rectangle.

DESCRIPTION: *Head, Male* (pl. 81, fig. 1).—Anterior margin of head broadly rounded;

with small but distinct frontal tubercle; preantennal area micropunctate; three irregular rows of bristles arranged 8(9)-5-3 with intercalary setae; eye subovate; lightly pigmented. Genal process subrounded. Maxillary lobe reaches almost to midpoint of distal segment of four-segmented maxillary palpus. Labial palpus five-segmented; reaches to about two-thirds length of forecoxa. Postantennal area with three rows bristles arranged 3(4)-5(6)-5(6). Microsetae along margin of antennal fossa. Pedicel of antenna without long bristles. Trabecula centralis prominent, ovate.

Thorax (pl. 81, fig. 2).—Pronotum with row of five (six) bristles; intercalary setae between bases of bristles; about 20–21 spines in pronotal comb. Mesonotum (*MSN.*) with small scattered setae on anterior portion followed by medial, irregular row of six or seven bristles, then row of four stout bristles with intercalary setae; two pseudosetae on flange. Mesepisternum (*MPS.*) with two to four stout bristles plus one to three fine medial setae; anterodorsal area with three to four fine setae. Mesepimere (*MPM.*) with about eight stout bristles. Metanotum (*MTN.*) with three rows bristles arranged 2(3)-6(5)-4; first row incomplete, second row irregular, third row with intercalary setae. Lateral metanotal area (*L.M.*) broader than long; with two stout bristles. Metepisternum (*MTS.*) with one long stout bristle. Squamulum well developed. Pleural arch well defined. Metepimere (*MTM.*) with five to seven bristles.

Legs.—Procoxa with about 35–38 bristles exclusive of marginals. Outer surface of profemur with six to eight thin setae; mesal surface with single seta. Protibia with seven dorso-caudal notches bearing bristles arranged (base to apex) 1-2-2-2-1-2-3; plus five to six medial bristles. Fifth tarsal segment on all legs longest; fourth segment shortest; six pairs plantar bristles, basal and distal pairs displaced medially. Internal rods of meso- and metacoxae strongly sclerotized. Meso-, metatibiae with eight dorso-caudal notches bearing bristles arranged (base to apex) 1-2-1-2-2-1-2-3; with 10–13 medial bristles.

Abdomen.—Terga 1–4 with apical spinelets; sometimes paired on terga 1–3. Tergum 1 with three rows bristles arranged 2-6-5 with some variation; terga 2–7 with two rows of bristles usually arranged 6–7 but may vary from 3–7 in first row and 5–7 in second row. Basal sternum with one seta; sterna 3–7 each with one row of three bristles, occasionally four bristles per row. One long antesensillial bristle between two short bristles; ventral bristle less than one-third length of middle bristle and three times longer than dorsal bristle.

Modified Abdominal Segments, Male (pls. 81, figs. 3–5; 82, figs. 4, 5).—Tergum 8 indistinct but caudal margin lies in close proximity to caudal margin of immovable process of clasper; with two long and three shorter bristles in dorsocaudal area. Sternum 8 with well developed process; highly variable in shape, number and position of bristles; usually broad, with two to three apical bristles plus three to five medial bristles. Distal arm of ninth sternum with well sclerotized mesal rod running from base almost to apex; bilobed, with well rounded ventral lobe bearing three or four stout marginal bristles plus seven or eight small medial setae; apical lobe bearing three marginal spiniform bristles plus five or six medial setae; cephalodorsal margin broadly rounded, bearing single thin bristle. Immovable process (*P.*) of clasper reticulate; apex short, subrounded, bearing three small bristles; caudal margin almost straight, with two long acetabular bristles. Movable finger of clasper (*F.*) equal to *P.* in length; apex subacuminate; caudal margin evenly rounded, bearing small subapical bristle, three stout marginal bristles plus three short, thin, submarginal bristles.

Aedaegus (pl. 82, fig. 4).—Aedeagal apodeme about three times longer than aedeagus proper; proximal spur (*P.S.*) prominent, ribbon-like; accessory spur of aedeagus (*A.S.P.*) small, seta-like, arising from base of slightly sinuous, acuminate accessory lateral lobe (*A.L.L.*). Crescent sclerite (*C.S.*) distinct. Median dorsal lobe (*M.D.L.*) inflated apically to form blade-like primary median dorsal lobe (*P.M.D.*); primary paradorsal lobe (*P.D.L.*) buttonhook-like. Lateral lobe of aedeagus (*L.L.*) with truncate apex lying near primary median dorsal lobe; with angular caudal margin. Crochet (*CR.*) roughly cone shaped but with beak-like and nipple-like projections on distal margin. Penis rods strongly recurved but not coiled.

Modified Abdominal Segments, Female (pl. 82, figs. 1–3).—Caudal margin of seventh sternum (7*S*.) with conspicuous sinus; dorsal lobe short, subrounded; margin ventrad of sinus almost straight; with medial row of four or five bristles per side. Eighth tergum (8*T*.) with about six or seven small bristles cephalodorsad of spiracle; approximately six long plus five shorter medial bristles; four or five caudomarginal bristles. Eighth sternum (8*S*.) poorly defined. Ninth sternum (9*S*.) inapparent. Dorsal anal lobe of proctiger with nine or ten marginal bristles plus eight medial bristles. Anal stylet about twice as long as wide; long apical bristle less than twice length of ventral bristle; dorsomarginal and medial microsetae. Ventral anal lobe with eight or nine marginal and four medial bristles. Head of spermatheca subglobular; tail almost twice as long as head, bent at right angles to head. Bursa copulatrix sinuate, cephalad end dilated.

REMARKS: This species is named for the type locality, Rancho Mojica (Bocas del Toro), comprised of two thatched huts and a few coffee trees but offering a welcome respite from two days on a mountainous jungle trail.

TYPE MATERIAL: Holotype male (host no. 8129) and allotype female (host no. 8136) from *Peromyscus nudipes nudipes*, Rancho Mojica, about 30 miles west of Almirante near the Río Changena (Bocas del Toro), elevation 5500 feet, 13 September 1961, collected by V. J. Tipton. Paratypes: 17 males and 15 females all from (15) *Peromyscus nudipes nudipes* with same data as above except collected from 8 thru 13 September 1961. Holotype and allotype deposited in the United States National Museum; one pair of paratypes in each of: the British Museum (Natural History), Chicago Natural History Museum, Gorgas Memorial Laboratory, private collections of Robert Traub, and the senior author.

Kohlsia tiptoni Mendez and Altman. Plates 83, 84.

Kohlsia tiptoni Mendez and Altman, 1960, Proc. Ent. Soc. Wash., 62, (1), pp. 45–50, figs. 1–11.

MATERIAL EXAMINED: 1 female from *Sciurus granatensis chiriquensis*, 1 female from nest, near Cerro Punta (Chiriquí); May 1961 and March 1962, collected by C. L. Hayward, C. M. Keenan, V. J. Tipton, and C. E. Yunker

REMARKS: Very little information can be added to that given by Mendez and Altman (1960). We have collected only 2 female specimens since the type material was collected.

Kohlsia traubi Tipton and Mendez. Plates 85, 86.

Kohlsia traubi Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), pp. 269–272, pls. 9, 10.

MATERIAL EXAMINED: 180 males and 177 females from *Peromyscus nudipes nudipes*, 1 male and 1 female from *Oryzomys alfaroi alfaroi*, 1 female from *O. fulvescens vegetus*, 3 females from *Sciurus granatensis chiriquensis*, 1 male from *Reithrodontomys creper*, 1 male from *Heteromys desmarestianus*, 3 females from nests, 1 female from workbench used for preparation of animal skins; all collected by C. M. Keenan, V. J. Tipton, and C. E. Yunker near Cerro Punta (Chiriquí), January 1960 to March 1962.

REMARKS: There is some variation in this species, but the taxonomic characters of significance are fairly constant, i.e., the shape of the crochet, the median dorsal lobe, the distal arm of the ninth sternum and the claspers. The shape and setation of the caudal process of the eighth sternum varies considerably (pl. 85, figs. 5, a, b) as does the caudal margin of the female seventh sternum.

Of a total of 365 specimens collected, almost 98 per cent (357) were from *P. nudipes nudipes.* No specimens were collected below 5000 feet and they appeared to be evenly distributed from 5000 feet to 8000 feet.

KEY TO THE PANAMANIAN SPECIES OF *KOHLSIA* TRAUB

1. Movable finger of clasper with four stout bristles on caudal margin; legs with tibial combs..*K. tiptoni* Mendez and Altman
   Movable finger of clasper with three stout bristles on caudal margin; legs without tibial combs 2
2. Length of setae on proximal lobe of distal arm of ninth sternum greater than width of proximal lobe; female with combination of following characters: length of head of spermatheca not greater than one-half length of tail; seventh sternum with no deep sinus on caudal margin and not more than four bristles........... ....*K. traubi* Tipton and Mendez
   Length of setae on proximal lobe of distal arm of ninth sternum less than width of proximal lobe; female without above combination of characters.................3
3. Distal arm of ninth sternum bilobed; caudal process of eighth sternum with more than four bristles per side; female seventh sternum with fewer than five bristles per side 4
   Distal arm of ninth sternum not bilobed (apex not bent caudad to form apical lobe); caudal process of eighth sternum with fewer than four bristles per side; female seventh sternum with more than five bristles per side..........................5
4. Median dorsal lobe of aedeagus with beak-like process; distal arm of ninth sternum with only one or two bristles between proximal and apical lobes; caudal margin of female seventh sternum with dorsal lobe subtruncate..................... ....*K. keenani* Tipton and Mendez
   Median dorsal lobe of aedeagus smoothly rounded, without beak-like process; distal arm of ninth sternum with at least five or six bristles between proximal and apical lobes; caudal margin of female seventh sternum with dorsal lobe sub-acuminate ....*K. mojica* n. sp.
5. Caudal process of male eighth sternum with single apical bristle; distal arm of ninth sternum with more than 36 bristles; crochet with tufted caudal process; caudal margin of female seventh sternum with pronounced sinus..*K. azuerensis* n. sp.
   Caudal process of male eighth sternum with two or three apical or subapical bristles; distal arm of ninth sternum with fewer than 36 bristles; crochet with fang-like caudal process; caudal margin of female seventh sternum straight or only slightly concave.........................*K. graphis graphis* (Rothschild)

Comments on the Genus *Kohlsia* Traub

There are now 18 described species and subspecies of the genus *Kohlsia* Traub of which four species are known only from Panama. *K. graphis graphis* (Rothschild) is known from both Panama and Nicaragua and *K. tiptoni* Mendez and Altman is known from Panama and Costa Rica. There are some peculiarities in the geographical distribution of the Panama species. In the mountains of western Panama within a radius of ten miles there are three distinct species of *Kohlsia* which occur on the same host species, *Peromyscus nudipes nudipes.* In the same area *K. graphis graphis* occurs on squirrels. Just over 150 airline miles to the southeast another species, *K. mojica* n. sp., is associated with *Peromyscus flavidus*. *K. tiptoni* is represented in our collections by only a few specimens so we are unable to establish true host relationships for this species. In the mountains of eastern Panama there are other *Peromyscus, Sciurus* and *Microsciurus* species and undoubtedly additional undescribed species of *Kohlsia*. Such a rich fauna seems unusual for a relatively small geographical area, though Panama is remarkable in its great ecological variety.

Climatic factors probably influence the distribution of fleas to a much greater extent than that of the hosts. Of the three species of *Kohlsia* on *P. n. nudipes* in western Panama one (*mojica*) was collected on the humid Atlantic slope and the other two on the drier Pacific slope. One of the latter two species, *traubi*, was very abundant and the other species, *keenani*, quite rare (total of 18 specimens). It may be either a nest species or the true host is unknown.

We suggest another possibility to account for the distribution of *Kohlsia* species in Panama. It seems unlikely that this flea genus and its host genera have evolved concurrently. It may be that some of the true hosts no longer occur in this area and certain of the present hosts have been "adopted."

Family **Hystrichopsyllidae**
Subfamily Ctenophthalminae
Genus **Adoratopsylla** Ewing

Adoratopsylla Ewing, 1925, Jour. Parasit., 12: 44.
Type-species: *Adoratopsylla bisetosa* Ewing, 1925.

Adoratopsylla intermedia copha (Jordan). Plates 87, 88.

Stenopsylla intermedia copha Jordan, 1926, Novit. Zool., 33: 391, fig. 15.
Adoratopsylla intermedia copha, Ewing and Fox, 1943, Fleas N. Am., p. 82.
Tritopsylla intermedia copha, Costa Lima and Hathaway, 1946, Pulgas, p. 228. Jordan, 1950, Bull. Wld. Hlth. Org., 2: 605.
Adoratopsylla (*Tritopsylla*) *intermedia copha*, Johnson, 1957, Mem. Ent. Soc. Wash., no. 5, p. 33, pls. 15, 16 (of *A. intermedia* ssp.).

MATERIAL EXAMINED: 138 males and 185 females from *Didelphis marsupialis caucae*, 199 males and 190 females from *Metachirus nudicaudatus dentaneus*, 25 males and 16 females from *Philander opossum fuscogriseus*, 3 males and 3 females from *Marmosa robinsoni*, 1 female from *Oryzomys caliginosus* and 1 female from *Proechimys semispinosus panamensis;* El Valle, Cerro Azul, Cerro Campana, Cerro Hoya and Cerro Punta; July 1956 to February 1962, collected by R. M. Altman, C. O. Handley, C. M. Keenan, V. J. Tipton, and Gorgas Memorial Laboratory.

REMARKS: The host animals on which *A. intermedia* ssp. occurs are large and are capable of harboring large populations of fleas. As many as 152 specimens have been collected from a single host animal. The host genera, *Philander, Marmosa, Metachirus* and especially *Didelphis*, are both widespread and numerous in Central America. They occur from sea level to elevations in excess of 5000 feet. Because the hosts are ubiquitous, their geographical range is large, and they are capable of harboring large numbers of fleas, it follows that there must be a tremendous population of this species of flea in South and Central America. A wide range of variation is thus expected.

In a series of 60 males and 92 females collected from a single host animal, *Didelphis marsupialis caucae* from Cerro Punta (Chiriquí), elevation 5300 feet, there is some variation in the outline of the female seventh sternum and in the shape of the movable clasper of the male. However, all of these specimens plus 225 additional males and 224 females collected west of the Canal Zone are readily identified as *Adoratopsylla intermedia copha.* An additional lot of 77 males and 77 females collected at Cerro Azul and Cerro Jefe (east of the Canal Zone) are much more variable and may represent a distinct subspecific population. A detailed study is necessary to properly evaluate the intra-specific populations according to hosts and geographical distribution.

Subfamily Neopsyllinae

Genus **Strepsylla** Traub

Strepsylla Traub, 1950, Fieldiana, Zool. Mem., 1: 75.

Type-species: *Strepsylla mina* Traub, 1950.

Strepsylla dalmati Traub and Barrera. Plate 89.

Strepsylla dalmati Traub and Barrera, 1955, Fieldiana Zool., 37: 541–544, pls. 10 (figs. 1–3), 13 (fig. 1). Tipton and Mendez, 1961, Ann. Ent. Soc. Amer., 54, (2), p. 272.

MATERIAL EXAMINED: A total of 10 males and 20 females as follows: 5 males and 9 females from *Peromyscus nudipes nudipes,* 2 males and 3 females from *Reithrodontomys creper,* 1 male from *R. sumichrasti vulcanius,* 1 male and 3 females from *Scotinomys xerampelinus,* 1 male and 3 females from *Sciurus granatensis chiriquensis* and 1 female from *Oryzomys fulvescens vegetus;* near Cerro Punta and on the Boquete Trail (Chiriquí); January and May 1960, April and May 1961 and March 1962, collected by C. O. Handley, C. M. Keenan, V. J. Tipton and C. E. Yunker.

REMARKS: For the most part our male specimens are in agreement with figures and description given by Traub and Barrera (1955). Differences in the shape of the distal arm of the ninth sternum may be more apparent than real, since the shape of the membranous portion is easily distorted in mounting. The entire caudal margin of the eighth sternum is convex in our specimens whereas there is a slight concavity shown in the original figure. Both the eighth and ninth sterna as well as the movable process of the clasper are slightly more setose in our specimens than in *S. dalmati, s. str.*

We withstood the temptation to describe the female in an earlier publication (1961) because of the possibility of having two distinct species represented in our relatively short series. Now, with a much longer series, we are quite confident that our 20 female specimens represent the undescribed female of *S. dalmati.*

DESCRIPTION: *Modified Abdominal Segments, Female* (pl. 87, figs. 5–7).—Caudalmost portion of seventh sternum (*7S.*) strongly convex followed by shallow concavity; row of four or five long bristles preceded by seven to nine smaller bristles. Eighth tergum (*8T.*) with row of five bristles over spiracle; second row of five bristles cephaloventrad of first; four or five thin bristles caudad of antesensillial bristles. Angular margin of eighth tergum ventral to ventral anal lobe, with five stout bristles; medial area with seven stout laterad-directed bristles plus eight or nine smaller caudad-directed bristles. Eighth sternum (*8S.*) with subacuminate apex bearing three small dorsomarginal bristles, seven thin lateral bristles plus one long bristle on ventro-caudal angle. Anal stylet more than four times as long as wide; long apical bristle flanked by two minute subapical bristles. Ventral anal lobe angulate, strongly sclerotized; with six or seven strong marginal bristles plus two or three medial bristles. Spermatheca subovate; head almost twice as wide as tail; head deeply invaginated by dorsal margin of tail; tail strongly recurved back over head. Bursa copulatrix lying in horizontal plane for most of its length; slightly sinuate.

Subfamily Rhadinopsyllinae

Genus **Wenzella** Traub

Wenzella Traub, 1953, Jour. Wash. Acad. Sci., 43: 77.

Type-species: *Wenzella obscura* Traub, 1953.

Wenzella yunkeri, new species. Plates 90, 91.

DIAGNOSIS: *Wenzella yunkeri* n. sp. can be easily distinguished from the type-species, *Wenzella obscura* Traub. In the latter species, the movable process of the clasper is narrow and extends beyond the apex of the immovable process of the clasper for almost one-half of its length, while in *yunkeri* it is broad and only slightly longer than the immovable process. The eighth sternum of *yunkeri* does not have the broadly rounded caudal margin as does *obscura* and it is more setose and the bristles are longer. The distal arm of the ninth sternum in *obscura* is straight and finger-like and the apical bristles are short. In *yunkeri* the apex is inflated and there are several stout apical and subapical bristles. The proximal arm of the ninth sternum of *yunkeri* has a subglobular apex but is truncate though somewhat inflated in *obscura*. The details of the aedeagus differ greatly in the two species although the basic design is quite similar. The crochet of *obscura* is a broad, curved, finger-like process which is simple and unadorned. In *yunkeri* it is a rod-like sclerite with a dorsal membranous flap.

DESCRIPTION: *Head, Male* (pl. 90, fig. 1).—Anterior margin of head shallow convexity; preantennal area with 20–21 scattered, fine setae; ocular row of two bristles; anterior arm of tentorium prominent, angular. Eye absent. Maxillary lobe (*MX.*) subacuminate, reaches apex of second segment of four-segmented maxillary palpus (*M.P.*). Genal process projecting ventrad to midpoint on second segment of maxillary palpus. Labial palpus reaches to apex of third segment of maxillary palpus. About 15 fine setae on postantennal area plus patch of about 20 fine setae on dorsal margin and submarginal area of antennal fossa. Second segment of antenna with marginal row of seven or eight delicate setae. Club of antenna subovate; with setae on all but first segment. Tentorial bridge prominent; long, narrow, with laterad-turned apex.

Thorax (pl. 90, fig. 2).—Prontotum with two irregular rows of bristles arranged 6–8; bristles of second row longer than first. Mesonotum (*MSN.*) with irregular row of 10–11 small, thin bristles followed by second row of six long bristles with intercalary setae of same size as bristles of first row; phragma prominent, triangular; flange with two pseudosetae. Mesepisternum (*MPS.*) with single lateral bristle in caudoventral angle; three or four minute setae on cephalodorsal margin. Mesepimere (*MPM.*) with two bristles in cephaloventral corner; third vinculum conspicuous, vermiform. Metanotum (*MTN.*) with first row of nine setae followed by second row of six stouter, longer bristles with intercalary setae; phragma very conspicuous, beak-like. Metepisternum (*MTS.*) with single, long, caudomarginal bristle; internal furca prominent, slightly bent cephalad. Metepimere (*MTM.*) with two long bristles; fourth vinculum crescent-shaped.

Legs.—Forecoxae with scattered bristles which become progressively heavier from base to apex. Mesocoxae with complete diagonal break; prominent notch in caudoventral angle; four stout bristles plus four or five setae on distal one-fifth. Metacoxae with six stout bristles plus several marginal and submarginal setae. Femora with row of 7–12 delicate setae on ventral margin. Tibiae with six (occasionally one metatibia has seven) dorsocaudal notches with stout bristles arranged 1-2-2-2-3; approximately 10 fine setae mediad of notches. One apical bristle of third tarsal segment reaches to apex of fourth segment. Fifth tarsal segment with five pairs plantar bristles; last two pairs delicate; tarsal claws weak.

Abdomen.—Tergum 1 with two rows of bristles preceded by single bristle; first row of eight bristles; second row of about six stout bristles. Terga 2–7 with three rows of bristles; first row incomplete, with four or five thin bristles; second row with 11–12 bristles; third row of eight or nine stout bristles with intercalary setae; dorsal ends of second and third rows bent cephalad. Bases of antesensillial bristles ventrally displaced; bristles slender; in male middle bristle about four times length of dorsal bristle; almost twice length of ventral bristles; in female ventral bristle subequal in length to middle bristle; dorsal bristle about one-half length of middle bristle. Sterna 2–7 each with row of five or six stout bristles preceded by patch of several smaller bristles.

Modified Abdominal Segments, Male (pls. 90, figs. 3–5; 91, figs. 4, 5).—Tergum 8 with broadly rounded apex bearing three or four small marginal bristles ventrad of sensillium. Eighth sternum (*8S.*) a broad caudal process with subtruncate apex bearing 19–20 long marginal-submarginal bristles plus 16–17 shorter medial bristles. Immovable process of clasper (*P.*) with broadly rounded caudal margin; knob-like apex bearing three or four small subapical bristles; medial row of four long bristles plus six smaller bristles ventrad of these. Movable process of clasper (*F.*) only slightly longer than immovable process; with broadly rounded caudal margin; 20–22 small marginal-submarginal setae plus two or three medial setae. Manubrium long, very narrow. Proximal arm of ninth sternum with subglobular apex; distal arm of ninth sternum (*D.A.* 9) inflated subapically on ventral margin to form bulbous apex; three or four stout submarginal bristles plus four or five smaller marginal-submarginal bristles; proximo-caudal margin of arm with eight or nine weak setae.

Aedeagus (pl. 91, fig. 4).—Aedeagal apodeme almost four times as long as broad; long neck; no spur or apical appendage. Median dorsal lobe (*M.D.L.*) straight to slightly sinuate; terminating in flap-like apicomedian sclerite (*AMS*). Sclerotized inner tube (*S.I.T.*) not well defined; with beak-like armature (*A.I.T.*). Crochet (*CR.*) consisting of well sclerotized, rod-like process with slightly swollen apex and dorsal membranous flap. Lateral lobes (*L.L.*) extend to base of crochet; proximoventral margin broadly rounded; distoventral margin straight. Crescent sclerite (*C.S.*) well defined. Penis rods recurved but not coiled.

Modified Abdominal Segments, Female (pl. 91, figs. 1–3).—Seventh sternum (*7S.*) with single caudal lobe; row of eight stout bristles preceded by patch of about eight smaller and two larger bristles. Eighth tergum (*8T.*) with subacuminate caudal margin produced caudad almost to apex of ventral anal lobe; many stout bristles scattered over caudoventral area as well as several smaller bristles near spiracle. Dorsal anal lobe with dense dorsal row of marginal-submarginal bristles plus five or six long bristles on caudoventral angle below anal stylet. Anal stylet about three times as long as wide; with long apical bristle plus too short subapical bristles. Ventral anal lobe well sclerotized; with patches of long bristles on apex and caudoventral angle. Spermatheca subglobular; tail only slightly longer than head.

TYPE MATERIAL: Holotype male (host no. 10252) from *Heteromys desmarestianus,* Boquete Trail, about five miles beyond Cerro Punta (Chiriquí), elevation 6900 feet, 9 March 1962, collected by C. O. Handley and V.

J. Tipton. Allotype female (host no. 10417), same data as the holotype, but 7300 feet elevation, 12 March 1962. Paratypes: A total of 22 males and 21 females same data as the holotype, but from (14) *H. desmarestianus*, between 6800 and 7700 feet elevation and between 7 and 14 March 1962. In addition, 1 male and 1 female (host. no. 7411) same data as holotype, but 7800 feet, collected by C. M. Keenan and C. E. Yunker on 2 May 1961.

Holotype and allotype deposited in the U. S. National Museum; one pair of paratypes deposited with each of the following named institutions and individuals: British Museum (Natural History), Chicago Natural History Museum, Gorgas Memorial Laboratory, Robert Traub and the senior author.

REMARKS: *Wenzella yunkeri* is an extremely interesting species. Although its generic assignment is not in doubt it is certainly distinct from *W. obscura*. Both species were collected from *Heteromys desmarestianus* at high elevations. Heteromyid rodents are rather common in Central America and there are species in South America. However, this is the southernmost extension of the subfamily Rhadinopsyllinae.

This species is named for Dr. Conrad E. Yunker to whom we owe a debt of gratitude for his cooperation and assistance in collecting some of the material reported in this paper.

Family **Stephanocircidae**

Subfamily Craneopsyllinae

Genus **Plocopsylla** Jordan

Plocopsylla Jordan, 1931, Novit. Zool., 37: 138.

Type-species: *Craneopsylla achilles* Rothschild, 1911.

Plocopsylla scotinomi, new species. Plates 92, 93.

DIAGNOSIS: *P. scotinomi* n. sp. is a member of a species complex which includes *hector* Jordan, *heros* Jordan, *ulysses* Hopkins, *phobos* Jordan, *phyllisae* Smit, and *thor* Johnson. In common with these species, *scotinomi* lacks a spine on the genal process, like *hector* it has a tibial comb and in details of the male genitalia and setation it closely resembles *phobos, phyllisae* and *thor*. *P. scotinomi* may be easily distinguished from *phyllisae* in that the latter species has short stubby, genal spines. The shape and position of the two large spiniform bristles on the distal arm of the ninth sternum serve to separate the remaining three species. In *thor* these two bristles are separated by a distance not much greater than the width of the base of one of the bristles and the ventralmost bristle is enlarged apically so as to resemble a wedge. In *phobos* the distance between the two bristles is equal to or greater than the length of the distalmost of the two bristles and the proximal bristle is rod-shaped and only slightly enlarged apically. In our species the distance between the two bristles is at least twice as great as the length of the distalmost bristle. The proximal bristle is rod-shaped as in *phobos* but is three to four times as long as the distal bristle, not twice as long.

DESCRIPTION: *Head, Male* (pl. 92, fig. 1).—Anterior margin of helmet broadly rounded; pre-ctenidial area narrow, with horizontal striae. Helmet comb of 14 spines in both sexes. Genal comb of four long spines; apex of genal process truncate but caudodorsal angle acute, subacuminate. Two long bristles in preantennal area. Postantennal area with four irregular rows of bristles arranged 5-4-6-7, with some variation. Bristles of scape of antenna do not reach middle of club. Maxillary lobe broad, short, does not extend to midpoint of second segment of 6-segmented labial palpus. Maxillary palpus four-segmented.

Thorax (pl. 92, fig. 2).—Pronotum with two rows of bristles of five bristles each; comb of 14 spines; with broad caudoventral lobe. Mesonotum (*MSN.*) with row of four bristles followed by row of five bristles. Metepisternum (*MPS.*) devoid of bristles. Metepimere (*MPM.*) with four or five bristles. Metanotum (*MTN.*) with two rows of bristles. Lateral metanotal area (*L.M.*) broader than long; with two bristles. Metepisternum (*MTS.*) with one long bristle. Metepimere (*MTM.*) with six long bristles (four broken off in holotype).

Legs.—Procoxae with scattered bristles from base to apex. Meso-metacoxae devoid of bristles except for four or five stout bristles in subapical area. Distal half of all femora with four or five lateral bristles. Partial row of dorsocaudal bristles on fore and middle tibiae. Hind tibiae with seven dorsocaudal notches with bristles arranged 2-2-3-3-3-3-4; with six lateral bristles. None of bristles on tarsal segments reach to apex of next segment.

Abdomen.—First three terga with apical spinelets. All terga with first row of bristles reduced; one exceptionally long bristle on each of first three terga. Male with one antesensillial bristle which barely reaches spiracle. Two antesensillial bristles slightly longer than head of spermatheca.

Modified Abdominal Segments, Male (pls. 92, figs. 3–5; 93, figs. 1, 2).—Eighth tergum (*8T.*) short, caudal margin truncate. Eighth sternum (*8S.*) with short, narrow process devoid of setae. Finger-like distal arm of ninth sternum (*9S.*) with two modified setae about midway on caudal margin; proximal bristle approximately same diameter for its length, almost one-half length of distal arm of ninth sternum; distal bristle short, about one-quarter length of lower bristle; two bristles separated by distance equal to three-quarters length of longer bristle; two thin apical-subapical bristles. Immovable process of clasper (*P.*) very prominent, extends caudad of other elements of genitalia; with about 12 long marginal bristles; about four shorter marginal, six medial bristles. Internal sclerite five times longer than wide with sides roughly parallel. Movable process of clasper (*F.*) bent sharply dorsad so that distal half is at right angle to proximal half; bulbous subapically with apex acuminate; medial bristle proximad of swollen portion modified, spindle-shaped, bent, striated; three or four medial microsetae, one marginal seta on bulbous portion plus subapical seta.

Aedeagus (pl. 93, fig. 1).—Distolateral lobe (*D.L.L.*) with broad apex; internal sclerotized band reaching to apex. Crochet (*CR.*) poorly developed; short, narrow band enlarged slightly in middle. Lateral lobe (*L.L.*) long, narrow. Sclerotized inner tube (*S.I.T.*) short, curved caudad. Lateral sclerite (*L.S.I.*) spade-like.

Modified Abdominal Segments, Female (pl. 93, figs. 3–5).—Caudal margin of seventh sternum (*7S.*) undulating but with no pronounced lobes or sinuses; with two rows of bristles of four bristles each plus three bristles cephalodorsad of rows. Eighth tergum (*8T.*) with five bristles in first row, three bristles in second row plus two bristles not in rows. Eighth sternum (*8S.*) with ventral patch of 12–14 bristles plus two additional bristles dorsad of patch. Dorsal anal lobe of proctiger reduced; with three bristles plus short spiniform cephalad of anal stylet; two bristles dorsad of anal stylet. Ventral anal lobe of proctiger with two bristles. Anal stylet almost three times as long as broad; long subapical bristles plus two shorter apical bristles. Head of spermatheca oblong, twice as long as tail.

TYPE MATERIAL: Holotype male (host no. 7409) from *Scotinomys xerampelinus* on Boquete Trail, about five miles beyond Cerro Punta (Chiriquí), elevation 7800 feet, 2 May 1961, collected by C. M. Keenan and C. E. Yunker. Allotype female, same data as the holotype. Paratypes: 1 female (host no. 6832), same data but elevation 6800 feet, 7 January 1961; 5 males and 10 females, same data, but from 14 host animals from 6900 to 7800 feet elevation, 7 to 15 March 1962, collected by C. O. Handley and V. J. Tipton. Holotype and allotype deposited in the United States National Museum; 1 pair of paratypes each deposited in the collections of the following institutions and individuals: British Museum (Natural History), Chicago Natural History Museum, Gorgas Memorial Laboratory, Robert Traub, and the senior author.

REMARKS: This is the first record of a stephanocircid flea in Central America. However, it is not an unusual finding in view of the host relationships. Species of the genus *Scotinomys* apparently fill the same ecological niche in Central America as that occupied by species of the closely related genus *Akodon* in South America.

Host-Parasite Relationships

Although our data are insufficient to be conclusive, some broad patterns are apparent. In Panama the flea fauna is much richer at high elevations (above 5000 feet). Host specificity is rather loose, two or three host genera, or perhaps a family, harboring a single species of flea. The flea fauna of a host group at low elevations, when it exists, is distinct from that of the same host group at high elevations.

There are some 95 recorded species of bats in Panama representing 40 genera and seven families. Only two bat families contain species which have been found to harbor fleas even though hundreds of bats of each family have been collected. *Myotis nigricans*, *Tadarida yucatanica*, *T. brasiliensis* and *Molossus coibensis*, the only species on which fleas have been found consistently, all live in closely-knit colonies. The molossids generally live under roof tile, under eaves or in low-ceilinged caves only a few inches from their droppings, making it a comparatively simple matter for adult fleas to gain access to a host. Generally, these bat species appear to rather consistently utilize the same roosts year after year. Whether or not a bat species harbors fleas may be determined in large measure by its roosting habits.

From sea level to the highest elevations where they are found in Panama, marsupials are infested with fleas, but below 2500 feet they apparently have no distinctive flea fauna. Both *Adoratopsylla intermedia* and *Juxtapulex echidnophagoides* occur in large numbers on *Didelphis marsupialis etensis* at elevations in excess of 5000 feet, but it is likely that the latter flea species is more commonly associated with the common armadillo.

Of the seven species of edentates in Panama, only one, the common armadillo, is consistently parasitized with fleas. At low elevations *Rhopalopsyllus cacicus saevus* is numerous on this host as well as in burrows, while *J. echidnophagoides* was collected from all host specimens obtained above 5000 feet.

There is a rich and interesting flea fauna on cricetid rodents above 5000 feet elevation but virtually none on cricetid hosts collected at low elevations. This is also true of the squirrels. However, fleas are commonly found on one species of pocket mouse and some hystrichomorph rodents at low elevations. The number of fleas found on carnivores and larger animals, including domestic animals and man, has not been great although the cat flea is abundant on cats and dogs in most localities.

HOST-PARASITE LIST

By Elevation

For each host (bold face type) listed below, column 1 shows the total number of specimens found to be infested by fleas (numerator), followed by the total number examined for parasites (denominator). Columns 2, 3, and 4 show these totals divided according to elevations of collecting localities. Some hosts which were found to be negative for fleas are also included.

Parasite statistics (light face) indicate the numbers of males (m) and females (f) for each species of fleas taken from the respective host, according to elevation of collecting localities.

Hosts and Parasites	**Host Totals**	**From Elevations:** *below 2500 ft.*	*2500– 5000 ft.*	*over 5000 ft.*
Class Aves				
Order Strigiformes				
Family Strigidae				
Glaucidium jardinii	1/2	..	..	1/2
Ceratophyllus altus n. sp.		..	..	1m/
Order Passeriformes				
Family Ptilogonatidae				
Ptilogonys caudatus	1/1	..	..	1/1
Dasypsyllus gallinulae perpinnatus (Baker)		..	..	/1f
Family Hirundinidae				
Notiochelidon cyanoleuca	1/1	..	..	1/1
Dasypsyllus lasius venezuelensis (I. Fox and Anduze)		..	..	/1f
Class Mammalia				
Order Marsupialia				
Family Didelphidae				
Caluromys derbianus	0/11	0/10	0/1	..
Monodelphis adusta	0/1	0/1	..	..

Hosts and Parasites	Host Totals	From Elevations: below 2500 ft.	2500–5000 ft.	over 5000 ft.
Marmosa mexicana	0/2	0/2	..	..
Marmosa robinsoni	5/108	3/86	2/19	0/3
Adoratopsylla intermedia copha (Jordan)		/1f	3m/2f	..
Polygenis roberti beebei (I. Fox)		/1f	/2f	..
Polygenis klagesi (Rothschild)		2m/1f	..	..
Philander opossum	15/109	6/91	9/18	..
Adoratopsylla intermedia copha (Jordan)		2m/	33m/28f	..
Rhopalopsyllus australis tupinus J. and R.		/1f	..	..
Rhopalopsyllus cacicus saevus J. and R.		/5f	..	..
Polygenis roberti beebei (I. Fox)		1m/	/2f	..
Metachirus nudicaudatus	27/41	0/7	27/34	..
Adoratopsylla intermedia copha (Jordan)		..	199m/190f	..
Rhopalopsyllus cacicus saevus J. and R.		..	/1f	..
Polygenis roberti beebei (I. Fox)		..	1m/	..
Polygenis dunni (J. and R.)		..	/2f	..
Didelphis marsupialis	43/207	23/183	9/12	11/12
Adoratopsylla intermedia copha (Jordan)		..	30m/28f	108m/157f
Juxtapulex echidnophagoides Wagner		..	..	78m/138f
Hoplopsyllus glacialis exoticus J. and R.		..	..	5m/3f
Ctenocephalides felis felis (Bouché)		2m/2f	3m/2f	11m/27f
Pleochaetis dolens dolens (J. and R.)		..	..	4m/8f
Rhopalopsyllus lugubris lugubris (J. and R.)		7m/2f	/1f	
Rhopalopsyllus australis tupinus J. and R.		2m/5f	..	/1f
Rhopalopsyllus cacicus saevus J. and R.		5m/10f	1m/2f	..
Polygenis klagesi (Rothschild)		3m/7f	..	..
Polygenis roberti beebei (I. Fox)		/2f	3m/5f	..
Chironectes minimus	1/2	1/2	..	..
Rhopalopsyllus australis tupinus J. and R.		3m/3f	..	..

Order INSECTIVORA
Family Soricidae

Hosts and Parasites	Host Totals	below 2500 ft.	2500–5000 ft.	over 5000 ft.
Cryptotis nigrescens	0/4	..	..	0/4

Order CHIROPTERA
Family Vespertilionidae

Hosts and Parasites	Host Totals	below 2500 ft.	2500–5000 ft.	over 5000 ft.
Myotis albescens	0/1	0/1	..	..
Myotis chiloensis	0/1	..	..	0/1
Myotis nigricans	7/143	0/94	0/1	7/48
Sternopsylla distincta speciosa Johnson		..	..	11m/12f

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Mixed collection of Myotis chiloensis (78) and Myotis nigricans (30)	**3/108**	..	..	3/108
Sternopsylla distincta speciosa Johnson		..	..	1m/3f
Eptesicus chiriquinus	**0/1**	..	..	0/1
Eptesicus fuscus	**0/2**	..	0/2	..
Rhogeessa tumida	**0/14**	0/14	..	..
Lasiurus borealis	**0/1**	0/1	..	..
Lasiurus ega	**0/1**	0/1	..	..
Family Molossidae				
Molossops planirostris	**0/15**	0/15	..	..
Tadarida brasiliensis	**2/8**	0/1	..	2/7
Sternopsylla distincta speciosa Johnson		..	..	2m/1f
Tadarida yucatanica	**60/88**	58/86	..	2/2
Sternopsylla distincta speciosa Johnson		..	..	1m/1f
Ptilopsylla dunni Kohls		83m/163f	..	..
Hormopsylla kyriophila n. sp.		2m/9f	..	..
Rhynchopsyllus megastigmata Traub and Gammons		/1f	..	..
Bat guano (from roosting place of *Tadarida yucatanica*)	**3/3**	3/3	..	..
Ptilopsylla dunni Kohls		2667m/5305f	..	..
Rhynchopsyllus megastigmata Traub and Gammons		4m/3f	..	..
Hormopsylla kyriophila n. sp.		11m/5f	..	..
Molossus bondae	**0/32**	0/32	..	..
Molossus coibensis	**25/222**	25/222	..	..
Ptilopsylla dunni Kohls		66m/129f	..	..
Hormopsylla kyriophila n. sp.		/3f	..	..
Molossus sinaloae	**0/13**	0/13	..	..
Promops centralis	**0/11**	0/11	..	..
Eumops auripendulus	**0/4**	0/4	..	..
Eumops bonariensis	**0/1**	0/1	..	..
Bat guano (from roosting place of *Myotis nigricans, M. chiloensis,* and *Tadarida brasiliensis*)	**1/1**	..	..	1/1
Sternopsylla distincta speciosa Johnson		..	..	313m/250f

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Order PRIMATES Family Hominidae				
Homo sapiens	14/25	11/18	..	3/7
Ctenocephalides felis felis (Bouché)		9m/6f	..	/1f
Pulex simulans Baker		30m/51f	..	..
Rhopalopsyllus lugubris lugubris J. and R.		/1f	..	..
Rhopalopsyllus lugubris cryptoctenes (Enderlein)		..	..	1m/1f
Rhopalopsyllus australis tupinus J. and R.		/4f	..	..
Juxtapulex echidnophagoides Wagner		..	..	/1f
Order EDENTATA Family Myrmecophagidae				
Tamandua tetradactyla	2/7	1/5	1/2	..
Rhopalopsyllus australis tupinus J. and R.		/1f	2m/1f	..
Cyclopes didactylus	0/3	0/3	..	..
Bradypus infuscatus	0/9	0/8	0/1	..
Choloepus hoffmanni	0/5	0/5	..	..
Cabassous centralis	0/2	0/2	..	..
Dasypus novemcinctus	18/20	11/13	..	7/7
Juxtapulex echidnophagoides Wagner		..	..	273m/326f
Rhopalopsyllus cacicus saevus J. and R.		77m/104f	..	..
Order LAGOMORPHA Family Leporidae				
Sylvilagus brasiliensis	7/14	3/9	0/1	4/4
Ctenocephalides felis felis (Bouché)		/1f	..	..
Hoplopsyllus glacialis exoticus J. and R.		..	..	24m/47f
Rhopalopsyllus australis tupinus J. and R.		1m/2f	..	..
Order RODENTIA Family Sciuridae				
Sciurus granatensis	46/129	0/63	3/10	43/56
Pleochaetis dolens dolens (J. and R.)		..	..	104m/141f
Kohlsia graphis graphis (Rothschild)		..	..	5m/11f
Kohlsia tiptoni Mendez and Altman		..	..	/1f
Kohlsia traubi Tipton and Mendez		..	..	/3f
Dasypsyllus gallinulae perpinnatus (Baker)		..	..	2m/6f
Strepsylla dalmati Traub and Barrera		..	..	1m/2f

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Sciurus granatensis (cont.)				
Polygenis dunni (J. and R.)		..	/1f	..
Polygenis roberti beebei (I. Fox)		..	/1f	..
Rhopalopsyllus australis tupinus J. and R.		..	1m/	..
Rhopalopsyllus sp.		..	..	/1f
Juxtapulex echidnophagoides Wagner		..	..	1m/
Sciurus variegatoides	0/6	0/5	0/1	..
Microsciurus alfari	0/3	..	0/3	..
Family Geomyidae				
Macrogeomys cavator	0/5	..	..	0/5
Family Heteromyidae				
Liomys adspersus	11/62	11/61	0/1	..
Polygenis dunni (J. and R.)		19m/19f	..	..
Polygenis klagesi (Rothschild)		/2f	..	..
Ctenocephalides felis felis (Bouché)		1m/	..	..
Heteromys australis	1/21	1/11	0/9	0/1
Polygenis klagesi (Rothschild)		/1f	..	..
Heteromys desmarestianus	18/80	0/4	1/42	17/34
Pleochaetis dolens dolens (J. and R.)		..	..	1m/
Wenzella yunkeri n. sp.		..	..	25m/34f
Polygenis roberti beebei (I. Fox)		..	/1f	..
Kohlsia traubi Tipton and Mendez		..	..	1m/
Family Cricetidae				
Oryzomys albigularis	7/25	..	..	7/25
Pleochaetis altmani Tipton and Mendez		..	..	1m/2f
Pleochaetis dolens dolens (J. and R.)		..	..	/3f
Kohlsia keenani Tipton and Mendez		..	..	1m/1f
Polygenis atopus (J. and R.)		..	..	1m/
Oryzomys alfaroi	7/26	..	3/5	4/21
Kohlsia keenani Tipton and Mendez		..	..	/2f
Kohlsia traubi Tipton and Mendez		..	..	1m/1f
Pleochaetis dolens dolens (J. and R.)		..	..	1m/3f
Polygenis roberti beebei (I. Fox)		..	3m/4f	..
Oryzomys bombycinus	3/7	..	3/7	..
Polygenis roberti beebei (I. Fox)		..	5m/5f	..
Polygenis klagesi (Rothschild)		..	/2f	..

Hosts and Parasites	Host Totals	From Elevations: below 2500 ft.	2500–5000 ft.	over 5000 ft.
Oryzomys caliginosus	**19/94**	**1/24**	**18/70**	..
Polygenis roberti beebei (I. Fox)		1m/1f	13m/28f	..
Adoratopsylla intermedia copha (Jordan)		/1f	1m/1f	..
Ctenocephalides felis felis (Bouché)		..	/1f	..
Rhopalopsyllus lugubris lugubris J. and R.		..	1m/	..
Oryzomys capito	**21/100**	**4/57**	**17/43**	..
Polygenis roberti beebei (I. Fox)		/1f	26m/22f	..
Polygenis klagesi (Rothschild)		1m/1f	1m/1f	..
Polygenis dunni (J. and R.)		/1f	..	..
Jellisonia sp.		..	/1f	..
Oryzomys fulvescens	**12/44**	**0/2**	**0/1**	**12/41**
Pleochaetis dolens dolens (J. and R.)		..	..	1m/6f
Strepsylla dalmati Traub and Barrera		..	..	/1f
Kohlsia keenani Tipton and Mendez		..	..	2m/4f
Kohlsia traubi Tipton and Mendez		..	..	/2f
Pleochaetis altmani Tipton and Mendez		..	..	2m/2f
Nectomys alfari	**2/3**	..	**2/3**	..
Polygenis roberti beebei (I. Fox)		..	2m/4f	..
Tylomys panamensis	**5/9**	**3/7**	**2/2**	..
Polygenis klagesi (Rothschild)		11m/16f	2m/2f	..
Nyctomys sumichrasti	**1/4**	..	**0/2**	**1/2**
Pleochaetis dolens dolens (J. and R.)		..	..	/3f
Reithrodontomys creper	**36/67**	..	..	**36/67**
Jellisonia johnsonae Tipton and Mendez		..	..	1m/
Strepsylla dalmati Traub and Barrera		..	..	2m/3f
Pleochaetis altmani Tipton and Mendez		..	..	28m/29f
Pleochaetis dolens dolens (J. and R.)		..	..	2m/4f
Juxtapulex echidnophagoides Wagner		..	..	1m/
Kohlsia traubi Tipton and Mendez		..	..	1m/
Reithrodontomys mexicanus	**9/40**	..	..	**9/40**
Pleochaetis altmani Tipton and Mendez		..	..	4m/1f
Pleochaetis dolens dolens (J. and R.)		..	..	4m/8f
Jellisonia johnsonae Tipton and Mendez		..	..	/2f
Strepsylla dalmati Traub and Barrera		..	..	1m/1f
Reithrodontomys sumichrasti	**18/67**	..	..	**18/67**
Jellisonia johnsonae Tipton and Mendez		..	..	3m/10f
Pleochaetis dolens dolens (J. and R.)		..	..	8m/6f
Pleochaetis altmani Tipton and Mendez		..	..	2m/
Strepsylla dalmati Traub and Barrera		..	..	1m/
Peromyscus flavidus	**4/7**	..	**4/6**	**0/1**
Kohlsia azuerensis n. sp.		..	6m/7f	..

Hosts and Parasites	Host Totals	From Elevations: below 2500 ft.	2500–5000 ft.	over 5000 ft.
Peromyscus nudipes	**182/322**	..	**1/1**	**181/ 321**
Kohlsia traubi Tipton and Mendez		..	..	180m/177f
Kohlsia keenani Tipton and Mendez		..	..	2m/3f
Kohlsia mojica n. sp.		..	..	18m/16f
Pleochaetis dolens dolens (J. and R.)		..	..	47m/58f
Pleochaetis altmani Tipton and Mendez		..	..	5m/12f
Jellisonia johnsonae Tipton and Mendez		..	..	6m/3f
Strepsylla dalmati Traub and Barrera		..	..	5m/9f
Polygenis atopus (J. and R.)		..	..	2m/3f
Polygenis roberti beebei (I. Fox)		..	/1f	..
Ctenocephalides felis felis (Bouché)		..	1m/	..
Zygodontomys microtinus	**9/74**	**5/61**	**4/13**	..
Polygenis klagesi (Rothschild)		1m/5f	2m/3f	..
Polygenis roberti beebei (I. Fox)		..	1m/2f	..
Polygenis dunni (J. and R.)		1m/1f	..	..
Rhopalopsyllus australis tupinus J. and R.		1m/1f	..	..
Rhopalopsyllus lugubris lugubris J. and R.		/1f	..	..
Scotinomys teguina	**16/38**	..	..	**16/38**
Jellisonia johnsonae Tipton and Mendez		..	..	14m/27f
Kohlsia keenani Tipton and Mendez		..	..	/1f
Pleochaetis dolens dolens (J. and R.)		..	..	1m/3f
Plocopsylla scotinomi n. sp.		..	..	/1f
Scotinomys xerampelinus	**37/83**	..	..	**37/83**
Jellisonia johnsonae Tipton and Mendez		..	..	4m/
Kohlsia keenani Tipton and Mendez		..	..	/2f
Pleochaetis altmani Tipton and Mendez		..	..	16m/12f
Pleochaetis dolens dolens (J. and R.)		..	..	4m/5f
Plocopsylla scotinomi n. sp.		..	..	6m/11f
Strepsylla dalmati Traub and Barrera		..	..	1m/4f
Sigmodon hispidus	**2/153**	**2/152**	**0/1**	..
Polygenis dunni (J. and R.)		1m/	..	..
Polygenis klagesi (Rothschild)		/1f	..	..

Family Muridae

Hosts and Parasites	Host Totals	below 2500 ft.	2500–5000 ft.	over 5000 ft.
Rattus norvegicus	**1/12**	**1/12**	..	..
Pulex simulans Baker		1m/4f	..	..
Rattus rattus	**3/110**	**2/97**	**1/13**	..
Xenopsylla cheopis Rothschild		2m/4f	1m/1f	..
Mus musculus Linnaeus	**1/17**	..	..	**1/17**
Pleochaetis dolens dolens (J. and R.)		..	..	1m/

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Family Erethizontidae				
Coendou mexicanus	4/5	..	..	4/5
Polygenis klagesi (Rothschild)		..	..	8m/25f
Ctenocephalides felis felis (Bouché)		..	..	/1f
Juxtapulex echidnophagoides Wagner		..	..	1m/
Coendou rothschildi	0/4	0/4	..	..
Family Hydrochaeridae				
Hydrochaeris hydrochaeris	0/2	..	0/2	..
Family Dasyproctidae				
Agouti paca	10/13	3/4	4/6	3/3
Rhopalopsyllus lugubris lugubris J. and R.		11m/14f	4m/2f	..
Rhopalopsyllus lugubris cryptoctenes (Enderlein)		..	..	51m/64f
Rhopalopsyllus cacicus saevus J. and R.		1m/	..	..
Rhopalopsyllus australis tupinus J. and R.		..	7m/8f	/3f
Dasyprocta punctata	23/35	18/26	5/9	..
Rhopalopsyllus australis tupinus J. and R.		64m/91f	32m/39f	..
Rhopalopsyllus cacicus saevus J. and R.		/2f	..	..
Rhopalopsyllus lugubris lugubris J. and R.		2m/3f	/1f	..
Polygenis klagesi (Rothschild)		1m/3f	..	..
Family Echimyidae				
Proechimys semispinosus	314/616	294/595	20/21	..
Polygenis klagesi (Rothschild)		815m/1153f	151m/194f	..
Polygenis dunni (J. and R.)		2m/1f	..	..
Polygenis roberti beebei (I. Fox)		..	2m/2f	..
Adoratopsylla intermedia copha (Jordan)		..	/1f	..
Rhopalopsyllus lugubris lugubris J. and R.		/1f	..	..
Rhopalopsyllus australis tupinus J. and R.		3m/11f	..	..
Rhopalopsyllus cacicus saevus J. and R.		1m/3f	..	..
Hoplomys gymnurus	5/9	2/3	3/6	..
Polygenis klagesi (Rothschild)		5m/11f	25m/40f	..
Diplomys labilis	0/3	0/3	..	..
Order CARNIVORA				
Family Procyonidae				
Procyon cancrivorus	0/2	0/2	..	..

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Procyon lotor	**1/1**	..	..	**1/1**
Pleochaetis dolens dolens (J. and R.)		..	..	/1f
Nasua nasua	**14/27**	**10/23**	**1/1**	**3/3**
Pleochaetis dolens dolens (J. and R.)		..	..	/1f
Rhopalopsyllus lugubris cryptoctenes (Enderlein)		..	..	4m/4f
Rhopalopsyllus australis tupinus J. and R.		24m/31f	/2f	/1f
Rhopalopsyllus cacicus saevus J. and R.		1m/1f	..	..
Polygenis klagesi (Rothschild)		19m/24f	..	..
Dasypsyllus gallinulae perpinnatus (Baker)		..	..	1m/
Ctenocephalides felis felis (Bouché)		5m/9f	..	/1f
Hoplopsyllus glacialis exoticus J. and R.		..	..	/2m
Potos flavus	**0/5**	**0/2**	..	**0/3**
Bassaricyon gabbii	**2/3**	**0/1**	..	**2/2**
Pleochaetis dolens dolens (J. and R.)		..	..	5m/9f
Jellisonia johnsonae Tipton and Mendez		..	..	/1f

Family Mustelidae

Mustela frenata	**1/1**	..	..	**1/1**
Pleochaetis dolens dolens (J. and R.)		..	..	/1f
Eira barbara	**2/3**	**1/1**	**1/2**	..
Rhopalopsyllus australis tupinus J. and R.		..	/1f	..
Ctenocephalides felis felis (Bouché)		4m/5f	..	..
Galictis allamandi	**1/1**	**1/1**	..	..
Rhopalopsyllus australis tupinus J. and R.		/1f	..	..
Conepatus semistriatus	**1/1**	..	..	**1/1**
Ctenocephalides felis felis (Bouché)		..	..	2m/5f
Pulex irritans Linnaeus		..	..	/2f
Lutra annectens	**0/1**	..	..	**0/1**

Family Canidae

Canis familiaris	**23/30**	**19/23**	..	**4/7**
Ctenocephalides felis felis (Bouché)		161m/412f	..	2m/9f
Juxtapulex echidnophagoides Wagner		..	..	1m/1f
Rhopalopsyllus australis tupinus J. and R.		..	..	/1f

Family Felidae

Felis cattus	**6/6**	**5/5**	**1/1**	..
Ctenocephalides felis felis (Bouché)		135m/197f	3m/9f	..

Hosts and Parasites	Host Totals	From Elevations: *below 2500 ft.*	*2500–5000 ft.*	*over 5000 ft.*
Felis onca	1/3	0/1	1/2	..
Juxtapulex echidnophagoides Wagner		..	19m/19f	..
Ctenocephalides felis felis (Bouché)		..	/1f	..
Felis pardalis	0/1	0/1	..	..
Felis yagouaroundi	0/1	..	0/1	..
Order PERISSODACTYLA Family Tapiridae				
Tapirella bairdii	0/1	..	0/1	..
Order ARTIODACTYLA Family Tayassuidae				
Tayassu pecari	0/5	..	..	0/5
Tayassu tajacu	1/1	1/1	..	..
Rhopalopsyllus australis tupinus J. and R.				
Family Suidae				
Sus scrofa	4/4	2/2	2/2	..
Tunga penetrans (Linnaeus)		17m/4f	14m/5f	..
Family Cervidae				
Odocoileus virginianus	0/4	0/2	0/2	..
NESTS				
Rodent nests	2/8	..	..	2/8
Jellisonia johnsonae Tipton and Mendez		..	..	5m/5f
Pleochaetis dolens dolens (J. and R.)		..	..	8m/16f
Bird nests	3/4	..	..	3/4
Dasypsyllus gallinulae perpinnatus (Baker)		..	..	5m/9f
Dasypsyllus lasius venezuelensis (I. Fox and Anduze)		..	..	194m/247f
Animal burrows (probably Armadillo)	16/20	16/20	..	..
Rhopalopsyllus cacicus saevus J. and R.		105m/159f	..	..

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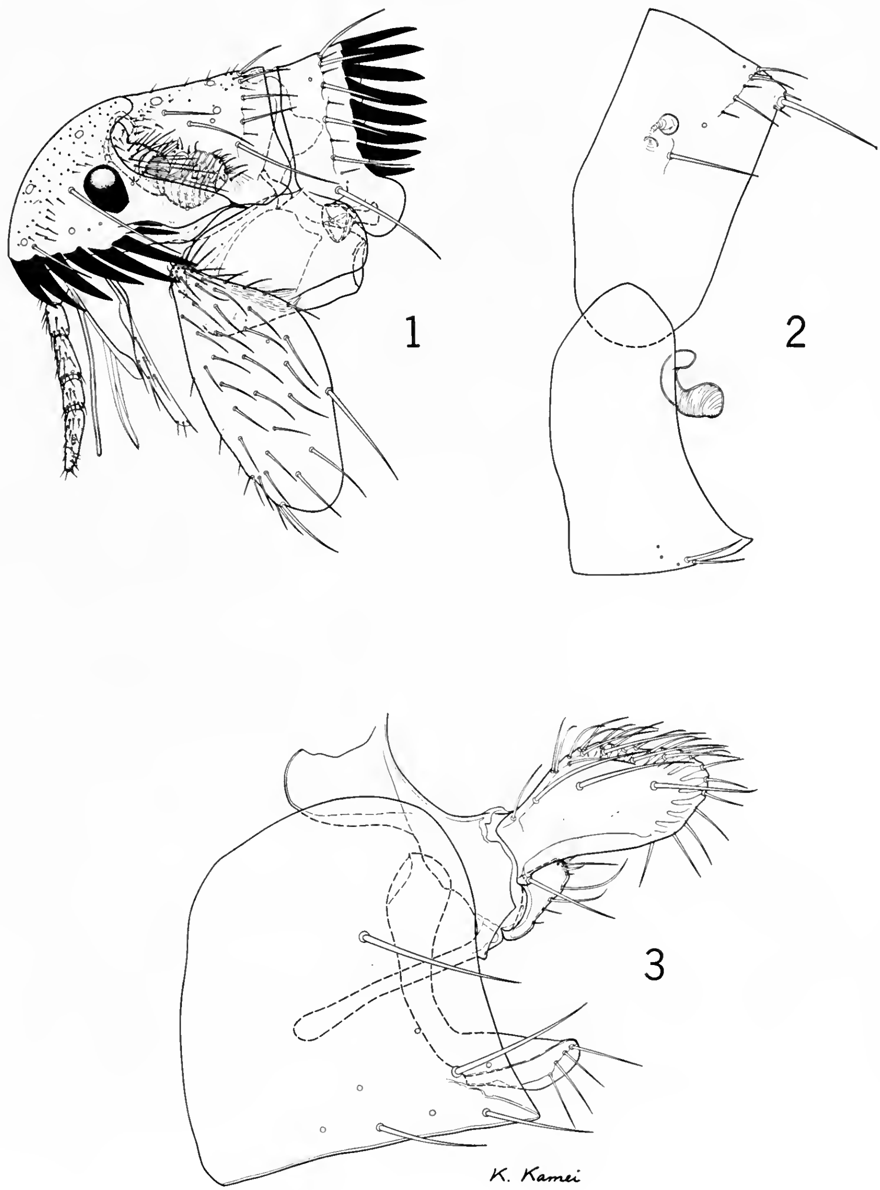
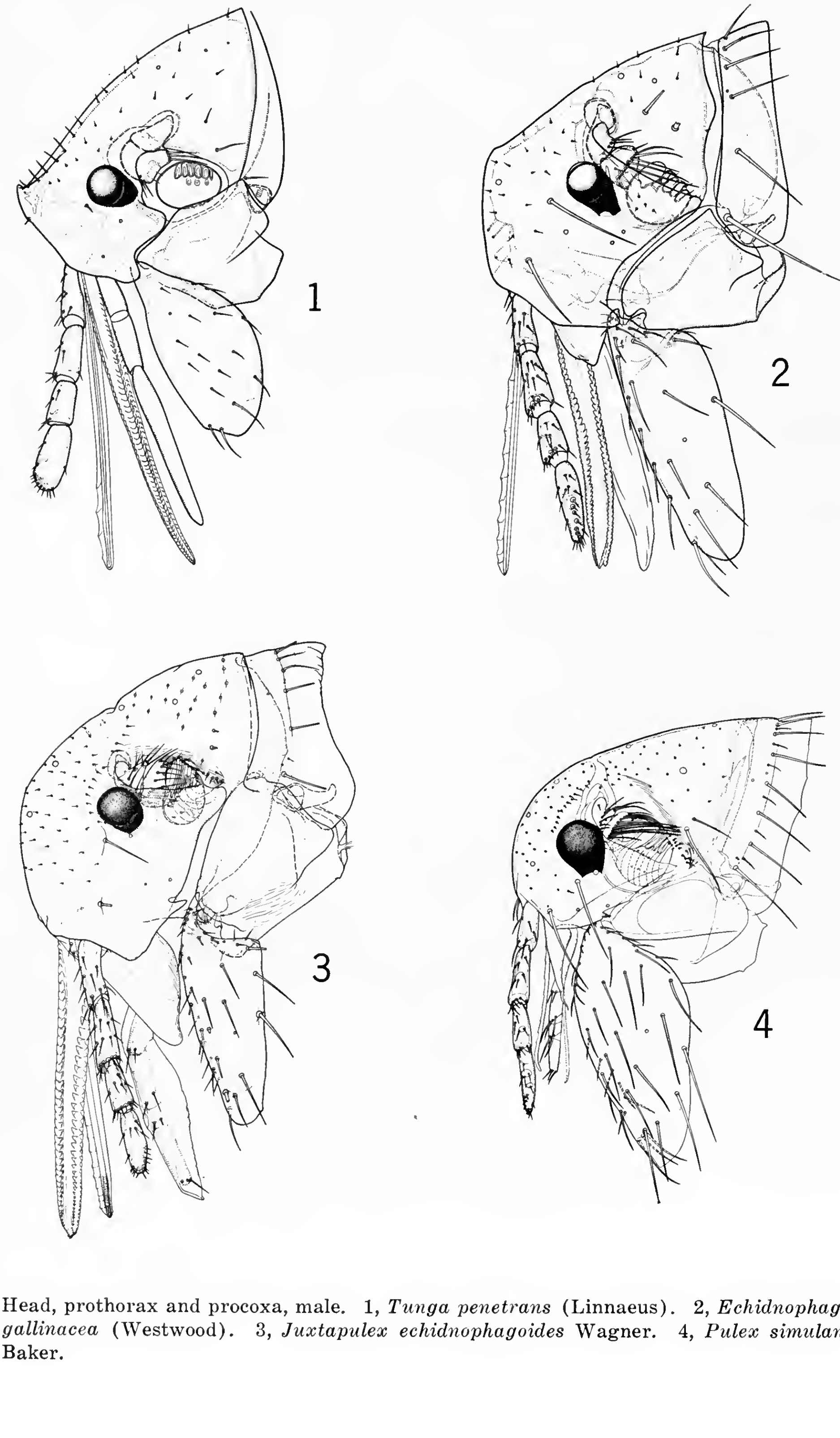
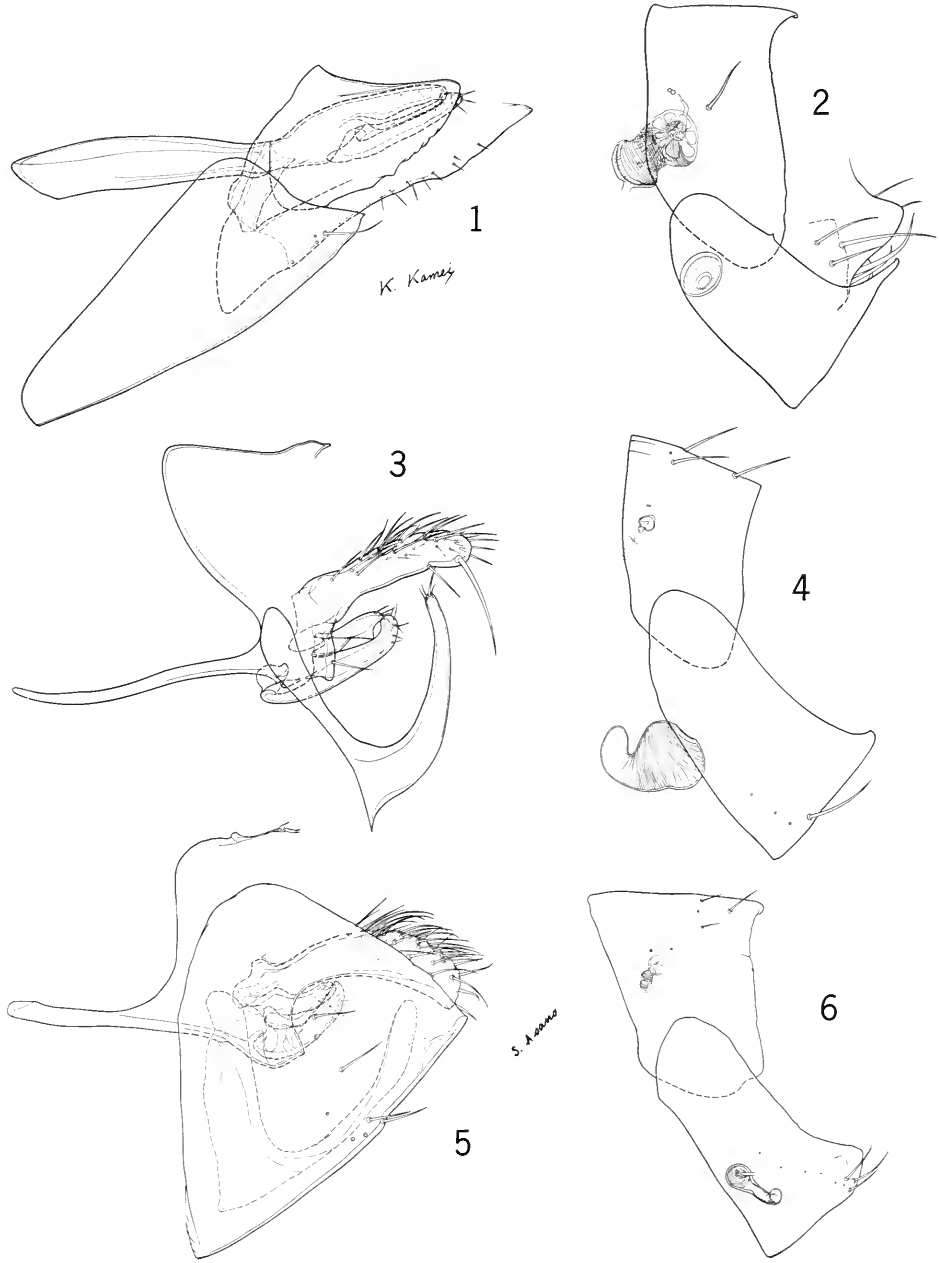


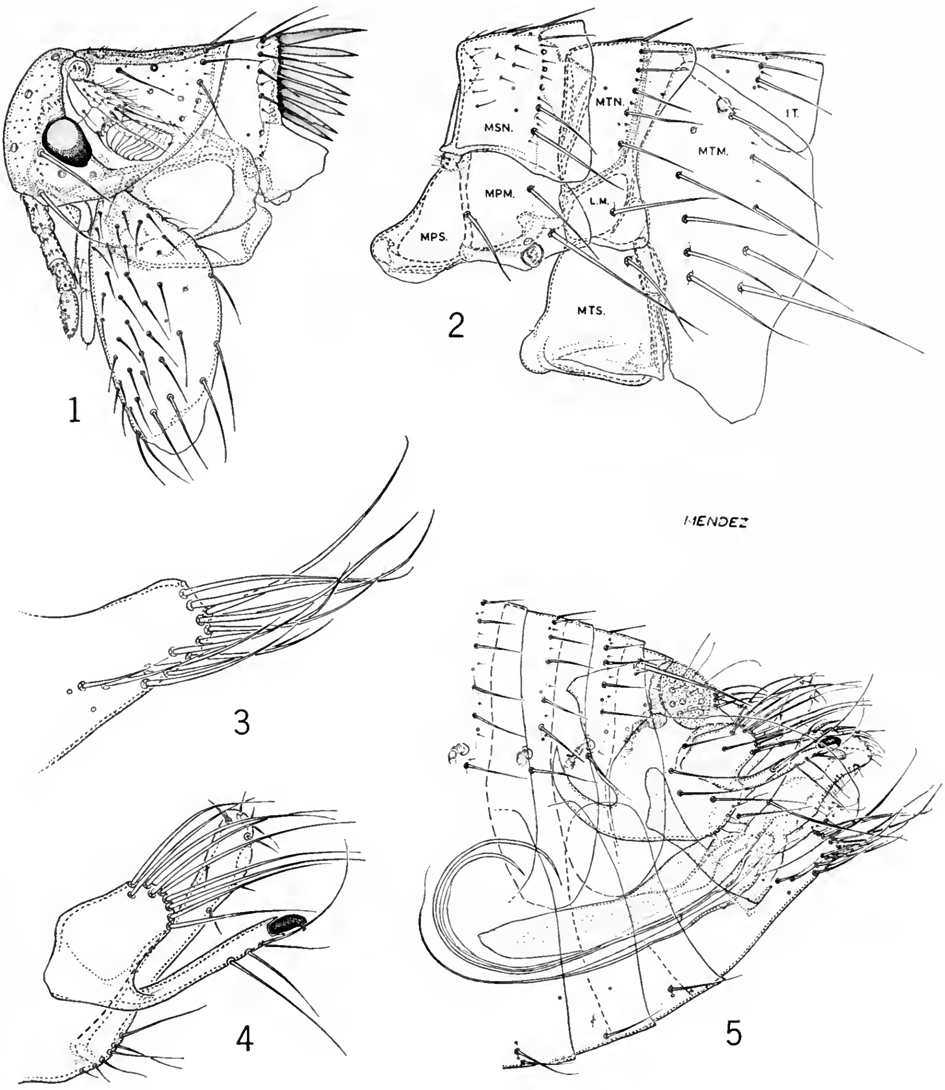
Ctenocephalides felis felis (Bouché). 1, male, head, prothorax and procoxa. 2, female, spermatheca and seventh abdominal segment. 3, male genitalia.



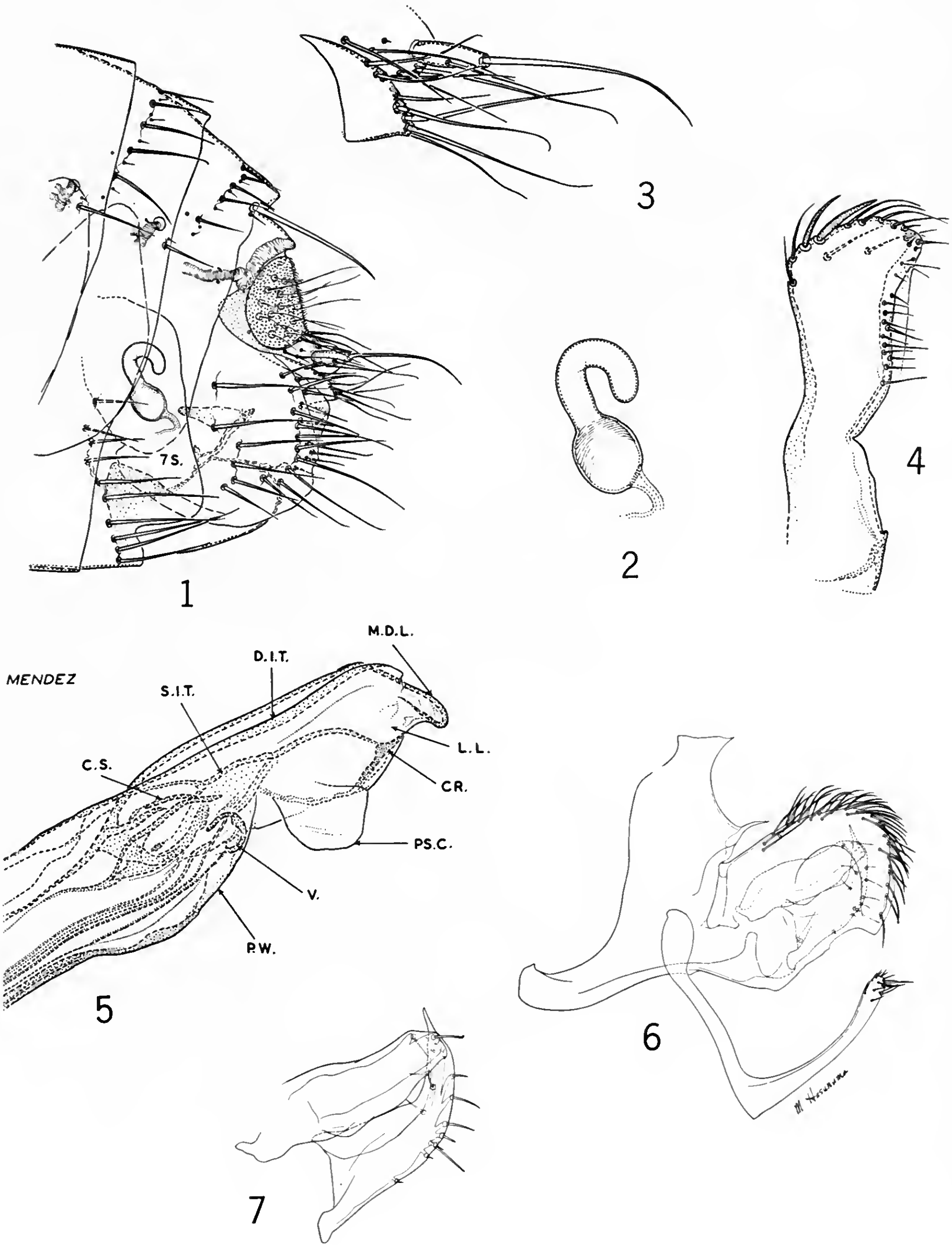
Head, prothorax and procoxa, male. 1, *Tunga penetrans* (Linnaeus). 2, *Echidnophaga gallinacea* (Westwood). 3, *Juxtapulex echidnophagoides* Wagner. 4, *Pulex simulans* Baker.



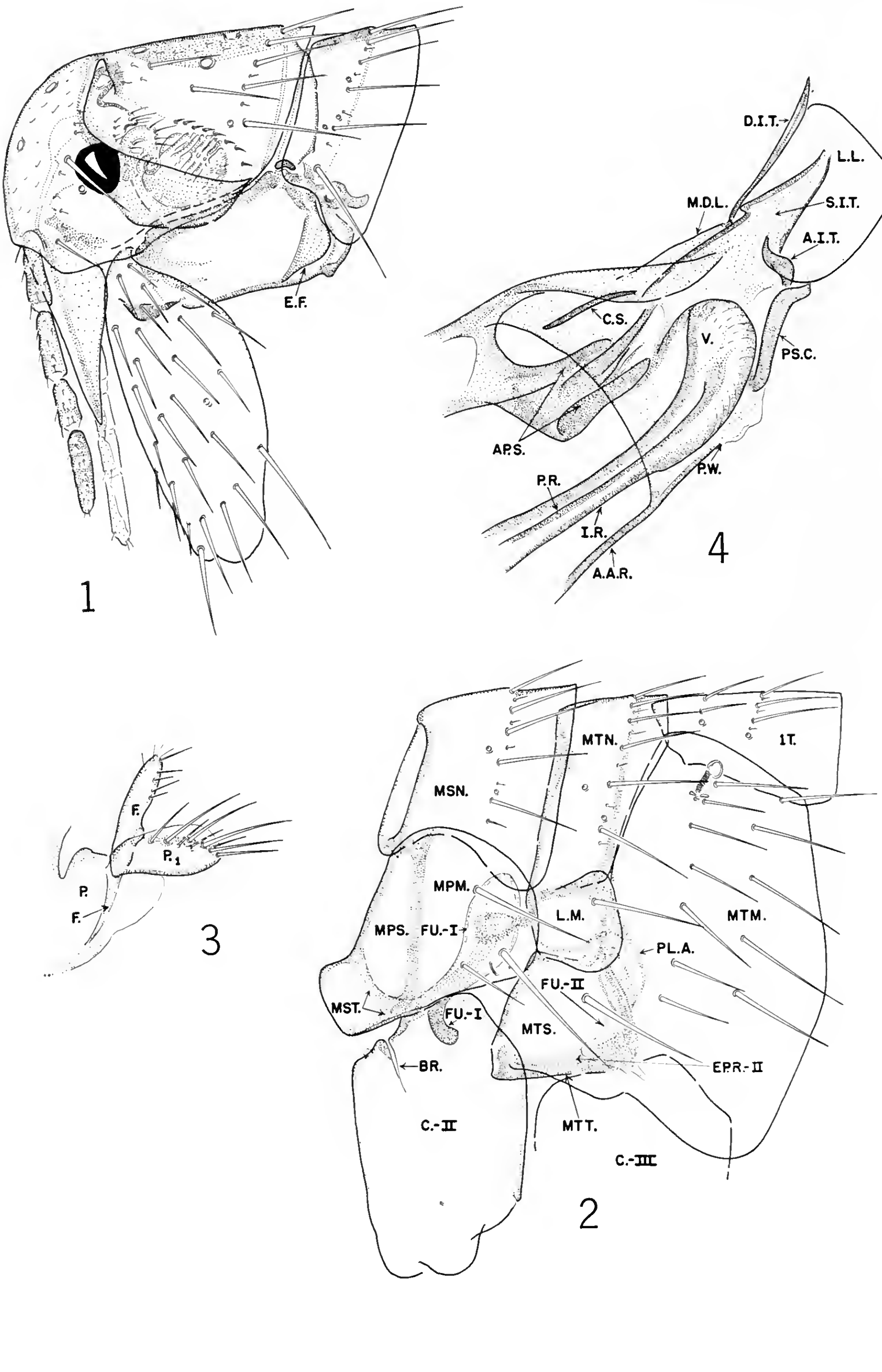
Tunga penetrans (Linneaus). 1, male genitalia. 2, female, spermatheca and seventh abdominal segment. *Echidnophaga gallinacea* (Westwood). 3, male genitalia. 4, female, spermatheca and seventh abdominal segment. *Juxtapulex echidnophagoides* Wagner. 5, male genitalia. 6, female, spermatheca and seventh abdominal segment.



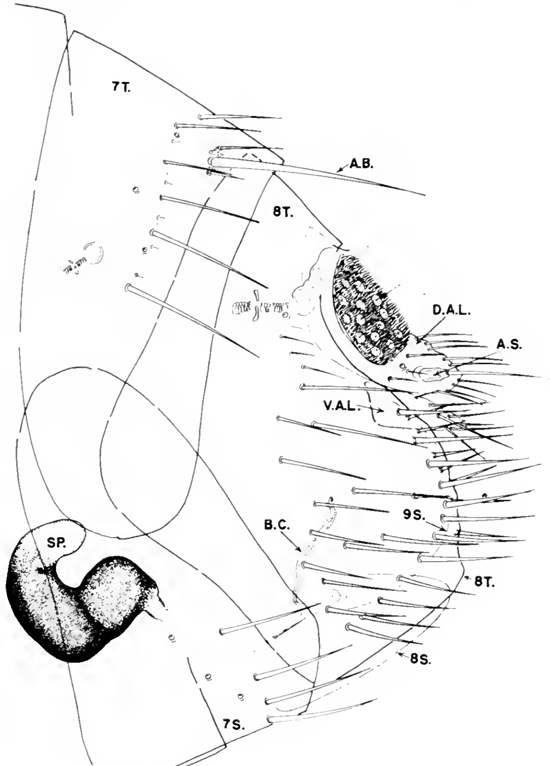
Hoplopsyllus glacialis exoticus Jordan and Rothschild, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, eighth sternum. 4, process and movable finger of clasper. 5, modified abdominal segment.



Hoplopsyllus glacialis exoticus Jordan and Rothschild. Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral and lobe; Male: 4, distal arm of ninth sternum; 5, apex of aedeagus. *Pulex simulans* Baker, male. 6, genitalia; 7, process and movable finger of clasper.



Xenopsylla cheopis Rothschild, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, process and movable finger of clasper. 4, apex of aedeagus. After Johnson, 1957.



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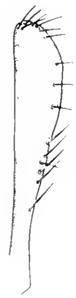

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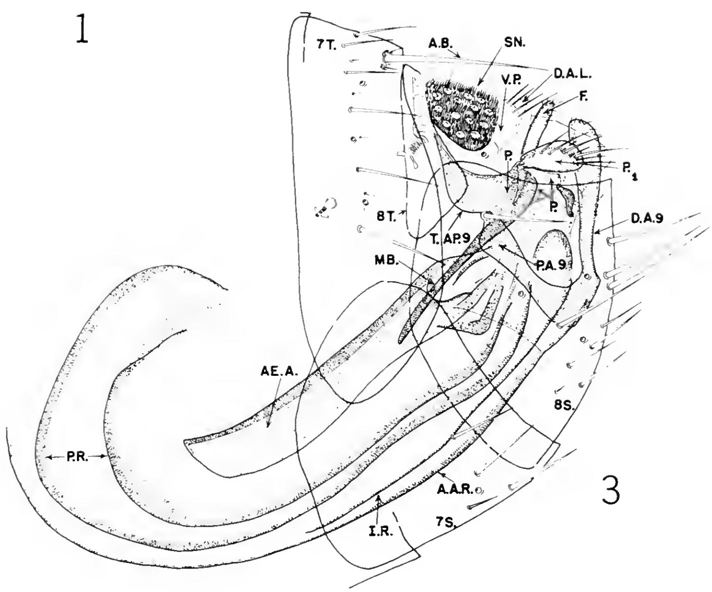

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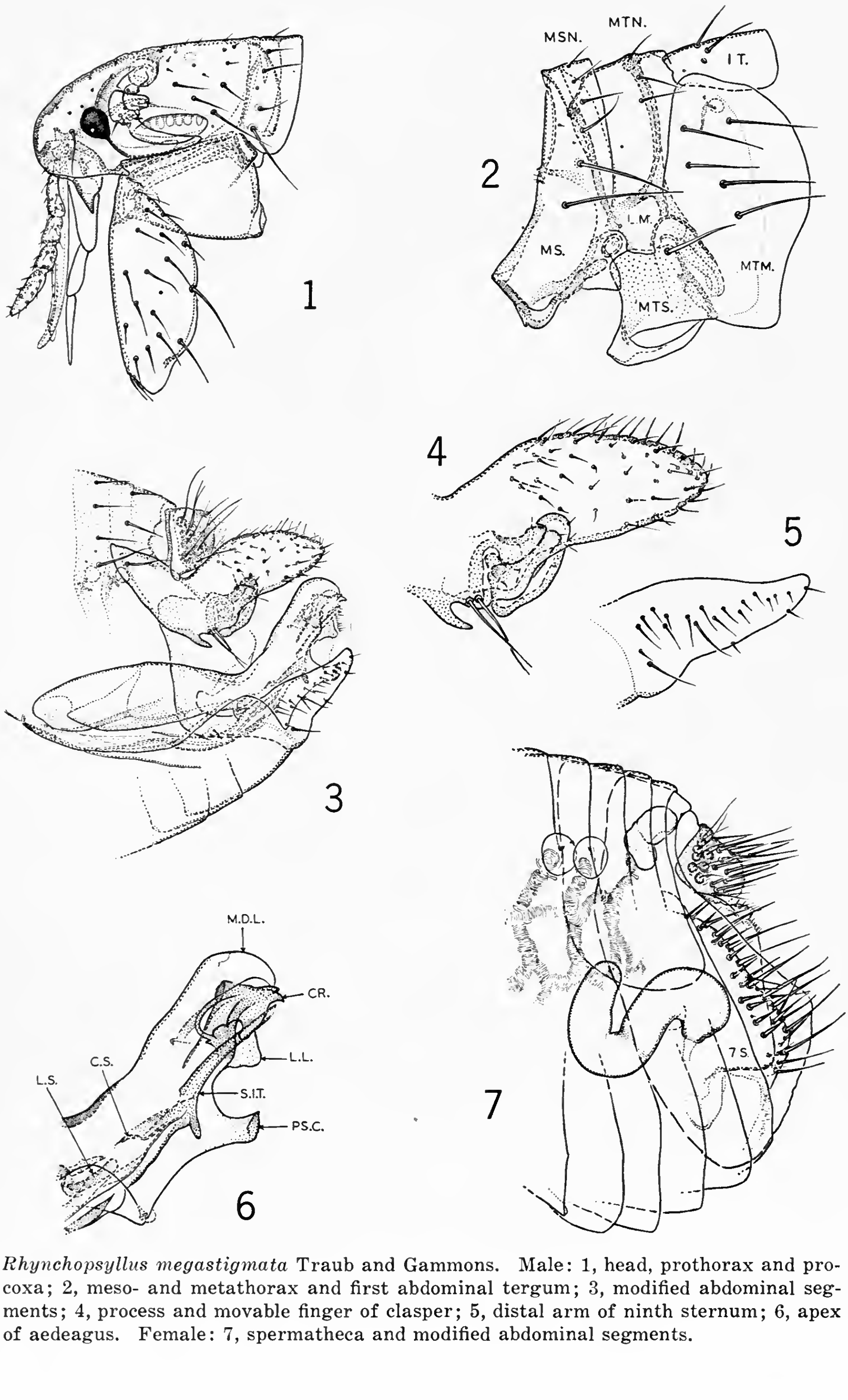
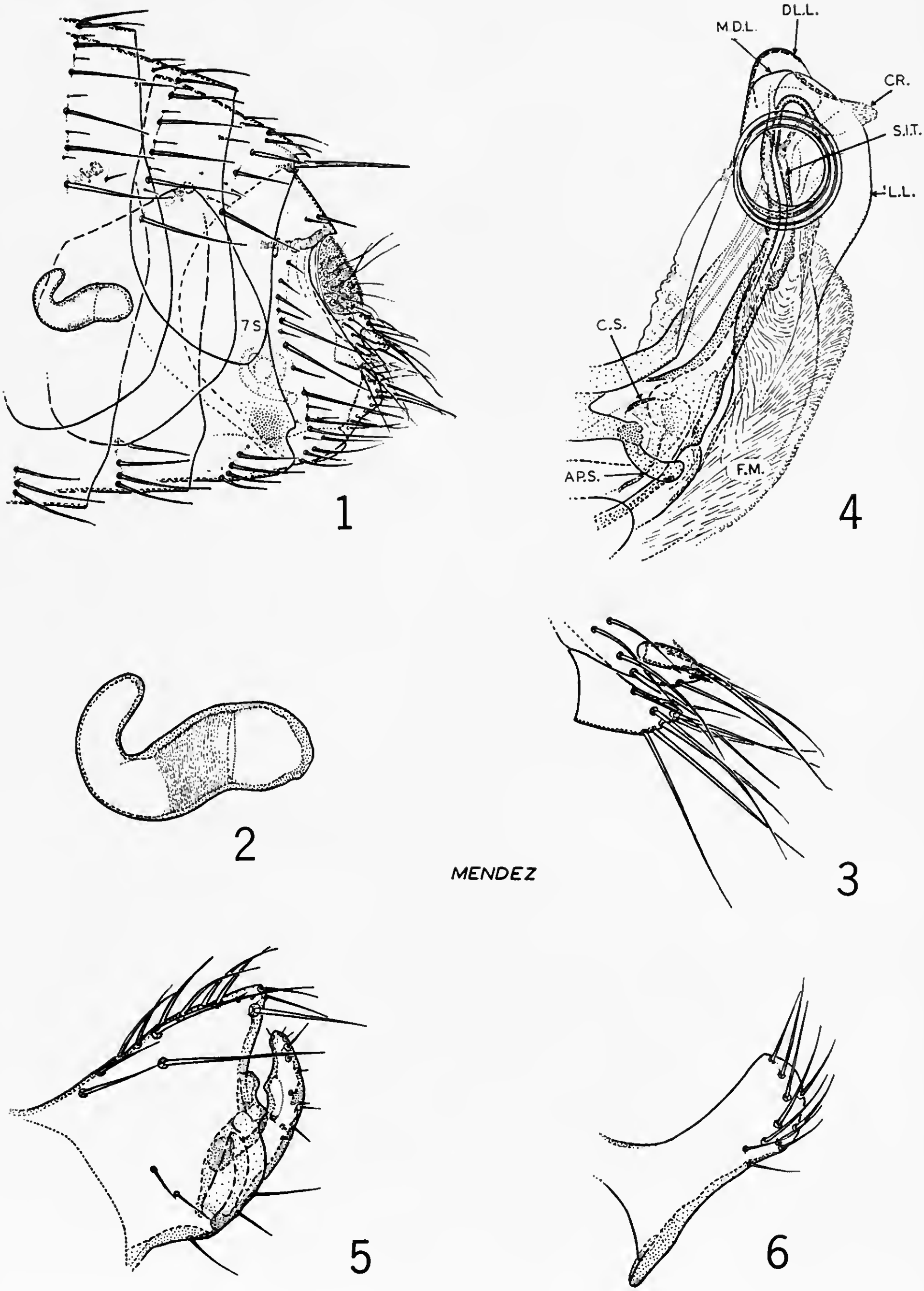
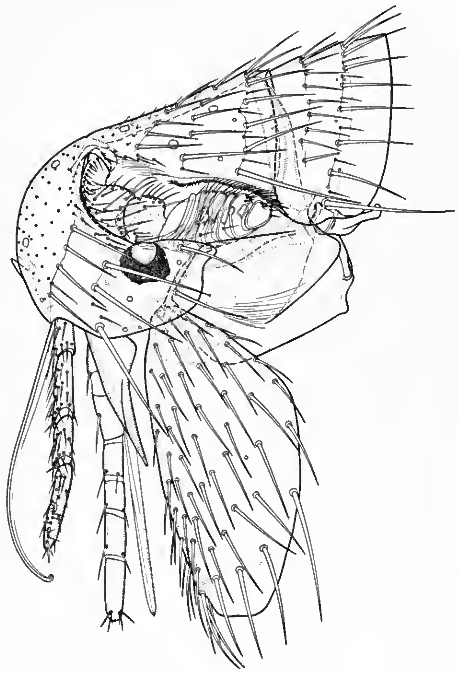
Xenopsylla cheopis Rothschild. Female: 1, modified abdominal segments. Male: 2, distal arm of ninth sternum; 3, modified abdominal segments.



Rhynchopsyllus megastigmata Traub and Gammons. Male: 1, head, prothorax and procoxa; 2, meso- and metathorax and first abdominal tergum; 3, modified abdominal segments; 4, process and movable finger of clasper; 5, distal arm of ninth sternum; 6, apex of aedeagus. Female: 7, spermatheca and modified abdominal segments.



Polygenis atopus (Jordan and Rothschild). Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, apex of aedeagus; 5, process and movable finger of clasper; 6, distal arm of ninth sternum.



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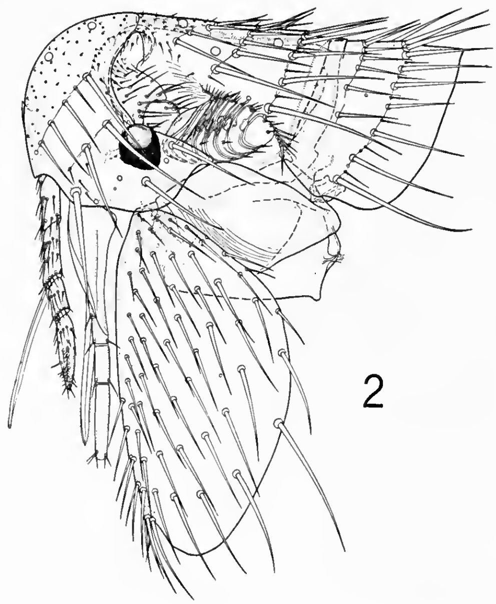

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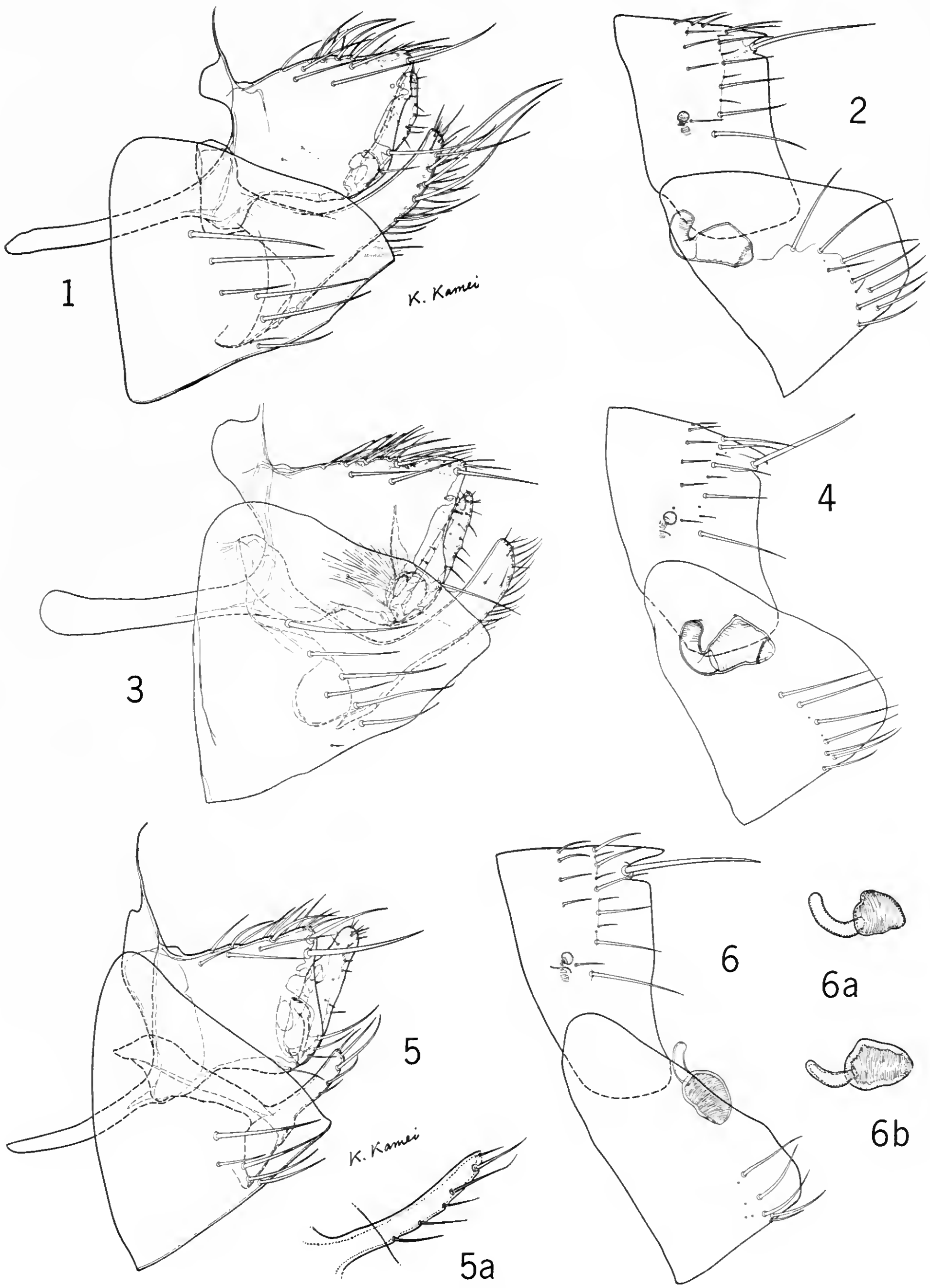
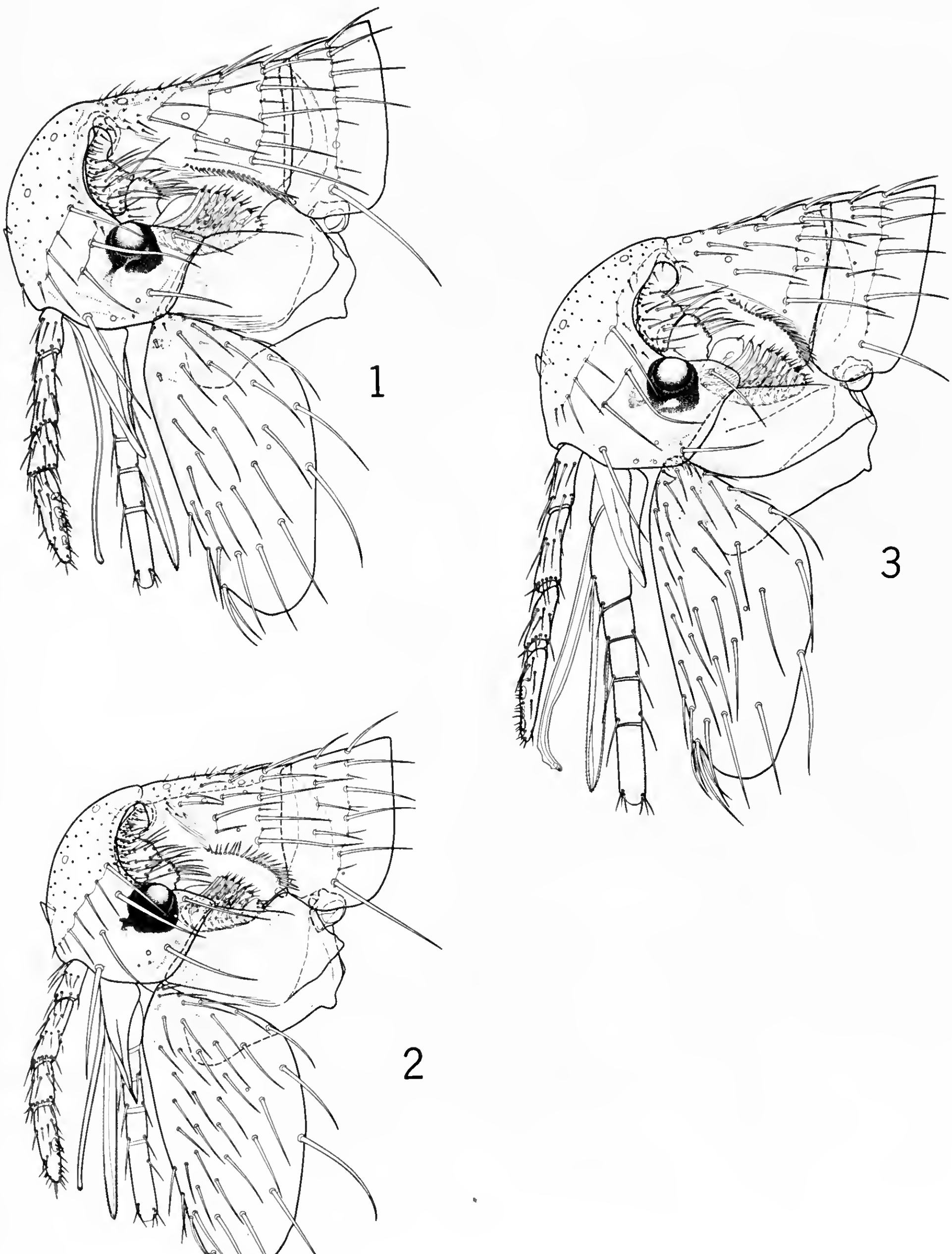
3

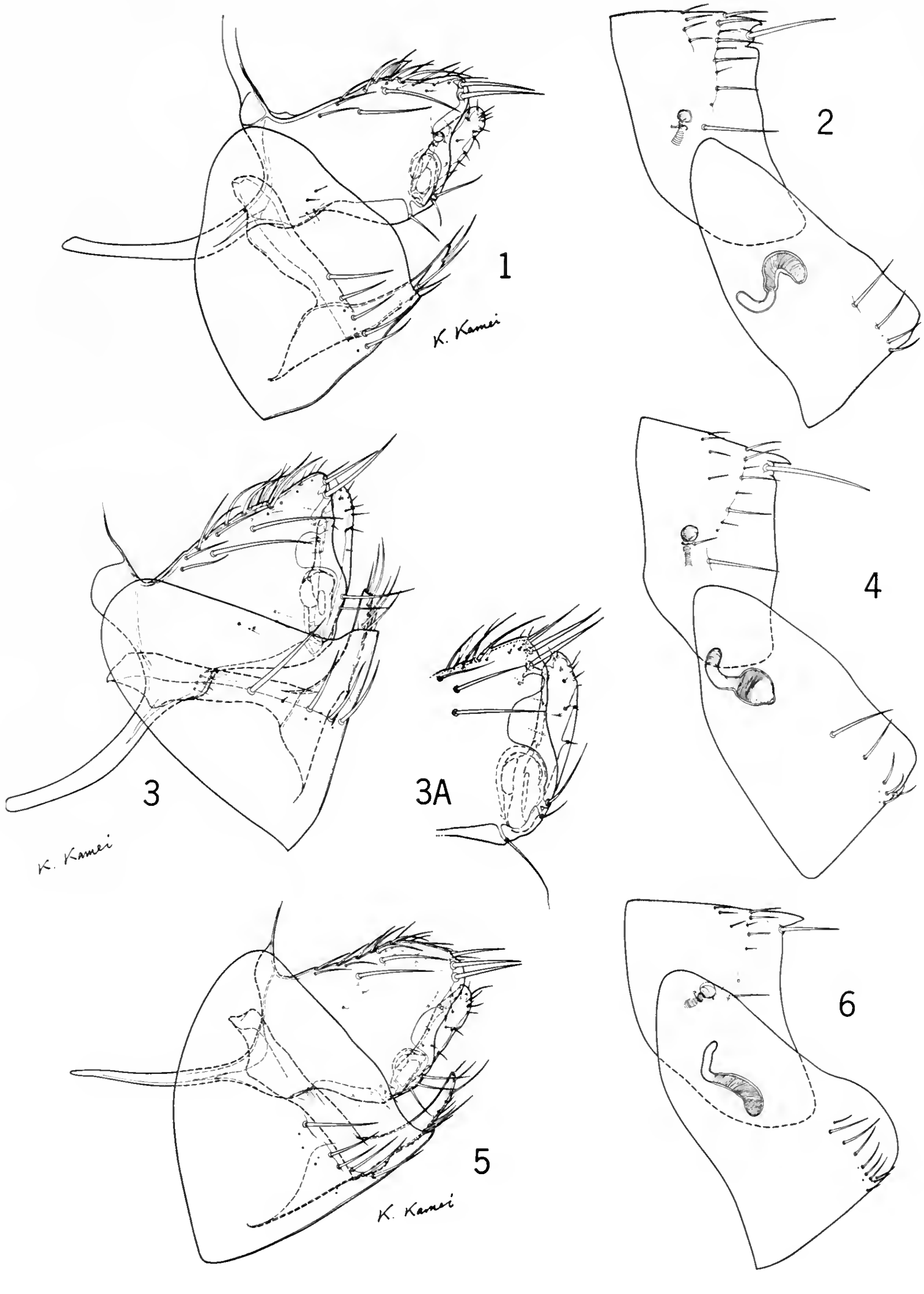
Head, prothorax and procoxa, male. 1, *Polygenis dunni* (Jordan and Rothschild). 2, *P. roberti beebei* (I. Fox). 3, *P. klagesi samuelis* (Jordan and Rothschild).



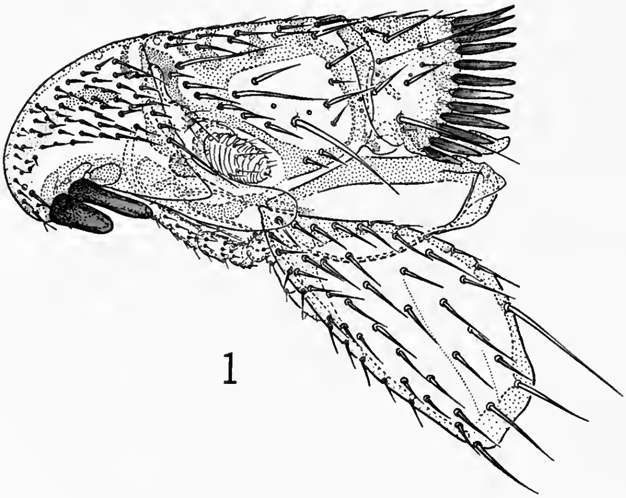
Polygenis dunni (Jordan and Rothschild). 1, male genitalia. 2, female, spermatheca and seventh abdominal segment. *P. roberti beebei* (I. Fox). 3, male genitalia. 4, female, spermatheca and seventh abdominal segment. *P. klagesi samuelis* (Jordan and Rothschild). 5, male genitalia; 5a, male, distal arm of ninth sternum of specimen from *Coendou mexicanus laenatus* showing variation. 6, female, spermatheca and seventh abdominal segment; 6a, 6b, female, spermathecae of specimens from *Coendou mexicanus laenatus* showing variation.



Head, prothorax and procoxa, male. 1, *Rhopalopsyllus australis tupinus* Jordan and Rothschild. 2, *R. lugubris lugubris* Jordan and Rothschild. 3, *R. cacicus saevus* Jordan and Rothschild.



Rhopalopsyllus australis tupinus Jordan and Rothschild. 1, male genitalia. 2, female, spermatheca and seventh abdominal segment. *R. lugubris lugubris* Jordan and Rothschild. 3, male genitalia. 4, female, spermatheca and seventh abdominal segment. *R. lugubris cryptoctenes* (Enderlein). 3a, male, process and movable finger of clasper. *R. cacicus saevus* Jordan and Rothschild. 5, male genitalia. 6, female, spermatheca and seventh abdominal segment.



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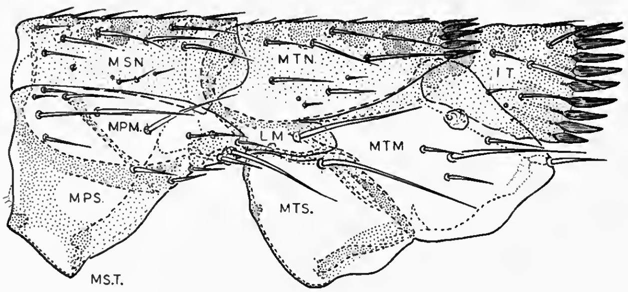
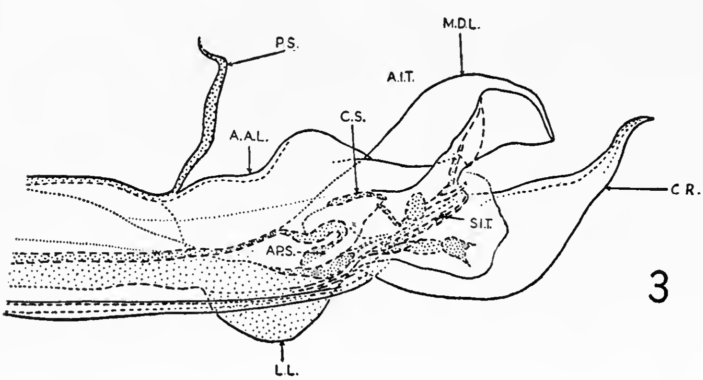
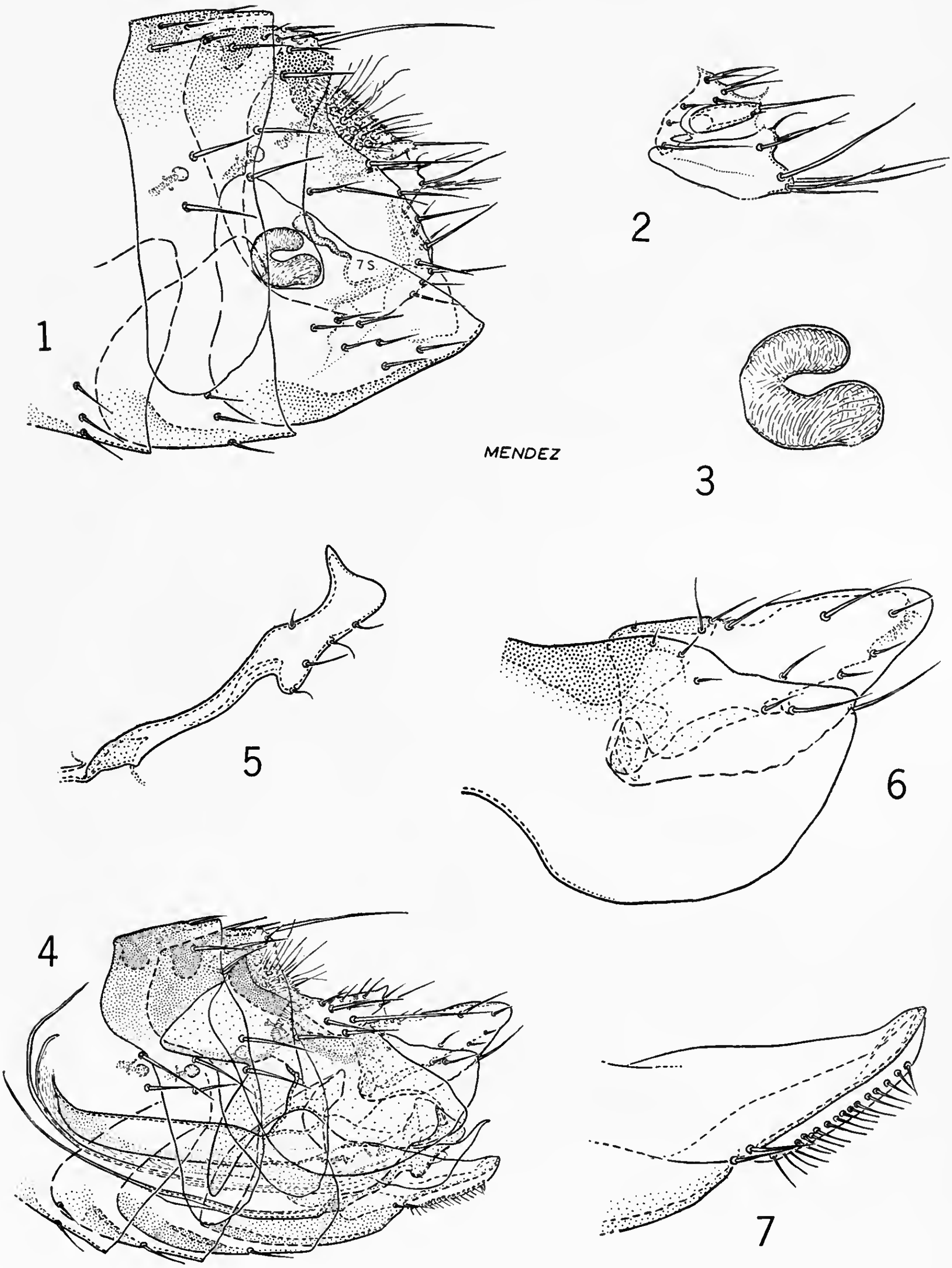


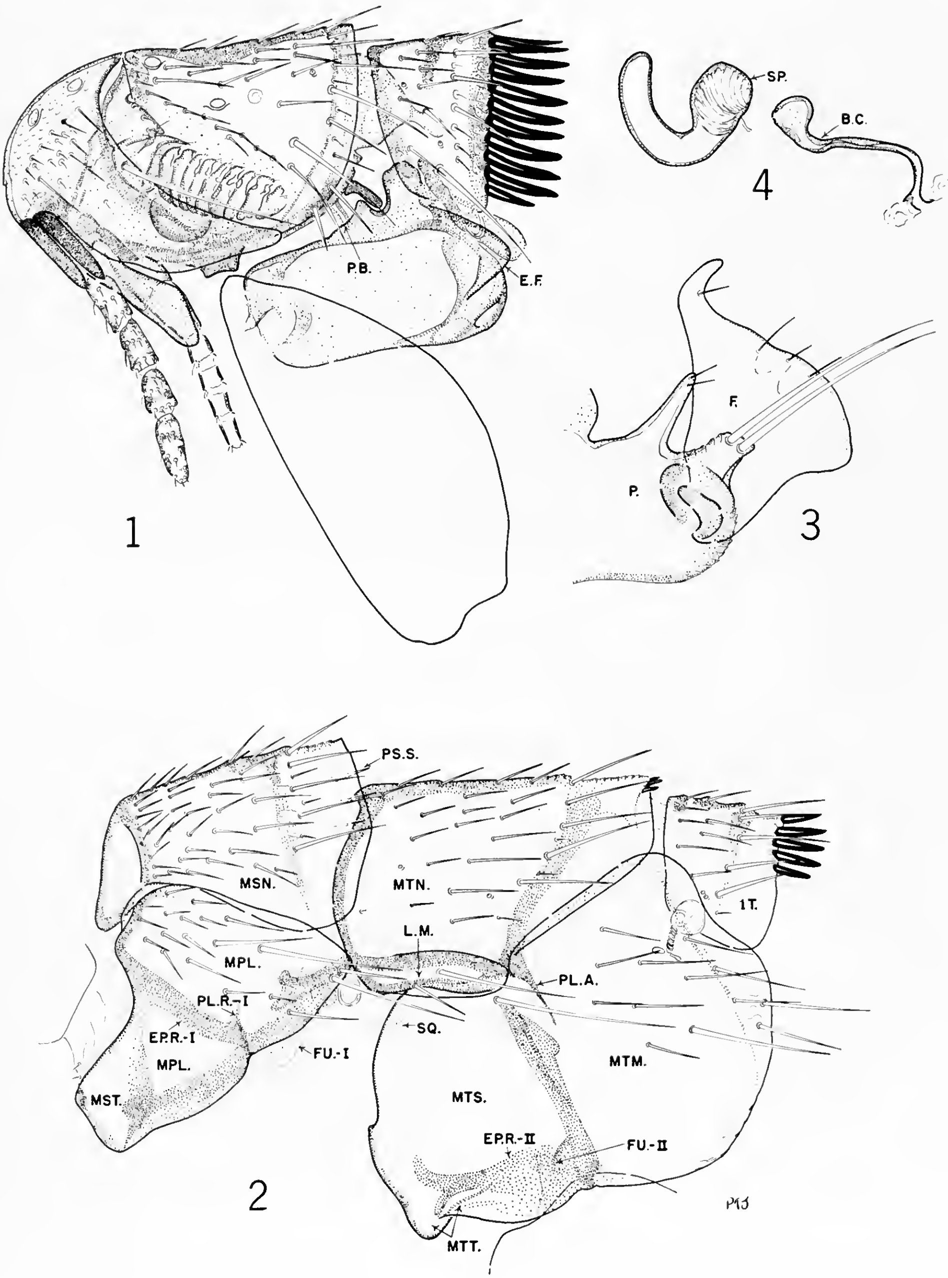


3

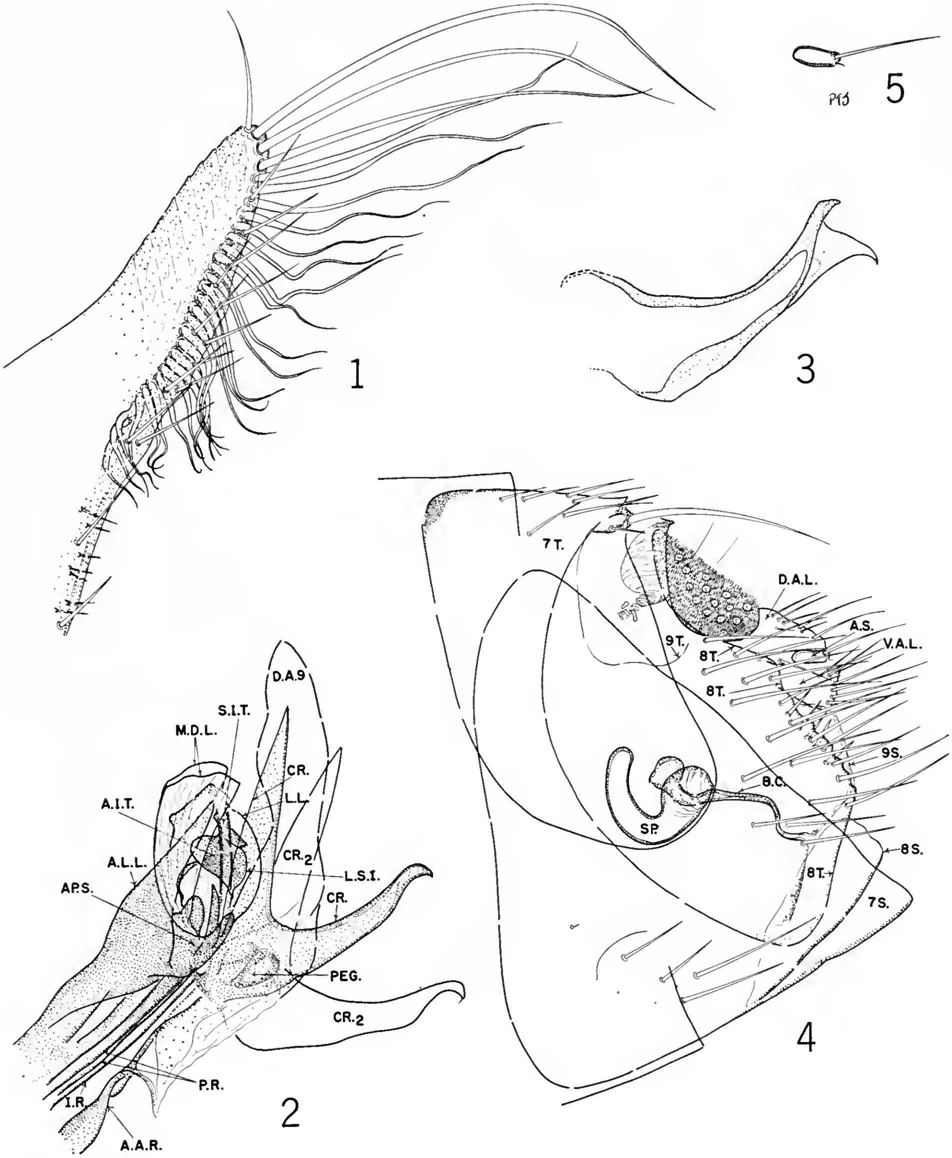
Hormopsylla kyriophila, new species, male. 1, head prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, apex of aedeagus.



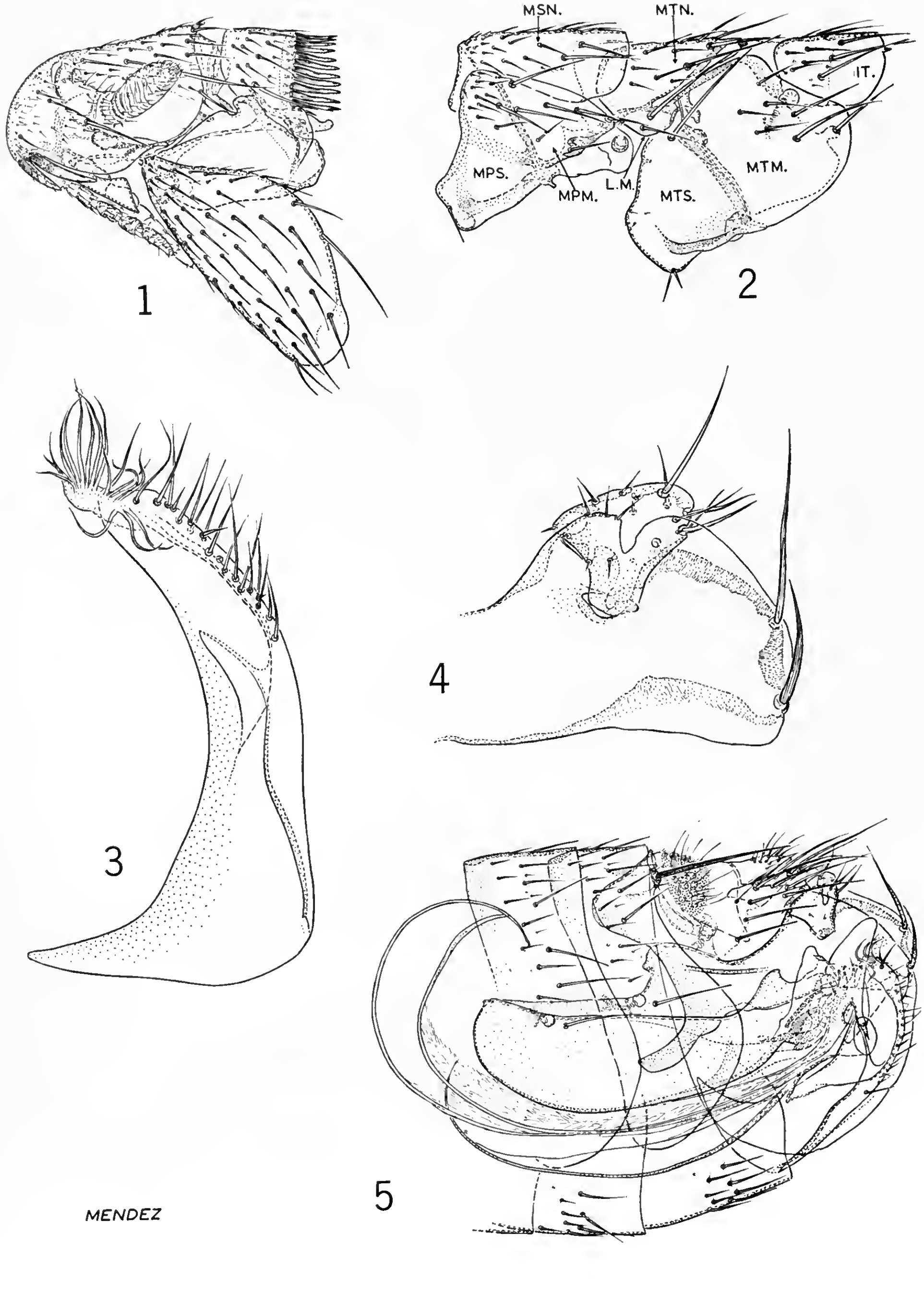
Hormopsylla kyriophila, new species. Female: 1, modified abdominal segments; 2, anal stylet and ventral anal lobe; 3, spermatheca. Male: 4, modified abdominal segments; 5, distal arm of ninth sternum; 6, process and movable finger of clasper; 7, eighth sternum.



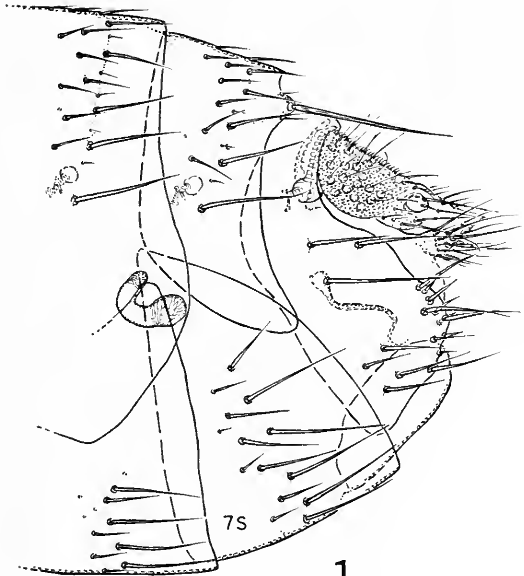
Ptilopsylla dunni Kohls. Male: 1, head, prothorax and procoxa; 2, meso- and metathorax and first abdominal tergum; 3, process and movable finger of clasper. Female: 4, spermatheca and bursa copulatrix. After Johnson (1957).



Ptilopsylla dunni Kohls. Male: 1, eighth sternum; 2, apex of aedeagus; 3, crochet. Female: 4, modified abdominal segments; 5, anal stylet. After Johnson (1957), except fig. 3.



Sternopsylla distincta speciosa Johnson, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, eighth sternum. 4, process and movable finger of clasper. 5, modified abdominal segments.



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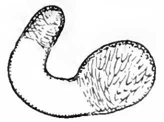

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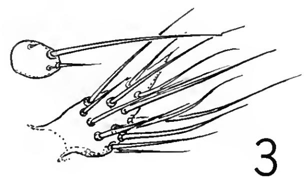

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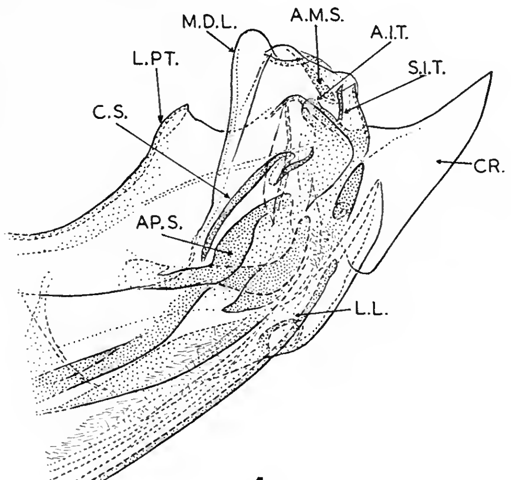

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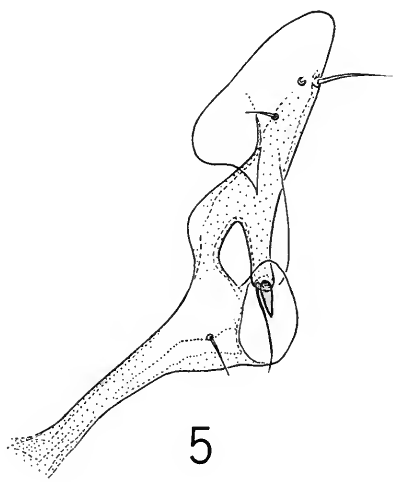
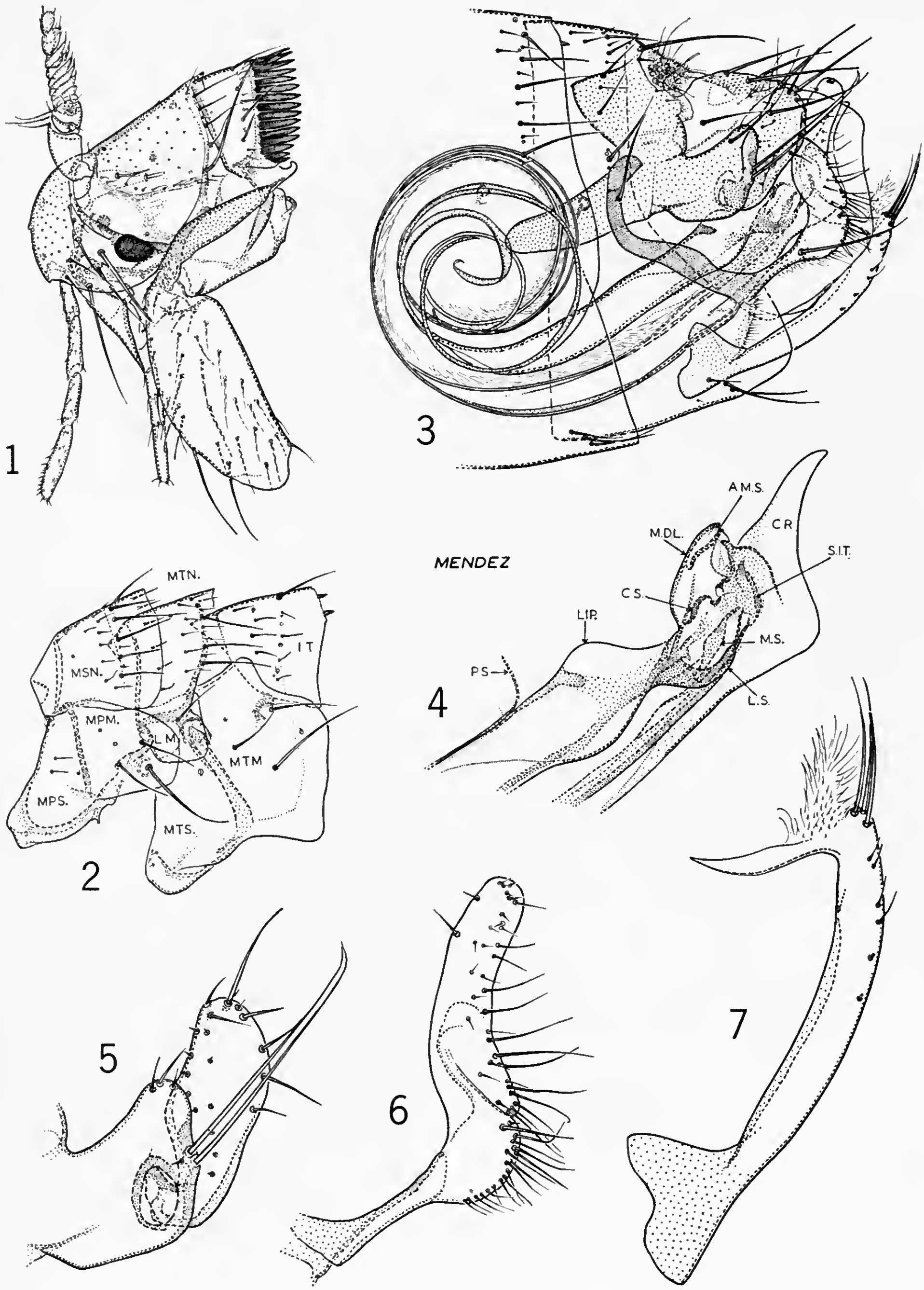
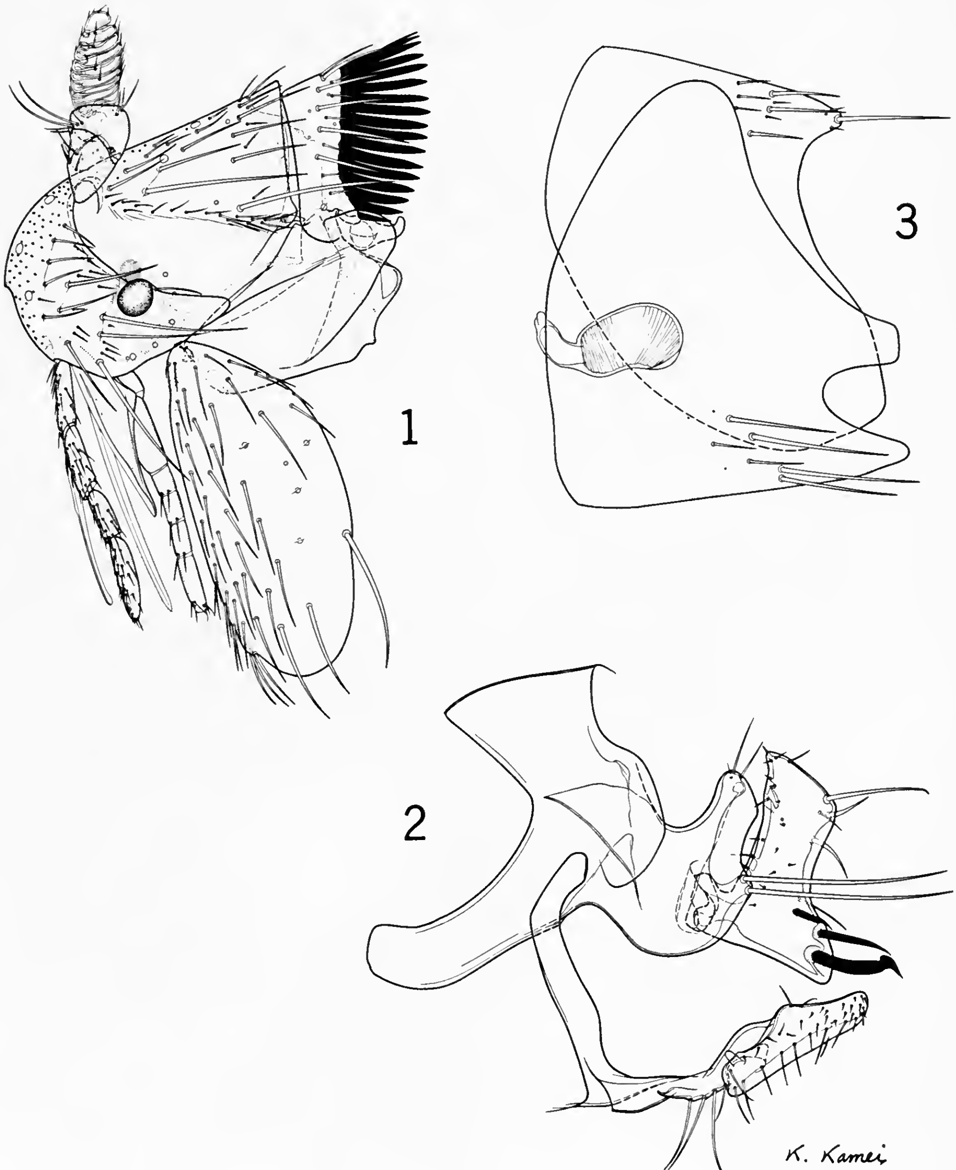


5

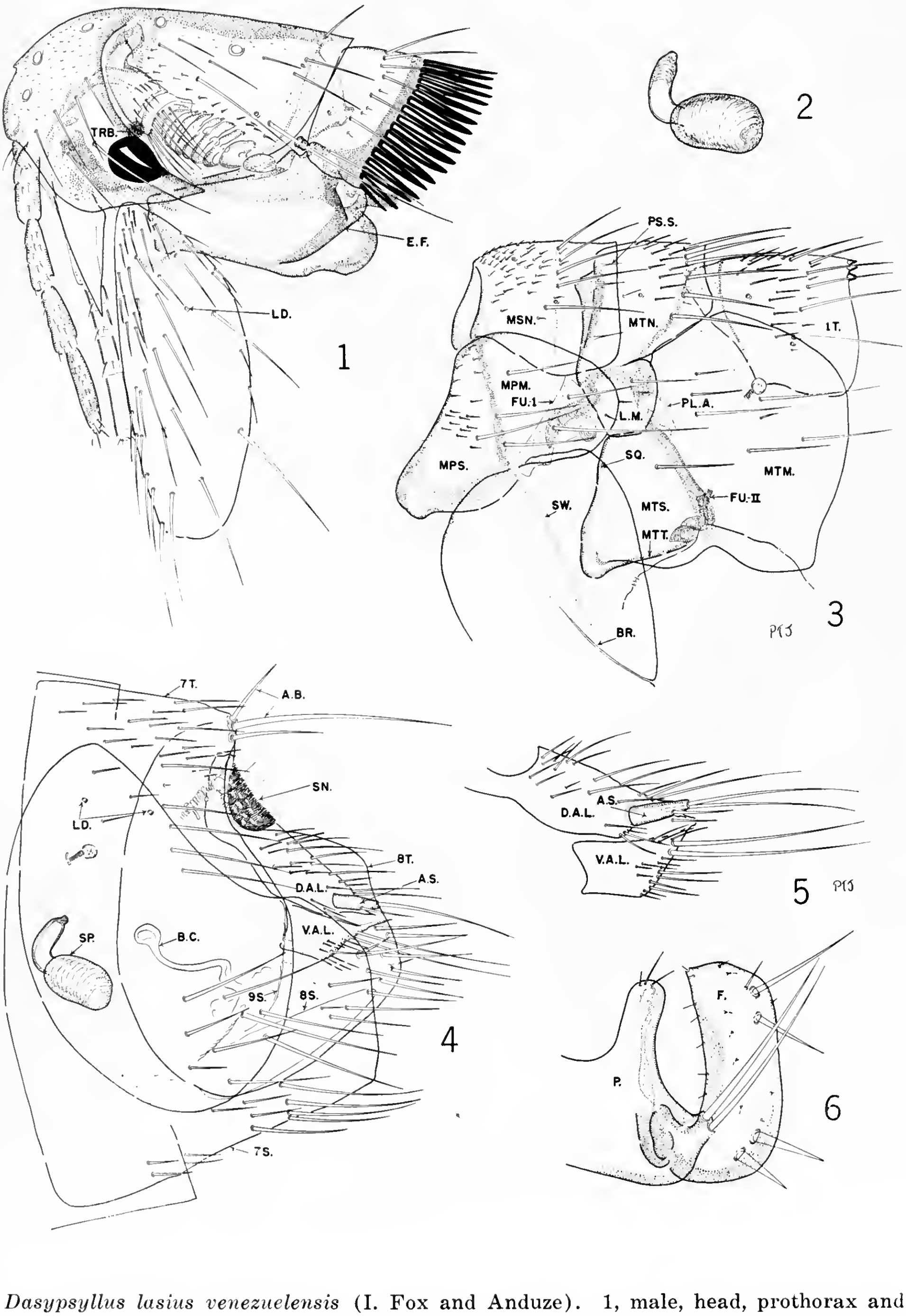
Sternopsylla distincta speciosa Johnson. Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, apex of aedeagus; 5, distal arm of ninth sternum.



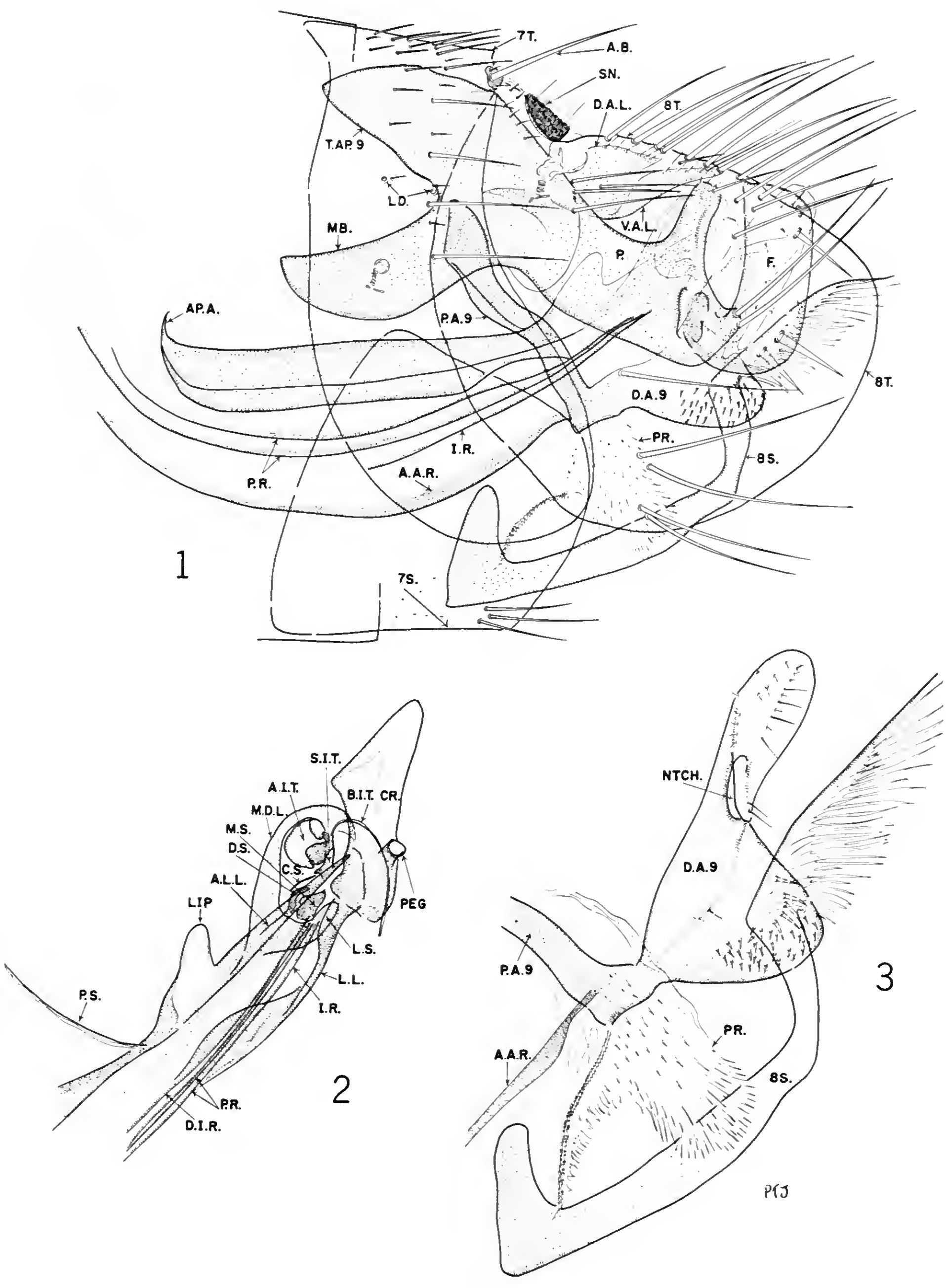
Ceratophyllus altus, new species, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, modified abdominal segments. 4, apex of aedeagus. 5, process and movable finger of clasper. 6, distal arm of ninth sternum. 7, eighth sternum.



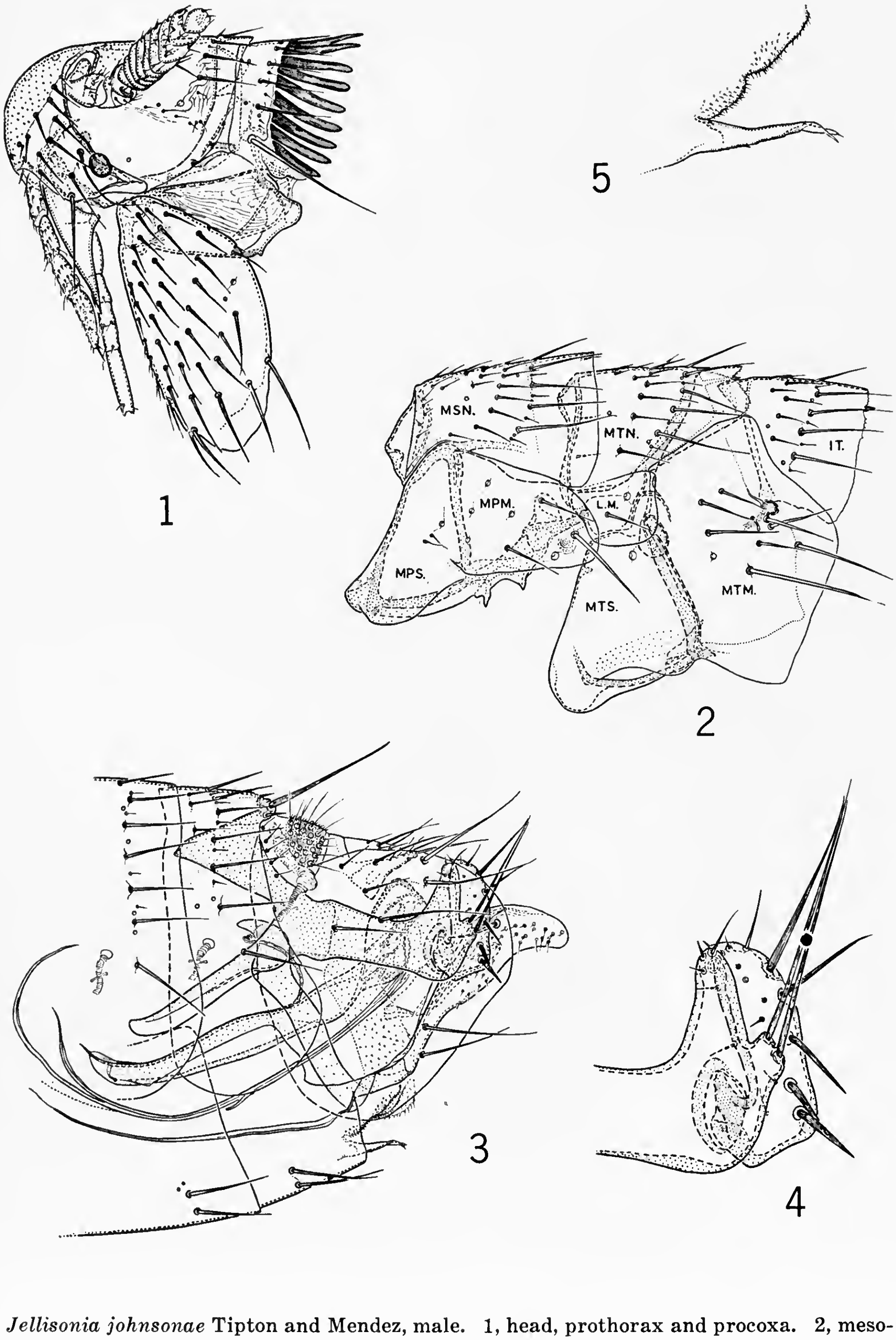
Dasypsyllus gallinulae perpinnatus (Baker). Male: 1, head, prothorax and procoxa; 2, genitalia. Female: 3, spermatheca and seventh abdominal segment.



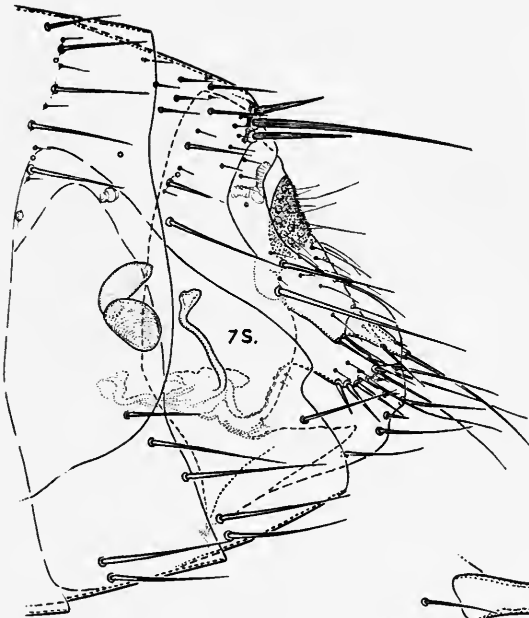
Dasypsyllus lasius venezuelensis (I. Fox and Anduze). 1, male, head, prothorax and procoxa. 2, female, spermatheca; 3, male, meso- and metathorax and first abdominal tergum. 4, female, modified abdominal segments. 5, female, anal stylet, dorsal and ventral anal lobes. 6, male, process and movable finger of clasper. After Johnson (1957).



Dasypsyllus lasius venezuelensis (I. Fox and Anduze), male. 1, modified abdominal segments. 2, apex of aedeagus. 3, eighth sternum and distal arm of ninth sternum. After Johnson, 1957.



Jellisonia johnsonae Tipton and Mendez, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, modified abdominal segment. 4, process and movable finger of clasper. 5, eighth sternum.



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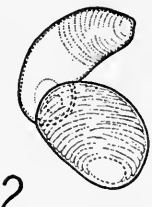

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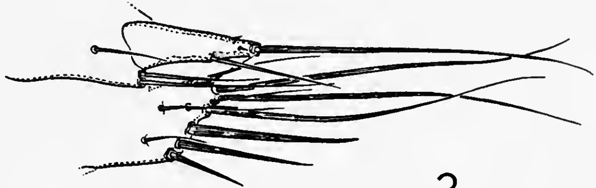

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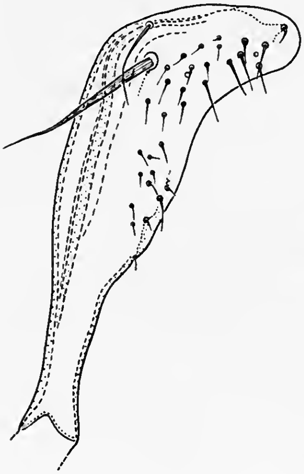

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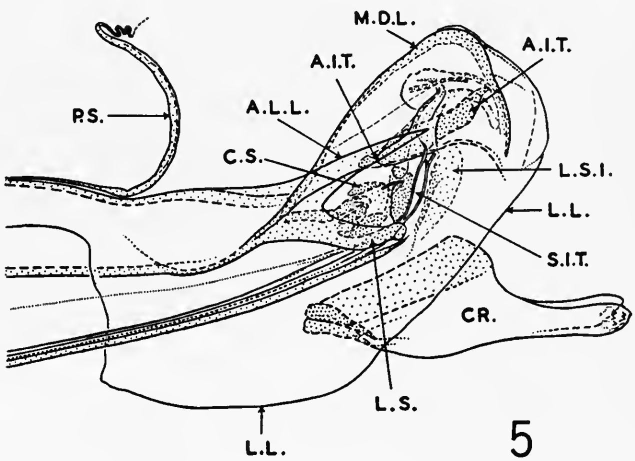
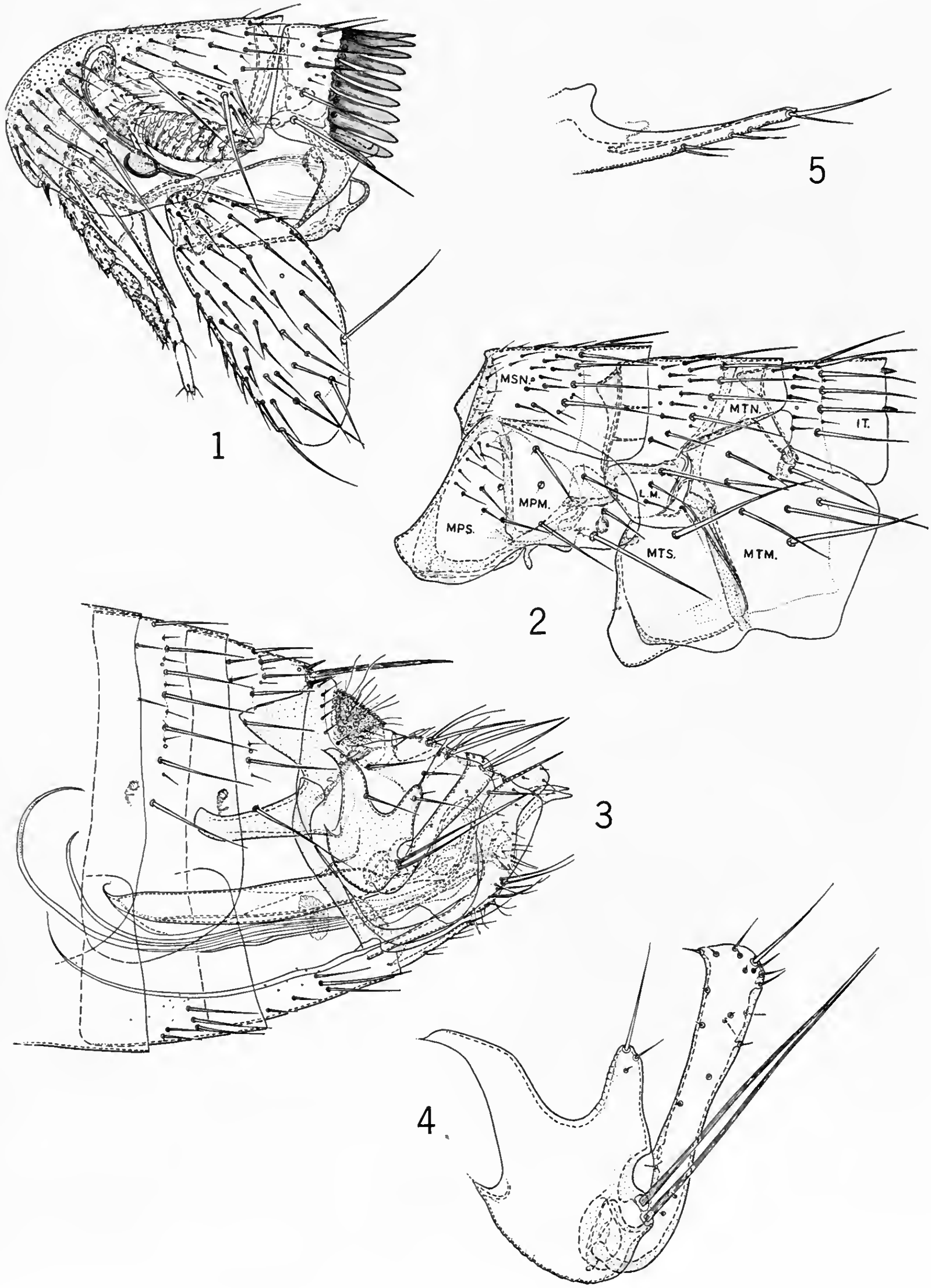
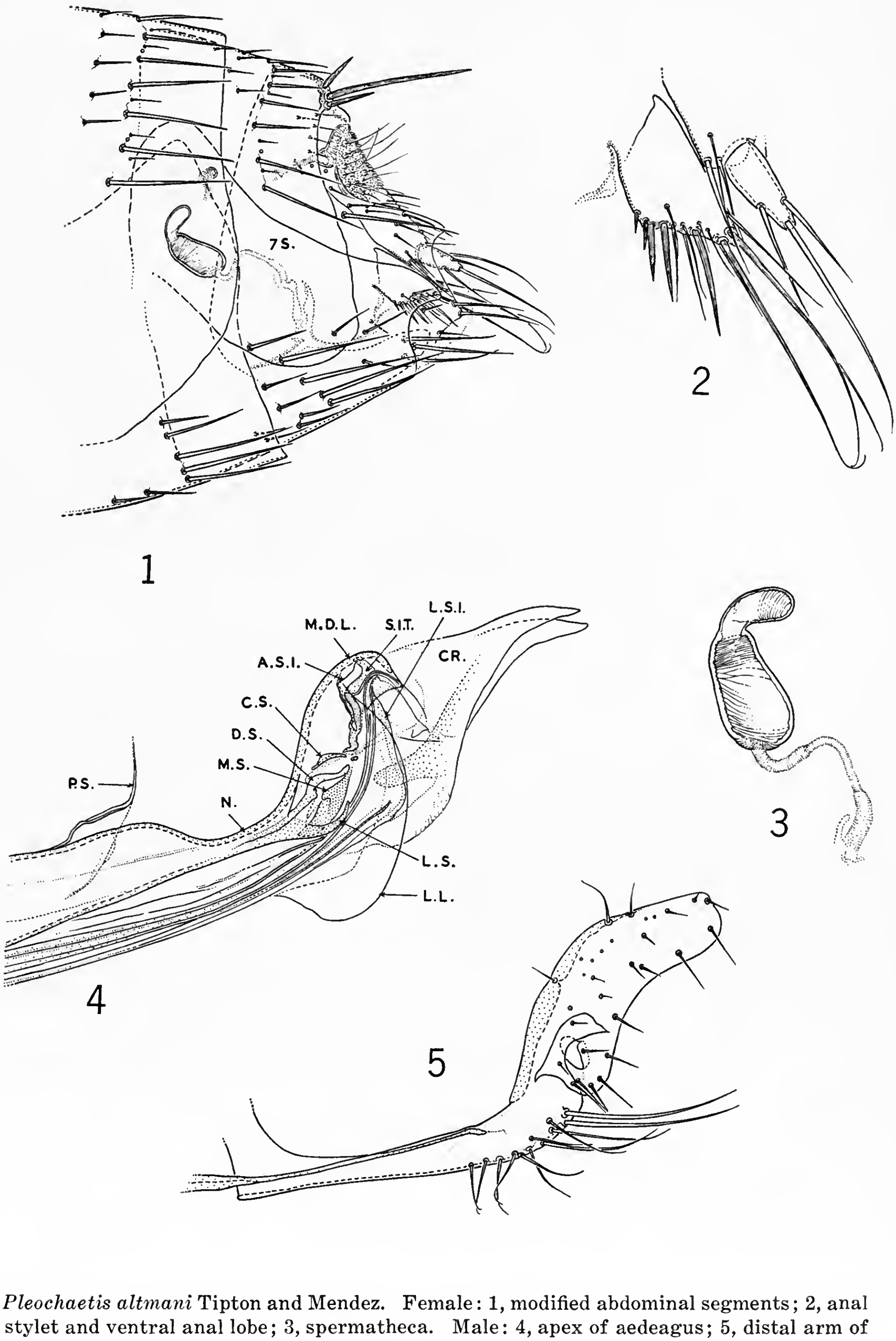


5

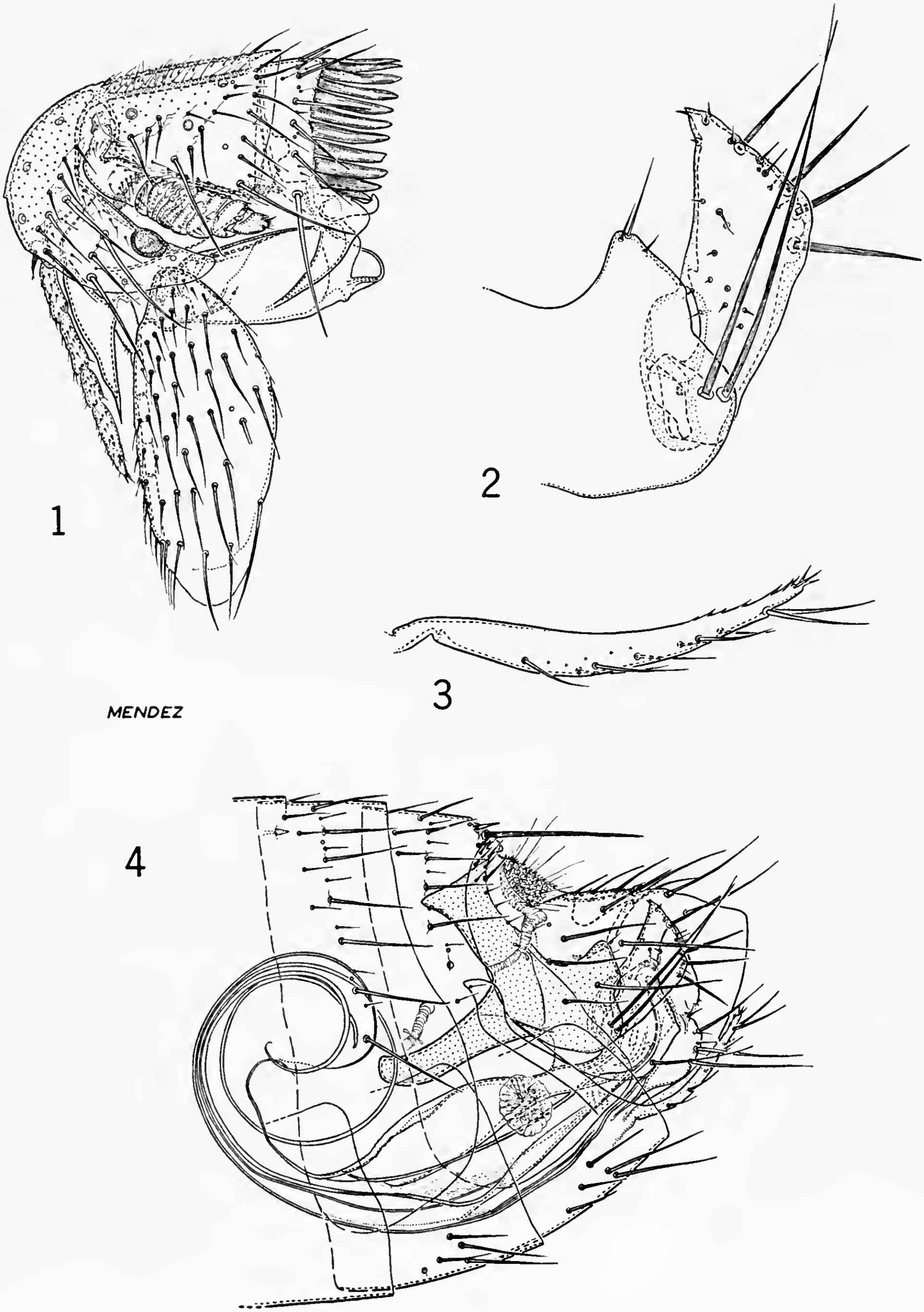
Jellisonia johnsonae Tipton and Mendez. Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, distal arm of ninth sternum. 5, apex of aedeagus.



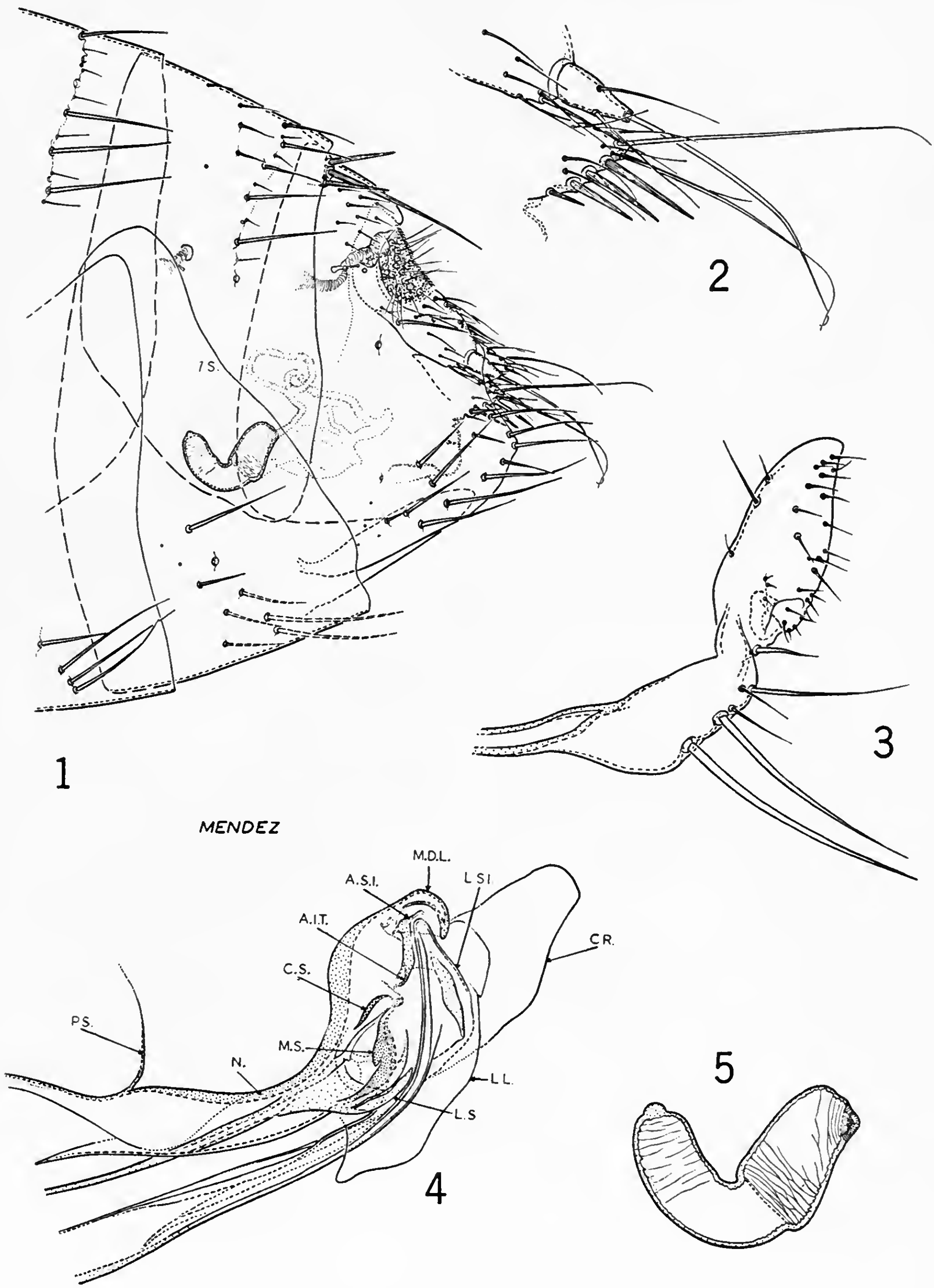
Pleochaetis altmani Tipton and Mendez, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, modified abdominal segments. 4, process and movable finger of clasper. 5, eighth sternum.



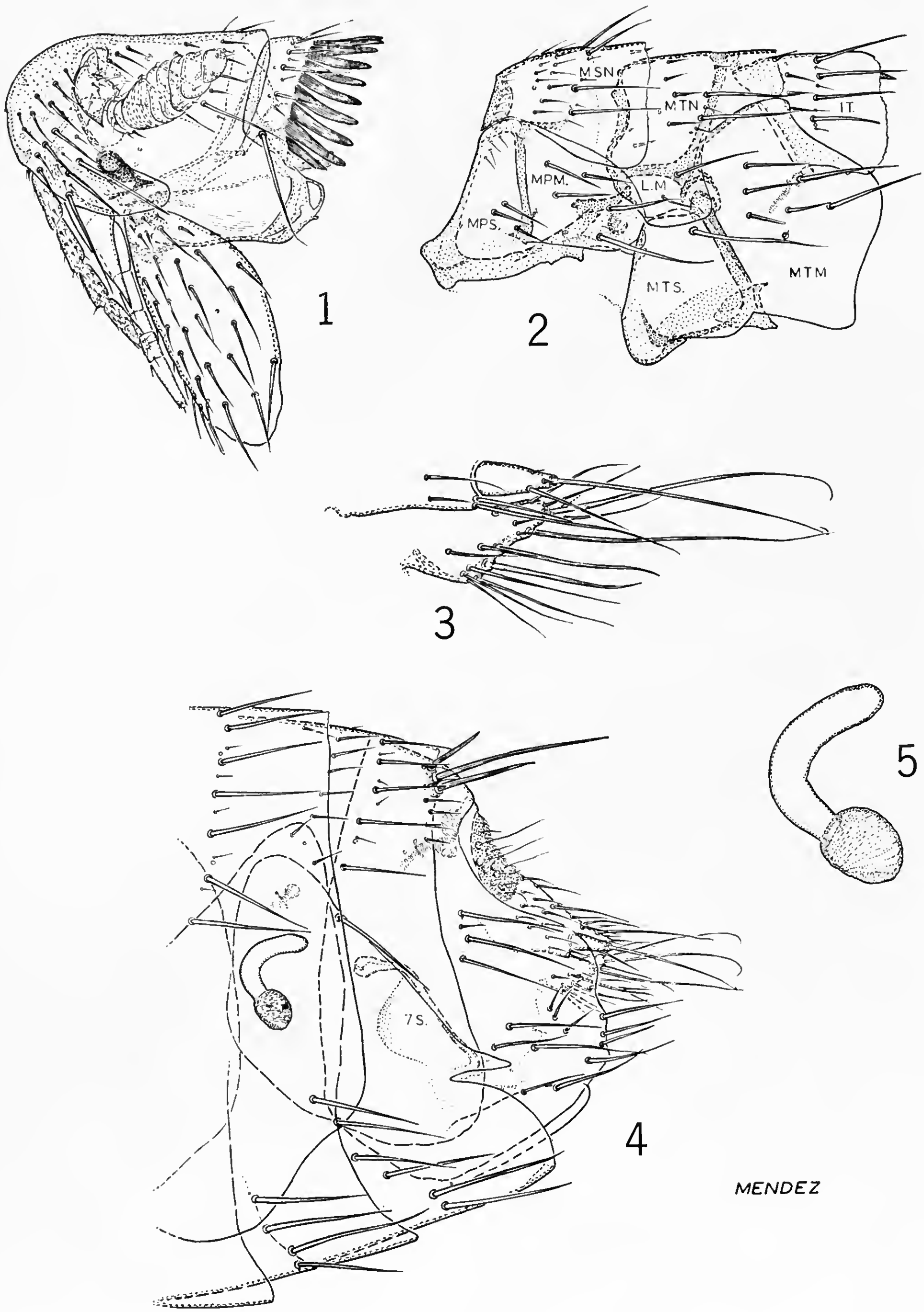
Pleochaetis altmani Tipton and Mendez. Female: 1, modified abdominal segments; 2, anal stylet and ventral anal lobe; 3, spermatheca. Male: 4, apex of aedeagus; 5, distal arm of ninth sternum.



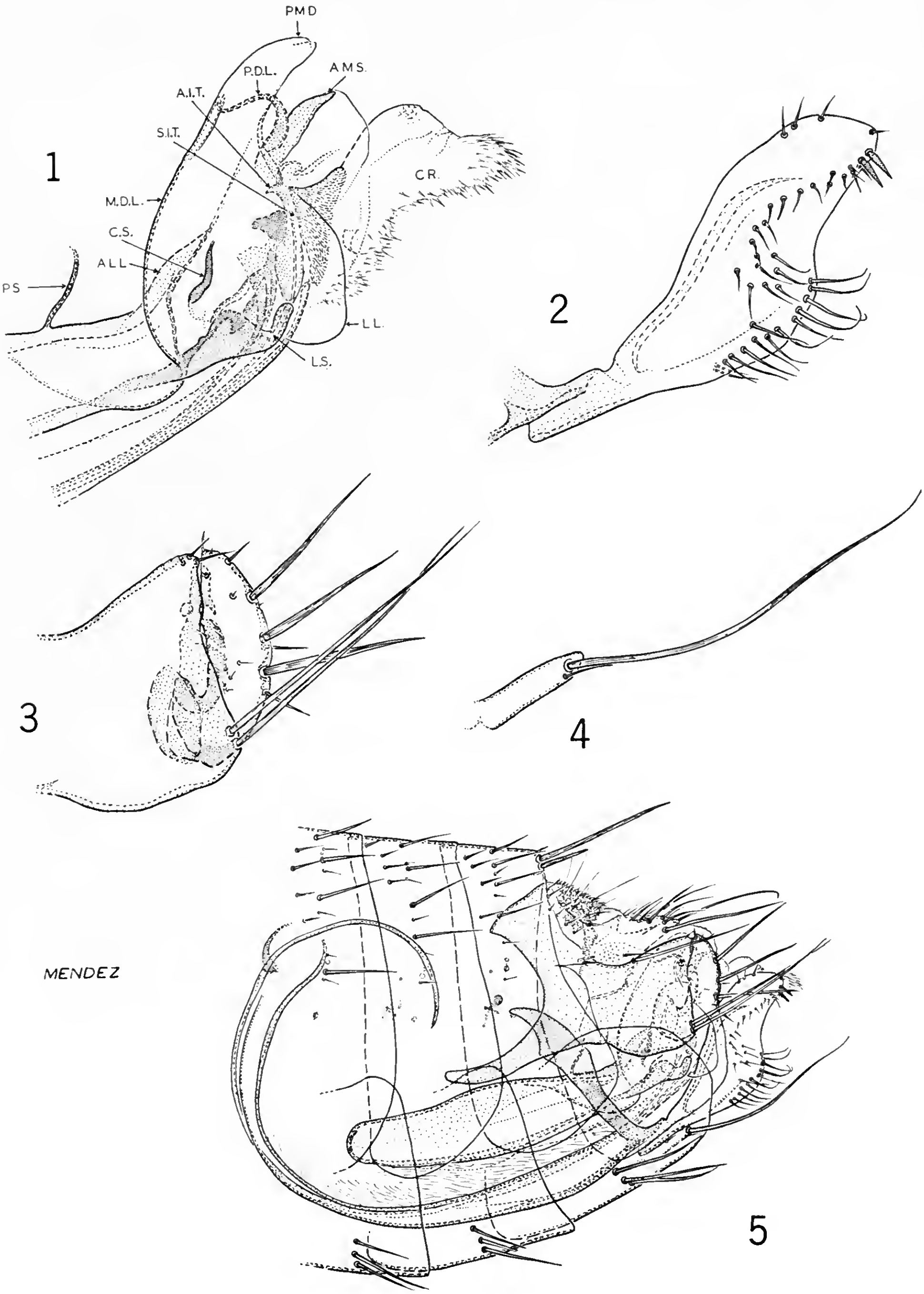
Pleochaetis dolens dolens (Jordan and Rothschild), male. 1, head, prothorax and procoxa. 2, process and movable finger of clasper. 3, eighth sternum. 4, modified abdominal segments.



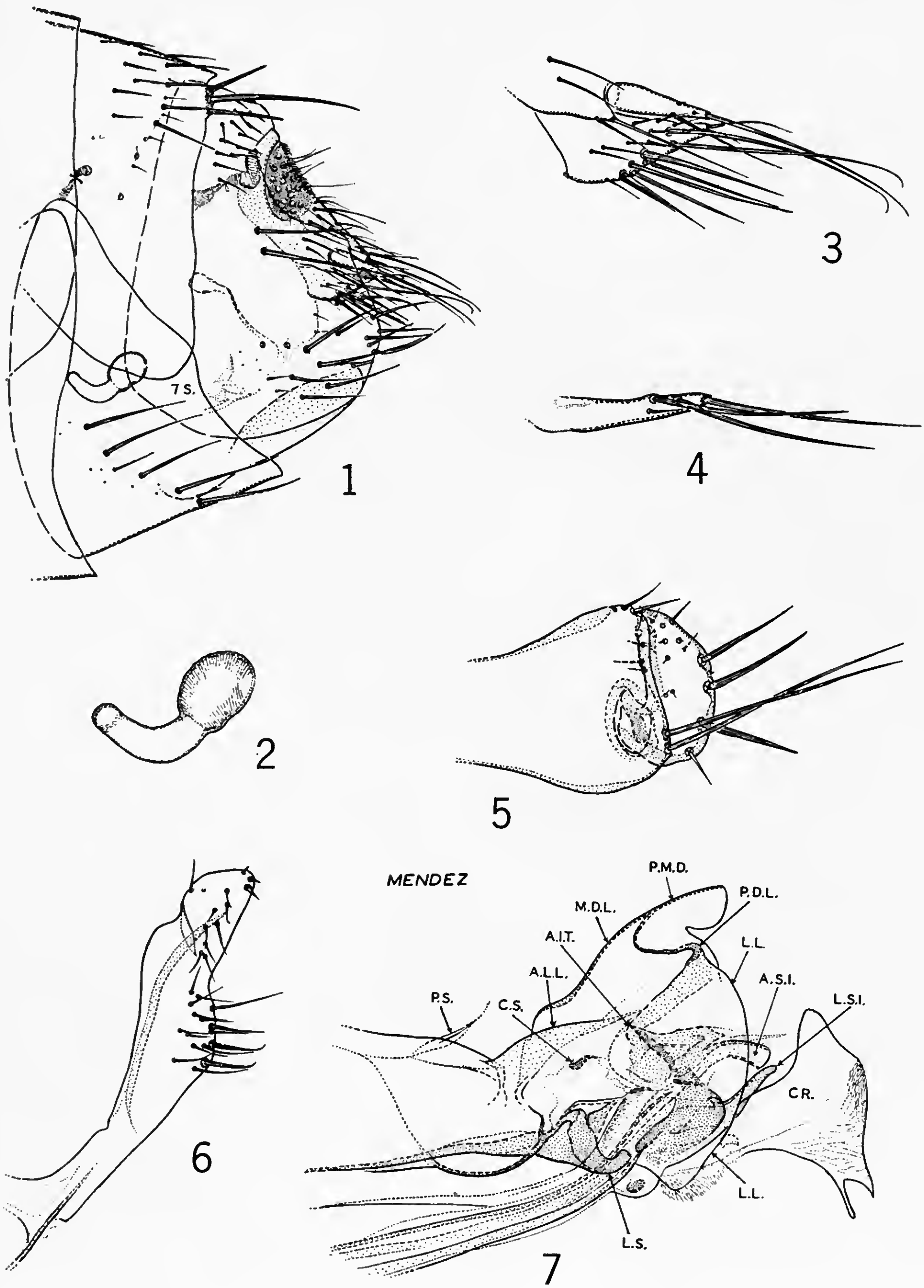
Pleochaetis dolens dolens (Jordan and Rothschild). 1, female, modified abdominal segments. 2, female, anal stylet and ventral anal lobe. 3, male, distal arm of ninth sternum. 4, male, apex of aedeagus. 5, female, spermatheca.



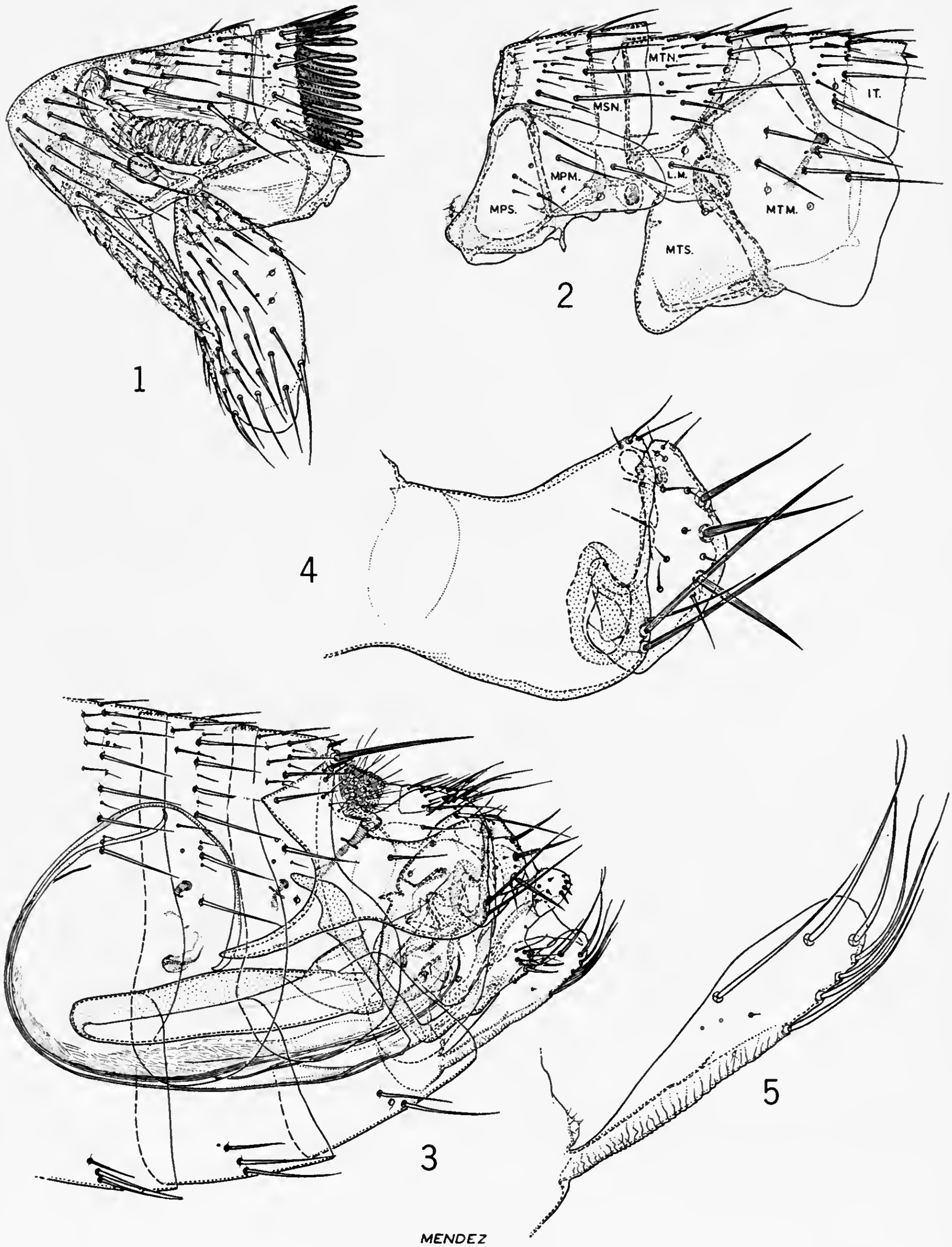
Kohlsia azuerensis, new species. Male: 1, head, prothorax and procoxa; 2, meso-metathorax and first abdominal tergum. Female: 3, anal stylet and ventral anal lobe; 4, modified abdominal segments: 5, spermatheca.



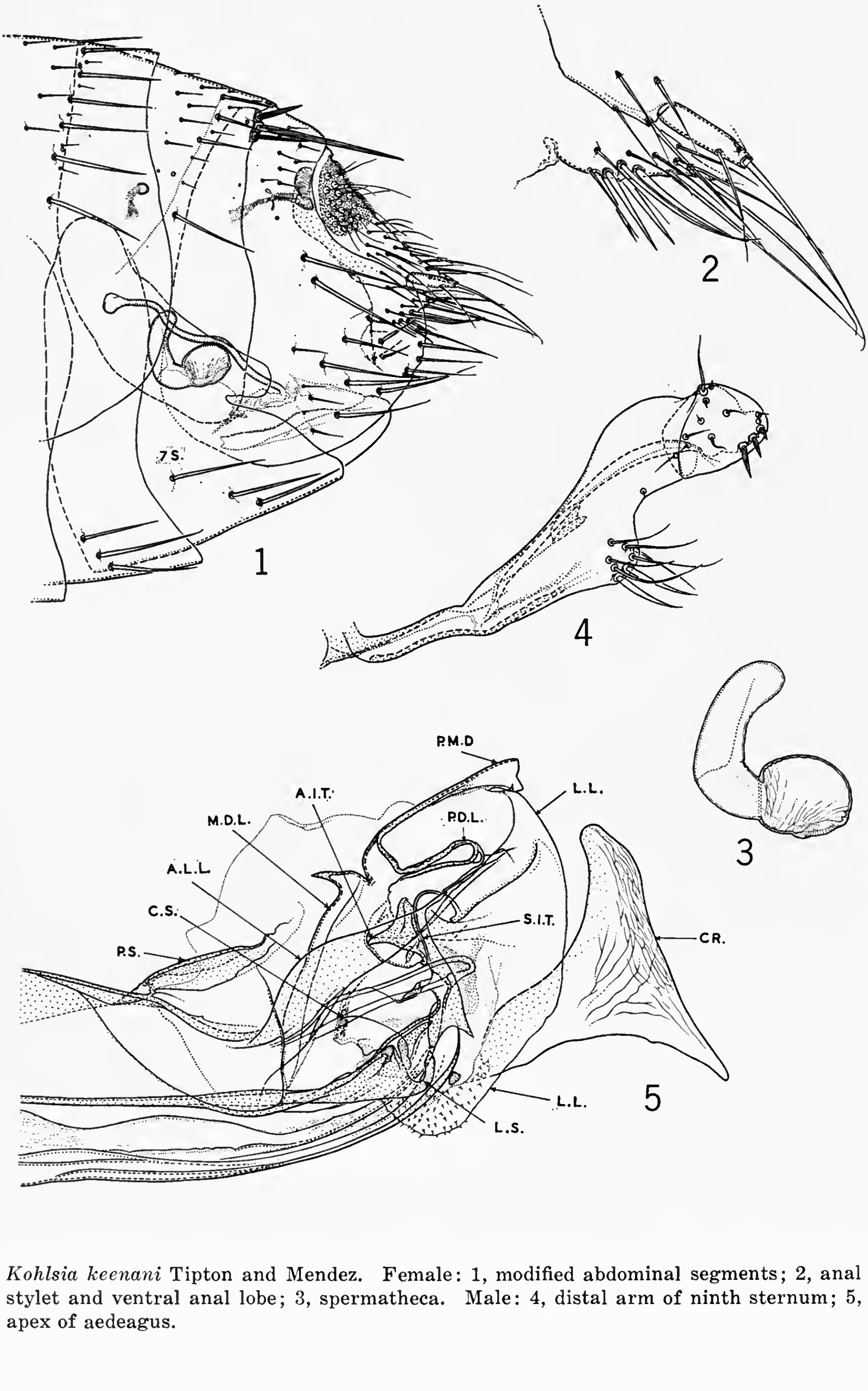
Kohlsia azuerensis, new species, male. 1, apex of aedeagus. 2, distal arm of ninth sternum. 3, process and movable finger of clasper. 4, eighth sternum. 5, modified abdominal segments.



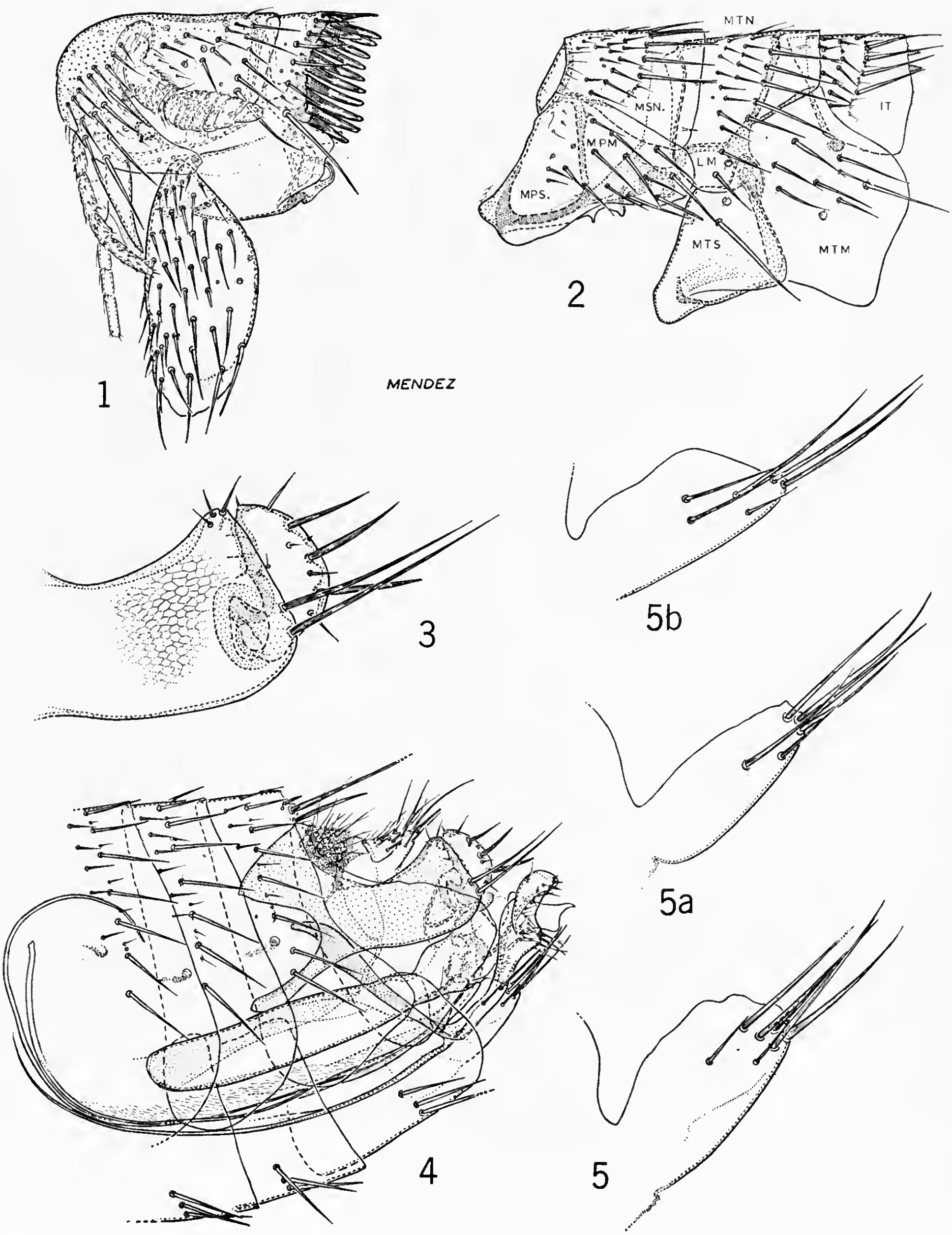
Kohlsia graphis graphis (Rothschild). Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, eighth sternum; 5, process and movable finger of clasper; 6, distal arm of ninth sternum; 7, apex of aedeagus.



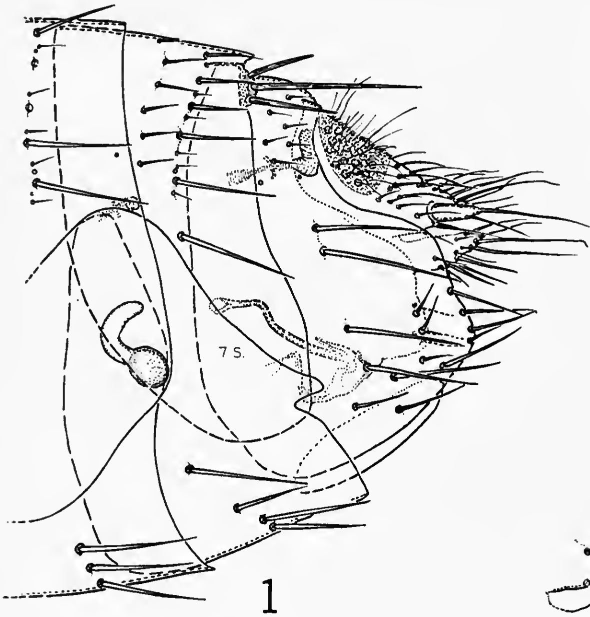
Kohlsia keenani Tipton and Mendez, male. 1, head, prothorax and procoxa. 2, meso and metathorax and first abdominal tergum. 3, modified abdominal segments. 4, process and movable finger of clasper. 5, eighth sternum.



Kohlsia keenani Tipton and Mendez. Female: 1, modified abdominal segments; 2, anal stylet and ventral anal lobe; 3, spermatheca. Male: 4, distal arm of ninth sternum; 5, apex of aedeagus.



Kohlsia mojica, new species, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, process and movable finger of clasper. 4, modified abdominal segments. 5, eighth sternum; a, b, variations.



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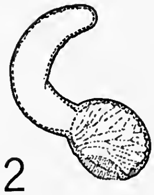

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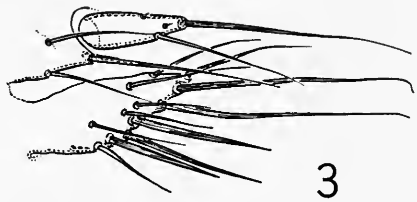
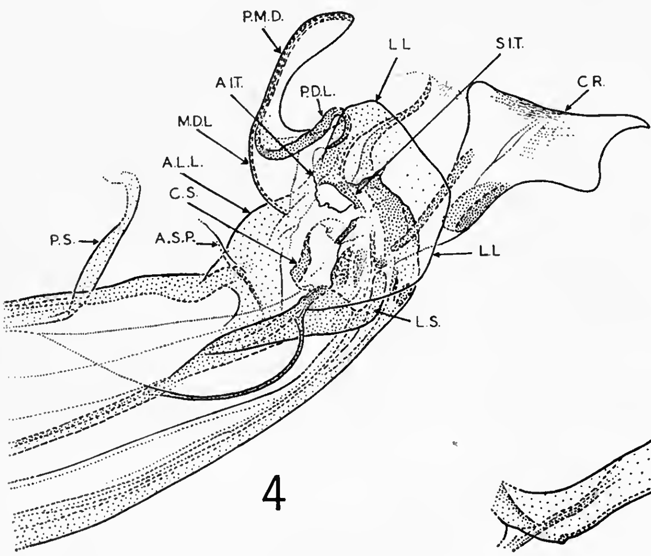


3

MENDEZ



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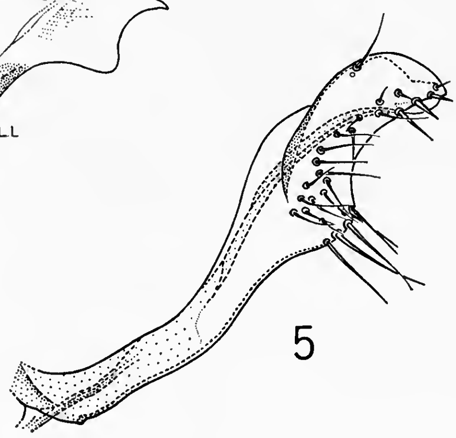
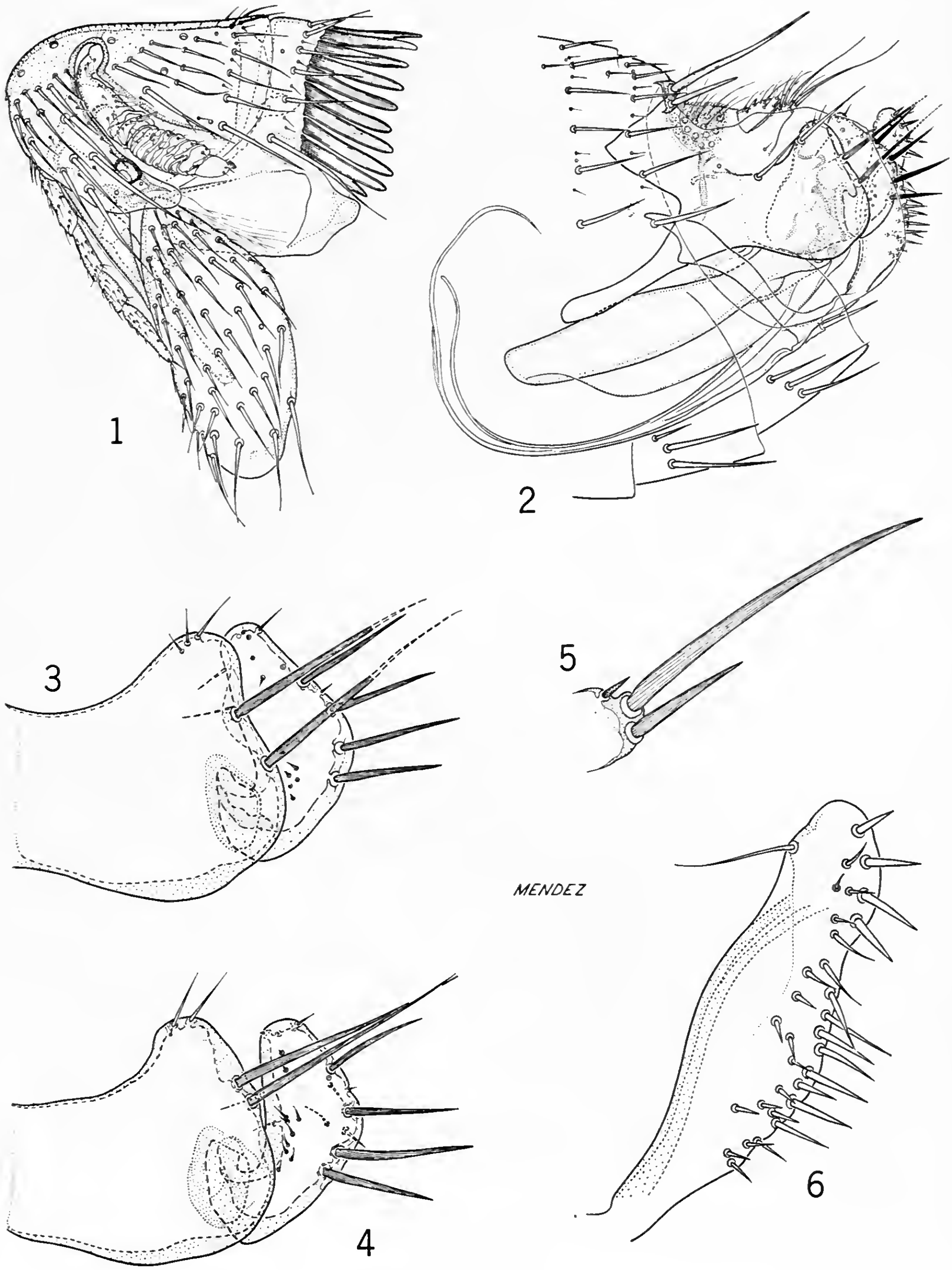
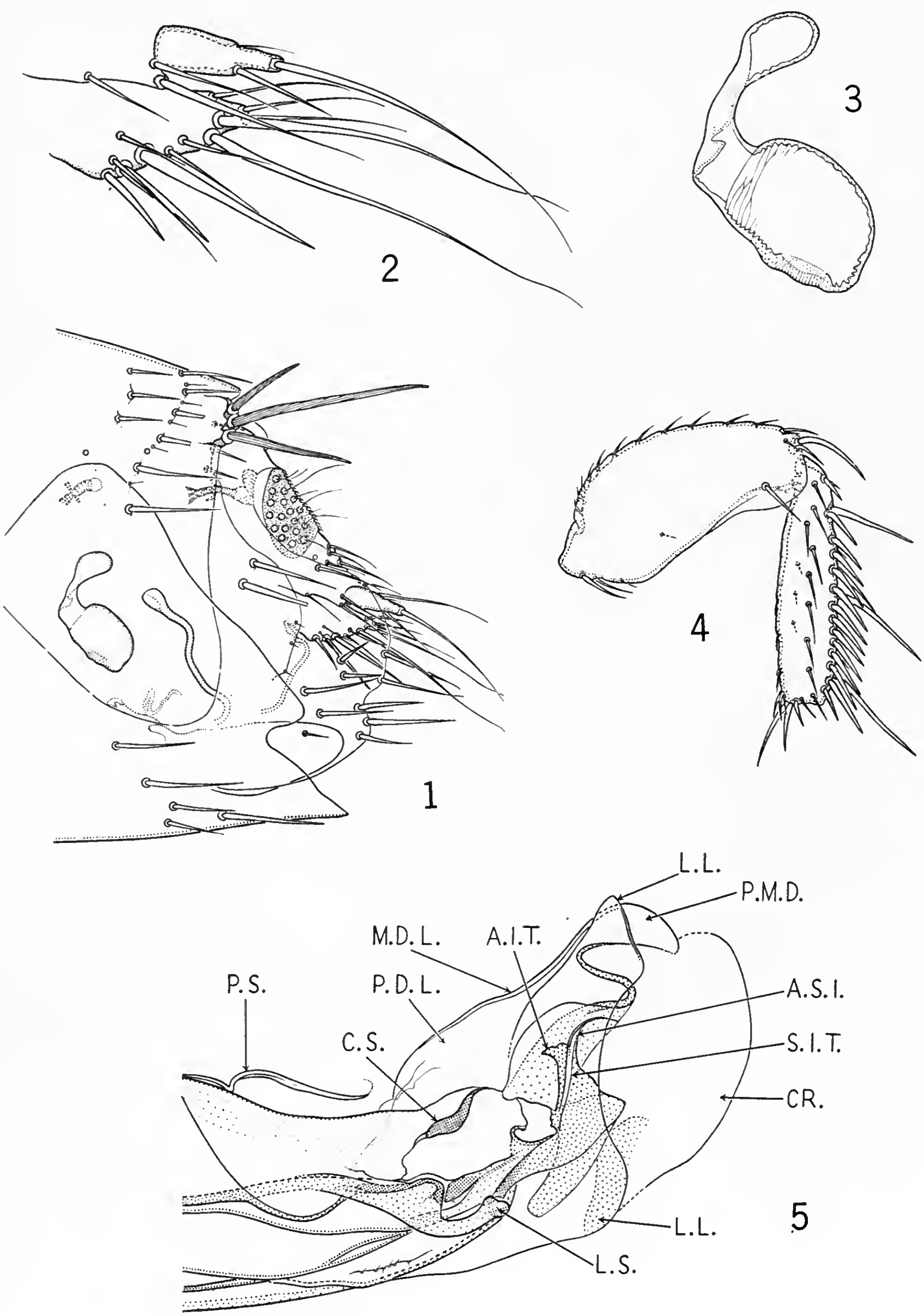


5

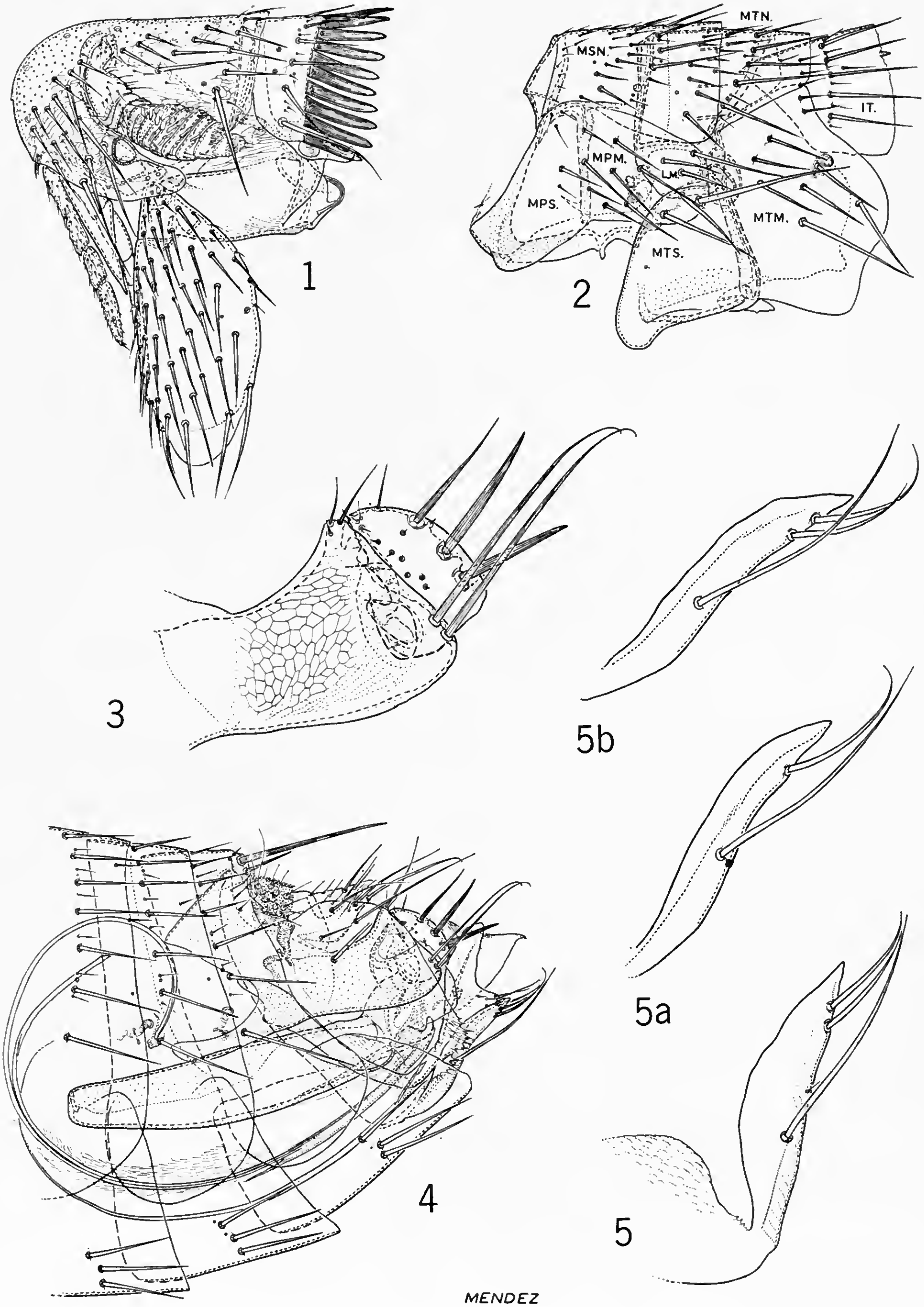
Kohlsia mojica, new species. Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, apex of aedeagus; 5, distal arm of ninth sternum.



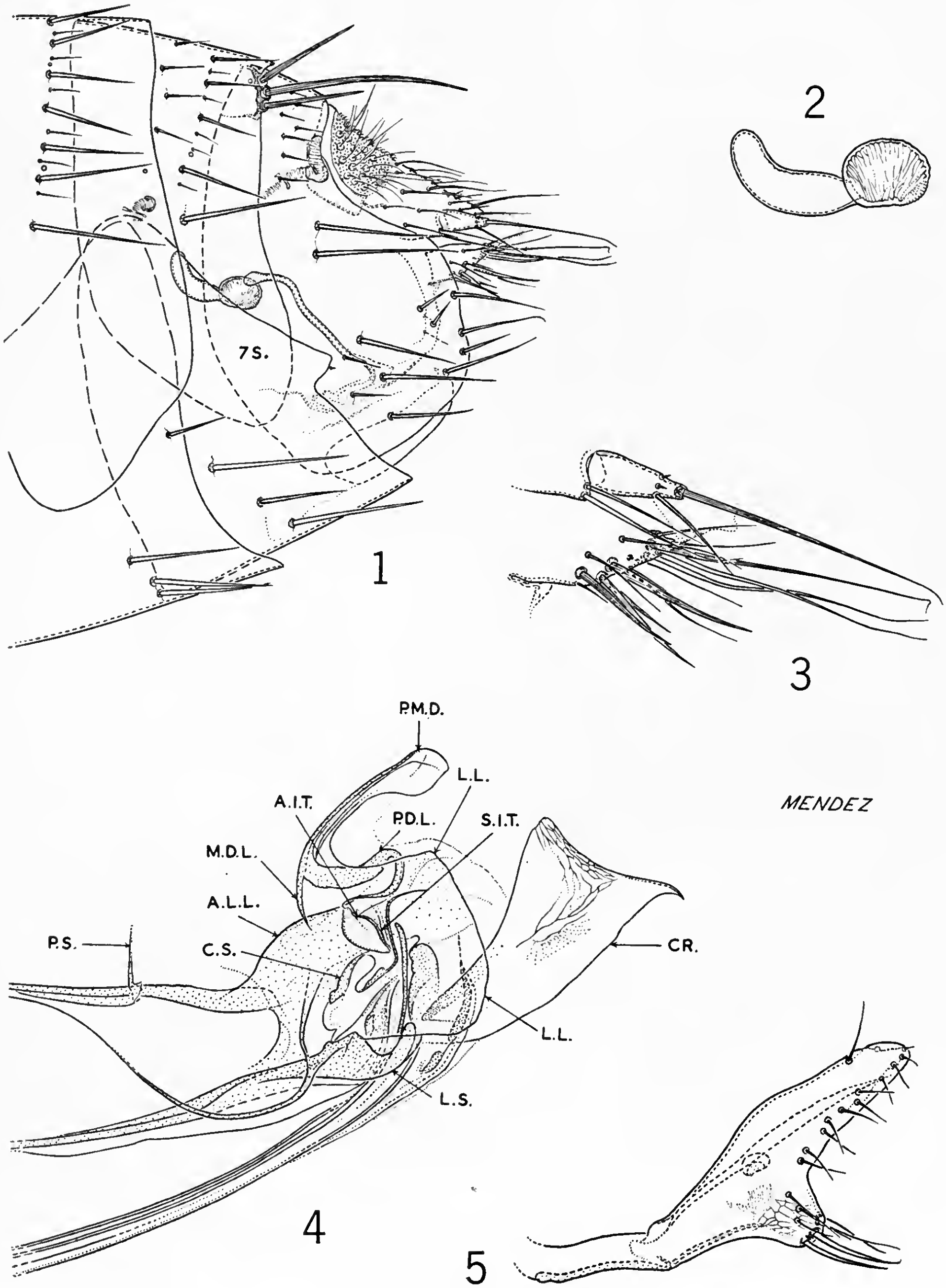
Kohlsia tiptoni, Mendez and Altman, male (figs. 1, 2, 3, 6, holotype male; 4, paratype male; after Mendez and Altman, 1960). 1, head, prothorax and procoxa. 2, modified abdominal segments. 3, 4, movable and immovable process of clasper of holotype and paratype, respectively. 5, antesensillial bristles. 6, distal arm of ninth sternum.



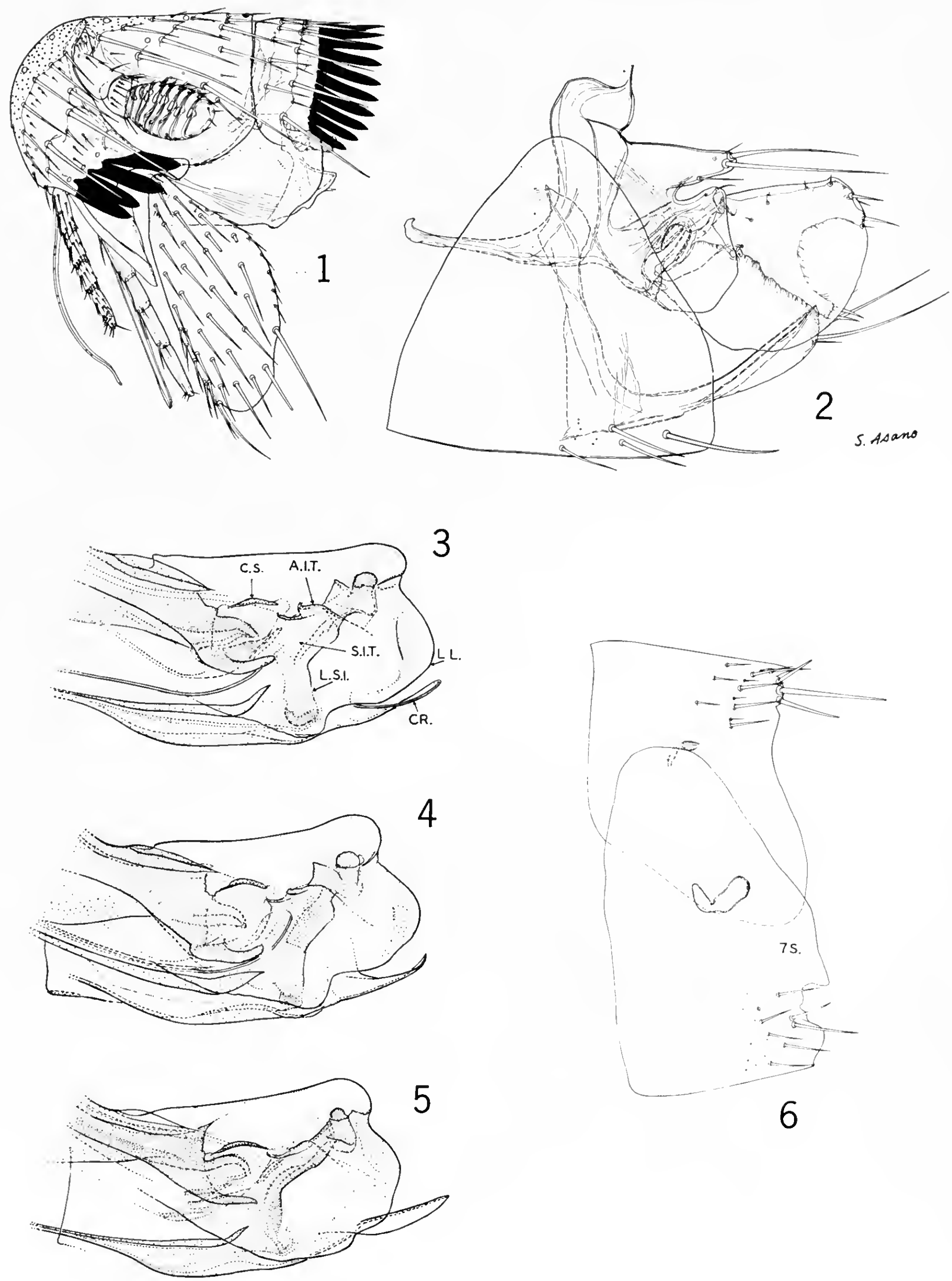
Kohlsia tiptoni Mendez and Altman (1–4, allotype female; 5, holotype male). Female: 1, modified abdominal segments; 2, anal stylet and ventral anal lobe; 3, spermatheca; 4, femur and tibia of hind leg. Male: 5, endchamber of aedeagus. After Mendez and Altman, 1960.



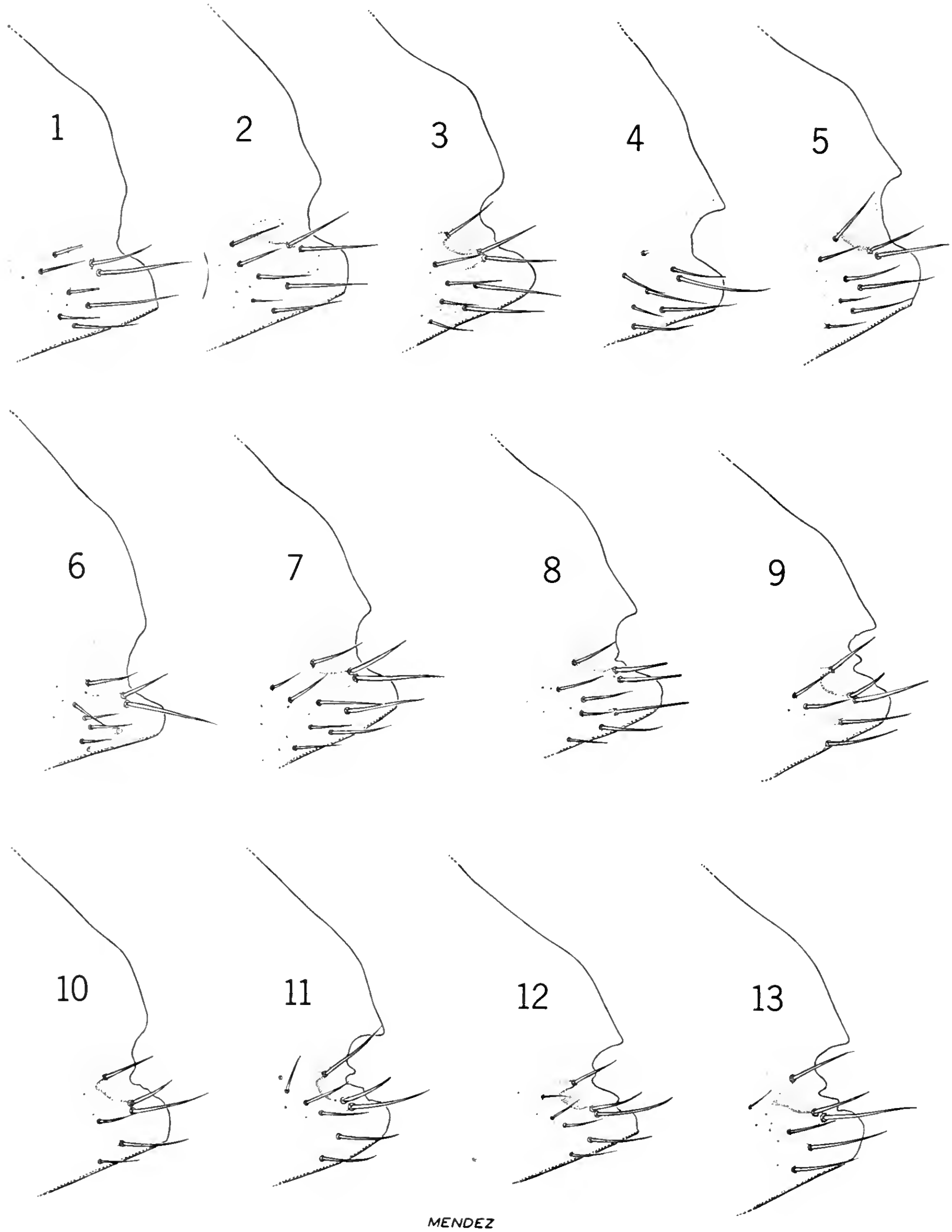
Kohlsia traubi Tipton and Mendez, male. 1, head, prothorax, and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, process and movable finger of clasper. 4, modified abdominal segments. 5, eighth sternum; a, b, variations of eighth sternum.



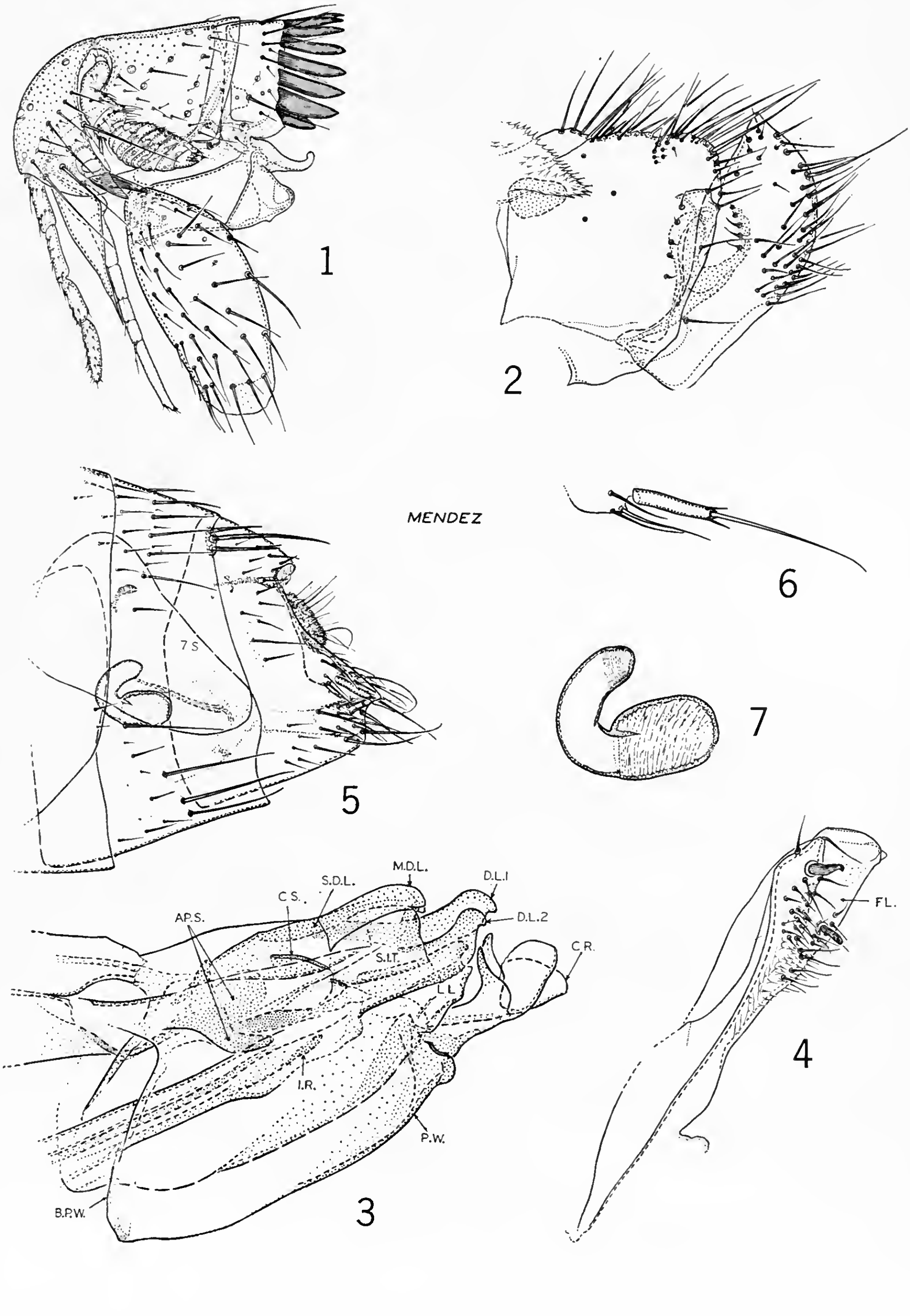
Kohlsia traubi Tipton and Mendez. Female: 1, modified abdominal segments; 2, spermatheca; 3, anal stylet and ventral anal lobe. Male: 4, apex of aedeagus; 5, distal arm of ninth sternum.



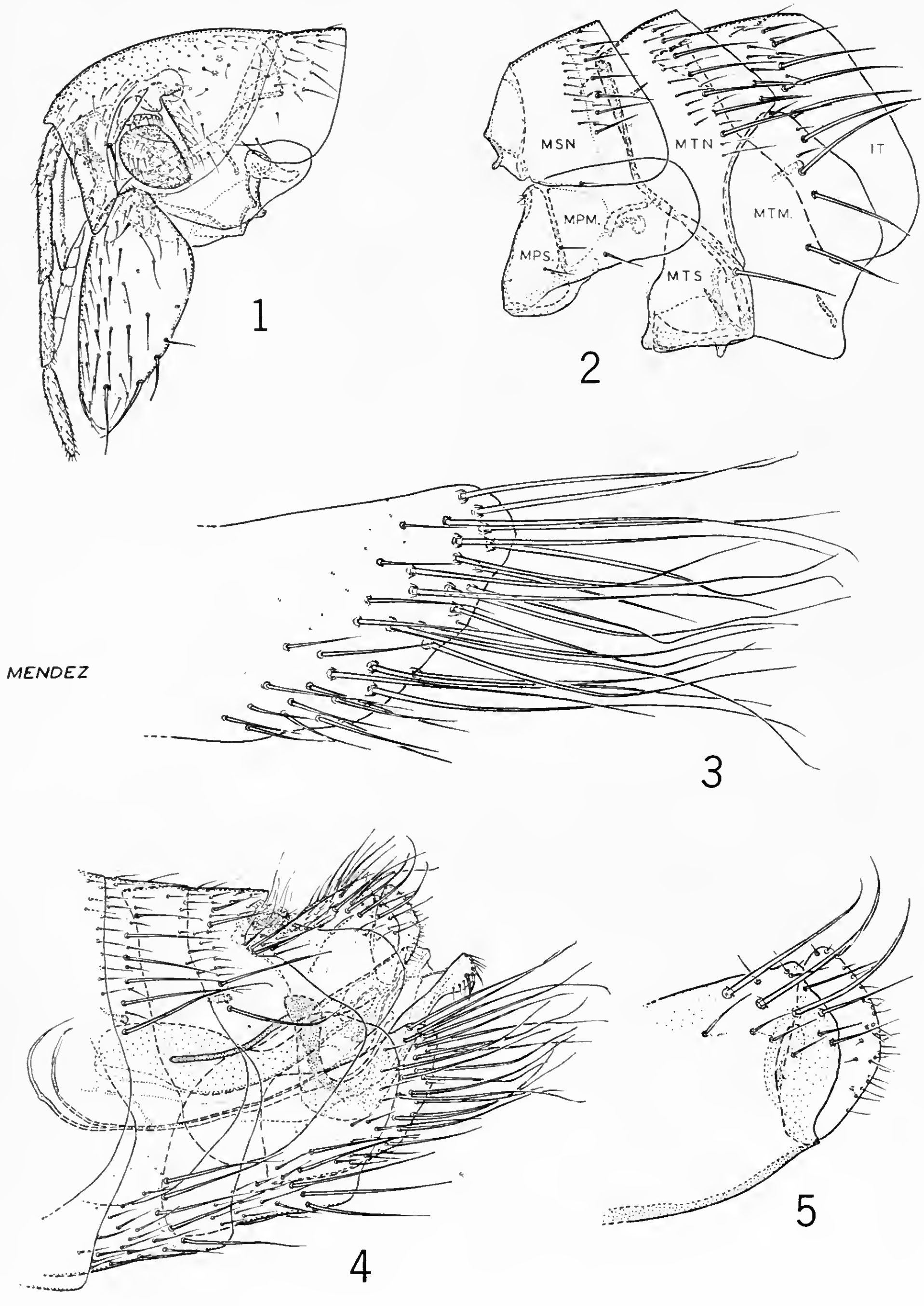
Adoratopsylla intermedia copha (Jordan). Male: 1, head, prothorax and procoxa; 2, genitalia; 3, apex of aedeagus, specimen from Cerro Punta (Chiriquí); 4, apex of aedeagus, specimen from El Valle (Coclé); 5, apex of aedeagus, specimen from Cerro Jefe (Panamá). Female: 6, spermatheca and seventh abdominal segment.



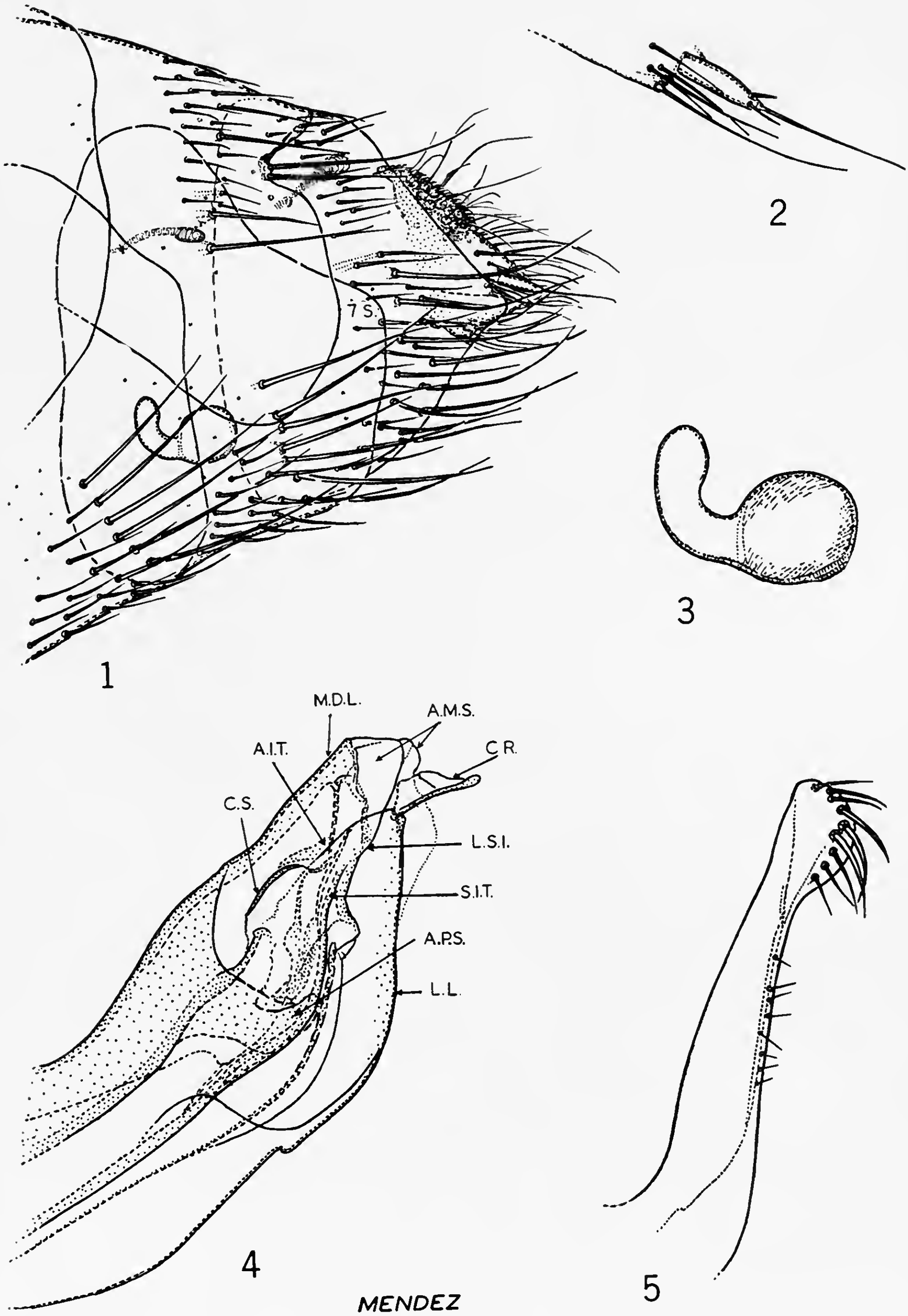
Adoratopsylla intermedia copha (Jordan). Female: Variations of seventh sternum. 1–5, specimens from Cerro Punta (Chiriquí). 6–9, specimens from El Valle (Coclé). 10–13, specimens from Cerro Azul (Panamá).



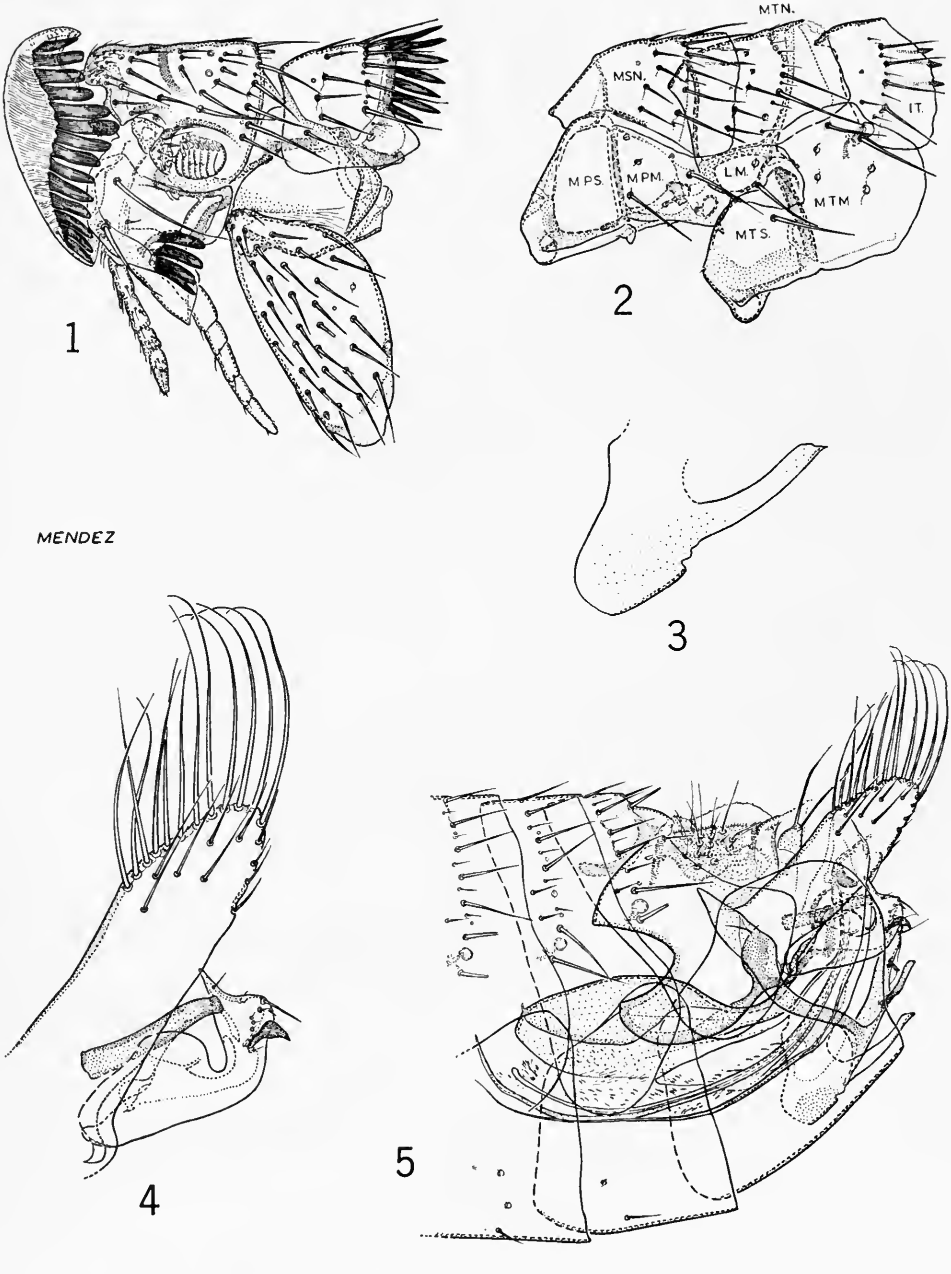
Strepsylla dalmati Traub and Barrera. Male: 1, head, prothorax and procoxa; 2, process and movable finger of clasper; 3, apex of aedeagus; 4, distal arm of ninth sternum. Female: 5, modified abdominal segments; 6, anal stylet; 7, spermatheca.



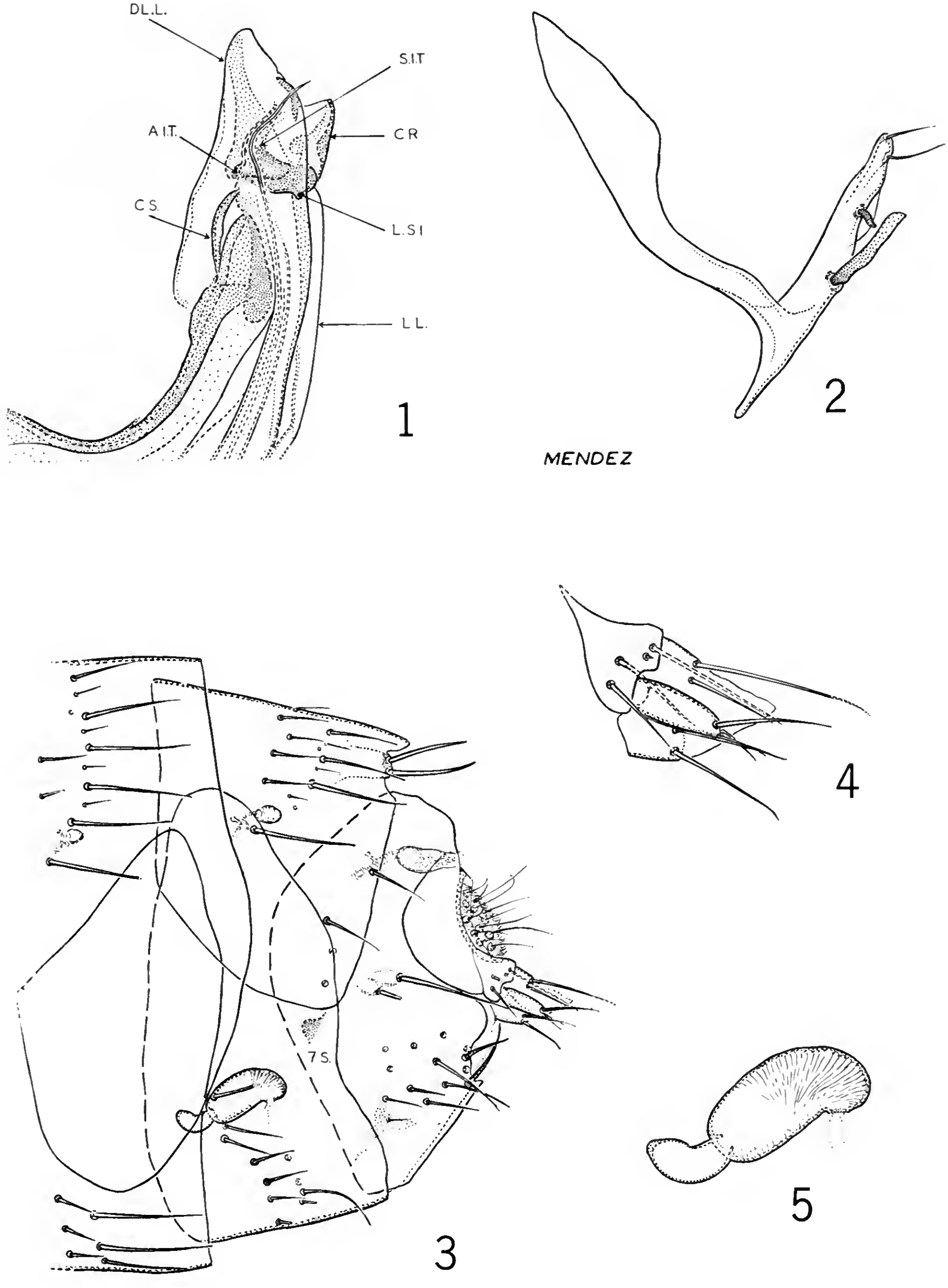
Wenzella yunkeri, new species, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, eighth sternum. 4, modified abdominal segments. 5, process and movable finger of clasper.



Wenzella yunkeri, new species. Female: 1, modified abdominal segments; 2, anal stylet and ventral anal lobe; 3, spermatheca. Male: 4, apex of aedeagus; 5, distal arm of ninth sternum.



Plocopsylla scotinomi, new species, male. 1, head, prothorax and procoxa. 2, meso- and metathorax and first abdominal tergum. 3, eighth sternum. 4, process and movable finger of clasper. 5, modified abdominal segments.



Plocopsylla scotinomi, new species. Male: 1, apex of aedeagus; 2, ninth sternum. Female: 3, modified abdominal segments; 4, anal stylet and ventral anal lobe; 5, spermatheca.

A Checklist of the Hippoboscidae of Panama
(Diptera)

Graham B. Fairchild [1]

The Hippoboscidae (louse flies) of the New World have been exhaustively treated by Dr. Joseph C. Bequaert in a series of papers culminating in his Monograph of the family (1953, 1954, 1955, 1957), which appeared in parts in the Entomologica Americana. Twenty-one species representing nine genera are recorded from Panama in this work. Our collecting of these insects has been incidental to other work, and only eight species have been secured. One of these appears to be a new record for Panama.

The Hippoboscidae are obligate, blood-sucking ectoparasites of birds and mammals. The wings of most species are fully developed. In some genera and species, the wings are deciduous, reduced, or absent. The larvae undergo their complete growth and development within the body of the female. Except in *Melophagus,* fully grown larvae are deposited away from the host (e.g., in the nest) or dropped on the ground. They then form a hard, seed-like puparium. Some species of Hippoboscidae are the invertebrate hosts of a number of blood parasites of vertebrates. The best known of these parasites are species of the genus *Haemoproteus,* which cause malaria-like diseases in birds.

All but two species of the Panamanian Hippoboscidae are parasites of birds. Most of the species are only moderately host specific and generally parasitize hosts of several related species, genera or families. A few are limited to a single host species. The species known from Panama, together with their recorded hosts and their range within the country, are listed below. References are limited to Bequaert's monograph, where a full discussion, descriptions, illustrations, and keys may be found.

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[1] Gorgas Memorial Laboratory, Panamá, Panamá.

Subfamily **Ornithoicinae**

Ornithoica vicina (Walker)

Bequaert (1954: 90, 574) lists it from *Crypturellus, Ramphastos,* and *Myiodynastes,* all from Chiriquí Province. It parasitizes a wide variety of hosts and occurs from Canada to Chile.

Ornithoica confluenta (Say)

Bequaert (1954: 107) did not record the species from Panama. We have taken it twice, both times from *Casmerodius albus* (Common Egret), Almirante (Bocas del Toro), 30 November 1961 and 3 February 1961, P. Galindo, collector.

Subfamily **Ornithomyinae**

Ornithoctona erythrocephala (Leach)

Bequaert (1954: 187, 192) records specimens from seven unrelated birds from Chiriquí Province and San José Island in Panama Bay. We have taken it once from *Eurypyga helias* (Sunbittern), Río Changena (Bocas del Toro), 21 September 1961, and once from *Daptrius americanus* (Red-throated Caracara), same locality, 7 September 1961.

Ornithoctona fusciventris (Wiedemann)

Bequaert (1954: 210, 213) records specimens from 10 species of hosts, nine of them *Passeriformes,* all from Chiriquí Province. He believes that the true breeding hosts are Passerine birds. In a supplement, Bequaert (1957: 576) adds a number of additional host records, also all from Chiriquí Province. We have taken the species four times, twice from Río Changena (Bocas del Toro), from *Dysithamnus puncticeps* (Spot-crowned Ant Vireo) and *Thryothorus atrogularis* (Black-throated Wren); and twice from Cerro Hoya (Los Santos), from "yellow water thrush," 13 February 1962, C. O. Handley, collector, and from "wren," 14 February 1962, C. O. Handley, collector.

Ornithoctona nitens (Bigot)

Bequaert (1954: 227, 228; 1957: 577) records specimens from several species of Trogonidae and a house wren, all from Chiriquí Province. Bigot's types were from Panama.

Stilbometopa ramphastonis Ferris

Bequaert (1955: 254) records the species from *Ramphastos swainsonii* (Chestnut-mandibled Toucan) and from a dove. The type came from Chiriquí Province, and Bequaert saw other specimens from Gamboa (Canal Zone) and Tapia (Panamá). We have taken a single female, which is believed to be this species, from *Monasa morphoeus grandior* (White-fronted Nunbird), Río Changena (Bocas del Toro) 20 September 1961.

Lynchia americana (Leach)

Bequaert (1955: 272, 291) records the species from *Bubo virginianus* (Great Horned Owl) from Chiriquí Province, and without host from Juan Diaz (Panamá). Bequaert believes the true hosts to be owls, hawks, and gallinaceous birds.

Lynchia angustifrons (van der Wulp)

Bequaert (1955: 305, 307) records a number of specimens from hawks and toucan, from localities in and near the Canal Zone and from Chiriquí Province. We have taken a single male from *Ramphastos swainsonii* (Chestnut-mandibled Toucan), Río Changena (Bocas del Toro), 8 September 1961. Bequaert believes hawks probably are the main breeding hosts, possibly also owls and toucans.

Lynchia wolcotti (Swenk)

Bequaert (1955: 311, 312) records from Chiriquí and Bocas del Toro Provinces, 3 lots, all from hawks, which appear to be the principal, if not the only, breeding hosts. We have 1 female, from *Otus guatemalae* (Vermiculated Screech Owl), Río Changena (Bocas del Toro), 21 September 1961.

Lynchia nigra (Perty)

Bequaert (1955: 314, 319) lists one record, from *Buteogallus anthracinus* (Common Black Hawk) from Pacora (Panamá).

Lynchia albipennis (Say)

Bequaert (1955: 330, 336) reports the species from *Cochlearius cochlearius* (Boat-billed Heron) from Puerto de Chorrera (Panamá); also from Ancón and Christóbal (Canal Zone), no host. Wading birds of the Order Ciconiiformes are the only true hosts.

Microlynchia crypturelli Bequaert

Bequaert (1955: 377) described the type specimens from *Crypturellus soui* (Little Tinamou) from La Vaca (Chiriquí). The only other known records of this rare species are from Southern Brazil, also mainly from *Crypturellus*.

Pseudolynchia canariensis (Macquart)

Bequaert (1955: 390, 397) saw material from Ancón (Canal Zone), and during the last war, the United States Army Signal Corps pigeons at Quarry Heights (Canal Zone) were heavily infested by this world-wide species. The only known host is the domestic pigeon, at least in the western hemisphere.

Pseudolynchia brunnea (Latreille)

Bequaert (1955: 411, 414) records specimens from *Chordeiles acutipennis* (Lesser Night Hawk) from Barro Colorado Island (Canal Zone).

We have 1 male and 2 females from 'capacho,' *Caprimulgus rufus* (Rufous Nightjar), Río Changena (Bocas del Toro), 16 September 1961. Bequaert notes that this species is known almost exclusively from Caprimulgiformes.

Olfersia spinifera (Leach)

Bequaert (1957: 429, 430) notes specimens from Panama and Taboguilla Island in Panama Bay, no host. It is a specific parasite of frigate birds (*Fregata*), and only occasionally parasitizes other marine birds.

Olfersia aenescens C. G. Thomson

Bequaert (1957: 437), gives one record from Panama from *Sterna fuscata* (Sooty Tern). The chief hosts are a variety of marine birds.

Olfersia bisulcata Macquart

Bequaert (1957: 457, 459) records a series of captures of this species, all from vultures of several species, of which it is a specific parasite. He notes it as a common species. There are specimens in the Gorgas Memorial Laboratory collection from turkey buzzard collected by L. H. Dunn. Recorded localities suggest the species is well distributed in Panama.

Olfersia fossulata Macquart

Bequaert (1957: 464, 465) gives a single record for the Canal Zone, without host. He states it to be a common parasite of marine birds.

Olfersia sordida Bigot

Bequaert (1957: 469, 470) lists 5 records for coastal Panama and Barro Colorado Island, the hosts being pelicans and, in one case, a cormorant. Pelicans appear to be the chief host.

Olfersia coriacea van der Wulp

Bequaert (1957: 474, 476) gives two records for this species, Juan Diaz, no host, and Upper Chagres River, from *Agriocharis ocellata* (Ocellated Turkey). This last seems to be an error, as this bird is not reported south of Guatemala. The species seems to occur only on Galliformes.

Subfamily **Melophaginae**

Lipoptena (Lipoptenella) mazamae Rondani

Bequaert (1957: 499, 501) refers to earlier records and adds Panama City, no host. Dunn (1934) took specimens from *Mazama* at Camp Pital (Chiriquí), and we have taken it several times from *Mazama*, Río Chucunaque (Darién), 18 February 1958, P. Galindo, collector; from *Odocoileus*, Cerro Hoya (Los Santos), 9 February 1962, C. O. Handley, collector; from *Mazama americana* (Red Brocket), upper Río Mono, Río Tuira Basin (Darién), 25 and 27 June 1962, A. Adames, collector; and from *Odocoileus virginianus* (White-tailed Deer), Los Santos Province, 20 February 1962, V. J. Tipton, collector. It is a specific parasite of deer.

Melophagus ovinus (Linnaeus)

Bequaert (1957: 507, 516) reports one record for Panama, but the species does not thrive in the moist tropics. It is a specific parasite of domestic sheep and is world-wide in distribution.

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1953–1957. The Hippoboscidae or Louse-flies (Diptera) of mammals and birds. Part I. Structure, physiology and natural history. 1953, Ent. Amer., (n.s.), **33**: 1–209, 211–442, figs. 1–21. Part II. Taxonomy, evolution and revision of American genera and species. 1954, ibidem, **34**: 1–232, figs. 22–44. 1955, ibidem, **35**: 233–416, figs. 45–82. 1957, ibidem, **36**: 417–611, figs. 83–104.

Nycteribiid Batflies from Panama
(Diptera: Nycteribiidae)

LINDOLPHO R. GUIMARÃES [1]

Two species of nycteribiids were hitherto known from Panama, *Basilia myotis* and *B. dunni,* both described by Curran (1935) from specimens taken from *Myotis nigricans.* In the present paper we add five more species of *Basilia,* of which two are new.

Genus **Basilia** Miranda Ribeiro

Basilia M. Ribeiro, 1903, Arch. Mus. Nac. Rio de Janeiro, 12: 177.
Pseudelytromyia M. Ribeiro, 1907, ibidem, 14: 233.
Guimaraesia Schuurmans-Stekhoven Jr., 1951, Acta Zool. Lilloana, 12: 109.
Type-species: *Basilia ferruginea* M. Ribeiro, 1903.

Only two genera of nycteribiids are known from the New World, *Basilia* M. Ribeiro, 1903, and *Hershkovitzia* Guimarães and D'Andretta, 1956. They are easily distinguished by several characteristics. However, the separation between *Basilia* and some Old World genera is rather subtle and is based primarily on the presence of two-faceted eyes in *Basilia.* The following characters are common to all New World *Basilia:*

Anterior region of head (vertex) sclerotized; eyes two-faceted; palps with sub-parallel margins. Noto-pleural sutures parallel, with lateral plates. Sternal plate with one suture on each side of the lateral margins. Tarsal segment I much longer than the remaining segments taken together. Abdomen of female with two or three sclerotized plates (visible tergites) on the dorsal side.

KEY TO PANAMANIAN SPECIES

FEMALES

1. Tibiae of all legs with four or five transverse rows of setae on the ventral margin. Tergal plate I transformed into two elongate lobes with short and long setae......2
   Tibiae with three rows of setae. Tergal plate II transformed into two elongate lobes with short and long setae or with posterior margin arcuate...............3

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[1] Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brasil.

2. Tibiae with four transverse rows of setae on ventral margin. Tergal plate II with sparse setae next to the median longitudinal suture. Posterior elevation of mesonotum without a median digitiform process..........*ferruginea* M. Ribeiro
   Tibiae with five rows of setae. Tergal plate II with numerous setae next to the median suture. A small digitiform process on middle of posterior elevation of mesonotum ....*handleyi* n. sp.
3. Tergal plate II transformed into two elongate lobes............................4
   Tergal plate II with arcuate posterior margin.................................5
4. Lobes of tergal plate II very thin. Lateral connexivum of abdomen (dorsal) with short pustulate setae and with a converging row of larger setae................ ....*wenzeli* Guimarães and D'Andretta
   Lobes of tergal plate II not very thin. Lateral connexivum of abdomen with medium and long pustulate setae.......................................*tiptoni* n. sp.
5. Tergal plate I short, with few discal setae. Each tergite of tergal plate I more than twice as long as broad. Third sternite obsolete....................... ....*anceps* Guimarães and D'Andretta
   Not so 6
6. Long setae of posterior margin of the tergal plate I reaching or crossing the posterior border of the tergal plate II. Discal setae of tergal plate II on lateral halves of tergite ....*myotis* Curran
   Long setae of posterior margin of the tergal plate I not reaching posterior margin of the tergal plate II. Discal setae of tergal plate II in irregular rows converging obliquely toward the mid-line...........................*dunni* Curran

Basilia ferruginea M. Ribeiro

Basilia ferruginea M. Ribeiro, 1903, Arch. Mus. Nac., **12**: 179, pl. I, figs. 1, 2. M. Ribeiro, 1907, ibidem, **14**: 231, pl. XXIV, fig. 1. Ferris, 1924, Ent. News, **35**: 195. Stiles and Nolan, 1931, Bull. Natl. Inst. Health, no. 155, p. 648. Schuurmans-Stekhoven Jr., 1931, Zeitschr. Parasitenk., **3**: 216. Curran, 1935, Amer. Mus. Nov., no. 765, p. 2. Scott, 1936, Linn. Soc. Jour., Zool., **39**: 497, 503, fig. 11. Del Ponte, 1944, Ann. Med. Reg., **1**: 118, 124. Guimarães, 1946, Arq. Zool. Est. S. Paulo, **5**: 14, 19, 20, figs. 12-20; Guimarães and D'Andretta, 1956, ibidem, **10**: 28, figs. 5, 6, 74.

Previous records: Brazil, from *Lasiurus borealis bonariensis;* Paraguay, from unknown host; Cuba, from *Lasiurus pfeifferi.*

PANAMANIAN MATERIAL EXAMINED: One male and 2 females from *Lasiurus borealis frantzii,* (host no. 11699), Armila (San Blas), 17 March 1963, collected by C. O. Handley.

REMARKS: *Basilia ferruginea* is characterized by the length of the pustulate setae of the lateral abdominal connexivum and by the presence of four transverse rows of setae on the ventral margin of all tibiae. The male has the same chaetotaxy on the tibiae and a large number (ca. 40) of spiniform setae on the posterior margin of the fourth abdominal sternite.

Basilia handleyi, new species. Figure 35A.

This species closely resembles *B. ferruginea,* but differs in having: much larger size; more abundant pilosity; a digitiform process on the posterior elevation of the mesonotum; 14 or 15 notopleural setae instead of eight or 10; five, instead of four, rows of setae on the tibiae; the discal setae of second tergal plate more numerous and concentrated along the mid-line; anal segment more conical and pilose; pustulate setae on lateral connexivum of abdomen more abundant, longer and thicker; 65 to 68 spines of the ctenidium of the distal margin of the basal sternite; two, instead of six, setae on the genital plate.

DESCRIPTION, FEMALE: *Head.*—Vertex with three or four pairs of setae near the anterior margin, between the eyes; anterior margin of each gena with eight setae. Postgena with five or six scattered short setae. Palpi with two terminal setae (one very long) and three or four pairs near the lateral margin on the ventral side; one of the eyes typically with two ocelli, the other with only one ocellus. The paratype has two ocelli on the two eyes.

Thorax.—Much wider than long (1.42 x 0.96 mm.). Mesonotum raised posteriorly,

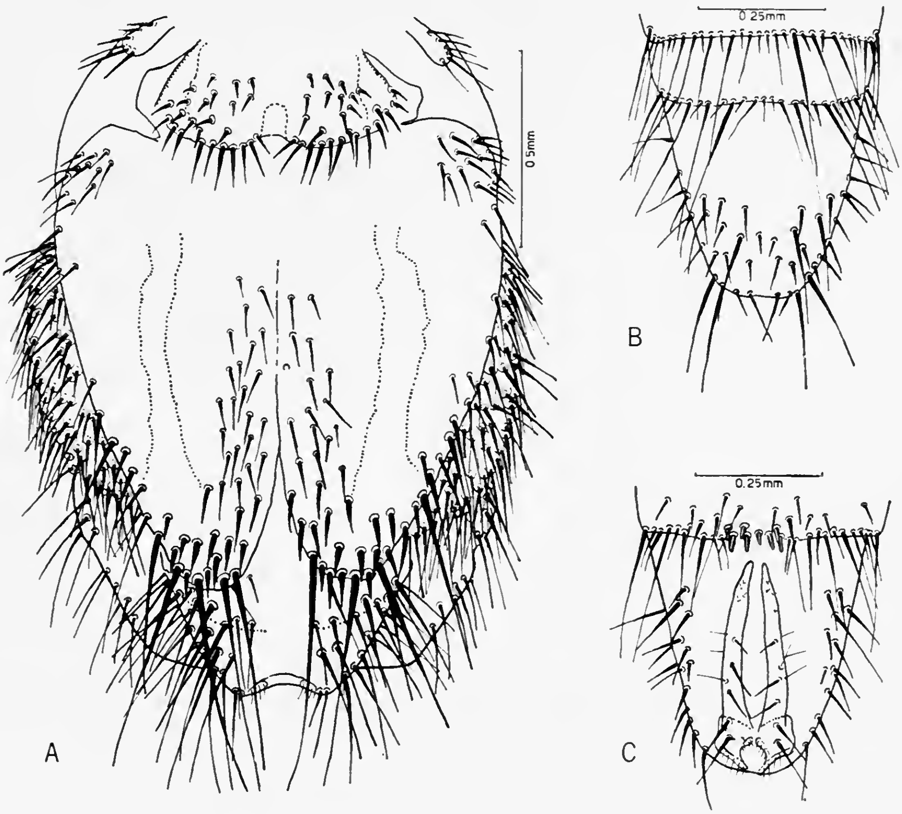

Fig. 35. *Basilia handleyi,* new species. A, dorsal view of abdomen, female. *Basilia anceps,* male. B, last two tergites, and C, terminal sternite.

with a conspicuous median digitiform process; 14 to 16 notopleural setae; thoracic ctenidium with 22 or 23 spines. Legs long, little laterally compressed. Tibiae scalpel-shaped, with five rows of setae ventro-distally. The proximal row, although less well-developed than the others, is rather conspicuous.

Abdomen.—Tergal plate I wider than long, with posterior margin slightly sinuate, paralleled by thick setae of medium length and showing, on each side of the mid-line, several blunt discal setae on the posterior half. Tergal plate II longitudinally divided; each half ending posteriorly as a lobe with three or four long, thick setae and some spine-like setae; lateral margins with medium and long setae; discal setae arranged in several irregular rows along the mid-line and clustering on the antero-lateral corners. Anal segment truncate, conical with numerous long, thick setae on each side of the mid-line. Lateral connexivum with long and medium pustulate setae. Ctenidium of hind margin of basal sternite with 65 to 68 spines. Behind the basal sternite there are five others, the two anterior ones limited posteriorly by a row of setae longer than the discals. Fourth sternite represented by two plates more sclerotized than the connexivum, separated medially and showing two rows of setae, the posterior row denser and stronger. Fifth sternite also made of two plates separated in the middle and with setae as in fourth. Distal sternite trapezoid, more than 2.5 times as broad as long; discal setae in four or five irregular rows on posterior two-thirds; lateral and posterior margins paralleled by setae that are a little longer than the discal setae. Only two genital setae, connected to the anal sclerite by a strip slightly more sclerotized than the connexivum.

Length, 2.72 mm.

MALE: Unknown.

TYPE MATERIAL: Holotype female from *Lasiurus castaneus* Handley (host no. 11176), Armila (San Blas), collected 23 February 1963, by C. O. Handley. In the collection of Chicago Natural History Museum. Paratype female, same data as the holotype but collected 26 March 1963 (host no. 11911), deposited in the Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil.

REMARKS: This is the only New World species of *Basilia* that has tergal plate II transformed posteriorly into two lobes and the fifth sternite longitudinally divided. All other species with lobes on tergal plate II have a whole fifth sternite.

Basilia wenzeli Guimarães and D'Andretta

Basilia wenzeli Guimarães and D'Andretta, 1956, Arq. Zool. Est. S. Paulo, **10**: 42, figs. 25-33, 57, 80.

Previous records: Venezuela, from *Eptesicus fuscus* and *Lonchorhina aurita;* Columbia, from *Histiotus* sp.

PANAMANIAN MATERIAL EXAMINED: From *Eptesicus brasiliensis propinquus:* Sibubé (Bocas del Toro), 1 male on 16 January 1963 (host no. 10659), 3 males and 4 females on 17 January 1963 (host no. 10706), and 1 male on 25 January 1963 (host no. 10935) all collected by C. O. Handley; Los Santos Province, 1 male and 1 female (host no. 10029), 26 February 1962, V. J. Tipton; Armila (San Blas), 1 female (host no. 11761), 20 March 1963, C. O. Handley. From *Artibeus j. jamaicensis,* Cerro Hoya (Los Santos), 1 female, 18 February 1962, V. J. Tipton.

REMARKS: The female of this species differs from all others by the great length of the terminal segment and by the forward position of the anal segment.

The posterior lobes of tergal plate II are rather thin, a character which indicates a close relationship of this species to *B. corynorhini* Ferris, 1916.

Basilia tiptoni, new species. Figure 36.

Very close to *B. silvae* (Brèthes, 1913), from which it differs in having: 12, instead of eight or ten, notopleural setae; a small digitiform process on the posterior elevation of the mesonotum; longer and more numerous pustulate setae on the lateral connexivum; lateral margins of anal segment subparallel (convergent in *silvae*). The main difference, however, is in the shape of tergal plate I, which has two median projections on the posterior border, each projection bearing two setae. The male of *B. tiptoni* n. sp. has only 11 spiniform setae on the posterior margin of the fourth abdominal sternite; there are 20 in *silvae*.

DESCRIPTION, FEMALE: *Head.*—Anterior margin of vertex slightly concave, paralleled by two pairs of setae. Anterior margin of each gena with six or seven setae; postgena with five or six scattered setae on each side. Palpi with a long apical seta and eight uneven setae near the sides of the ventral aspect. Eyes typically two-faceted.

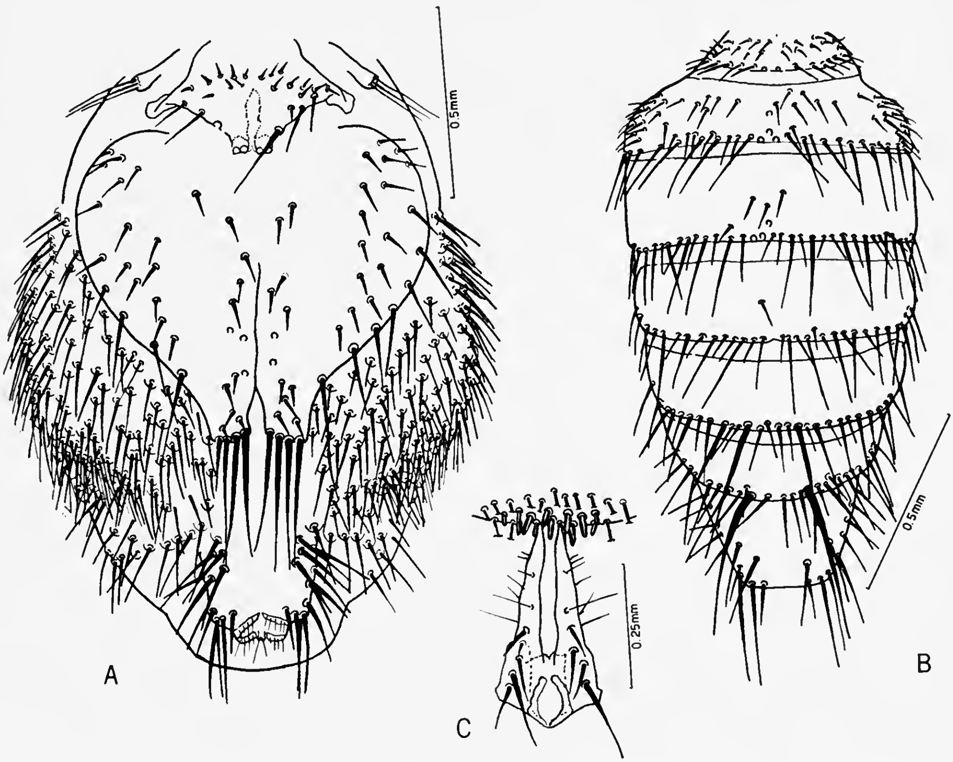

Fig. 36. *Basilia tiptoni*, new species. A, dorsal view of abdomen, female. B, abdomen, and C, claspers, male.

Thorax.—Wider than long (1.08 x 0.95 mm.). Mesonotum raised posteriorly, with a median digitiform process; 12 notopleural setae. Thoracic ctenidium with 18 or 19 spines. Legs long and little laterally compressed; tibiae scalpel-shaped with three rows of setae on the distal half of the ventral aspect.

Abdomen.—Posterior margin of tergal plate I with two slight lobes, each with two setae (deciduous in the type); three or four setae on each side of the posterior margin; some scattered spine-like setae on the disc. Tergal plate II longitudinally divided; each half ending posteriorly in a lobe with four long, thick setae; discal setae concentrated along the median suture and on the outer halves of the tergites. Anal segment with subparallel sides, bearing 11 or 12 thick setae on each side. Lateral connexivum with medium and long pustulate setae, some of which are as long as the discal setae of tergal plate II. Ctenidium of basal sternite with 44 or 45 spines. Posterior to the basal sternite are five other sternites, well set off by the setae on their posterior margins. The second sternite is completely covered with setae; the third has, in addition to the setae of the hind margin, only a few lateral setae; the fourth sternite is divided into two plates medially and bears one row of setae; the fifth is entire and bears two irregular rows of setae. The terminal segment is wider than long, with rounded margins paralleled by 13 or 14 uneven setae; the discal setae are few (four or five), restricted to the posterior half. Genital plate with three setae.

Length, 2.59 mm.

MALE: Head, thorax and legs as in the female; however, in the single male specimen, the vertex bears three pairs of setae instead of two. Thorax slightly broader than long (1.03 x 0.93 mm.) and has no digitiform process on the mesonotum. It is possible to recognize seven abdominal tergites; the first is short, has two or three rows of small discal setae and a row of slightly larger setae on the hind margin; the second is longer, with 12 or 13 discal setae arranged in two irregular rows, plus, on each side, a group of setae as long as or shorter than the discals, and still, on the posterior margin, a row of interspersed medium and short setae; third dorsal segment with a posterior row of setae and four or five discals; fourth to sixth segments with setae only along the posterior margin; terminal tergite with one or two irregular rows of setae on the posterior margin. Ventrally, five sternites are recognizable; the ctenidium of the basal sternite has 44 or 45 spines; the second sternite has three irregular rows of discal setae and one row of larger ones on the posterior margin; the third sternite has setae only along the posterior margin, while the fourth sternite, besides these, has an irregular row of discals near the posterior margin plus a group of 11 spiniforms grouped on the mid-line.

Length, 2.39 mm.

TYPE MATERIAL: Holotype female from *Lonchorhina* or *Tonatia* (host no. 8288) 22 miles south of Changuinola (Bocas del Toro), collected 6 September 1961 by V. J. Tipton and C. M. Keenan. In the collection of Chicago Natural History Museum. Allotype male, same data and repository as holotype.

ADDITIONAL MATERIAL EXAMINED: The following seem also to belong to this species: 1 male, same data as the holotype but from a bat "like *Tonatia*" (host no. 8294); 1 male from *Mimon crenulatum keenani* (host no. 10724), Sibubé (Bocas del Toro), 18 January 1963, C. O. Handley, Jr.

Basilia myotis Curran

Basilia bellardii Schuurmans-Stekhoven Jr., 1931 (nec Rondani, 1878), Zeitschr. Parasitenk., 3, (2), p. 207, figs. 1-6. Hase, 1931, ibidem, p. 220, figs. 1-17. Scott, 1936, Jour. Linn. Soc., Zool., 39: 497 (partim). Bequaert, 1942, Bol. Ent. Venez., 1, (4), p. 83. Guimarães, 1946, Arq. Zool. Est. S. Paulo, 5: 15, 62 (partim). Karaman, 1948, Rad. Acad. Yougosl., 273: 42, fig. 4.

Basilia myotis Curran, 1935, Amer. Mus. Novit., no. 765, p. 3, figs. 3-5. Scott, 1936, Linn. Soc. Jour., Zool., 39: 497. Bequaert, 1942, Bol. Ent. Venez., 1, (4), p. 84. Del Ponte, 1944, Ann. Inst. Med. Reg., 1, (1), pp. 118, 124. Guimarães, 1946, Arq. Zool. Est. S. Paulo, 5: 16, 19. Guimarães and D'Andretta, 1956, ibidem, **10**: 76, figs. 85, 106-111, 124, 129, 145.

Guimaraesia bellardii Schuurmans-Stekhoven Jr., 1951, Acta Zool. Lilloana, **12**: 112, fig. 4.

Previous records: Guatemala, from *Myotis nigricans* (probably subsp. *nigricans*), *Molossus* sp. (*bondae?*); Colombia, from *Myotis nigricans* (probably subsp. *nigricans*), *Uroderma bilobatum*; Peru, from unknown bat; Venezuela, from *Myotis* sp., *Myotis n. nigricans, Dasypterus* sp., *Molossus crassicaudatus,* unknown bat; British Guiana, from *Myotis n.*

nigricans; Panamá, type locality and host—Tapia, from *Myotis nigricans* (probably subsp. *nigricans*)—and Camogantí (Darién), from *Myotis n.* nigricans.

PANAMANIAN MATERIAL EXAMINED: From *Myotis n. nigricans*, in the Canal Zone, collected by V. J. Tipton; Gamboa, 2 females (host no. 6411), 23 September 1960; Fort Davis, 1 male and 2 females (host no. 3934) on 28 July 1959, 1 male and 3 females (host no. 4767) on 14 October 1959, 3 lots of 1 male, 1 female, and 2 females (host nos. 5171, 5173-4) on 7 January 1960; Barro Colorado Island, 14 males and 15 females (host no. 5595) on 12 June 1960.

REMARKS: The citations of *B. bellardii* as synonyms of this form are due to Schuurman-Stekhoven Jr., who described (1931) as *Basilia bellardii* what Curran described (1935) as *B. myotis.*

Basilia myotis replaces *B. speiseri* in northern South America, as the most common nycteribiid of *Myotis n. nigricans.* It ranges from British Guiana south to Peru and north to Guatemala. The two species are morphologically very similar. However, *B. myotis* has a longer tergal plate I, with discal setae only on anterior two-thirds of the tergite and longer and more numerous setae on the posterior margin, the latter setae extending well beyond crossing the hind margin of tergite II.

Guimarães and D'Andretta (1956, p. 76) have suggested that *B. myotis* may be a synonym of *B. ferrisi* Schuurman-Stekhoven Jr., 1931.

Basilia dunni Curran. Figure 37.

Basilia dunni Curran, 1935, Amer. Mus. Nov., no. 765, p. 3, figs. 1-2. Scott, 1936, Linn. Soc. Jour., Zool., 39: 497. Del Ponte, 1944, Ann. Inst. Med. Reg., 1, (1), pp. 118, 124. Guimarães, 1946, Arq. Zool. Est. S. Paulo, 5: 16, 20. Guimarães and D'Andretta, 1956, ibidem, 10: 95, figs. 152, 153.

Previous Panamanian records: Santa Rosa (Colón), from *Myotis n. nigricans* (type locality and host).

MATERIAL EXAMINED: 1 male and 5 females from *Myotis n. nigricans* (host no. 5688) Juan Mina (Canal Zone), 28 July 1960, V. J. Tipton; 2 males and 2 females from *Myotis albescens* (host no. 6375), Río Tuira (Darién), 2 March 1958, V. J. Tipton, and 2 females (host no. 6378), same data but 5 March 1958.

REMARKS: This species was described from a single female; it was redescribed and figured by Guimarães and D'Andretta (1956).

There are, in the region, two species whose females may be confused with that of *B. dunni,* namely, *myotis* Curran and *costaricensis* Guimarães and D'Andretta, 1956. *B. dunni* differs from *myotis* in having tergal plate I relatively shorter and with a larger number of discal setae, in the distribution of the discal setae of tergal plate II, in the shape of the anal segment, and in the chaetotaxy of the fourth sternite.

Basilia costaricensis, although somewhat similar to *dunni,* is easily characterized by the chaetotaxy of the fourth and fifth abdominal sternites and by the shape of the distal sternite. It also has a small digitiform process on the posterior elevation of the mesonotum; this process is absent in *dunni.*

However, the species most closely related to *dunni* is *carteri* Scott, 1936, from Paraguay, southern Brazil, northern Argentina, and southern Bolivia. The differences are not pronounced but are constant. They are primarily in the shape and chaetotaxy of tergal plate I, which in *dunni* is more slender posteriorly and has a less rounded posterior margin; the discal setae of this tergite are more numerous and extend close to the mid-line, not leaving the median longitudinal glabrous strip characteristic of *carteri*.

Until now only the female of *B. dunni* was known; we here describe the male.

DESCRIPTION, MALE: *Head.*—Vertex with three pairs of setae forming two diverging lines between the eyes (the allotype has five setae on one row); anterior border of each gena with seven or eight setae; same number of scattered setae on postgena. Palpi with 12 or 13 uneven setae on ventral aspect and one long setae on apex. Eyes typically two-faceted.

Thorax.—Broader than long (0.95 x 0.78 mm.) with anterior margin distinctly arcuate and posterior slightly sinuate. Thoracic ctenidium with 18 or 19 spines. Twelve setae on notopleural sutures. Legs long, little laterally compressed; all tibiae with three transverse rows of setae on ventral margin.

Abdomen.—Seven segments recognizable dorsally. The first tergite is short, with a row of medium setae on hind margin; on the sides a group of short setae, increasing in length posteriorly. Tergites II to VI with a dense row of setae on the hind margin and another row, parallel to the former but not reaching the sides, consisting of fewer and shorter setae. Besides the posterior row, the second tergite has several discal setae. The terminal tergite is wider than long, truncate conical, the posterior two-thirds with numerous setae in uneven rows, the lateral margins with numerous setae, three or four long setae on the hind margin. Basal sternite shorter than in the female, with 59 to 62 spines. Second sternite with a row of setae on the posterior margin, and three uneven rows of small discals. Third sternite with one row of setae on the posterior margin plus one or two irregular rows of small setae. Fourth sternite with two rows of discal setae, longer than those on the third plus one row of setae on the posterior margin and a group of 27 or 28 spiniforms, arranged into two rows; distal sternite with a dense group of thick setae arranged into several irregular lateral rows.

Length, 2.26 mm.

Basilia anceps Guimarães and D'Andretta. Figure 35B, C.

Basilia anceps Guimarães & D'Andretta, 1956, Arq. Zool. Est. São Paulo, **10**: 113-116, figs. 188-191.

Previous records: Colombia, from *Myotis n. nigricans;* Peru, from *Myotis n. nigricans.*

PANAMANIAN MATERIAL EXAMINED: From *Myotis nigricans,* Los Santos Province, collected by V. J. Tipton: 2 males and 1 female on 21 February 1962 (host no. 9962), and 1 male and 1 female on 24 February, 1962 (host no. 10003). From *Myotis simus,* Armila (San Blas), 2 females, 30 March 1963, collected by C. O. Handley and F. M. Greenwell (host no. 12049).

REMARKS: This species and *juquiensis* Guimarães, 1946, form a sharply differentiated group, being very similar to each other and differing from the rest of the genus in having only five sternites. They can be easily distinguished by the length of the pustulate setae of the lateral connexivum. In *juquiensis* these are long and of even length; in *anceps* they are predominantly long in front of spiracle IV, being very short from there backwards, except for three or four on the posterior region.

Tergal plate II also differs in the two species. In *juquiensis* it has almost straight lateral and posterior margins, which are rounded and continuous in *anceps.* The two San Blas females (from *Myotis simus*) have no setae on the anterior region of the tergite.

To date, only the female has been known; we here describe the male.

DESCRIPTION, MALE: *Head.*—Vertex with three pairs of setae, one between the eyes and two near the front margin; margin of each gena with seven or eight setae; postgena with six or seven scattered setae on each side; palpi with eight uneven setae ventrally and one apical seta. Eyes two-faceted (one specimen with single facets on both eyes).

Thorax.—Little broader than long (0.70 x 0.62 mm.). Thoracic ctenidium with 17 or 18 spines, notopleural sutures with six or seven setae. Legs relatively short and somewhat laterally compressed; tibiae slightly dilated distally and with three transverse rows of setae ventrally.

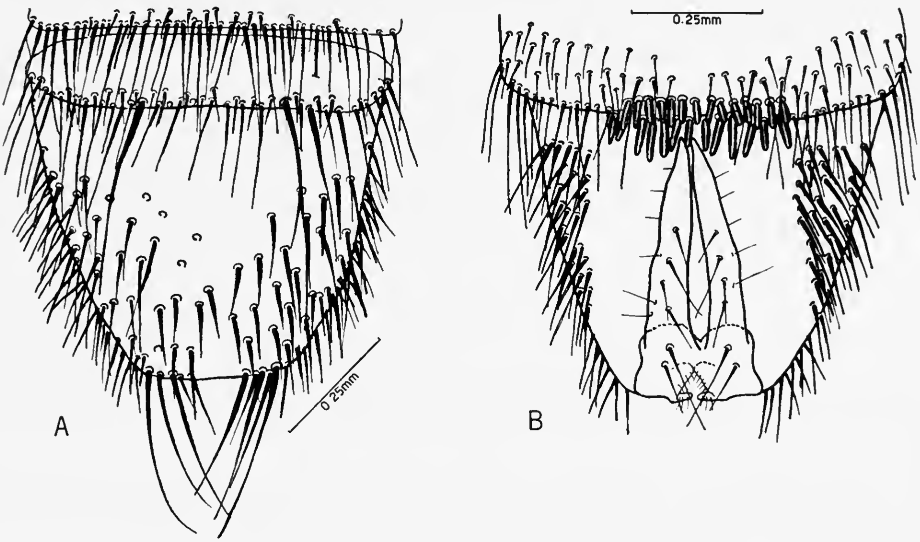

Fig. 37. *Basilia dunni,* male. A, terminal sternite. B, last two tergites.

Abdomen.—Basal tergite wider than long, with a few short setae on the posterior margin, plus some discal setae. Tergites II to VI with setae only on the hind margin. Distal tergite with 19 or 20 discal setae on the hind margin, some setae on the sides and four or five uneven setae on each side of the posterior margin. Basal sternite with 50 to 52 spines on the ctenidium of the posterior margin; sternites II to IV with some discal setae besides the row of setae on the posterior border; in addition, the fourth sternite has eight spiniforms on the median region of the hind border. Distal sternite with few setae on the sides.

Length, 180 mm.

Distribution and Host-Parasite Relationships

The present collection is comprised of 84 specimens from 27 lots. This raises the total of reported Panamanian specimens (Curran, 1935; Guimarães and D'Andretta, 1956) to 112 specimens, belonging to seven species of nycteribiids from 34 lots.

Panamanian nycteribiids seem to belong to the South American assemblage of *Basilia* species. Four of the seven have been found in South America more than once: *myotis,* 23 records; *anceps,* two; *wenzeli,* four and *ferruginea,* seven. The remaining three species, although thus far known only from Panama, have clear relationships with South American species. *Basilia dunni* is very close to *carteri,* the differences being rather subtle; *handleyi* n. sp. is related to *ferruginea; tiptoni* n. sp. is closer to *silvae,* so far known only from Chile, although in some ways it resembles *boardmanni* Rozeboom, 1934, from the United States east of the Mississippi, and *rondanii* Guimarães and D'Andretta, 1956, known from Guatemala to Texas.

On the subject of host-parasite relationships, the present data fully bear out our previous conclusions as to the close association of New World *Basilia* with vespertilionid bats. Among 32 host records, 26 refer to vespertilionids and only six to phyllostomids.

Four of the species which occur in Panama (*myotis, dunni, ferruginea* and *handleyi*) have been found exclusively on vespertilionids; two (*anceps* and *wenzeli*) on both vespertilionids and phyllostomids, and one (*tiptoni*) only on a phyllostomid.

Basilia myotis, although recorded from *Dasypterus* (once), *Uroderma* (once) and *Molossus* (twice) is predominantly a parasite of *Myotis nigricans* (24 records). On the southern part of the range of the host, *myotis* is replaced by *speiseri.*

Basilia dunni has been found twice on *Myotis nigricans* and twice on *M. albescens.* For the closely related *carteri* there are five records from *nigricans* and three from *albescens.*

Basilia anceps also seems to be associated with *Myotis nigricans,* although not as closely as *B. myotis.* Of seven records, four are from *M. nigricans,* one from *M. simus* and two from *Artibeus lituratus palmarum.*

Basilia wenzeli is beyond doubt linked to *Eptesicus.* There are three records from *Eptesicus fuscus,* five from *E. brasiliensis propinquus,* one each from *Histiotus, Lonchorhina* and *Artibeus.*

Three species of *Basilia* have been found on vespertilionid bats of the genus *Lasiurus. Basilia speiseri* was found once on *Lasiurus borealis bonariensis,* possibly as a straggler. However, *B. ferruginea* has been recorded five times from this host subspecies, once from *Lasiurus borealis frantzii* and once from *Lasiurus pfeifferi* (from Cuba).

Basilia handleyi n. sp. is closely related to *ferruginea* but distinct. Its occurence on *Lasiurus castaneus* (whose distribution overlaps that of *L. borealis frantzii* in Panama) seems to confirm the status of *castaneus,* recently described by Handley (1960), as a good species.

Basilia tiptoni n. sp. is the only Panamanian species of Nycteribiidae thus far recorded exclusively from Phyllostomidae.

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The Streblid Batflies of Panama
(Diptera Calypterae: Streblidae)

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The Streblidae, like the Nycteribiidae, are blood-sucking pupiparous flies and are obligate parasites of bats. All are external parasites except the females of the Old World genus *Ascodipteron,* which embed themselves in the skin of the host and become endoparasitic. Like their hosts, the Streblidae are primarily tropical in distribution. Relatively few species occur in the subtropical and warm temperate zones. Their distribution and host-parasite relationships suggest an ancient origin and dispersal. The Old and New World faunae have no streblid taxa in common, even on bats of the families Molossidae, Emballonuridae, and Vespertilionidae which are represented in both hemispheres. Of the streblid subfamilies, the Nycteriboscinae (= Brachytarsininae, with three genera, and about 45 species) and the Ascodipterinae (one genus and 17 species), are restricted to the Old World; the Nycterophiliinae (one genus, four species), Trichobiinae (18 genera, about 69 species), and the Streblinae (four genera, 21 species) occur only in the New World. The greatest diversification of genera and species has occurred on families of bats that are endemic to the New World, especially the Phyllostomidae.

The radiation of the New World Streblidae is correlated not only with taxonomic and biological diversity of the hosts, but also with adaptations of the flies to living and feeding on particular body regions of their hosts. Some bats like *Phyllostomus hastatus* normally harbor three or four species of Streblidae at the same time, and most hosts harbor at least two. The co-

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existence of these parasites seems to be possible because of their feeding specializations.

The adaptive radiation of the Streblidae is reflected in a wide range of size, form, and structure. The minute mite- or louse-like species of *Mastoptera* may be as small as 0.74 mm. long, while gravid females of *Joblingia schmidti* Dybas and Wenzel may attain a body length of 5.55 mm. The latter is the largest species of streblid known. Reduced wings have evolved independently a number of times in such apparently unrelated genera as *Megistopoda, Aspidoptera, Mastoptera, Joblingia,* and *Metelasmus.* Wings are absent in *Paradyschiria.* The legs of the louse-like species are usually short and powerful for clinging to the host. In *Megistopoda* and related genera, the venter forms a shield whose anterior margin is upwardly reflexed like the tip of a ski. In these flies, the hind legs are greatly elongated and apparently assist the fly in moving through the fur of the host by pushing. The Streblinae, which can appress themselves against the wing membranes of the host are compressed dorso-ventrally and have very short fore- and midlegs. The species of *Nycterophilia,* which resemble fleas in form and movement, are very strongly, laterally compressed. A postgenal ctenidium has apparently evolved independently in the Streblinae and in *Eldunnia.*

Many of the relationships between genera are obscured by convergences in adaptive modifications like those mentioned. Comprehensive morphological and biological studies are needed to clarify both the intra- and interfamilial relationships. We agree with Hennig (1941) that the Streblidae and Nycteribiidae are closely related families of calypterate Diptera, and that neither are closely related to the Hippoboscidae. Cooper's (1941, p. 126) notes on the chromosomes and karyotypes of these families supports this view. Little more can be said at this time about their relationships with other Diptera.

The principal earlier papers dealing with the New World Streblidae are those of Speiser (1900), da Costa Lima (1921), and Kessel (1925). These are now of historical and nomenclatural interest only. From 1936 to 1949, Jobling (see references) published a series of eight important papers dealing with the taxonomy of New World species. He also published several papers (1929, 1949b, and 1951) that dealt rather extensively with the morphology of both Old and New World species. In these superbly illustrated studies, he described only three new species and one new genus, but he redescribed 21 species, re-defined eight genera and revised three. During the same period, important contributions were also made by Guimarães, Pessôa and Guimarães, and Hoffmann (see references).

We consider about 42 species of the previously described New World Streblidae to be valid. Seventeen of these have been reported from Panama by Kessel (1924, 1925), Curran (1934, 1935), Jobling (1936, 1938, 1939, 1949a), Bequaert (1940), and Cooper (1941). Except for the material reported upon by Cooper, most of the specimens treated by them were obtained by Major Lawrence H. Dunn, Medical Corps, United States Army (see Introduction by Fairchild). In the present paper, we treat 84 species, 50 of them new. Sixty-six (44 new) are recorded from Panama. In the collections of Chicago Natural History Museum, there are more than 30 additional undescribed neotropical species. An explanation of the reasons for this relatively great increase in number of species is warranted.

First, the collections upon which earlier authors based their studies were small and included mostly common species from abundant and widely distributed hosts. The present study is based on about 12,000 specimens collected from more than 50 of the 100 species of host bats collected in Panama. We have also studied about 10,000 additional neotropical Streblidae in the collections of Chicago Natural History Museum. Obviously, one may expect to discover a number of completely new species in collections of this magnitude. This is an important factor in explaining the number of new species recognized by us, but it is only one.

Second, the approach to streblid systematics was very conservative in the past. The paucity of specimens and the inadequacy of the data largely prevented one from using host data in parasite discrimination. There was also a reluctance to exploit certain taxonomic characters such as those of the male genital apparatus. The resulting taxonomic "picture" was that of relatively few species, quite variable morphologically and occurring on a variety of host species.

Third, in past collecting, little care was taken to safeguard against contamination or errors of association. It was not uncommon to place several host species in the same field bag, or to collect specimens from a skinning table and to arbitrarily assign the number or name of the host which the collector thought most probable. Many of the specimens reported in the literature were removed from preserved specimens in museum collections, or from the bottoms of jars which, at one time or another, contained several species of host bats.

Finally, the hosts were frequently misidentified. While this was often due to hasty and uneducated guesses in the field, it was also due to the primitive state of bat taxonomy in the nineteenth and early twentieth centuries. Even today, a sophisticated specialist may be unable to adequately characterize and/or identify many neotropical bat species and so-called races.

In this study, we were most fortunate in not being handicapped, as were earlier authors, by the inadequacy of collections and host data. The collections made in the Panama survey, consisting of several thousand lots, were taken from individual bats representing more than 50 host species. Errors of association, though they occurred, were kept to a minimum (see "Techniques and Methods," below.).

The host bats were carefully and uniformly identified by one person, Dr. C. O. Handley, Jr., as he pursued his revisional studies on the mammals of Panama. Any changes in host identification have been made in the streblid data, too, insofar as possible. The accurate host identifications and associations were essential for parasite discrimination (for a discussion of parasite discrimination, see Mayr, Linsley and Usinger, 1953, p. 113).

Consequently, we were able to examine and carefully compare large series of parasites from the same host as well as from different host species. This enabled us to re-evaluate taxonomic characters used in the past and to exploit new ones such as the male gonapophyses. It was soon evident that series of closely related species had been confused under such names as *Trichobius dugesii* and *Euctenodes mirabilis*, and further, that many of them exhibit a remarkably high degree of host specificity.

In our citations, we have omitted many of the earlier references. As noted above, the host records published in many earlier papers are unreliable. Further, transfers of Streblidae to other hosts in the same roosts are fairly common, though apparently mostly transitory. In addition, a species may be replaced by another species on the same host in another geographic area (and possibly habitat). This is common but not well understood. For these reasons and because of the extensive taxonomic and nomenclatural changes made in our study, it is not possible to verify or correct most of the published records without examining the specimens upon which they were based.

Acknowledgments

About 10,000 of the Panamanian Streblidae studied were collected by personnel of the Environmental Health Branch, Office of the Chief Surgeon, United States Army, Caribbean, including Charles M. Keenan, Lt. Col. (then Major) Vernon J. Tipton, and Lt. Col. (then Major) Robert M. Altman. They were assisted in the field by Vicente Alvarez, Wilbur Lowe, Edmund Mattaden, Pantaleon Sanchez, and Sulpice Modestin, and in the laboratory by Wilbur Lowe. Many other specimens were collected by: Dr. Pedro Galindo and Eustorgio Méndez of the Gorgas Memorial Laboratory; Dr. Charles O. Handley, Jr. and Francis M. Greenwell of the Smithsonian Institution, Washington, D. C.; Dr. Nathan Gale, Canal Zone Veterinarian; and Dr. Conrad E. Yunker of the Middle America Research Unit. A few specimens collected earlier by Col. F. S. Blanton, while he was stationed in the Zone, were also examined. To all these persons, as well as to numerous unnamed individuals who assisted in the field, we express our appreciation.

The status of much of this material could not have been worked out had it not been for extensive ancillary material collected on various expeditions by former and present staff members, associates, and field collectors of Chicago Natural History Museum. Among these are: H. A. Beatty (Surinam); Philip Hershkovitz (Surinam and Colombia); Celestino Kalinowski (Peru); Rodger D. Mitchell and Luis de la Torre (Guatemala); the late Colin C. Sanborn (Trinidad and Peru); the late Franklin J. Schmidt (Guatemala); and the late Karl P. Schmidt (Guatemala and Peru). The enthusiastic cooperation of these people helped us acquire basic collections that made study of the Panamanian material possible. A small collection made in Guatemala by F. J. and K. P. Schmidt in 1936 first interested the senior author in studying the Streblidae. Later, in 1948, R. D. Mitchell and L. de la Torre accompanied the senior author to Guatemala. Here they collected the largest assemblage of New World Streblidae that had been obtained up to that time.

In addition, a number of other specimens were borrowed from other institutions. For their cooperation in making this material available, we wish to thank: Dr. Thomas H. G. Aitken of the Trinidad Virus Laboratory

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We were also assisted by a number of persons who supplied us with information regarding collections in their care. For this we wish to thank Dr. Walter Forster, Zoologische Sammlung des Bayerischen Staates, Munich, Germany; Dr. H. D. Folkhard, Naturhistorische Museum, Bern, Switzerland; and Dr. H. Schumann, Institut für Spezielle Zoologie und Zoologisches Museum, Humboldt Universität, Berlin.

A special expression of gratitude is owed: Dr. B. Jobling, now retired, of the Wellcome Institute of Tropical Medicine (London) for supplying us with information regarding material on which he had published and for giving us permission to use a number of his illustrations, of which he furnished us copies; Dr. T. C. Maa for supplying unpublished information resulting from his study of streblid types and for his opinions on certain taxonomic and nomenclatural problems; Prof. Oskar Theodor, Hebrew University Medical School, Jerusalem, for advice and assistance; Dr. Lindolpho Guimarães for lending us his published illustrations of *Paradyschiria "dubia";* Miss Marion Pahl, Staff Artist, Chicago Natural History Museum, for preparing some of the illustrations; and Lt. Col. Hugh Keegan, MSC, Chief of the Department of Entomology, 406th Medical General Laboratory, Tokyo, Japan, for supervising the preparation of a number of beautifully executed drawings by members of his staff.

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Above all, we are indebted to Dr. C. O. Handley, Jr. not only for the invaluable material collected by him, but especially for his untiring cooperation in supplying and re-checking host identifications and other data, and for providing valuable information on the habits of host bats. Without his cooperation, this paper could not have been written.

Unless otherwise specified, all Panamanian specimens were collected by

Charles M. Keenan and Lt. Col. V. J. Tipton, assisted by personnel of the Environmental Health Branch. Where initials of an institution are given in brackets, it indicates that the specimens concerned are from the collections of that institution. Where the initials GML appear following data, but not in brackets, the specimens concerned were collected by personnel of the Gorgas Memorial Laboratory. The initials MA preceding a host number indicate field numbers of Dr. Carlos Machado-Allison of the Universidad Central de Venezuela.

Abbreviations used for collections are as follows:

AMNH	American Museum of Natural History, New York.
BISHOP	Bernice P. Bishop Museum, Honolulu, Hawaii.
BMNH	British Museum (Natural History), London.
BVP	B. V. Peterson, Entomology Research Institute, Canada Department of Agriculture, Ottawa, Ontario.
CAS	California Academy of Sciences, San Francisco.
CIS	California Insect Survey, Department of Entomology and Parasitology, University of California, Berkeley.
CNHM	Chicago Natural History Museum, Chicago, Illinois.
CU	Department of Entomology, Cornell University, Ithaca, New York.
DZSP	Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil.
EHB	Environmental Health Branch, Office of the Chief Surgeon, United States Army Forces Southern Command, Fort Amador, Canal Zone.
FCUCV	Departamento de Microbiología, Faculdad de Ciencias, Universidad Central de Venezuela, Caracas.
GML	Gorgas Memorial Laboratory, Panamá, Panamá.
INM	Instituto Nacional de Microbiología, Buenos Aires.
KU	Snow Entomological Museum, University of Kansas, Lawrence.
LACM	Los Angeles County Museum, Los Angeles, California
MCZ	Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts.
MNHN	Museum Nationale d'Histoire Naturelle, Paris.
OT	Oskar Theodor, Department of Parasitology, Hebrew University, Jerusalem.
SNI	Senckenberg Naturforschende Institut, Frankfurt a/Main.
TVL	Trinidad Regional Virus Laboratory (Rockefeller Foundation), Port-of-Spain.
USNM	United States National Museum, Washington, D. C.
ZMHU	Institut für Spezielle Zoologie und Zoologische Museum, Humboldt Universität, Berlin.
ZMH	Zoologisches Staatsinstitut und Zoologische Museum, Hamburg.

Techniques and Methods

Collecting Hosts.—As one can determine from Dr. Handley's account (see "Checklist of Mammals"), bats roost in a remarkably wide variety of situations. Accordingly, collecting techniques were varied and often novel. Bats that could not be obtained in any other way were brought down with dust shot. This was often necessary where they were roosting high in a hollow tree or cave. When possible, shooting should be avoided, because of undue disturbance of the parasites.

A variety of nets and net-collecting techniques were employed. Where bats roosted in culverts, it was common procedure to place a loose mesh net (fish seine) over one end and to send a man through the culvert from the other end. He literally pushed the bats ahead of him with a leafy branch. As the bats "hit" the net at the other end, they were quickly removed by men wearing gloves. One person stood alert with a hand insect net, to capture bats that escaped through side openings. If the culvert was impassible, firecrackers were thrown in the open end. Bats in tree holes were obtained by essentially the same technique, the net being strung over the opening, and a leafy branch or bough of appropriate size introduced through one side and pushed up into the cavity to dislodge the bats.

Hand insect nets (with coarse mesh bags) are often useful in caves, especially near the openings. They may also be used to collect bats, such as *Saccopteryx,* that roost on tree trunks or under branches.

The roosting places of many bats are inaccessible or unknown. The use of "mist" nets makes it possible to obtain many of these species and their parasites. Immediate removal of the bat and its parasites lessens the loss or incidence of transfer. Dr. Handley found it desirable to remove some of the very active streblids from the bats while they were still enmeshed in the net.

Collecting Parasites.—Most of the host bats collected in the Panama survey were, upon capture, immediately placed in individual paper or plastic bags, together with a field number, and etherized. The flies were removed as quickly as possible and placed in vials with the corresponding field numbers. This is important, because they do not preserve as well, if transferred an hour or two after death. Paper bags were discarded after one use. Plastic bags were thoroughly washed and reversed, before being re-used.

In collecting the host, it is essential that it be bagged as quickly and with as little unnecessary handling as possible. Some Streblidae, like *Speiseria ambigua* and *Trichobius uniformis* not only leave the host at the slightest disturbance but will often land on another nearby bat, frequently of another species. Such "disturbance transfers" are not uncommon, among Streblidae of bats caught in nets. These flies often return to the original host, if time and opportunity permits. Others like *Strebla,* though strong fliers, tend to stay with their host, even when disturbed.

While the need for the most rigorous precautions in collecting ectoparasites is well known, in the past they have rarely been observed in the case of batflies. Unfortunately, the same has often been true for many other ectoparasites. Our experience leads us to believe that a substantial number of the host records published for them are valueless.

Preparation and Study.—When possible, identifications should be made using both slide preparations and specimens preserved in 70-75 percent ethyl alcohol. In preparing Streblidae for slide mounts, the following procedures were followed. With *minuten nadeln,* small punctures were made in the abdomen and other membranous parts of the body wall. The flies were then placed in a 10 percent solution of cold or warm KOH for from 5 to 20 hours, washed in distilled water, passed through a series of graded alcohols, including absolute alcohol, cleared in oil of cloves, and mounted in a good grade Canada balsam.

The male terminalia were removed and mounted separately. A slit was made in either the dorsal or ventral wall of the abdomen while the specimen was in oil of cloves. The terminalia were removed through the slit by means

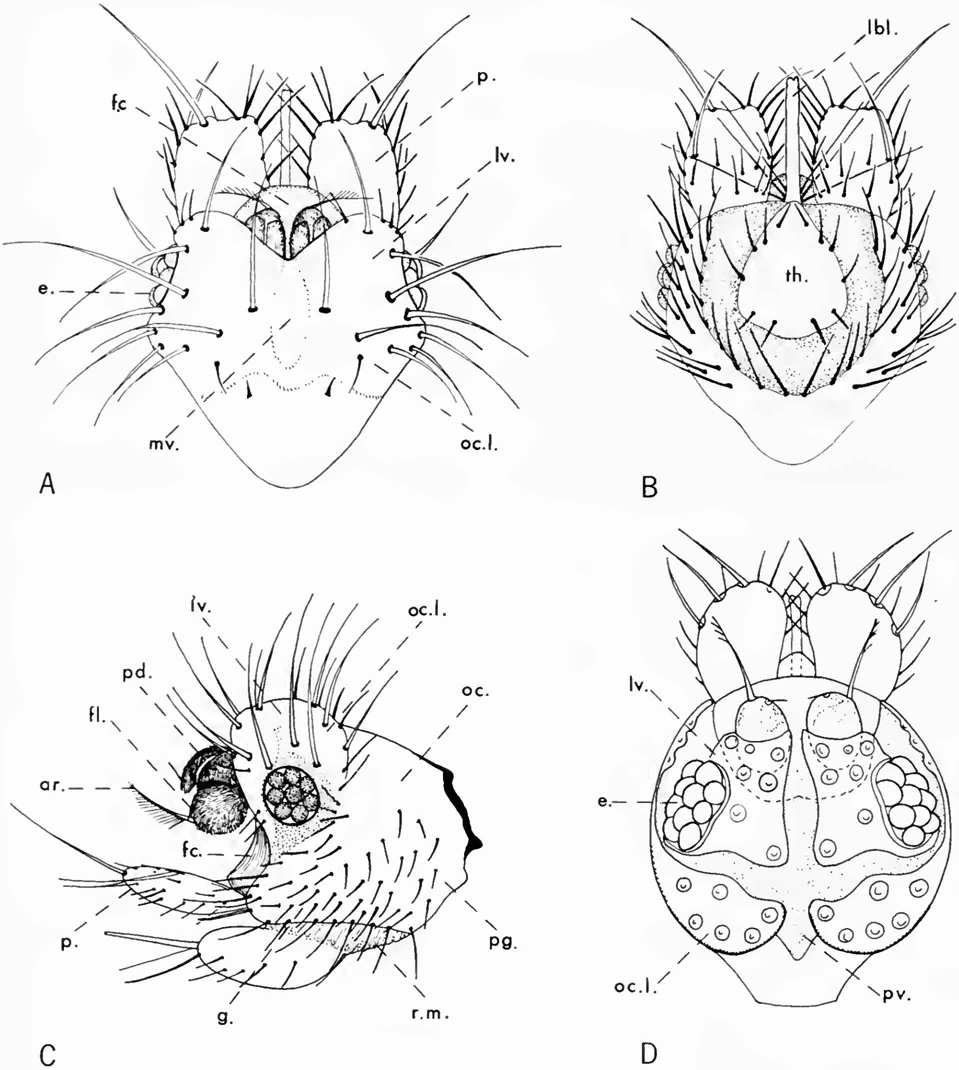

Fig. 38. Structures of streblid head. A–C, *Trichobius sphaeronotus* Jobling. A, dorsal, B, ventral, and C, lateral views of head. D, *Trichobius* sp. (?*longipes* Rudow), dorsal view, semi-diagrammatic, setae omitted. A–C from Zeve and Howell (1962) with modified terminology. D adapted from Jobling (1929). See text for explanation.

of very fine jewelers' forceps. In this way, they could usually be removed *in toto* with much less difficulty than by dissecting them out through the genital "pouch." In order to insure reasonably uniform interpretation of the characters of the gonapophyses, the terminalia were mounted on their right side. Illustrations and descriptions were based on a lateral view. However, in some Streblidae, the gonapophyses are frequently twisted to the left and sometimes only feebly, if at all, curved ventrally. This is true in certain species of *Trichobius,* especially of the *dugesii* and *longipes* groups. When this is so, rotation of the terminalia, as by pressure of the cover slip, may orient the gonapophyses so that they appear to be curved dorso-ventrally when they are actually curved to the left. One must take

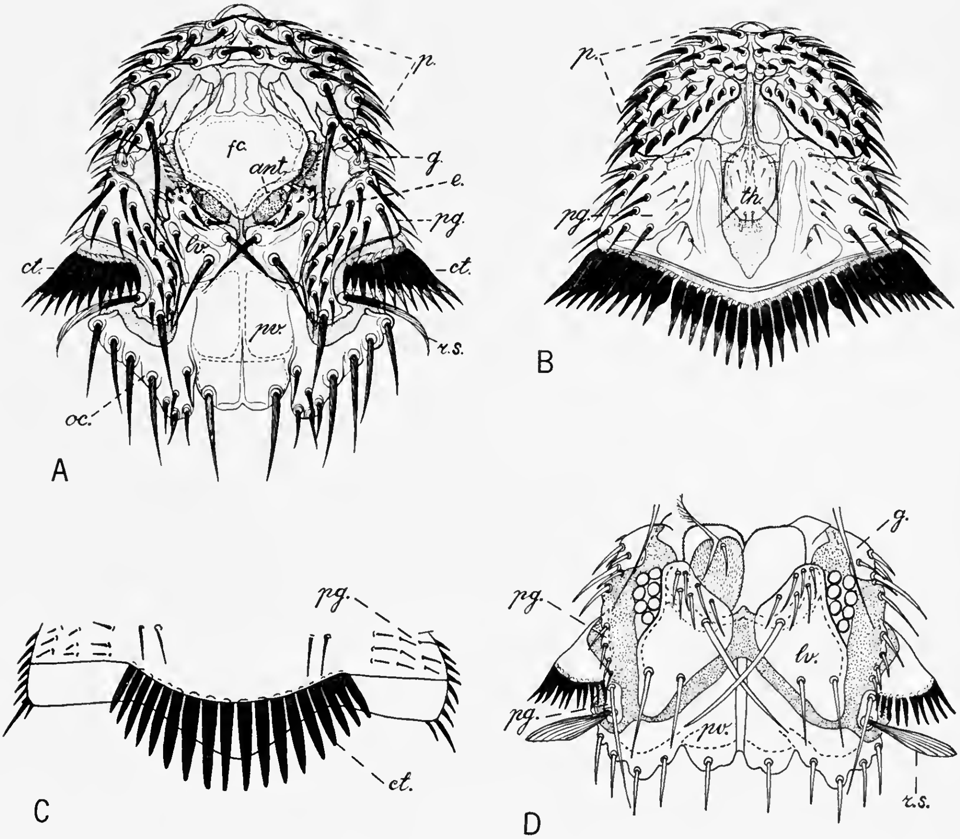

Fig. 39. Structures of streblid head. A, B, *Metelasmus pseudopterus* Coquillet, dorsal and ventral views of head, respectively (post-ctenidial area not shown in B). C, *Eldunnia breviceps* Curran, ventral view of posterior margin. D, *Anastrebla* sp., dorsal view, palpi and frontoclypeal area omitted. A and B from Jobling (1936); C after Jobling 1929. See text for explanation.

this into account in mounting and interpreting male terminalia. We believe that we largely avoided such rotation in most of the preparations from which we made illustrations.

It is desirable to remove the wings and mount them separately. This should be done with fine jewelers' forceps or dissecting needles before the fly is placed in KOH. Wings should not be subjected to KOH, but only passed through the graded alcohols and oil of cloves before mounting.

We strongly recommend the use of a high grade Canada balsam in preference to such media as Hoyer's or polyvinyl alcohols. Pieces of glass coverslips, slides, or other supports such as glass or plastic rings of appropriate thickness, must be used to prevent the coverslip from crushing the specimens. We also use small squares, of various thicknesses, of good quality heavy paper such as manila cover paper. They are soaked in xylol before being introduced into the medium. For wing and genital preparation, we have found it very convenient to use ⅜ inch diameter coverslips.

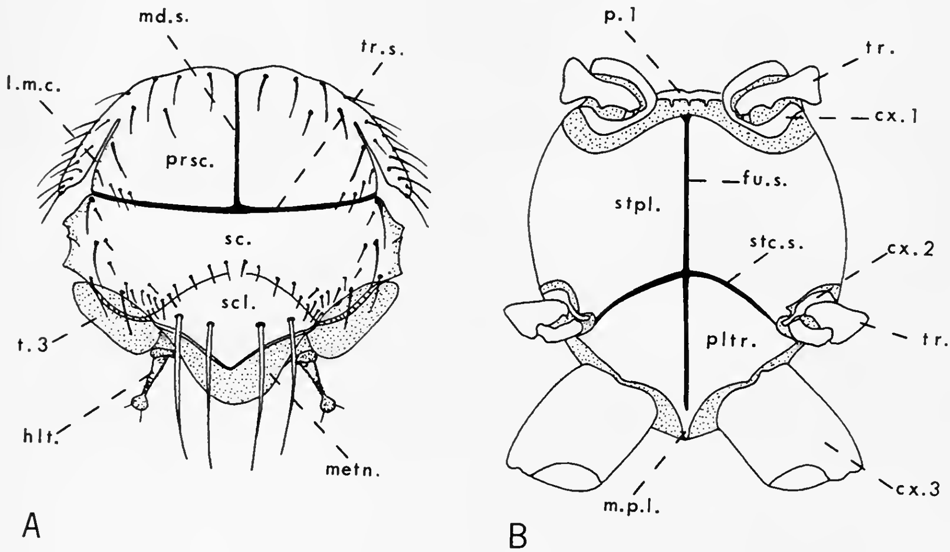

Fig. 40. *Trichobius sphaeronotus* Jobling. A, dorsal and B, ventral views (semi-diagrammatic). Adapted from Zeve and Howell (1962). See text for explanation.

Measurements.—All measurements given are in millimeters. Wing length (WL) has been measured from the fractureline (fig. 42, *f.l.*) at the base of the radius to the apex of the wing; width (WW) was measured at the broadest portion. The base of the radius was selected as a measuring point, because it was rarely damaged or removed in dissecting off the wings for slide preparations, while axillary sclerites were frequently damaged or lost. Body length (BL) has been measured from anterior margin of frontoclypeus to apex of abdomen, thoracic length (TL) from anterior margin of prescutum to posterior tip of metanotum. FL = length of femur.

Illustrations.—The photographic illustrations were prepared as follows: paper negatives were made by projecting slide preparations onto enlarging paper; positive prints were made on contact print paper, as with film negatives, emulsion to emulsion, the light exposure being made through the paper negative. Although this technique has many limitations, it saves much time in preparing illustrations of material for which it is suited. Other illustrations made by us were prepared from slide preparations with the aid of a microprojector.

Figures 76–78 (A, B), 97–99, and 122–124 were executed by artists of the 406th Medical General Laboratory in Tokyo. Illustrations borrowed from Mr. Jobling are credited to him in the legends. Most of the remaining drawings were prepared by the senior and junior authors, in collaboration.

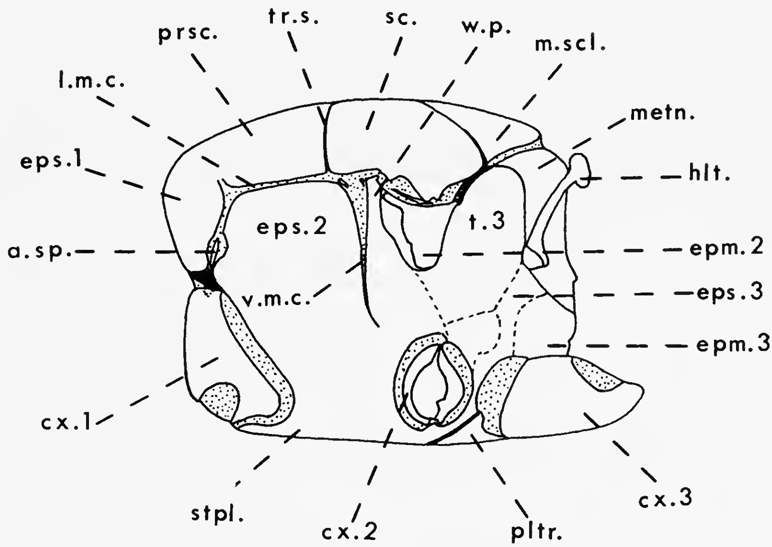

Fig. 41. Thorax, lateral view (diagrammatic), *Trichobius* sp. Adapted from Zeve and Howell (1963). See text for explanation.

MORPHOLOGY AND SYSTEMATICS

Morphology

The comparative morphology of the Streblidae has been treated in several papers by Jobling (1929, 1936, 1938, 1958). Zeve and Howell (1962, 1963) treated the morphology of three North American species of *Trichobius* of the *major* group. These authors differ with Jobling in the interpretation of certain structures. It is obvious that further detailed studies covering a broad taxonomic representation of the family must be undertaken if one is to resolve these differences and to arrive at a better understanding of other structures not investigated in detail by either. We were not in a position to undertake such studies. However, we feel it is desirable to discuss some of these differences in interpretation and to explain the terminology used by us. Unless otherwise noted, the following discussion concerns only New World Streblidae.

Head.—The head of New World Streblidae has been described by Jobling (1929, 1936) and by Zeve and Howell (1962). The terminology employed for head structures in this paper is shown in figs. 38, 39. In the *caecus*, *pallidus*, and *major* groups of *Trichobius*, the subdivisions of the vertex are not clearly differentiated (fig. 38A, C) into subregions. In these, there is a median, membranous or less distinctly sclerotized mediovertex (*mv.*); the anterior subregions or laterovertices (*lv.*) and the posterior subregions (occipital lobes, *oc.l.*) are usually separately rounded or separated by a vague transverse groove; laterally they may be partially separated by a membranous strip (fig. 38C). In most other Trichobiinae and in the Nycterophiliinae, the laterovertices and occipital lobes are well differentiated (fig. 38D); especially in those species in which the head is flattened dorsally.[4] In these, the occipital lobes may be more or less flattened plates. Zeve and Howell (loc. cit.) appear to interpret each side of the entire dorsum posterior to the

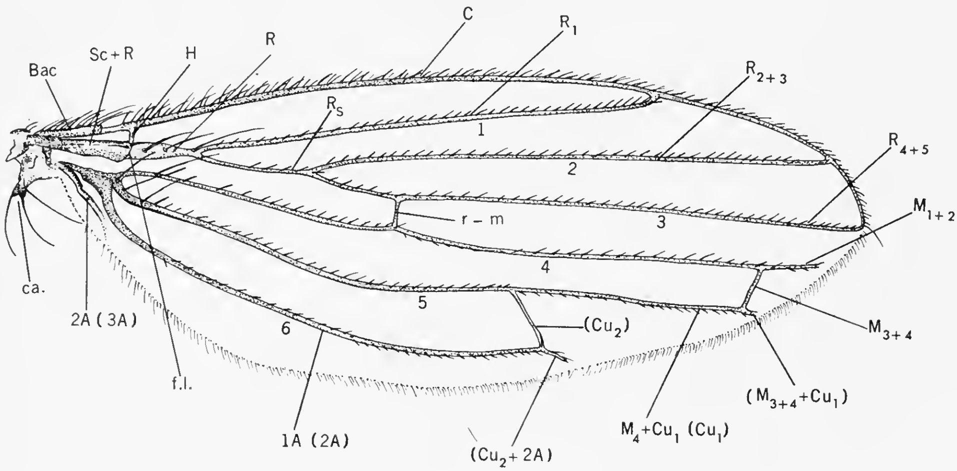

Fig. 42. Wing, *Trichobius sparsus* Kessel. Adapted from Jobling (1938). See text for explanation.

antennae as the laterovertices. Until a detailed comparative study can be made of the head, we prefer to use the terms indicated above. The posteromedian area, called the postvertex (*pv.*) may be membranous (fig. 38D) or form a sclerite (fig. 39A, D). In the Streblinae, the postgenae extend posteriorly on the dorsal surface, as conspicuous plates (fig. 39A, *pg.*) in *Strebla* and *Metelasmus*, or as a sclerotized strip in *Anastrebla* (fig. 39D). In the Streblinae the occipital plates have a festooned posterior margin, as does the postvertex, and, a conspicuous postgenal ctenidium is present on the underside (fig. 39B). This extends around to the dorsal surface (fig. 39A, D). A short ventral ctenidium is also present in *Eldunnia* (fig. 39C).

Thorax.—The principal structures referred to in our descriptions are illustrated and labeled in figs. 40, 41. A few remarks are in order. The

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[4] Pessôa and Guimarães (1940, figs. 2, 3) figured the head of *Nycterophilia*. Their illustrations do not show the laterovertices as distinct from the narrow occipital strips, as they appear in stained material. On the basis of their interpretation, they assigned the genus to the Nycteroboscinae (Brachytarsininae).

mesonotum (fig. 40A) consists of mesoprescutum (*prsc.*), mesoscutum (*sc.*) and mesoscutellum (*scl.*). In our descriptions, we have not qualified these with the prefix but have referred to them simply as prescutum, scutum, and scutellum.

Zeve and Howell (1963) have referred to the upper portion of the mesepisternum and mesepimeron as the mesoanepisternum and mesoanepimeron, respectively. Since there is no suture separating the mesoanepisternum from the mesokatepisternum, etc., we prefer to simply use the term mesepisternum (fig. 41, *eps.* 2) and mesepimeron (*epm.* 2) for taxonomic purposes. Jobling (various papers) has referred to the mesepisternum as the mesopleuron. Since this includes the mesepimeron as well, we use the more restrictive term.

Zeve and Howell (loc. cit.) have referred to the two major divisions of the venter of the thorax (fig. 40B) as meso- and metasternum. We have employed the terms sternopleura (*stpl.*) and pleurotrochantines (*pltr.*) primarily because of past usage by Jobling. We are not able to judge which terms more truly reflect the composition of these sclerites. The median posterior margin of the pleurotrochantines may be produced as a lobe, called by us the median pleurotrochantinal lobe (*m.p.l.*). In some species, for example in the *longipes* group of *Trichobius,* this may ascend dorsally and unite with the metepimeron (fig. 62A).

Wings.—Jobling (1936 and 1938) treats the wing venation of the Streblidae. Zeve and Howell (1963) agree with him in their interpretation of the anterior veins of the wing, but differ as to the posterior ones. In fig. 42, we have shown the terminology of Jobling (1938). Where it differs, we have shown the terminology of Zeve and Howell in parentheses. In our descriptions, we have tried to avoid confusion by using names or symbols for the costa, R_1, and R_S and referring to the other veins by number. In those species of *Nycterophilia* that have fully developed wings (fig. 52), only a few anterior veins are well developed and sclerotized; remnants of some vannal (?) veins are also sclerotized. Nine others seem to be represented by rows of setae. If these rows of setae actually represent veins, then a more complete complement is present in the Nycterophiliinae than in any other Streblidae known to date. The anterior venation somewhat resembles that of male *Ascodipteron,* as figured by Jobling (1940), though there are obvious differences. In brachypterous and stenopterous wings (*sensu* Hackman, 1964) venation may be essentially complete and identifiable (*Aspidoptera*) or very much reduced (*Noctiliostrebla, Neotrichobius*). In some undescribed species of *Nycterophilia* the wings are micropterous.

Abdomen.—There are seven pairs of spiracles in all of the known New World Streblidae. Terga I and II are completely fused in the Trichobiinae and Streblinae. They are separated ventrally but fused dorsally in the Nycterophiliinae. Sternum I is much smaller than II in the Trichobiinae and Streblinae, but longer than II in the Nycterophiliinae. In the following discussion, we refer to the abdominal membrane as the connexivum.

Male: The structures of the male abdomen (fig. 44B) are labeled according to the interpretations of Jobling (1951). The fifth sternum (*st.V*) may

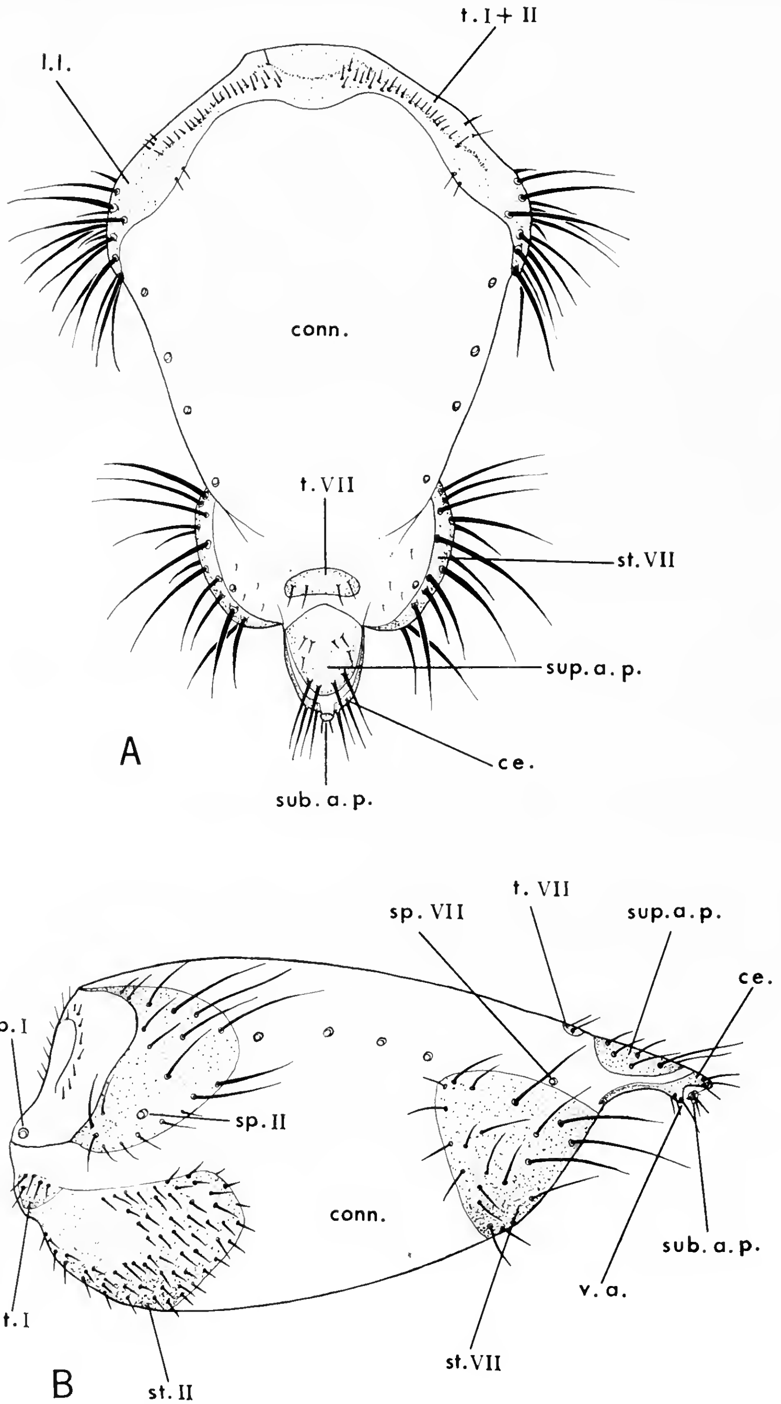

Fig. 43. Female abdominal structures, *Trichobius sphaeronotus* Jobling. A, dorsal, and B, lateral views. Adapted from Zeve and Howell (1963). See text for explanation.

be entirely absent, it may be a single transverse sclerite (in most Streblidae), or it may be divided into two sclerites as in *Anatrichobius* and some species of the *Trichobius major* group. Sternum VI (*st. VI*) may be present, or absent, in related species (*Trichobius*) or well developed in all of the species of a genus (*Strebla*).

Jobling (loc. cit.) and Zeve and Howell (loc. cit.) differ greatly in their interpretation of the composition of the male hypopygium (*hyp.*). Zeve and Howell, contending that the spiracles of segment VII could not be enclosed by a sternum,[5] maintain that the dorsal synsternum VII+VIII of Jobling is a syntergum (VII+VIII). To account for the position of these spiracles, Jobling suggests that part of tergum VII may enter into the formation of the hypopygium. We are in no position to judge the merits or demerits of these opposing points of view. Neither appears to be compatible with the facts.[6] However, we believe Jobling has demonstrated that there has been rotation within the postabdomen, a fact not consistent with the interpretation of Zeve and Howell. For this reason, we have followed Jobling's terminology, though with some reservations.

Synsternum VII+VIII is quite variable in its structure. It may be divided into two clearly separated lateral plates, which lack any dorsal connection (e.g., *Trichobius major*), or it may be continuous dorsally (*Noctiliostrebla* ?) or at least apically (*Strebla*). The suture between VII and VIII may be visible (*Strebla*) or not. Within the same genus (*Trichobius*), VII+VIII may be fused to tergum IX or clearly separated by a membranous suture.

In the genus *Nycterophilia*, the abdomen differs markedly from that of other New World Streblidae. In the male, segments I–VI are represented by clearly defined, sclerotized sterna. The hypopygium consists of a conspicuous synsternum (VII+VIII) whose apex is closed dorsally to form a ring; the apex articulates with a dorso-apical sclerite, tergum IX, which bears the terminalia and the anus. The cerci appear to be represented by very small setose flaps on each side of the anus. Excepting segment IX, the hypopygium is sclerotized ventrally for its entire length.

Male terminalia.—The morphology of the male terminalia (fig. 45B) of the Streblidae has been discussed by Jobling (loc. cit.), Zeve and Howell (loc. cit.) Theodor (1954), and Theodor and Moscona (1954). The internal clasper-like structures were referred to as claspers by Jobling (1936) and later (1951) as gonapophyses. Zeve and Howell (1963) also use the term gonapophyses. Theodor (1954) has referred to them as parameres. In

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[5] The position of the spiracles does not in itself seem to us to be a valid criterion. In *Nycterophilia*, the first spiracle is so close to the upper margin of sternum I that it sometimes seems to be incorporated in the margin, and the second lies just above the posterior angle of sternum II. In all other New World Streblidae, they are clearly situated on tergum I+II.

[6] Comparison of the structure of the New World Streblinae and Trichobiinae with that of the Old World genus *Brachytarsina* (=*Nycteribosca*) suggests that part of tergum VI may be included in the anterior part of the hypopygium.

fig. 45B we have not shown the U-shaped sclerites illustrated by Jobling and Zeve and Howell.

In the Trichobiinae and Streblinae, each gonapophysis (*gon.*) typically bears a pair of distinctive ventral or ventro-lateral setae. These paired gonapophyseal setae (*p.g.s.*) consist typically of a macroseta (*ms.*) and a smaller accessory seta (*a.s.*). Other setae may also be present. The accessory seta is posterior to the macroseta in the *uniformis, dugesii,* and *longipes* groups of *Trichobius,* and in *Speiseria, Pseudostrebla, Stizostrebla, Aspidoptera, Mastoptera, Noctiliostrebla, Paradyschiria,* and *Exastinion.* It is anterior to the macroseta in the *major, caecus,* and *phyllostomae* groups of *Trichobius* and in *Joblingia, Megistopoda, Neotrichobius, Paratrichobius, Anastrebla, Metelasmus, Paraeuctenodes,* and *Strebla.* In *Joblingia schmidti,* there are two pairs of macrosetae, and sometimes two pairs of accessory setae. In *Trichobioides perspicillatus,* the accessory seta is ventral or ventral and slightly posterior to the macroseta. In *Eldunnia* there are four well-developed setae in a row, the two posterior setae shorter than the two anterior ones.

Generally, the paired setae are similar in position on the two gonapophyses and are inserted along the ventral margin near base. However, they may be situated near mid-length or (as in *Paratrichobius* and related genera) near apex. In *Trichobius phyllostomae* and related species, their location may differ markedly between the two gonapophyses. In some (e.g., *Trichobioides*), the paired setae may be inserted on the lateral face of the gonapophysis.

We have not studied the aedeagus (*aed.*) in detail, though its structure differs between genera and species. In many New World Streblidae, the extrusible portion of the aedeagus is dorso-ventrally flattened and ribbon-like, but it may be cylindrical or even flagelliform. In others (e.g., *Noctiliostrebla*), it is blade-like in profile and may even have a dorso-apical spine. In most (except *Nycterophilia, Noctiliostrebla,* and *Paradyschiria*), its posterior portion is coiled, and extrusion is accomplished through straightening of the coil by contraction of muscles associated with the aedeagal apodeme (*aed.a.*). In *Nycterophilia,* the apodeme is short and straight. In *Noctiliostrebla* and *Paradyschiria,* it is feebly coiled.

In the Trichobiinae and Streblinae, there is a pair of flap-like, usually setose structures in the wall of the genital pockets and closely associated with the dorsal connection of the membrane to the gonapophyseal sheath. These are referred to by Jobling (1951) as the surstyli.

In *Nycterophilia,* unlike any other Streblidae except *Ascodipteron,* the terminalia are external, and consist of three principal elements (fig. 45A). There is an outer pair of "claspers," each consisting of a long cylindrical clasper shaft (*cl. sh.*) which is continuous with the body wall of tergum IX and not separated from it by a suture of any kind. Each of these bears a distal, movable harpago (*ha.*). Internal to the claspers and articulated to the ventral apical margin of synsternum VII+VIII is another pair of broad clasper-like structures, apparently homologous with the gonapophyses of other New World Streblidae and, like them, each bearing a pair of ventral setae. Situated between the gonapophyses is the extrusible, ribbon-like

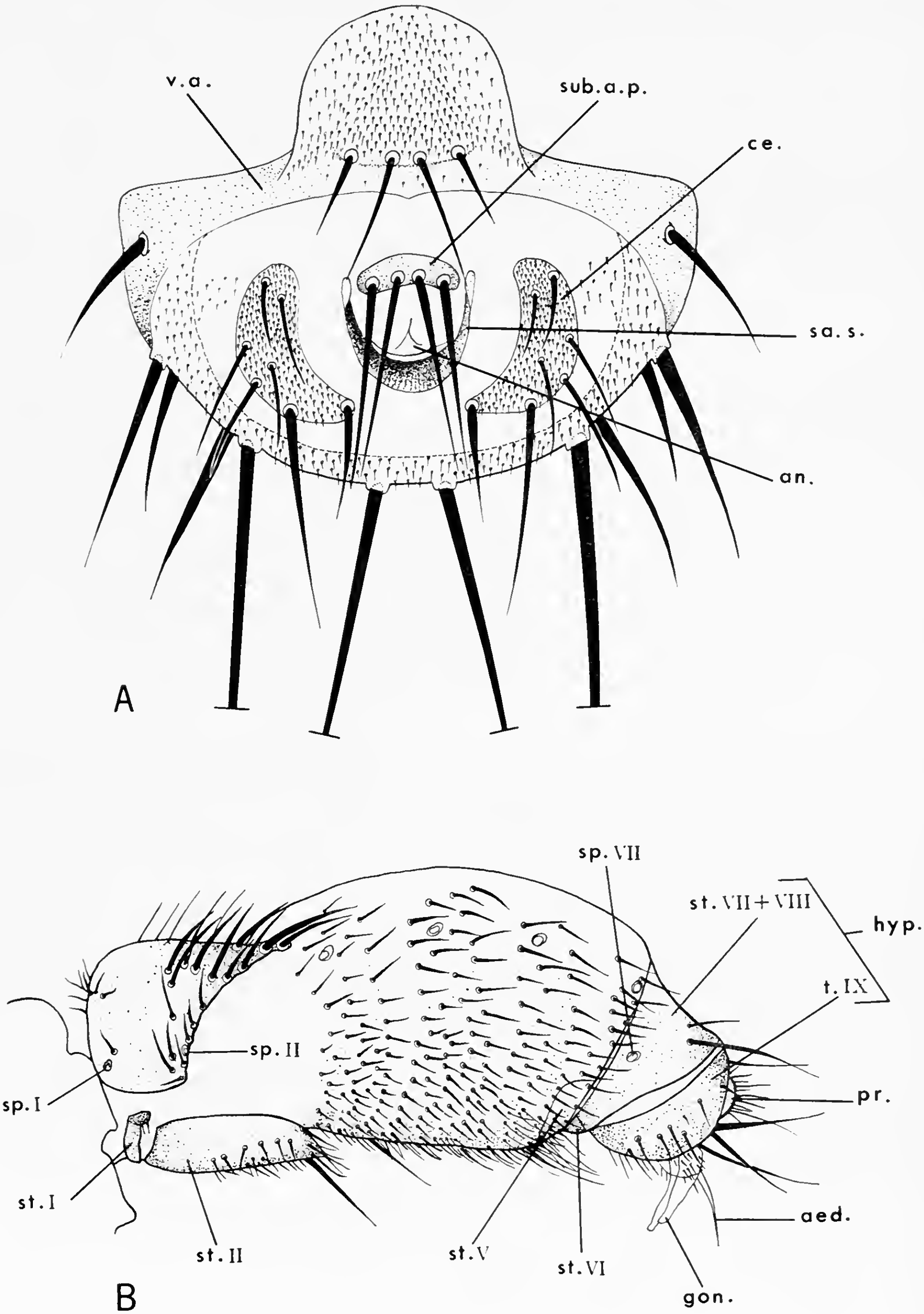

Fig. 44. A, female terminalia, ventral view, *Strebla christinae*, new species. B, male abdomen, lateral view, *Strebla* sp. B adapted from Jobling (1951). See text for explanation.

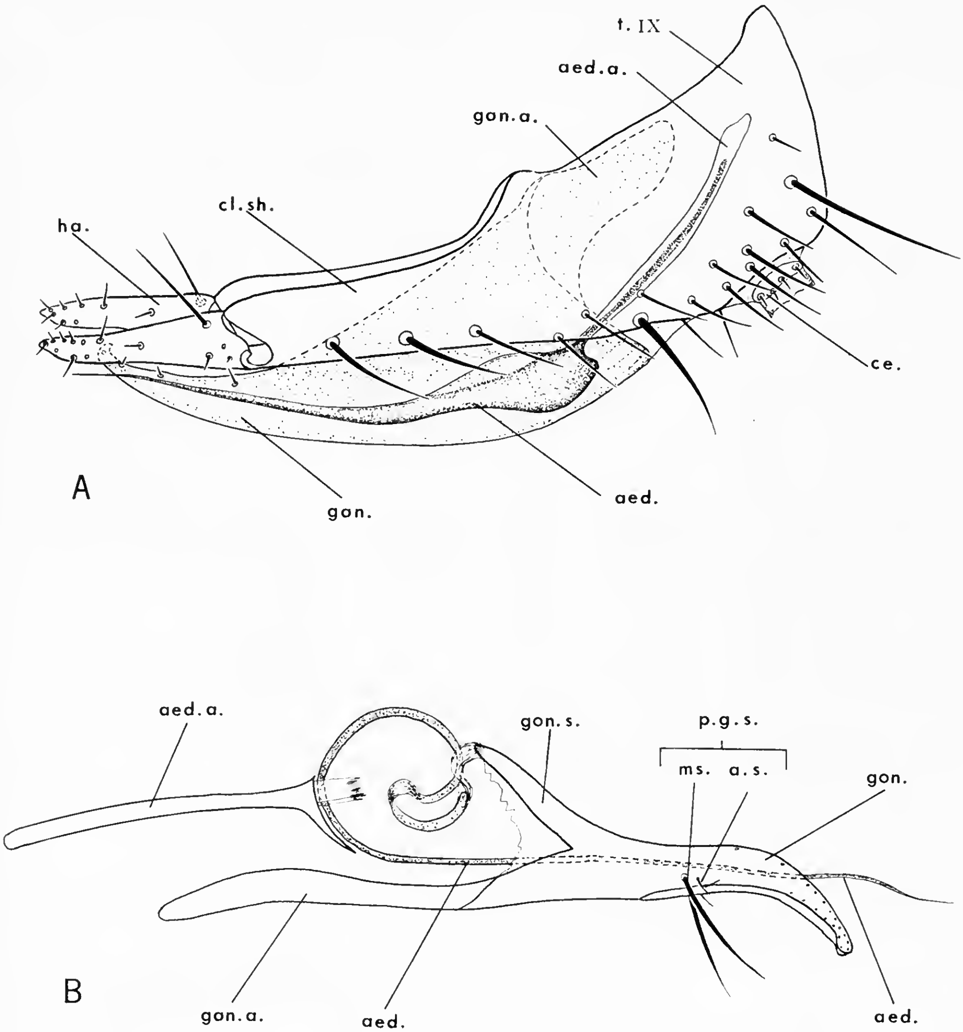

Fig. 45. Male terminalia. A, *Nycterophilia parnelli,* new species. B, *Strebla* sp. (U-shaped sclerites omitted). See text for explanation.

aedeagus. This has a simple, short apodeme which cannot be coiled as it can in most other New World Streblidae.

We believe the abdominal morphology shows that the species of *Nycterophilia*—in spite of the remarkably specialized flea-like adaptions—are the most generalized New World Streblidae known. Interestingly, the only other Streblidae which, like *Nycterophilia,* seem to approach a generalized type, are the males of *Ascodipteron.* In these, the abdominal terga and sterna, though weakly sclerotized, are identifiable. The females of *Ascodipteron,* on the other hand, are the most highly specialized, morphologically and biologically, of all the Streblidae.

Abdomen.—Female: Jobling (1951) and Zeve and Howell (1963) agree in their interpretation of segments I–VII in the female abdomen. Although they differ in the terminology they apply to the apical structures, neither seems to have resolved the homologies. Our preliminary studies indicate that characters of the postabdomen are not only of value in identifying species, but may assist in an understanding of relationships within the family.

Tergum VII varies greatly in extent, shape, and sclerotization. It is best developed in *Strebla.* Sometimes it is not at all pigmented but may be represented by micropile and/or paired setae. Occasionally, it is united or even completely fused with the supra-anal plate to form part of the terminal cone (see below). In a very few instances (e.g., *Noctiliostrebla, Joblingia,* and *Trichobius major*) tergum VII may be divided into two tergites.

Zeve and Howell (loc. cit.) have not discussed the segmental nature of the terminal cone (also called hypopygium and proctiger by Jobling). We believe this composite structure to be formed of elements of segments VIII –X (and, theoretically, XI). In some streblids, even tergum VII is fused with the supra-anal plate of the cone. Characteristically, the most conspicuous structure of the cone is a sclerotized ring consisting of a dorsal supra-anal plate (*sup.a.p.*) and a narrow ventral arc (*v.a.*). The supra-anal plate may be longer than wide (fig. 43A) or very short and scarcely longer than the ventral arc (fig. 44A). The ventral arc may be produced anteriorly as a median lobe (fig. 44A) or on each side as a narrow strut (figs. 43A, B). Between the ventral arc and the anus is a small setose sclerite called the subanal plate (figs. 43B, 44A, *sub.a.p.*) by Jobling (1951).

In *Joblingia schmidti,* the cerci are united with the ventral arc, which is separate from the supra-anal plate and so situated as to appear to be a sternum of that plate. This is also true in species of the *Trichobius major* group (fig. 43) and other streblids. The fusion of the cerci to a sternal structure raises a question as to their identity, since cerci are generally regarded as tergal appendages. Perhaps the streblid cerci are paraprocts. In *J. schmidti,* there are also two U-shaped anal sclerites in the wall of the proctiger. One of these (supra-anal sclerite) lies above the anus, the other (infra-anal sclerite) lies below it. These are absent in many species and genera. In *Strebla christinae* n.sp., there is a single supra-anal sclerite (fig. 44A, *sa.s.*).

We restrict the term proctiger (*pr.*) to the membranous projection which bears the anus, anal sclerites, the subanal plate, and the cerci.

In species of the *Trichobius caecus* group, and some other streblids, there is a small sclerotized strip that has an apical crescent-shaped thickening or rim which we refer to as the postgenital sclerite. It is situated between the vulva and the ventral arc. We interpret this as sternum IX. It is best developed in the species of the *Trichobius caecus* group and is useful in identifying them. It is most easily observed in alcohol-preserved specimens and should be examined from a posterior view. Its shape cannot ordinarily be determined from slide preparations.

In the abdomen of female *Nycterophilia,* syntergum I+II and sometimes tergum VII are sclerotized. In non-gravid females, many of the segmental margins are indicated by external indentations of the connexivum. The terminal cone (fig. 51B *t.c.*) is apically produced above the proctiger (*pr.*) and bears conspicuous distal macrosetae. The proctiger is free. The abdominal sterna, though indicated, are incompletely represented and very weakly, if at all, sclerotized. Below the proctiger is a small sclerite that is connected by a sclerotized strip to a small transverse sclerite lying posterior to the vulva. These appear to be comparable to the structures figured by Jobling (1951, fig. 1A, B) for *Nycteribosca gigantea.* He regarded the sclerotized strip as representing sternum X and the sclerite as sternum IX. The latter sclerite is similar in form and position to the postgenital sclerite (see above) of the *Trichobius caecus* group.

Chaetotaxy.—We have used the term microseta for extremely minute setae. In some instances, these may be unusually minute and relatively dense, forming a micropile. They are usually visible only in slide preparations, and some can be distinguished only under oil immersion. The term macroseta has been used for setae that are conspicuously long or longer than other associated setae.

In general, the dorsal abdominal setae are well developed and indeed sometimes very long in brachypterous and wingless species, e.g., the female of *Joblingia schmidti.* In *Nycterophilia,* certain coarse abdominal setae, especially the connexival setae, may appear "braided" even under relatively low magnification. In some instances, their margins appear serrate.

List of Abbreviations

A	anal vein
aed.	aedeagus
aed.a.	aedeagal apodeme
an.	anus
ant.	antenna
ar.	arista
a.s.	accessory gonapophyseal seta
a.sp.	anterior thoracic spiracle
Bac.	basicosta
C	costa
ca.	calyptera
ce.	cercus
cl.sh.	clasper shaft
conn.	abdominal connexivum
c.s.	coxal spur
ct.	ctenidium
Cu	cubitus
cx. 1	procoxa
cx. 2	mesocoxa
cx. 3	metacoxa
d.c.s.	(paired) dorsal abdominal connexival setae
e.	eye
epm. 2	mesepimeron
epm. 3	metepimeron
eps. 1	proepisternum
eps. 2	mesepisternum
eps. 3	metepisternum
e.s.	epi-anal sclerite
fc.	frontoclypeus
f.l.	fracture line of radius
fu.s.	furcasternal suture
g.	gena
gon.	gonapophysis
gon.a.	gonapophyseal apodeme
gon.s.	gonapophyseal sheath
H	humeral vein
ha.	harpago
hlt.	halter
h.s.	hypo-anal sclerite
hyp.	hypopygium
lbl.	labella
l.l.	lateral lobe of tergum I+II
l.m.c.	lateral membranous cleft
lv.	laterovertex
M	medius
md.s.	median mesonotal suture
metn.	metanotum
m.p.l.	median pleurotrochantinal lobe
m.scl.	mesoscutellum (scutellum)
ms.	gonapophyseal macroseta
mv.	mediovertex
oc.	occiput
oc.l.	occipital lobe
p.	palpus (maxillary)
p. 1	pronotum

pd.	pedicel	*stc.s.*	sternacostal suture
pg.	postgena	*stpl.*	sternopleuron (a)
p.g.s.	paired gonapophyseal setae	*sub.a.p.*	subanal plate
pltr.	pleurotrochantine (s)	*sup.a.p.*	supra-anal plate
pr.	proctiger	*t.*	tergum
prsc.	mesoprescutum (prescutum)	*t.3*	laterotergite (metapleuron of Jobling)
pv.	postvertex		
R	radius	*t.c.*	terminal cone
R_s	radial sector	*th.*	theca
r.m.	rostral membrane	*tr.*	trochanter
r.s.	remiform scale	*tr.s.*	transverse mesonotal suture
sa.s.	supra-anal sclerite	*v.a.*	ventral arc
sc.	mesoscutum (scutum)	*v.g.m.*	ventral gonapophyseal macroseta
scl.	scutellum		
sp.	spiracle	*v.m.c.*	vertical membranous cleft
st.	sternum	*w.p.*	wing process

Biological Notes

As indicated above, the Streblidae are obligate pupiparous ectoparasites of bats. There are few published studies or notes on their biology. The only paper of consequence that deals with the habits and life history of New World species is that of Ross (1961) who reported on several species of *Trichobius* that occur in Arizona.

From unpublished field observations of the senior author and of Prof. Kenneth W. Cooper (pers. comm.), it appears that many species occupy rather specific niches on the host, such as the wing membranes, head, or trunk. Many of the modifications of size, form, and structure appear to be adaptations to these niches. Field and laboratory studies are needed to analyze them.

The movements of some of these flies on the wing membranes of the bat are remarkable. Using a low power binocular microscope, we observed that *Paratrichobius dunni* (Curran), *Trichobius longipes* (Rudow), *T. joblingi* n. sp., and various species of *Strebla* run rapidly with equal facility, in forward, backward, lateral, and oblique directions. Their skittery movements reminded one of a bit of mercury rolling on a plane surface that was being tilted in various directions.

The senior author has tried to keep colonies of Streblidae alive in the laboratory. He succeeded only when the flies were kept on the host. Fourteen *Carollia p. azteca* were "deloused" after being caged for several days in the laboratory. Only two were negative for parasites; the remaining 12 had an average of 2.15 specimens of *T. joblingi* and 0.25 specimens of *Strebla carolliae* per bat. When removed, the streblids died in one or two hours or less. This agrees with the experience of Ross (op. cit.), working with Arizona Streblidae. At first, it was thought that the flies died of desiccation. However, they died as quickly when kept in ceramic pots with relatively high humidity. The species handled were *Strebla carolliae* n. sp. and *Trichobius joblingi* n. sp., on *Carollia p. azteca,* and *Strebla mirabilis* (Waterhouse), *S. hertigi* n. sp., and *Trichobius longipes* (Rudow), on *Phyllostomus h. panamensis.* All were collected in the Canal Zone.

These species rarely leave the host. They appear to feed constantly and have been observed "diving" in and out of the fur as they feed briefly and move from one site to another. Why they feed so often is an interesting question. Perhaps it is because rapid conversion and utilization of food are needed to nourish the developing intra-uterine larva. Only one larva matures at a time, and it may be that a short developmental period is required to maintain the population. Unfortunately, nothing is known about the population dynamics of these flies. Nor do we know if the males feed as frequently as the females.

On the other hand, it may be that the continual rapid movements of these flies require a high energy intake. The very active species which were seen to feed constantly stay on the host most of the time. We suspect that the host bats preen themselves and that the movements of the flies are evading actions. More generalized species like *Joblingia schmidti* Dybas and Wenzel and *Trichobius yunkeri* n. sp. do not stay on the host as much of the time nor do they feed as frequently as do the more specialized streblids. Many specimens of *J. schmidti* were found crawling in guano and on the walls of a bat cave. *T. yunkeri* and related species are much less rapid flyers than most *Trichobius* species and may be found in swarms in the roosting places of the hosts.

Whatever the need, the suggestion that food is converted rapidly is supported by the observations of Dr. Phyllis Johnson (pers. comm.). While at the Gorgas Memorial Laboratory, she dissected live specimens of *Trichobius longipes* and *Strebla mirabilis.* She noted that the blood in the gut appeared to have been broken down and absorbed more quickly in these flies than in any other blood-sucking insect she had dissected. This suggests that the short survival time of these flies off the host, might literally be due to exhausting their energy. Dr. Glenn Richards (pers. comm.) has suggested that a need for a high water intake rather than of food might be a more important limiting factor. The problem is an interesting one and warrants study.

At best, the fecundity of these flies must be low. The females do not appear to have a well-developed spermatheca for sperm storage. The species observed by Ross (loc. cit.) mate on numerous occasions. Even if the mortality rate is low and the flies are long-lived, it must require a considerable period of time for a population to achieve sizable numbers. This may explain why the flies are absent or the population density low in certain bat roosts, especially new or temporary sites. For example, an abandoned power house shelter at Madden Airstrip, built during World War II, had a large colony of *Carollia p. azteca* and *Phyllostomus h. panamensis.* No puparia could be found in this shelter nor were any flies seen on the walls or in the air. The bats had few flies. Conversely, population densities of flies like *T. yunkeri* were often very high on bats, like *Pteronotus parnellii fuscus,* which roosted in large colonies in caves or similar long established habitats.

Crude experiments on "homing" and host selection were also undertaken in the laboratory of the Environmental Health Branch at Corozal, to determine the feasibility of future studies along these lines. Specimens of two hosts (*Carollia p. azteca* and *Phyllostomus h. panamensis*) were very lightly anesthetized with ether. Their flies were removed, and the bats were returned to a screened cage. After a few minutes, the flies recovered from the anesthesia. They were released in the room containing the hosts' cage. Most of them flew quickly and directly to the cage and literally clawed and burrowed their way through the screen to return to the hosts. The parasites of these two species of bats always returned to their normal host. Carefully controlled multiple choice experiments along these lines may provide insights into some of the problems of host selection and specificity.

Ross (loc. cit.) observed that the Streblidae which he studied deposited their pupae off the host, sometimes in communal sites in crevices or on the walls and floor of the roosting site. This agrees in general with our observations. We have occasionally found puparia in small numbers in the fur of the bats. We believe this to be abnormal. Ross (loc. cit.) also reported being bitten by Streblidae. We have never observed this, and it may be true only of certain species. Host-parasite specificity is discussed following the section on systematics.

Systematics

There are three described genera of New World Streblidae that have not been taken in Panama. These are *Synthesiostrebla*, *Stizostrebla*, and *Paraeuctenodes*. *Synthesiostrebla* (*amorphochili* Townsend) is known only from Peru. *Tonatia silvicola* (=*amblyotis*) the host of *Stizostrebla longirostris* occurs in Panama, and it is likely that the fly will eventually be collected there, too. We have seen specimens of *Paraeuctenodes* from Trinidad and from Guatemala. Thus, it seems likely that the genus is represented in Panama.

The following key is designed not to reflect relationships of genera, since these are largely obscure, but to facilitate identification.

KEY TO THE GENERA OF NEW WORLD STREBLIDAE

1. Body strongly, laterally compressed, flea-like (fig. 46). Wings, if fully developed, with most veins represented only by rows of setae (fig. 52); wings sometimes reduced to inconspicuous strut-like structures. *Male* (figs. 49, 50): Preabdomen with sterna I–VI sclerotized and distinct; terminalia (fig. 45A) external, aedeagus lying between well-developed gonapophyses, these in turn lying between conspicuous claspers (Nycterophiliinae) .... *Nycterophilia* Ferris

   Body, if laterally compressed, never flea-like. Wings, if fully developed, with six longitudinal veins (fig. 42); wings sometimes reduced to oval or elongate structures, or (rarely) completely absent. *Male:* Pre-abdomen (segments I–VI) with only sterna I and II sclerotized and distinct; I usually very small, sometimes reduced to a very small sclerite on each side; terminalia internal, consisting of aedeagus and a pair of gonapophyses (fig. 45B) 2

2. Head with a ctenidium (fig. 39) 3

   Head without a ctenidium (fig. 38) 7

3. Ctenidium consisting of only 18–19 spines, restricted to postero-ventral part of head (fig. 39C); palpi "free," with normal setae, not forming a triangular shield for the front of the head .... *Eldunnia* Curran

   Ctenidium consisting of numerous spines, extending around sides to dorso-lateral parts of head (fig. 39A, B, D); palpi very broad, festooned with numerous, heavy thorn-like setae, together forming a triangular shield for the front of the head (fig. 39A, B; Streblinae) 4

4. Wings brachypterous. Dorsal connexivum of abdomen covered with setae (fig. 140). Prescutum with a complete median suture. Postgena, behind the ctenidium, with a remiform scale (fig. 39A, *r.s.*) .... *Metelasmus* Coquillet
   Wings macropterous. Dorsal connexivum of abdomen bare (but with micropile), except for segmentally arranged pairs of setae. Median suture of prescutum usually short, never complete 5
5. Hind tibiae long and slender, with numerous short setae, lacking conspicuous macrosetae on upper edge...6
   Hind tibiae with at least two, sometimes six or eight macrosetae on upper edge; in some species as many as 12-13 setae conspicuously longer than the others .... *Strebla* Wiedemann
6. Postgenae, behind the ctenidium, each with a laterally directed remiform scale (fig. 39D, *r.s.*) .... *Anastrebla* n.g.
   Postgena without a remiform scale. .... *Paraeuctenodes* Pessôa & Guimarães
7. Wings normally developed and functional....................................17
   Wings much reduced or absent 8
8. Wings absent, or represented only by a very minute, inconspicuous flap............9
   Wings reduced, but conspicuous..10
9. Minute species, body 1.29–1.48 mm. long. Legs of approximately equal size. Scutum membranous except for a short sclerotized strip connecting the prescutum and scutellum on each side (fig. 114A) .... *Paradyschiria* Speiser
   Larger species, body 1.70–2.48 mm. long. Hind legs greatly elongated, at least twice as long as the front legs (fig. 101A). Scutum sclerotized, the suture between it and the scutellum rigid......................... *Megistopoda* Macquart
10. Venter of thorax shield-like (fig. 98), anterior and posterior margins broadly rounded, the anterior margin dorsally reflexed and runner-like. Hind legs elongated, conspicuously longer than the others............................16
    Venter of thorax not thus. Hind legs, if elongated, not conspicuously longer than the others 11
11. Median mesonotal suture extending posteriorly beyond the transverse suture to the scutellum (figs. 79, 83)...15
    Median mesonotal suture not extending posteriorly beyond the transverse suture...12
12. Median and transverse mesonotal sutures united to form an inverted "Y" (fig. 108A); longitudinal and vertical membranous clefts closed without evidence of a suture. Laterovertices of head each with a longitudinal pigmented suture.... .... *Noctiliostrebla* n.g.
    Median and transverse mesonotal sutures, united to form an inverted "T" (fig. 103A); longitudinal and vertical membranous clefts present (open) or, if closed, the line of fusion is marked by a heavily pigmented, rigid suture...............13
13. Posterior margin of head rounded. Median mesonotal suture not bifurcate anteriorly; both longitudinal and vertical membranous clefts open.................14
    Head with two oblique flap-like occipital lobes, whose truncated posterior margins are festooned with setae (fig. 105E). Median mesonotal suture bifurcate anteriorly; longitudinal and vertical membranous clefts closed, the line of fusion marked by heavy pigmented sutures.......................... *Exastinion* n.g.
14. Palpi slightly longer than wide, nearly vertical. Dorsum of abdomen clothed with short setae. *Male:* Sternum V absent; gonapophyses with accessory setae inserted posterior to the macrosetae..................... *Aspidoptera* Coquillet
    Palpi oval, nearly horizontal. Dorsum of abdomen clothed with long setae (figs. 76A, 78A). *Male:* Sternum V present, divided into two rounded sternites; gonapophyses with accessory setae inserted anterior to the macrosetae (fig. 78C) .... *Anatrichobius* n.g.
15. Minute species, 0.73–1.29 mm. long, with short legs. Wings with indistinct venation; with an (rarely, two) apical, setigerous, digitiform process (fig. 83)..... .... *Mastoptera* n.g.
    Large species, 3.96–5.55 mm. long, with powerful, elongated legs. Wings with distinct venation, without an apical digitiform process (fig. 79) .... *Joblingia* Dybas & Wenzel

16. Inner face of profemora with stout spines (fig. 97). Mesepisternum divided into dorsal and ventral parts by a horizontal, longitudinal, membranous cleft similar to that separating the prescutum from the mesepisternum. Wings with only three longitudinal veins (fig. 99C) .... *Neotrichobius* n.g.
    Inner face of profemora lacking stout spines; mesepisternum not divided into two parts by a membranous cleft. Wings with four or more longitudinal veins (figs. 100D, 101E) .... *Megistopoda* Macquart
17. Middle of anterior prescutal margin (fig. 115A) with two closely placed, sharp teeth which fit into grooves on the posterior part of the head; humeral calluses strong, flat projections which fit under posteroventral margin of head. Costal vein heavily sclerotized, wider and bearing strong setae from base to junction with R_1, beyond which it is narrower, less strongly sclerotized, and bears short setae; *r-m* near fork of R_s (fig. 115A) .... *Synthesiostrebla* Townsend
    Anterior margin of prescutum often sinuate, with blunt median projections, but never with a median pair of sharp teeth. Costa usually rather uniform in width and sclerotization throughout its length, *r-m* situated some distance from fork of R_s (fig. 86A) 18
18. Upper surface of posterior tibiae with at least two, sometimes five or six, macrosetae which are conspicuously longer than the others 22
    Upper surface of posterior tibiae with setae more or less uniform, never with conspicuously longer macrosetae 19
19. Venter of thorax shield-like, as in *Megistopoda* and *Neotrichobius* (fig. 98), broadly rounded anteriorly and posteriorly, the anterior margin reflexed upwardly. Inner surface of profemora with a diagonal row of heavy spines (represented by strong setae in one species); hind legs greatly elongated..... .... *Paratrichobius* Costa Lima
    Venter of thorax not thus, the lateral margins oblique anteriorly and posteriorly. Inner face of profemur without spines, though strong setae may be present (fig. 102); hind legs may or may not be greatly elongated.................... 20
20. Palpi with setae along margins only, ventral surface bare, the dorsal surface with micropile but appearing bare under low magnifications. R_1 united with costal vein opposite third crossvein, both with strong macrosetae to this point....... .... *Trichobioides* n.g.
    Palpi with setae on ventral surface and along margins. R_1 united with costal vein at a point distinctly beyond level of third crossvein...................... 21
21. Hind legs greatly elongated and twice as long as the forelegs...... *Speiseria* Kessel
    Hindlegs not twice as long as forelegs; if elongated, then fore and middle legs are also elongated.. *Trichobius* Gervais
22. Occipital lobes produced posteriorly as broad flaps (fig. 119A) which overlap the antero-lateral margins of the prescutum, the latter lacking a median suture and produced anteriorly as a truncate median projection which fits between the occipital flaps; genae and postgenae evenly covered with numerous short, posteriorly directed setae of nearly uniform size........... *Stizostrebla* Jobling
    Posterior margin of occipital lobes rounded, not flap-like, though a short tubercle may be present; genae and postgenae with both long and short setae; anterior margin of prescutum sinuate, with a bilobed median projection, the median suture well developed, usually complete.................................. 23
23. Head distinctly broader than long, and as broad as thorax or nearly so; postgenae and occiput (viewed from beneath) conspicuously expanded laterally; postvertex sclerotized, separated from the occipital lobes by a dark suture. *Female:* Ventral abdominal connexivum without a subapical row of blunt spines; cerci not united with the ventral arc...................... *Pseudostrebla* Costa Lima
    Head distinctly narrower than thorax; postgenae and occiput not conspicuously expanded; postvertex membranous as in *Trichobius* and *Paratrichobius*. *Female:* Ventral abdominal connexivum with a subapical row of stout spines (fig. 116B); cerci united with the ventral arc.................. *Parastrebla* n.g.

Subfamily **Nycterophiliinae** Wenzel, new subfamily

Until now, only one species of the genus *Nycterophilia* has been described. All specimens recorded by authors have been referred to the type-species, *N. coxata* Ferris, 1916. The senior author has segregated six new species in the collections of Chicago Natural History Museum. Without doubt, additional species exist. Three new species have been identified in the collections from Panama.

The species of this genus differ remarkably from other Streblidae, and one can argue that a new family should be created for them. However, this should not be done until detailed comparative studies are made of the morphology of both Old World and New World Streblidae (including the Ascodipterinae) and of the Nycteribiidae. For this reason, we only propose a new subfamily at this time.

DIAGNOSIS: Body strongly, laterally compressed, flea-like. *Thorax.*—Short and very deep. Mesonotum without a median suture. Spiracles situated just above midpoint between dorsal and ventral thoracic margins. *Wings.*—Either macropterous or micropterous (strut-like); when fully developed, with much reduced venation, only a few anterior veins and remnants of vannal veins sclerotized. *Legs.*—Femora and tibiae with unsclerotized annuli similar to those of Nycteribiidae. Profemora greatly enlarged and strongly, laterally compressed. Tibiae with marginal incrassations (seen in slide preparations). *Abdomen.*—Seven pairs of spiracles present, the first spiracle lying along or above the upper margin of sternum I, the second in the connexival membrane between the posterior angles of tergum I and sternum I. Terga I and II separated ventrally by a membranous suture, fused dorsally. Sternum I longer than II. *Female:* Intermediate sterna not sclerotized or only very feebly sclerotized; tergum VII a very small plate if sclerotized; terminal cone setose, dorsal to proctiger. Seventh sternites present, ventro-lateral in position. Also a small ventral sclerite and strip anterior to vulva. *Male:* Sterna III–VI well developed as distinct sclerites; VII and VIII united to form longitudinal portion of the hypopygium; tergum IX bearing a pair of claspers with a terminal movable harpago, an inner pair of blade-like gonapophyses, and a ribbon-like aedeagus with a short non-coiled apodeme (fig. 45A).

The strongly compressed, flea-like body, the distinctive wing venation, the external male terminalia, the claspers with movable harpago, and the full complement of pre-abdominal sterna in the male, clearly separate this from the other subfamilies of Streblidae. Further, the position of the first and second spiracles differs greatly from that of other New World Streblidae, in which both are situated in tergum I+II.

Jobling (1951) did not discuss the systematic position of *Nycterophilia*, though he apparently regarded it as belonging to the Trichobiinae. Pessôa and Guimarães (1940) assigned the genus to the Nycteriboscinae, but as noted earlier, they appear to have misinterpreted the structure of the head, probably because of a lack of material suitable for study. *Nycterophilia* does possess some features in common with the Nycteriboscinae, especially in the structure of the sterna IX and X in the female. However, similar sclerites are found in some of the Trichobiinae. The genus appears to be more closely related to the New World Streblidae. The presence of paired ventral setae on the male gonapophyses suggests this, as does the number and position of the abdominal spiracles in both sexes, the divided female seventh sternum, and the structure of the male hypopygium. It especially appears to be related to *Trichobius* species of the *caecus* and *pallidus* groups, which, for the most part, occur on the same hosts as *Nycterophilia*. In these, the male cerci are very long and are connected by apodemes to the surstyli, suggesting a resemblance to the clasper shaft and harpago of *Nycterophilia*. On the other hand, the non-pigmented annuli of the legs, the abdominal segmentation of the male, and the external claspers suggest a relationship with the Nycteribiidae.

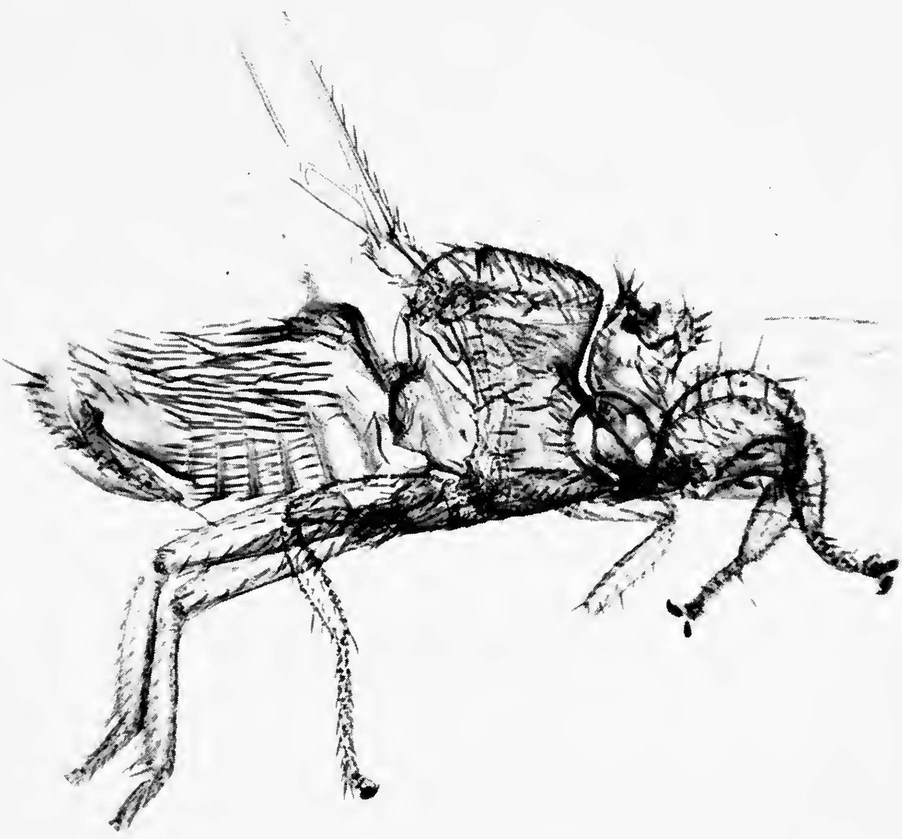

Fig. 46. *Nycterophilia parnelli*, new species, holotype male; lateral view.

We tentatively suggest that both *Nycterophilia* and *Ascodipteron* represent specialized developments from a stock which gave rise to both Streblidae and Nycteribiidae. *Ascodipteron* should probably be regarded as belonging to a separate family, as it was by earlier authors.

Genus **Nycterophilia** Ferris

Nycterophilia Ferris, 1916, Ent. News, **37**: 436–437 (diagnosis). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., **5**: 25 (keyed), 30 (cit.). Stiles and Nolan, 1931, Bull. Nat., Inst. Hlth., Wash., no. 155, p. 654. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, **28**: 361, 362 (morph.). Bequaert, 1940, Rev. Acad. Colomb. Cien. Exact., Fis. y Nat., **3**: 417 (keyed); 1942, Bol. Ent. Venez., **1**: 85 (keyed). Jobling, 1949, Parasitology, **39**: 321 (keyed); 1951, Trans. Roy. Ent. Soc. Lond., **102**: 215 (morph.). Maa, 1965, Jour. Med. Ent., **1**: 385 (cit.).

Nycterophila Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 12 (keyed), 13. Pessôa and Guimarães, 1940, Arq. Inst. Biol. São Paulo, **11**: 421–424 (syst. pos.). Schuurmans Stekhoven Jr., 1941, Zool. Anz., **136**: 80.

Type-species: *Nycterophilia coxata* Ferris, 1916.

DIAGNOSIS: Body form strongly, laterally compressed, flea-like. *Head.*—Vertex strongly projecting as dorsal lobes; occiput and post-occiput obliquely declivous, the posterior surface concave and apposed to the anterior margin of thorax. Laterovertices differentiated, bearing the eyes; occipital plates consisting of thin, feebly sclerotized transverse strips. Eyes not always differentiated, never with more than a single facet. Each postgena ventrally produced, below oral cavity, as a process bearing a stout seta; a series of two to five short spinelets present on each side immediately below oral cavity. Theca and palpi vertical in repose.

Thorax.—Short, deep, anterior margin (figs. 46–48) inwardly declivous. Mesonotum without a median suture; transverse suture strong, complete. Scutellum very short and strongly convex, with a pair of closely appressed (partially fused) macrosetae which arise from the same theca. Longitudinal and vertical membranous clefts present, well-defined. Spiracles situated behind anterior margin about halfway between dorsal and ventral margins, or slightly above this. Pleurotrochantinal plate movable, separated from sternopleura by a membranous suture.

Wings.—Emarginate distally in macropterous species; costa, a longitudinal vein, and part of a third vein normally developed and sclerotized anteriorly, and with sclerotized rudiments of two veins in vannal region; also with nine longitudinal rows of setae which may represent reduced veins; longitudinally folded in repose. Wings of micropterous species reduced to short strut-like structures without identifiable venation. Halteres large, conspicuous (fig. 50A, *hlt.*).

Legs.—Femora and tibiae each with a non-pigmented cuticular annulus similar to those of Nycteribiidae. Inner face of profemora with a few discal setae, bearing a pair of heavy spines near base and a blunt spine at about middle above ventral margin, as well as smaller peg-like submarginal spines antero-dorsally; with a ventral groove on inner face for reception of the protibia; outer face with more numerous setae; upper margin with both short setae and macrosetae; with an irregular and incomplete non-sclerotized annulus. Procoxae large, projecting dorsally; latero-ventral and ventral posterior margins armed with heavy or spiniform setae, which form a "pseudo-ctenidium". Middle and hind femora normal, spindle-shaped, clothed with setae and with a few macrosetae, the hind femora longer than the middle ones. Hind tibiae with a pair of conspicuous subapical, bifid, spine-like setae; inner face with dense, short setae on apical half. Protarsi with minute setae ventrally, with spinelets dorsally and laterally. Middle and hind tarsi longer than tibiae; inner face of first segment of hind tarsi with dense, short setae similar to those on inner face of hind tibiae. Tarsal claws with oblique parallel grooves on outer face, sometimes appearing pectinate, though the ventral margin does not seem to be incised.

Abdomen.—Terga I and II separated ventrally by a vertical membranous suture, fused dorsally; a vertical row of marginal setae present on I along suture; lateral lobes of II with discal setae and, on posterior margin, three heavy "braided" spiniform setae, the dorsal one much smaller than the other two. Spiracles situated as follows: first pair just above middle of dorsal margin of sternum I; second pair just above dorsal angle of sternum I on line with interval between I and II; third pair in connexival membrane just below posterior angles of tergum II and above interval between sterna II and III; fourth to sixth pairs situated more dorsally than the preceding, in the connexival membrane just above the lateral connexival setae and opposite intersternal membranes; seventh pair situated more ventrally than the three preceding, being just anterior to the hypopygium and dorsal to postero-dorsal edge of seventh sternites, in the female, and in the middle of the dorsal edge of synsternum VII+VIII, in the male.

Female: Segments III–VI represented, at most, by paired median, dorsal connexival setae; VII represented by setae or by a small setose sclerite. Terminal cone prominent, dorsal to the proctiger, the latter separate and free (fig. 51). Lateral connexivum with micropile and coarse setae which are coarser than those on ventral half. Sterna III–VI at most very feebly sclerotized, if at all, but represented by vertical rows of coarse setae which become coarser dorsally. Ventral to the proctiger is a small sclerotized plate, connected by a sclerotized strip to a small sclerite in front of the vulva. Seventh sternites normally triangular, ventro-lateral in position.

Male: Segments III–VI may also be represented by median paired dorsal connexival setae. Sterna I–VI well developed and sclerotized with coarse spiniform paired median ventral setae and, along sides, with marginal setae along posterior margin, these becoming coarser and "braided", dorsally, similar to the lateral connexival setae; sternum VI fused along median ventral line with anterior portion of hypopygium, the latter long, sclerotized, membranous dorsally except at apex where it is sclerotized and "closed" to form a "ring" together with the ventral portion. The apical portion of the hypopygium a separate sclerotized segment bearing the terminalia. These consist of a long clasper-like, ventral shaft, on each side, which distally bears an articulated "harpago"; a pair of conspicuous gonapophyses between the "claspers" and articulated basally with the ventral posterior margin of the hypopygium; and, between the gonapophyses a ribbon-like (viewed dorsally) aedeagus. The aedeagal apodeme is relatively short and is not coiled. Tergum IX with dorso-apical macrosetae. Cerci a pair of small setose flaps on each side of anus. Spiracles situated very much as in female, but seventh pair situated just within dorsal margin, of hypopygial "ring" at mid-length.

According to Ross (1961, p. 241), the greatly enlarged first pair of legs [profemora] "is not used in locomotion by *N. coxata,* but is held forward at the sides of the head in such manner as to part the fur as it progresses through it." Their well developed musculature suggests that these have other functions, too.

These flies resemble fleas so closely in their movements that they deceive even the expert. When on the host, the wings are folded longitudinally and held over the upper sides of the abdomen. Thus, the similarity to fleas is enhanced. The forms with reduced strut-like wings must be even more flea-like in life.

KEY TO THE SPECIES OF *NYCTEROPHILIA*

1. Dorso-apical spur of hind coxa long, conspicuous (fig. 50A) 3
   Spur short, inconspicuous, sometimes nipple-like (figs. 47A, B) 2
2. Antero-lateral angles of thorax sparsely setose; mesepisternum with a row of submarginal bristles along margins of both the longitudinal and vertical membranous clefts and five or six other, discal setae[7] (fig. 47A). *Female:* Terminal cone with two apical macrosetae (fig. 51C). *Male:* Gonapophyses (lateral view) strongly but evenly tapered from base to apex. Host: *Pteronotus parnellii* .... *parnelli* n.sp.

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[7] The discal setae are those in an imaginary quadrangular area bounded by the longitudinal and vertical membranous clefts and the inner edge of the anterior thoracic spiracle (figs. 47A, *d.s.*; 48).

Antero-lateral angles of thorax rather densely setose; mesepisternum with 13 or 14 discal bristles (fig. 47B). *Female:* Terminal cone with four apical macrosetae (fig. 51B). *Male:* Gonapophyses (lateral view) abruptly tapered apically. Hosts: *Pteronotus psilotis, P. suapurensis* .... *fairchildi* n.sp.

3. Each lateral lobe of tergum II with two large and one much shorter spinelets on posterior margin plus nine or ten other setae. Postgenae with two or three minute spinelets. *Male:* Paired dorsal connexival setae on abdominal segments III–V conspicuous (fig. 50A). Host: *Natalus stramineus mexicanus*.... *natali* n.sp.

Each lateral lobe of tergum II with six to eight setae in addition to the posterior spinelets. Postgenae with four or five minute spinelets. *Male:* Paired dorsal connexival setae on segments III–V very fine, short, inconspicuous (fig. 50B). Hosts: *Macrotus mexicanus, M. californicus*. .... *coxata Ferris*

Nycterophilia parnelli Wenzel, new species. Figs. 45A, 46, 47A, 49A, 51C.

Nycterophilia coxata (not Ferris, 1916), Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 13 (part.). Jobling, 1949 (part.), Parasitology, 39: 316 ff., 327. Bequaert 1940, Rev. Acad. Colomb. Cien. Ex. Fis. y. Nat., 3: 418.

Closely related to *fairchildi* n. sp., and like it having a short metacoxal spur, but differing in thoracic chaetotaxy (fig. 47A), in that the female has only two (instead of four) apical macrosetae on the terminal cone and lacks a row of ventral abdominal spiniform setae anterior to the vulva, and the male gonapophyses are strongly but rather evenly tapered from base to apex (lateral view).

DESCRIPTION: *Head.*—Eyes conspicuous, pigmented. Laterovertices with 10–11 setae of variable size, two or three pairs conspicuously longer than the others though they are not macrosetae; occiput with a pair of dorsal macrosetae on each side; posterior margins of head on each side with a vertical row of seven to nine short, distinct setae; side of head with a transverse row of five to seven short setae across middle; three or four postgenal spinelets present. *Thorax.*—Mesonotum covered dorsally with short setae. Chaetotaxy of sides as shown in fig. 47A. Scutum with six prominent setae anteriorly, consisting of two on each side and a median pair; the latter followed posteriorly by a median pair of shorter setae; scutellum with a median pair of closely appressed, often partially fused very long prominent macrosetae that arise from the same theca; lateral to the scutellum a macroseta and a short seta on each side. *Wings.*—As in *N. coxata*. *Legs.*—Profemora with five macrosetae alternating with short setae on upper margin; outer face with dorsal submarginal and numerous discal setae arranged in irregular longitudinal rows, inner face with three peg-like spines above, two of them more slender and situated near middle, a longer one near apical third; a ventral submarginal spinelet near base; a large curved blunt spine above margin near middle and a short weak spinelet basal to it. Protibiae feebly tapered apically; incrassations of the margin not strong; in addition to marginal and submarginal setae of outer face there is a median longitudinal row, the uppermost setae of this row strong, coarse. Metacoxa with a short inconspicuous dorsal spur (fig. 47A). Other tibiae and tarsi very similar to those of *N. coxata*.

Abdomen.—*Female:* Tergum I with two setae, one above the other, along middle of antero-lateral face; posterior margin with short fine setae. Tergum II at middle of posterior margin with four very slender long setae, two on each side; lateral lobes with two large stout spiniform setae at posterior margin, a shorter spiniform above them and fine setae anterior to these. Dorsal connexivum bare except as follows: segments III–V represented dorsally by paired macrosetae, those of VI and tergum VII shorter; III represented by two pairs, these "connected" to setae of lateral connexivum on each side by a row of setae slightly anterior to them; tergum VII small, feebly sclerotized, with four setae. Terminal cone with a single pair of dorso-apical macrosetae and ventral to these about eight setae of varying lengths, one of these (antero-median) much longer than the others. Posterior margin of sternum I with a median ventral pair of strong setae and dorsally with a row of setae, the more ventral ones very fine and short, the

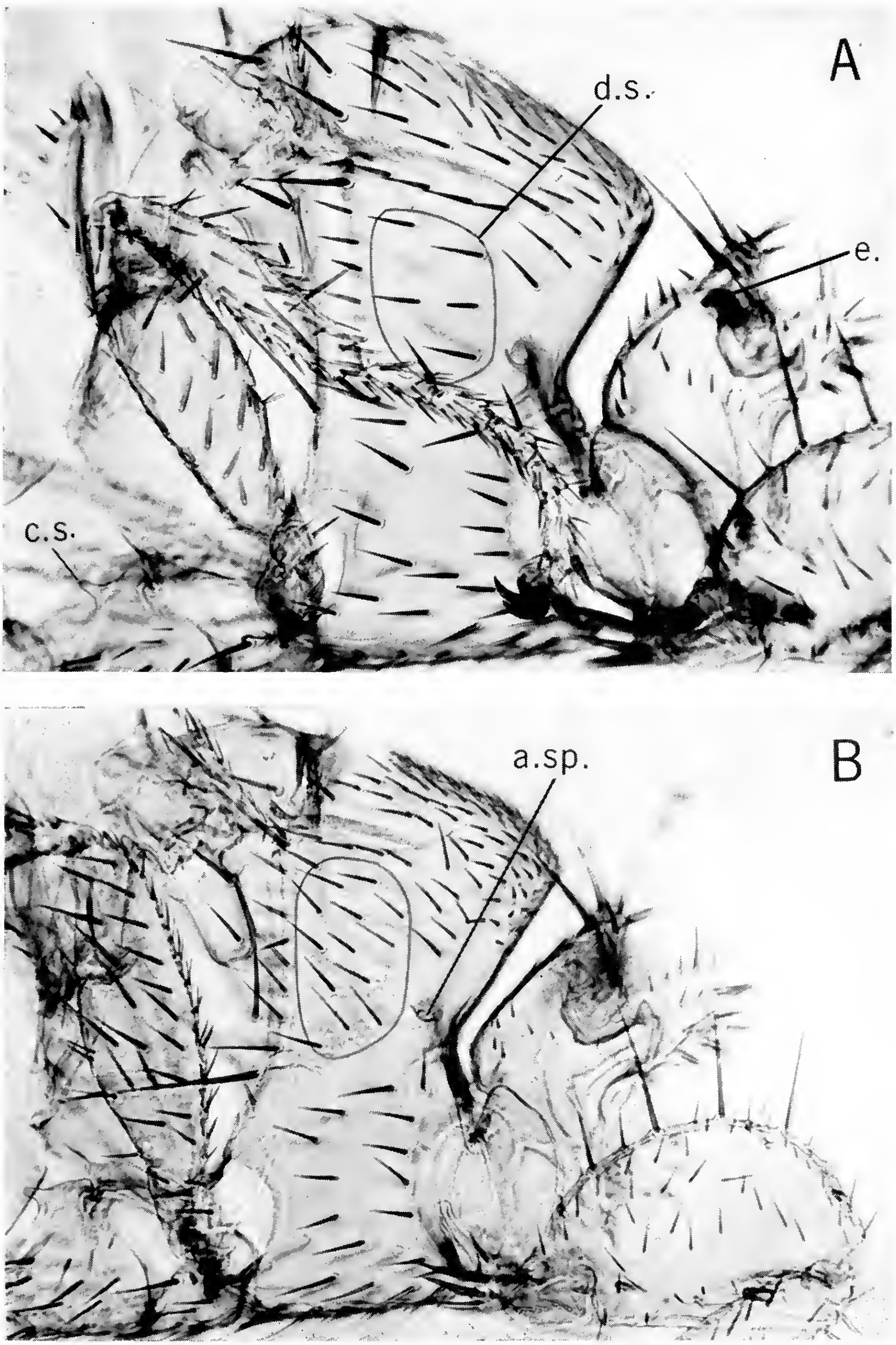

Fig. 47. Head and thorax, lateral view. A, *Nycterophilia parnelli*, new species, female paratype from *Pteronotus parnellii fuscus* (no. 7167), Madden Airstrip (Panamá). B, *N. fairchildi*, new species, female paratype from *Pteronotus suapurensis* (no. 8777), Penonomé Caves (Coclé). See text for explanation.

setae becoming coarse, "braided", dorsally. Posterior margin of sternum II with braided setae, these becoming longer, stout and braided and similar to the connexival setae dorsally; ventro-median edge of sternum V with a fringe of somewhat longer setae; VI bare and connected with VII+VIII along ventral midline.

Measurements:	BL	TL	WL	WW
Male	1.35–1.40	0.42–0.46	1.15–1.32	0.55–0.58
Female	1.42–1.65	0.44	1.21–1.32	0.60–0.66

TYPE MATERIAL: Holotype male and allotype female (slides) from *Pteronotus parnellii fuscus* (host no. 3924), railroad culvert, Paraíso (Canal Zone), C. M. Keenan and V. J. Tipton, 24 July 1959. In the collection of Chicago Natural History Museum.

Paratypes.—116 specimens (18 lots) all from *Pteronotus parnellii fuscus* as follows: 43 (1 lot), railroad culvert, Paraíso (Canal Zone), 24 July 1959; 8 (6 bats), same locality 15 and 16 September 1959, and 1, same locality, 1 December 1959; 2, railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959; 12 (1 bat), Madden Air Field, Casa Larga (Panamá), 23 May 1961; 12, Chilibrillo Caves (Panamá), L. H. Dunn no. 271 [MCZ]; 3, same locality (labeled as from "*Chilonycteris r. rubiginosa*") [CU]; 3 (3 bats), Guánico (Los Santos), 22 January and 16 February 1962; 1, Cerro Hoya (Los Santos), 14 February 1962; 7, Penonomé (Coclé), L. H. Dunn [MCZ]; 26, same locality, in cave, 11 March 1954, H. Trapido. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED: From *Carollia perspicillata azteca* (!): 2, Buena Vista (Colón), 3 September 1959; 2 (from preserved bats in museum collection), Chilibrillo Caves (Panamá), 30 August 1935. In addition, we have seen numerous specimens which we tentatively assign to this species, from various hosts, taken in MEXICO, GUATEMALA, VENEZUELA, and TRINIDAD.

Nycterophilia fairchildi Wenzel, new species. Figures 47B, 49B, 51B.

? *Nycterophilia coxata* (not Ferris, 1916), Pessôa and Guimarães, 1940, Arq. Inst. Biol., 11: 421.

Very similar to *N. parnelli* n. sp. and, like it, with a short inconspicuous dorso-apical spur on metacoxa; differing conspicuously from it in the thoracic chaetotaxy (fig. 47B); in that the female has four (instead of two) apical macrosetae on the terminal cone and has a ventral transverse row of about eight heavy spiniform setae anterior to the vulva; and in that the male gonapophyses are broad at base and abruptly tapered apically (in lateral view).

DESCRIPTION: Very similar to *parnelli* in most characters. *Head.*—With three post genal spinelets. *Thorax.*—Chaetotaxy as in fig. 47B. *Wings and legs.*—As in *parnelli. Abdomen.—Female:* Lateral lobes of tergum II with eight setae in addition to the three coarse marginal spiniform setae. Chaetotaxy of dorsal connexivum very similar to that of *parnelli,* except that setae of segment VI are lacking; the setae on III are connected to lateral connexival setae by a group of five or six setae on each side. Terminal cone with four apical macrosetae (two each side) and five or six other setae on each side. Sterna I and II similar to those of *parnelli,* the lateral disc of II with a row of three to five setae in addition to the setae along posterior margin. Seventh sternites with about 12 setae, of which the ventral and dorso-apical ones are macrosetae, the others of varying lengths. Anterior to the vulva (ventral and between the seventh sternites) is a trans-

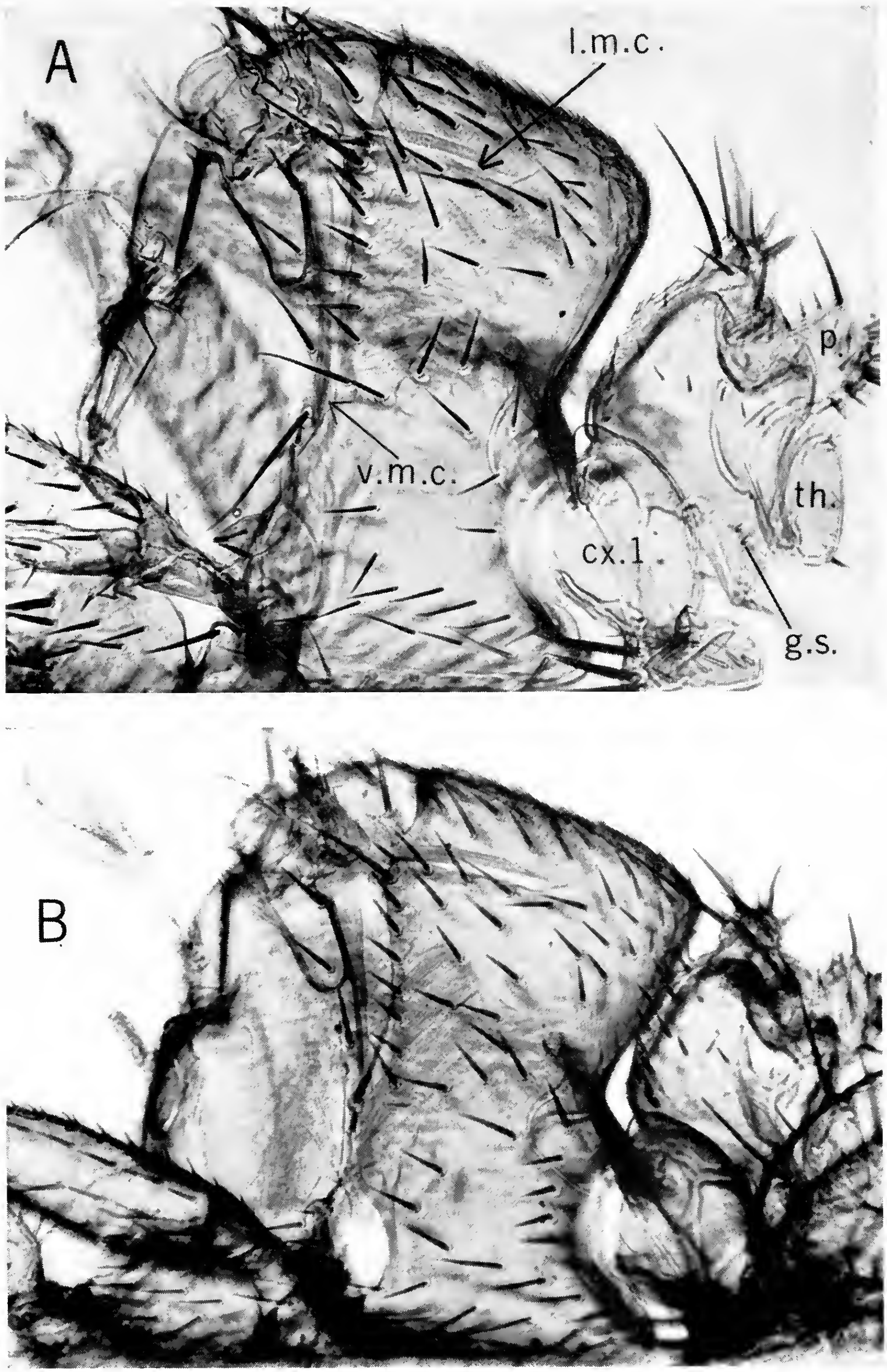

Fig. 48. Head and thorax, lateral view. A, *Nycterophilia natali*, new species, female from *Natalus* sp. (CNHM host nos. 64731–807), Santa Clara, Sierra de las Minas (Zacapa), GUATEMALA. B, *N. coxata* Ferris, from *Macrotus mexicanus*, La Galarza (Puebla), MEXICO. See text for explanation.

verse sclerotized strip which bears a row of eight conspicuous spiniform setae, four on each side appearing somewhat like a ctenidium. *Male:* Lateral lobes of tergum II each with 9–11 setae in addition to the very heavy spiniform setae on posterior margin. Dorsal connexivum bare except for very fine, very short paired segmental setae on III–IV. Sternum VII+VIII with about 13 or 14 setae on each side. Upper portion of segment IX with about 14 setae in addition to the stout dorsal macroseta; shaft of claspers typically with a row of five, sometimes four, setae; harpago with a long basal ventral seta, a short very fine sub-basal dorsal seta, two short setae at about basal third, two very fine distal ventral setae and some apical microsetae that are visible only under oil immersion. Gonapophyses strongly but rather evenly tapered from base to apex.

Measurements:	BL	TL	WL	WW
Male	1.37	0.44	1.13–1.15	0.55–0.60
Female	1.59	0.47	1.29	0.55

TYPE MATERIAL: Holotype male and allotype female (slides) from *Pteronotus suapurensis* (host no. 8777), Penonomé Caves (Coclé), 15 December 1961, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *Pteronotus suapurensis:* 9 (3 bats), same data as the holotype; 6, no locality (CBK host no. 5014), 2 May 1957 [USNM]. From *Pteronotus psilotis:* 4 (3 bats), same locality, collectors and date as holotype; and 1, same data but 24 January 1962. From *Pteronotus* sp.: 58, same locality as holotype, 11 March 1954, H. Trapido. From "*Pteronotus davyi*": 3, same locality, without date, L. H. Dunn [MCZ]. Non-Panamanian paratypes.—From *Pteronotus personatus:* 47, Cartagena, COLOMBIA, 22 June 1965, C. J. Marinkelle. Paratypes to be deposited in the collections listed on p. 410, and in the collection of C. J. Marinkelle, Universidad de los Andes, Bogota, Colombia.

OTHER MATERIAL EXAMINED: We have seen additional specimens, which we tentatively assign to this species, from MEXICO, GUATEMALA, and VENEZUELA.

REMARKS: To our knowledge, *Pteronotus davyi*, listed as a host for the specimens collected by Dunn [MCZ], does not occur in Panama.

N. fairchildi is named in honor of Dr. Graham B. Fairchild of the Gorgas Memorial Laboratory, Panamá, Panamá.

Nycterophilia natali Wenzel, new species. Figures 48A, 50A.

Nycterophilia coxata (not Ferris, 1916), Hoffmann, 1953 (part.), Mem. Congr. Cient. Mex., 7: 183, 187.

N. natali n. sp. differs from both *fairchildi* and *parnelli* in that it has a conspicuous long (rather than a short) dorsal metacoxal spur. In this respect, it resembles *N. coxata*. However, the male holotype differs from *coxata* in that the pairs of dorsal segmental connexival setae on III–V are conspicuous rather than very fine and short; and the "harpago" of the male terminalia lacks a long, conspicuous, ventral, basal seta. *N. natali* also differs from *coxata* in the number of postgenal spinelets and in the number of setae on the lateral lobes of abdominal tergum II, as indicated in the key.

In addition to characters *natali* has in common with *fairchildi, parnelli,* and *coxata,* the following may be noted:

DESCRIPTION: *Head.*—Setae of posterior margin of head finer and shorter than in *fairchildi* and *parnelli;* three or four postgenal spinelets present. *Thorax.*—Ventral

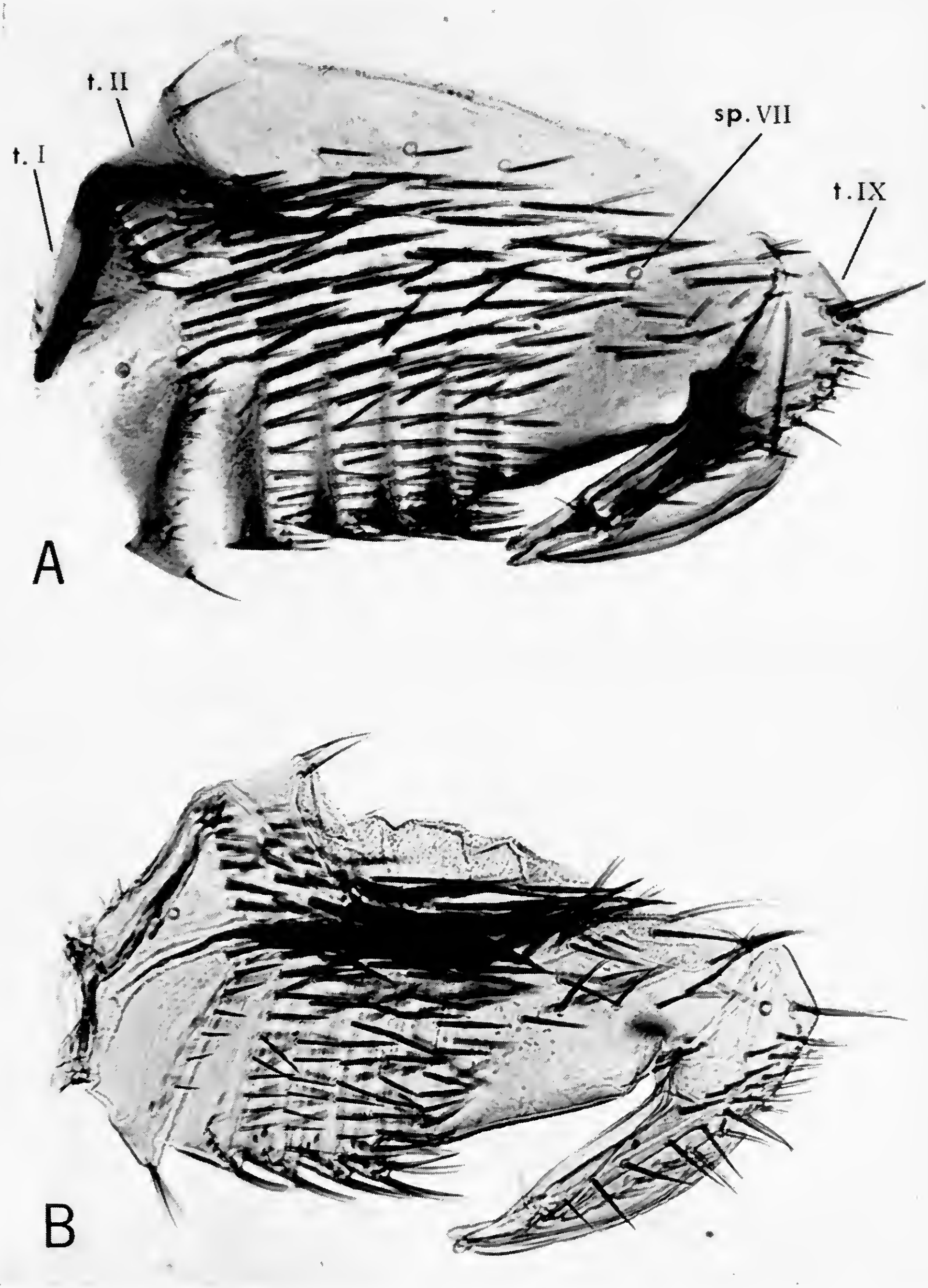

Fig. 49. Male abdomen. A, *Nycterophilia parnelli* new species, paratype from *Pteronotus parnellii fuscus* (no. 7167). B, *N. fairchildi*, new species, paratype from *Pteronotus suapurensis* (no. 8777). See text for explanation.

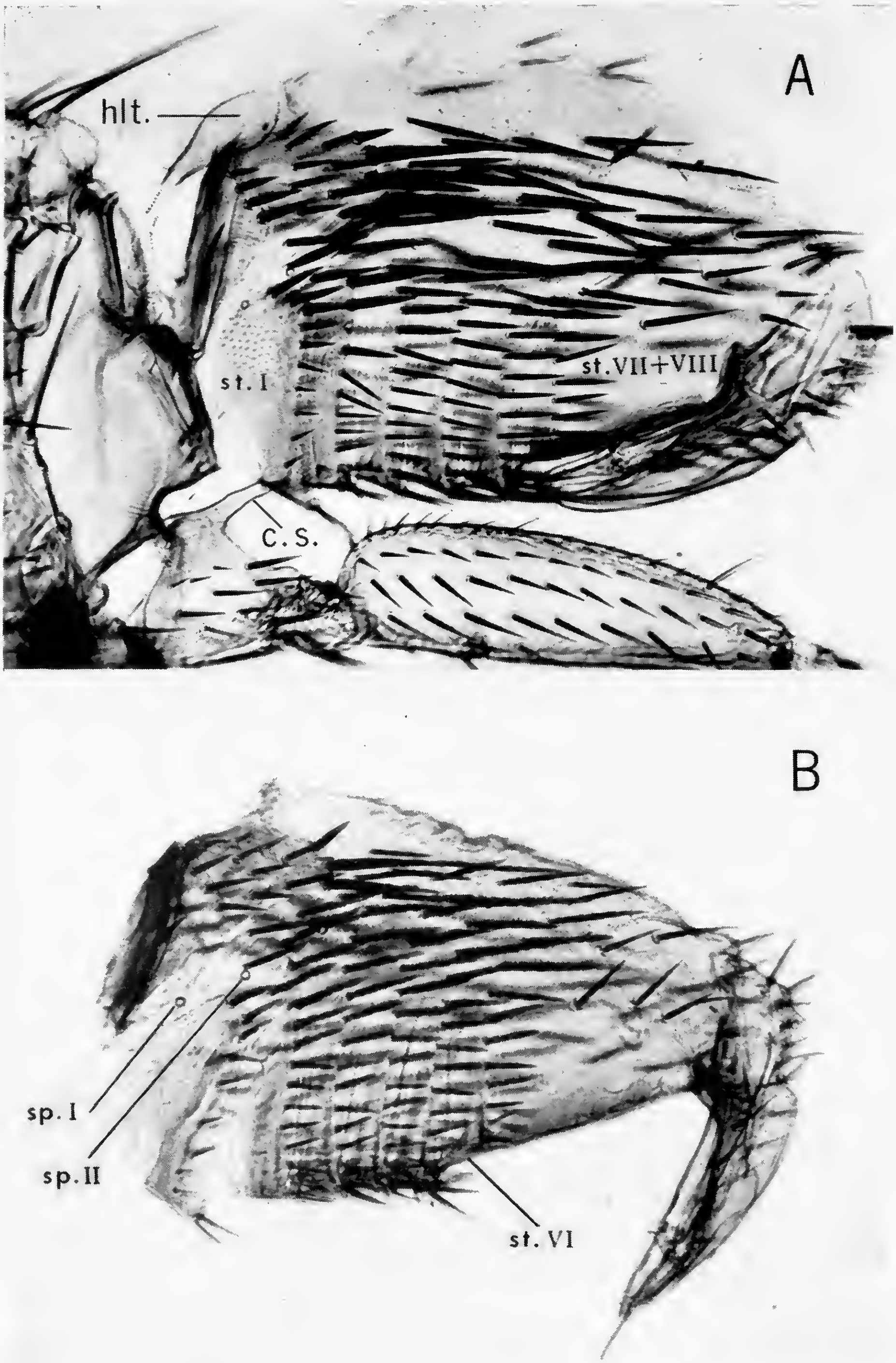

Fig. 50. Male abdomen, lateral view. A, *Nycterophilia natali*, new species, holotype. B, *N. coxata* Ferris (same specimen as 48B).

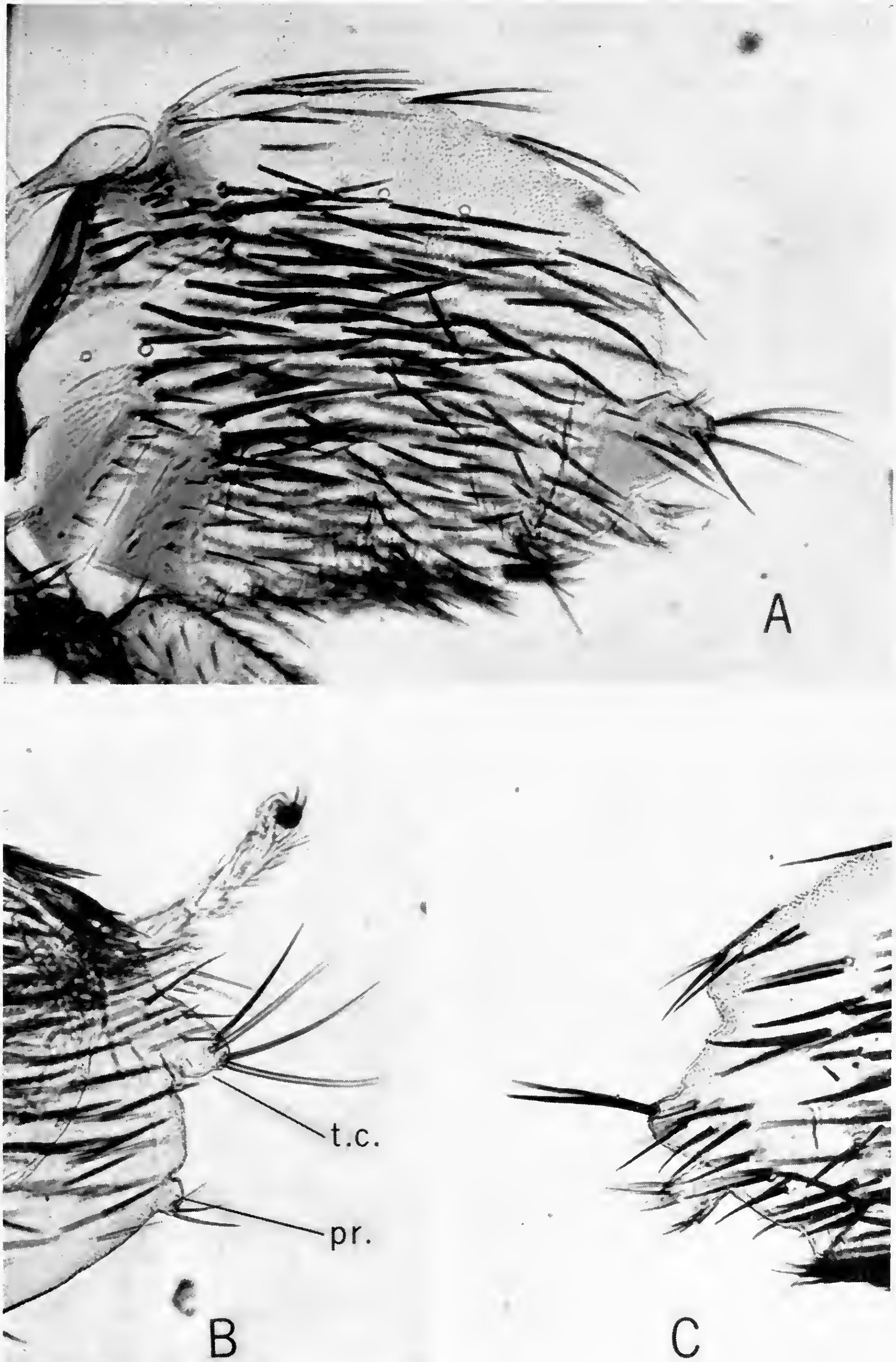

Fig. 51. Female abdomen, lateral view. A, *Nycterophilia coxata* Ferris, from *Leptonycteris nivalis*, Pima County, Arizona. B, *N. fairchildi*, new species, from *Pteronotus suapurensis* (no. 8777). C, *N. parnelli*, new species, from *Pteronotus parnellii fuscus* (no. 7167). See text for explanation.

setae of procoxae spine-like. Lateral lobes of tergum II with the usual heavy spine-like setae on posterior margin, and anterior to these, nine additional setae. Segmentally arranged dorsal pairs of connexival setae on segments III–V moderately long, conspicuous. Hypopygial "ring" with eight setae on each side. Segment IX on each side above the ventral shaft, with nine or ten setae in addition to the dorso-apical macroseta; shaft with four setae along posterior edge; harpago without a long ventral basal seta, but with a fine rather short sub-basal seta dorsally and another ventrally, as well as microsetae on apical half of inner and dorsal margins.

Measurements:	BL	TL	WL	WW
Male (Holotype)	1.32	0.44	1.21	——
Female (GUATEMALA and MEXICO)	1.52	0.47–0.48	1.36	0.66

TYPE MATERIAL: Holotype male (slide) from *Natalus stramineus mexicanus* (host no. 6732), San Lorenzo Caves, Fort San Lorenzo (Canal Zone), 15 March 1961, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

OTHER MATERIAL EXAMINED: We have several specimens that appear to be *natali,* taken from *Natalus* sp. in Guatemala and Mexico. However, the *Trichobius* from *Natalus s. mexicanus* in Panama appears to be different from that (*galei*) taken from the same host in Guatemala and it is possible that the *Nycterophilia* may be different, too. This may be easier to determine when series of both sexes are known from both localities.

REMARKS: The females from Guatemala differ from those of *coxata* in the characters noted above. On the ventral margin anterior to the vulva there is a row of coarse setae set somewhat apart from the others. These may be homologous to the spiniform setae borne on a sclerotized strip in *fairchildi* n. sp.

Subfamily **Trichobiinae**

Genus **Trichobius** Gervais

Trichobius Gervais, 1844, Atlas. Zool., p. 14, pl. 53. Speiser, 1900, Arch. Naturg., **66**A, Bd. I, pp. 62 (cit.), 65 (key), 33–37 (notes on morph.). Brues, 1904, Bull. Amer. Mus. Nat. Hist., **20**: 131–134. Coquillet, 1910, Proc. U. S. Nat. Mus., **37**: 616. Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Veter., Nictheroy, **5**: 25 (keyed), 26–28 (cit., records). Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 12 (keyed), 14–18 (synopsis). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 655. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); Bull. Amer. Mus. Nat. Hist., **66**: 522 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 6. Jobling, 1936, Parasitology, **28**: 357 ff. (morph., syst. pos.). Guimarães, 1937, Rev. Mus. Paul., **23**: 653–666, 2 pls., (S. Am. spp.). Jobling, 1938, loc. cit., **30**: 358–387, figs. 1–14 (revision of species). Bequaert, 1940, Rev. Acad. Colomb. Cien. Exact., Fis. y Nat., **3**: 417 (keyed); 1942, Bol. Ent. Venez., **1**: 86 (keyed), 87–88 (records, Venezuela). Schuurmans Stekhoven Jr., 1941 (& 1951), Beitr. Fauna Perus, **2**: 95 (Peruvian species). Jobling, 1949, loc. cit., **39**: 321 (keyed), 326 (records, Trinidad spp.). Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 178 (keyed), 179–182 (key, Mexican spp.), 182–183 (records, Mexican spp.). Maa, 1965, Jour. Med. Ent., **1**: 384 (list of spp.)

Trichobius Townsend, 1891 [with *dugesii* Townsend as type-species], Ent. News, **2**: 105–106. Williston, 1896, Man. Fam. Gen. N. Am. Dipt., 2nd ed., p. 152 (keyed).

Trichobia Guérin-Meneville, 1844, Icon. Régne Anim., **3**: 556. Bigot, 1885, Ann. Soc. Ent. Fr., **5**: 228.

Strebla Kolenati, 1863, Hor. Soc. Ent. Ross., **2**: 11 (not Wiedemann, 1824).

Kolenatia Rondani, 1878, Ann. Mus. Civ. Stor. Nat. Genova, 12: 169 [type-species: *Strebla wiedemannii* Kolenati 1863, not Kolenati 1856]. Bigot, 1885, Ann. Soc. Ent. Fr., (6), 5: 232 (keyed). Speiser, 1900, Arch. Naturg., 66A, Bd. I, pp. 33, 43 (synonymizes *Kolenatia* under *Trichobius*).

Kesselia Curran, 1934, Bull. Amer. Mus. Nat. Hist., 66: 522 [type-species: *Kesselia pallida* Curran]; 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28: 359 (venation).

Type-species: *Trichobius parasiticus* Gervais, 1844.

Seventeen previously described species of this genus are considered by us to be valid. One of these is assigned to a new genus, *Trichobioides*. Twenty-seven species are treated in this paper. Of these, six previously described and 17 new species are recorded from Panama. *T. caecus* Ed-

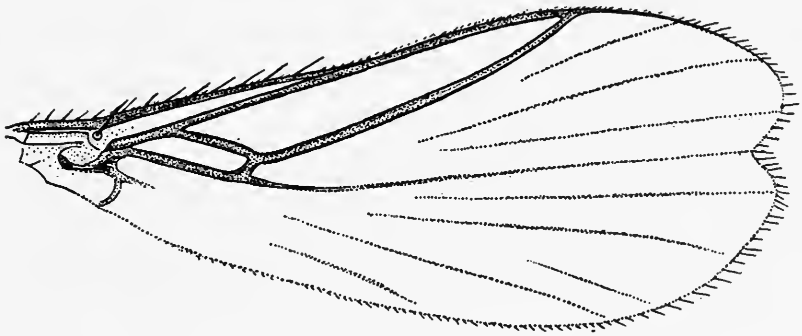

Fig. 52. Wing, *Nycterophilia* sp. From Jobling (1949b).

wards and *T. furmani* n. sp. are included, in order to assist in defining closely related Panamanian species. *T. pallidus* Curran (in key) and *T. diphyllae* n. sp. are included, because their hosts have been taken in Panama and the flies may also be found there.

The new species treated below bring the total number of described species of *Trichobius* to 34, making it the largest new world genus of Streblidae. In the collections of Chicago Natural History Museum, there are about a dozen additional species. Undoubtedly, many more will be discovered.

The genus includes diverse types, representing at least six, and possibly more, groups or species complexes. In the *major* group, we include *T. major* Coquillet, *hirsutulus* Bequaert, *corynorhini* Cockerell, *pseudotruncatus* Jobling, *sparsus* Kessel, and several undescribed species from Central America and the West Indies; *T. sphaeronotus* Jobling and *truncatus* Kessel appear to belong here. The species of the *major* group occur primarily on Vespertilionidae, though one may occur secondarily on Molossidae of the genus *Tadarida*. *T. sphaeronotus* occurs on *Leptonycteris*, a genus of Glossophaginae (Phyllostomidae).

The *caecus* group includes *T. caecus* Edwards, three new species described below, and several additional undescribed species. All occur on bats of the families Natalidae and Chilonycteridae.

T. pallidus Curran, which was taken on *Furipterus* (Furipteridae) superficially appears to be related to species of the *caecus* group. However, it differs in several essential features and until a series can be studied in detail, we would place this species by itself. Two undescribed species from Peru, one from a furipterid (*Amorphochilus schnablii*), seem to be related to *pallidus* but have a simple median suture.

The relationships of *T. adamsi* Augustson are not clear. It may be a specialized member of the *major* group.

The species of the *phyllostomae* group, including *T. phyllostomae* Kessel, *T. brennani* n. sp., *T. vampyropis* n. sp. and an undescribed species from Brazil occur on fruit-eating bats of the subfamily Stenoderminae (including Sturnirinae of authors).

Most of the remaining described species belong to the related *dugesii* and *longipes* groups. The species of the *longipes* group occur mostly on Phyllostominae of the genera *Phyllostomus* and *Tonatia*, although *T. dunni* n. sp. and several related undescribed species are apparently restricted to bats of the genus *Molossus*. The species of the *dugesii* complex are apparently mostly specialized types derived from species of the *longipes* complex and have radiated from the Phyllostominae to the Stenoderminae, Carolliinae, Glossophaginae and Desmodidae.

KEY TO PANAMANIAN SPECIES OF *TRICHOBIUS*[8]

1. Sixth longitudinal vein without setae near basal angle (fig. 42) 2
   Sixth longitudinal with setae at or near basal angle (fig. 61) 7
2. Median suture of prescutum bifurcate, short (fig. 56) 3
   Median suture not bifurcate, usually extending to middle of prescutum or beyond 10
3. Eyes with a single facet 4
   Eyes with more than one facet .... *pallidus* Curran
4. A broad median area of mesonotum without micropile; scutum at middle with only three transverse rows of bristles, including the antescutellars (fig. 54). Wing vein R_s twice as long as distance between fork and crossvein *r-m*. *Female*: Postgenital sclerite as in fig. 57K; seventh sternites with macrosetae along posterior margin, most discal setae well-developed; chaetotaxy of terminal cone as in fig. 57J. *Male:* Hypopygium with long, sparse setae dorsally and apically. Gonapophyses strongly curved, apices at approximately a right angle to base (fig. 57L). Host: *Natalus stramineus mexicanus* .... *galei* n. sp.
   Mesonotum and scutellum with micropile throughout; scutum at middle with about four transverse rows of bristles including the antescutellars (fig. 56A). R_s slightly to no more than a third longer than distance between fork and crossvein *r-m*. *Female:* Seventh sternites each with only three to five macrosetae along posterior margin, the rest of the setae small to minute. *Male:* Setae of hypopygium short except along apical margin 5
5. Chaetotaxy of lateral lobes of tergum I+II as in fig. 55A. *Female:* Postgenital sclerite as in fig. 57H; seventh sternites usually with three, sometimes four, macrosetae. Chaetotaxy of terminal cone as in fig. 57G. *Male:* Gonapophyses as in fig. 57I. Hosts: *Pteronotus suapurensis, P. psilotis* .... *johnsonae* n. sp.
   Chaetotaxy of lateral lobes of tergum I+II as in fig. 55B. Host: *Pteronotus parnellii fuscus* 6

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[8] Two of the included species, *T. pallidus* Curran and *T. diphyllae* n. sp. have not been recorded from Panama but may occur there. Two others, *T. caecus* Edwards and *T. furmani* n. sp., are included in the key in order to assist in differentiating between some closely related species that occur in Panama.

6. *Female:* Inner pair of basal setae on tergum VII absent or very small (fig. 57A); seventh sternites each with three or four macrosetae near apical margin; subgenital sclerite as in fig. 57B. *Male:* Gonapophyses as in fig. 57C. .... *caecus* Edwards

Female: The inner pair of basal setae on tergum VII well developed (fig. 57D); each seventh sternite usually with five or more macrosetae along apical margin; postgenital sclerite as in fig. 57E. *Male:* Gonapophyses as in fig. 57F. .... *yunkeri* n. sp.

7.[9] Wing vein R_1 strongly sinuate, the costal cell rather abruptly narrowed apically (fig. 59A); R_s markedly longer than distance between fork and crossvein *r-m*, and the latter distance no more than twice the length of *r-m*. *Female:* With a distinct cluster of longer discal setae in posterior angles of sternum II. *Male:* Gonapophyses (fig. 60D), wedge-shaped in lateral view, ventral margin nearly straight, with a submarginal row of fine setae. .... *lonchophyllae* n. sp.

Wing vein R_1 straight or only very feebly sinuate (fig. 61), the costal cell rather evenly tapered or nearly subparallel apically; length of R_s and distance between fork and crossvein *r-m* subequal, the latter distance more than twice the length of *r-m*. *Female:* Marginal setae of sternum II longer toward posterior angles but discal setae not longer within the angles. *Male:* Gonapophyses (figs. 60A–C) ventrally curved and tapered, at most with one or two submarginal setae along ventral margin 8

8. Posterior margin of each occipital plate with a prominent posteriorly-directed tubercle which bears a very short spinelet-like seta; eyes separated by their width or more from lateral margin of head. *Male:* Gonapophyses as in fig. 60C. .... *uniformis* Curran

Posterior margin of each occipital plate with a short seta borne on an inconspicuous tubercle, the seta not a spinelet; eyes extending to lateral margins of head or separated from margins by less than their width. 9

9. *Female:* Four setae of tergum VII arranged in a transverse row. *Male:* Gonapophyses as in fig. 60A. Hosts: *Micronycteris megalotis, M. nicefori* .... *keenani* n. sp.

Female: Four setae of tergum VII arranged one pair behind the other, the anterior and posterior pairs widely separated. *Male:* Gonapophyses as in fig. 60B. Host: *Lionycteris spurrellii* .... *lionycteridis* n. sp.

10. Scutum and prescutum covered with setae 13

Scutum and prescutum with conspicuous areas devoid of setae (figs. 58B, 67B, 73B) 11

11. Prescutum with a longitudinal cluster of six to nine very short setae at middle anterior to the transverse suture (fig. 67B). Hosts: *Phyllostomus* spp. .... *costalimai* Guimarães

Prescutum without such a cluster of setae.....................................12

12. Size smaller, body 1.36–1.70 mm. long. Thorax distinctly flattened; prescutum with a transverse row of setae immediately anterior to transverse mesonotal suture and a median group of four to six setae, these sometimes separated from a lateral group on each side (fig. 73A); W-shaped band of setae along posterior margin of scutum consisting of very short setae only. Hosts: *Desmodus rotundus, Diaemus youngii*.................................*parasiticus* Gervais

Size larger, body 1.65–2.25 mm. long. Thorax deeper, not flattened; row of setae anterior to transverse mesonotal suture broadly interrupted at middle (fig. 58B); band of setae along posterior margin of scutum with a row of very long antescutellar setae and anterior to these a transverse patch of very short setae. Host: *Pteronotus parnellii fuscus* .... *sparsus* Kessel

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[9] The species of the *uniformis* group are extremely difficult to identify without comparative material, except by the structure of the male gonapophyses.

13. Sternopleura strongly projecting between the procoxae; lateral margins of the projection subparallel apically (fig. 62D) 14
Sternopleura less strongly projecting between the coxae, the lateral margins oblique (fig. 62E) 15

14. Size larger, body 2.20–2.65 mm. long. Prescutum two-thirds as long as broad, the anterior margin very strongly projecting at middle; mesonotal chaetotaxy as in fig. 74B. Wing vein R_s about as long as distance between fork and crossvein *r-m*. Host: *Vampyrops vittatus* ....*vampyropis* n. sp.
Size smaller, body 2.09–2.39 mm. long. Prescutum only slightly more than half as long as broad, the anterior margin projecting but less strongly so; mesonotal chaetotaxy as in fig. 74A. Wing vein R_s only slightly more than half as long as distance between fork and crossvein *r-m*. Host: *Sturnira ludovici*.............
....*brennani* n. sp.

15. Occipital lobes of head with 10–12 setae. Abdominal tergum I+II with a cluster of short setae on each side of middle of basal margin, a group of coarse long setae on lateral lobes, and a single seta (occasionally two) on anterior face, situated laterally and ventrally to median basal group 16
Occipital lobes of head with 17–19 setae. Abdominal tergum I+II with a cluster of about 10 short setae on anterior face on each side lateral and ventral to median basal cluster. ....*dunni* n. sp.

16. Median pleurotrochantinal lobe present, reflexed dorsally and united with a descending process of the metepimeron so as to close the coxal cavities mesally (fig. 62A) 17
Median pleurotrochantinal lobe absent, or if one is present and reflexed, it is not united with the metepimeron so as to close the coxal cavities (figs. 62B, C) 20

17. Median anterior prescutal setae of about the same size as those along sides, and longer than median discal setae (fig. 66A); prescutum with a distinct patch of micropile on each side in front of transverse suture, the patch extending mesad to or slightly beyond the second seta from lateral margin and anteriorly to second seta from transverse suture. *Male:* Gonapophyses as in fig. 63A. Host: *Tonatia minuta* ....*bequaerti* n. sp.
Median anterior prescutal setae distinctly shorter than lateral setae, often only slightly longer, if any, than dense short median discal setae (figs. 64, 65); scutum with a very narrow longitudinal band of micropile along inner margin of longitudinal membranous cleft, scarcely entering upon disk, if at all 18

18. Prescutal setae noticeably and rather abruptly denser on basal half of median discal area than they are laterally and anteriorly (figs. 64, 65B) 19
Prescutal setae gradually sparser anteriorly and laterally (fig. 65A). *Male:* Gonapophyses as in fig. 62B. Host: *Tonatia silvicola* ....*dybasi* n. sp.

19. Size larger, 1.76–2.35 mm. long. Genal-postgenal margins rather strongly convergent posteriorly. *Male:* Gonapophyses as in fig. 63F. Host: chiefly *Phyllostomus hastatus* ....*longipes* Rudow
Size smaller, 1.59–1.73 mm. long. Genal-postgenal margins subparallel or feebly convergent for part of their length, then broadly rounded apically. *Male:* Gonapophyses as in fig. 63D. Host: *Tonatia minuta* ....*mendezi* n. sp.

20. Pleurotrochantinal lobe present (fig. 62B), this usually rounded, translucent, and feebly reflexed dorsally, though it may be long and strongly reflexed and superficially appear to unite with a ventrally directed spiniform process of the metepimeron. *Male:* Sternum VI present (except in *macrophylli*) 23
Posterior margin of pleurotrochantines without a median lobe (fig. 62C). *Male:* Sternum VI absent 21

21. Median discal mesonotal setae extremely minute and fine, sometimes almost indistinguishable except in slide preparations at high magnification (fig. 73B). Host: *Diphylla ecaudata* ....*diphyllae* n. sp.
Median discal mesonotal setae very distinct, easily visible even if minute. 22

22. Mesonotal setae gradually becoming longer posteriorly, the median antescutellar setae no more than twice as long as those immediately anterior to them (fig. 71). *Male:* Gonapophyses with scattered thorn-like setae (fig. 68D) .... *dugesioides* n. sp.
    Median setae of antescutellar row three to four times as long as the mesonotal setae anterior to them (fig. 72). *Male:* Gonapophyses with fine normal setae (fig. 68C). Host doubtful. .... *furmani* n. sp.
23. Median setae of antescutellar row scarcely longer than the discal scutal setae anterior to them (fig. 69) 24
    Median setae of antescutellar row distinctly longer than the scutal setae anterior to them (figs. 66B, 70) 25
24. Prescutal setae rather evenly distributed and becoming gradually longer laterally and anteriorly, the minute discal setae extending anteriorly beyond the middle (fig. 69B). *Male:* Sternum VI absent. Host: *Macrophyllum macrophyllum* .... *macrophylli* n. sp.
    Prescutal setae becoming rather abruptly longer laterally and anteriorly, the median discal area of denser minute setae extending to about middle (fig. 69A). *Male:* Sternum VI present. Host: *Glossophaga soricina* .... *dugesii* Townsend
25. Size larger, 1.46–2.17 mm. long. Antero-lateral setae of prescutum very long (fig. 66B). *Male:* Apices of gonapophyses distinctly curved ventrally (fig. 68I). Host: *Uroderma bilobatum* .... *urodermae* n. sp.
    Size smaller, 1.21–1.7 mm. long. Antero-lateral setae of mesoprescutum long but not unusually so. *Male:* Gonapophyses (lateral view) nearly straight apically (fig. 68E). Hosts: Chiefly *Carollia* spp., ... *joblingi* n. sp.

Trichobius pallidus group

This group contains a single described species, *T. pallidus,* from British Guiana, taken from *Furipterus horrens* (fam. Furipteridae). Two apparently related, undescribed species are known to us from South America. One is from *Amorphochilus schnablii,* the only other species and genus of the family Furipteridae. In both of these undescribed species, the median mesonotal suture is simple, not bifurcate. We have seen only a single paratype of *pallidus,* and have not been able to satisfy ourselves that the median suture is truly bifurcate as in the *caecus* group, to which *pallidus* is obviously related. Interestingly, the Furipteridae are regarded as South American relatives of the Natalidae, which like the Chilonycterinae, are hosts of the *caecus* group. The *pallidus* group may be characterized as follows:

With the characters of the *caecus* group but differing in having multi-faceted eyes, the sixth sternum absent in the male, the tarsi shorter with the segments more compressed antero-posteriorly, and in lacking a ventral comb-like scale on the first tarsomere of the hind tarsi.

Trichobius pallidus (Curran). Figure 53.

Kesselia pallida Curran, 1934, Bull. Amer. Mus. Nat. Hist., **66**: 522—Kartabo, British Guiana, ex *Furipterus horrens* (American Museum of Natural History, N. Y.).

Trichobius pallidus, Jobling, 1936, Parasitology, **30**: 365 (keyed), 372 (redescr.), fig. 373; 1949, ibidem, **39**: 317 (host).

This species is known only from the type series, consisting of the holotype and two paratypes, all males. The type host was collected in Panama, and it is possible that *T. pallidus* occurs there, too.

Trichobius caecus group

The species of this group are apparently restricted to the Chilonycterinae (Phyllostomidae) and Natalidae. They probably should be regarded as a separate genus. The group may be characterized as follows:

Head.—Dorsal surface of head not sub-divided into distinct laterovertices and occipital plates; setae of occiput limited to lateral area; eyes a single large facet projecting beyond lateral margins of head. *Thorax.*—High (deep), convex, anterior face

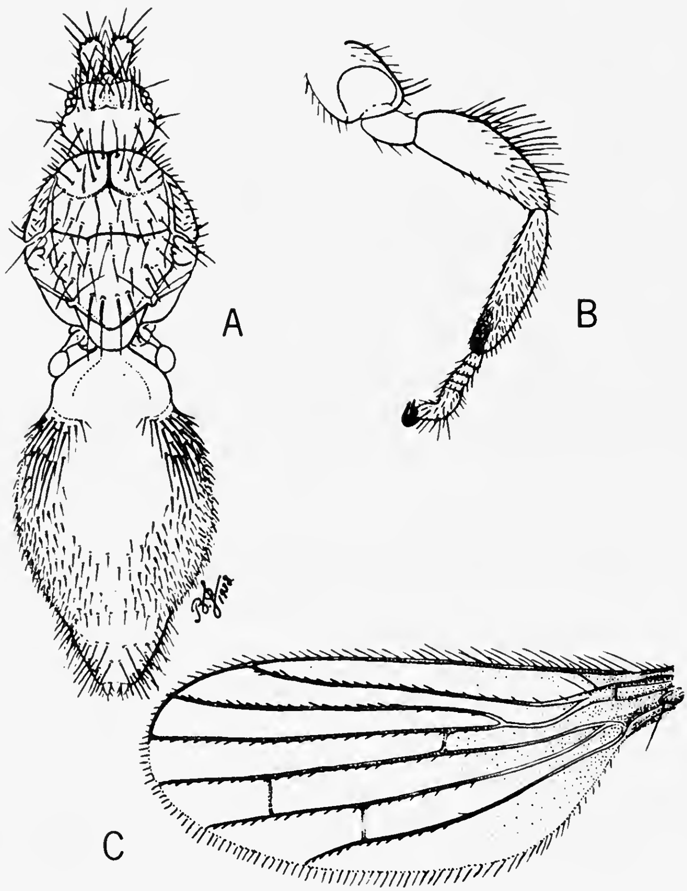


Fig. 53. *Trichobius pallidus* (Curran). A, dorsal view. B, hindleg. C, wing. From Jobling (1938).

oblique in profile, the upper edge projecting anteriorly above insertion of head. Mesonotum convex, the median suture short, bifurcate; anterior margin of prescutum rounded; setae of rather even size and distribution. Anterior margin of sternopleura angulate, feebly produced between the procoxae; posterior margin of pleurotrochantines straight; hind coxae nearly approximate. *Wings.*—Fourth and sixth longitudinal veins without setae near base. *Legs.*—First segment of hind tarsi with a ventral transverse comb-scale, inserted in a groove. *Abdomen.*—*Female:* Median dorsal connexivum not bare along entire mid-length, with at least two or more transverse rows of setae near apex; tergum VII and the "supra-anal plate" incompletely separated. *Male:* Sternum

V feebly sclerotized, transverse. Sternum VI very well developed, longest at middle and with distinctive marginal and submarginal setae along posterior edge. Gonapophyses symmetrical (in dorsal view), apices curved ventrally (in lateral view), paired ventral setae inserted at same level on each, the accessory seta of each pair situated anterior to the macroseta.

The comb-scale on the first segment of the hind tarsi and the presence of marginal and submarginal setae on sternum VI (male) are characters not found in any other New World Streblidae. A well-developed male sixth sternum does not occur among any other Trichobiinae, but does in the Streblinae, as defined here. It is of interest that the absence of setae along the base of the fourth longitudinal vein is also characteristic of the *caecus* group and of the Streblinae.

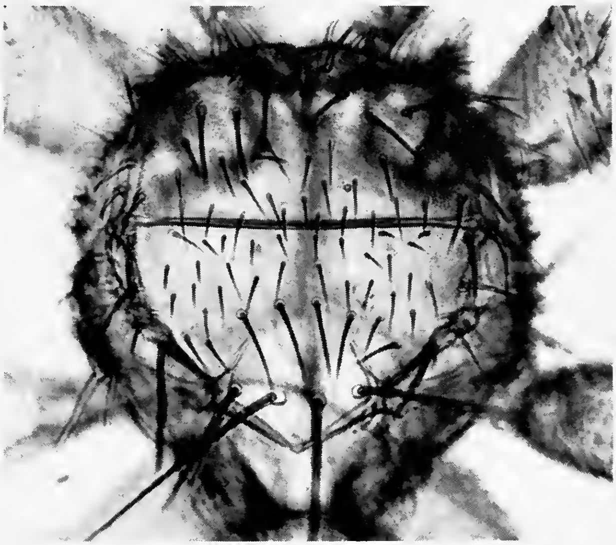


Fig. 54. Thorax, dorsal view, *Trichobius galei*, new species, from *Natalus stramineus mexicanus* (no. 6731), San Lorenzo Caves (Panamá).

Trichobius galei Wenzel, new species. Figures 54, 57J–L.

A small species, easily separated from the others of the group by the presence of only two rows of setae between the antescutellars and the transverse suture, the long, discal bristles on the seventh sternites of the female and on the hypopygium of the male, as well as by the short, very strongly bent male gonapophyses.

DESCRIPTION: In general, with the characters of *T. caecus* excepting as follows: *Thorax.*—Anterior margin of prescutum scarcely projecting at middle, if at all; scutum at middle with only two transverse rows of setae between antescutellars and transverse suture. *Wings.*—R_s bare on basal half or slightly less, at least twice as long as distance from fork to crossvein *r-m*. *Abdomen.*—Lateral lobes of syntergum I+II with 9–13 coarse setae and below these usually several shorter, finer setae. *Female:* Tergum VII with only a pair of macrosetae; supra-anal plate with three much longer, apical macrosetae and a pair of lateral setae (one on each side) which are about as long as those on tergum VII; seventh sternites with all setae well developed, four or more macrosetae near apical margin; postgenital sclerite as in fig. 57K. *Male:* Hypopygium covered with long setae dorsally and apically, with shorter setae ventrally; gonapophyses as in fig. 57L.

Measurements:	BL	TL	WL	WW
Male	1.18–1.30	0.47–0.54	1.04–1.07	0.44–0.52
Female	1.32–1.65	0.48–0.55	1.04–1.37	0.52–0.60

TYPE MATERIAL: Holotype male and allotype female (slides) from *Natalus stramineus mexicanus* (host no. 6731), San Lorenzo Caves, Fort Sherman (Canal Zone), 15 March 1961, C. M. Keenan and V. J. Tipton. In the

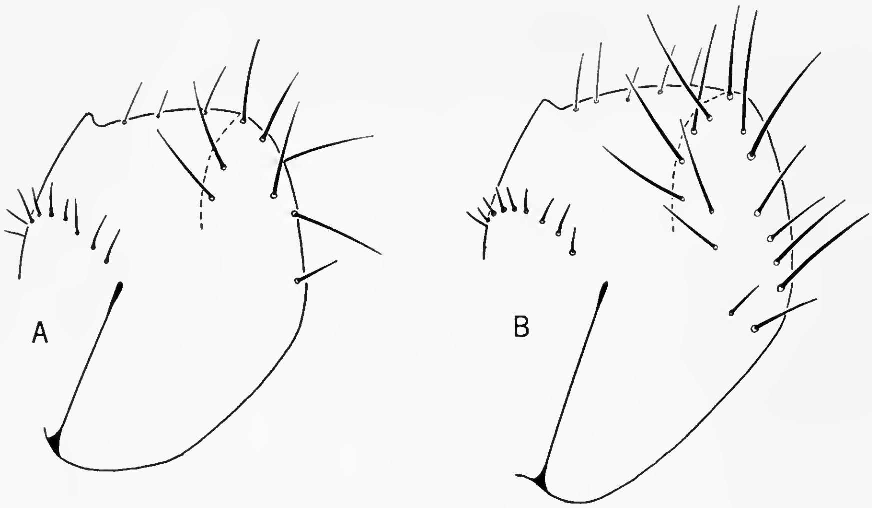


Fig. 55. Lateral lobe of tergum I+II, lateral view. A, *Trichobius johnsonae,* new species. B, *T. caecus* Edwards.

collection of Chicago Natural History Museum. Paratypes.—Approximately 107 (27 bats), same data as the holotype. From *Natalus* sp.: 2, Camp Chágres, Madden Dam (Canal Zone), 19 June 1963, GML. Paratypes to be deposited in the collections listed on p. 410.

REMARKS: This species is apparently restricted to *Natalus stramineus mexicanus.* A closely related species is known to us from the same host in Guatemala and Mexico. *T. galei* n.sp. is named in honor of Dr. Nathan Gale, Canal Zone Veterinarian.

Trichobius caecus Edwards. Figures 55B, 57A-C.

Trichobius caecus Edwards, 1918, Ann. Mag. Nat. Hist., (9), 1: 424.—Guacharo Caves, Trinidad, from unknown host (British Museum Natural History).—Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., 122: 223.

Trichobius caecus Edwards (part.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 14 (keyed), 16 (records). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., no. 155, p. 655. Curran, 1935, Amer. Mus. Novit., no. 765, p. 8 (keyed). Jobling [as *coecus*], 1938, Parasitology, 30: 371; 1949, ibidem, 39: 316, 326.

This species is known to us only from Trinidad. Dr. Harold Oldroyd of the British Museum (Natural History) informed us that the type series of *T. caecus* Edwards consists of three female cotypes mounted on one slide and an additional cotype preserved in alcohol. He kindly forwarded the slide containing the three females. The specimens had been mounted in euparol, still soft after many years. The mount was crushed in transit despite very careful packing. Although two of the specimens were obviously in poor condition when mounted and all three suffered some damage, the characters could still be clearly seen. All were remounted in euparol. One, which suffered little damage, was mounted separately on the original slide and has been designated as the lectoholotype. We have not seen the fourth specimen and do not know whether it is a male or female. Our description of the male is based on other Trinidad specimens from Tamana Caves.

Dr. Oldroyd also forwarded to us the specimens which Kessel (1925, p. 16) recorded as *caecus* from *Pteronotus davyi* from Dominica. These specimens, preserved in alcohol, are in extremely poor condition. From specimens we mounted on slides, it is evident that they represent a species very closely related to *T. johnsonae* n. sp., but better preserved and geographically representative samples from *Pteronotus davyi* and related hosts will be needed in order to determine their status.

Dr. B. Jobling (*in litt.*) has informed us that in his revision of the genus *Trichobius* (1938, p. 371) he redescribed *T. caecus* "from two specimens which have been compared with the type of *caecus*. One of these was collected by Dr. L. H. Dunn from *'Chilonycteris rubiginosa rubiginosa'* (= *Pteronotus parnellii fuscus*) in Chilibrillo Caves, Panama, and the other by R. G. Hoves from *Natalus stramineus* in Jamaica." Jobling's illustrations (fig. 56) are obviously of the Panamanian specimen. This is evidenced by the chaetotaxy of the mesonotum and of the apex of the female abdomen, as well as by the host. These correspond with the characters and host of *T. yunkeri* n.sp. Jobling's Jamaican specimen from *Natalus stramineus* is almost certainly *T. galei* n. sp. or a closely related new species. Although Jobling's description of *caecus* seems to be based on both *yunkeri* and *galei* (or a related species), it could for the most part apply equally well to any species of the *caecus* group.

DESCRIPTION: *Head.*—Vertical, dorsal surface elevated in middle; theca pyriform, palpi horizontal; laterovertices and occipital lobes not completely differentiated as separate sclerotized plates, though they are partially separated laterally by a transverse membranous strip; setae of occiput at sides only.

Thorax.—High (deep), the anterior face oblique in lateral view, the upper edge (prescutum) projecting above insertion of head; anterior margin of prescutum rounded, narrowly incised at middle, the median suture short, bifurcate, the transverse suture straight, complete; mesonotal setae rather evenly distributed, the setae much longer anteriorly than posteriorly; scutum with three or four irregular, transverse rows of bristles between the long antescutellars and the transverse suture; scutellar bristles unusually long, the median pair nearly as long as mesonotum. Sternopleura angulate between the front coxae, only feebly produced; pleurotrochantines together relatively narrow, the posterior margin straight, hind coxae nearly approximate. Suture between sternopleura and pleurotrochantines strongly angulate. *Wings.*—Costa and R_1 united at a point midway between second and third crossveins; costa with well-developed macrosetae near base, these gradually smaller apically; fourth and sixth longitudinal veins bare basally; bases of R_1 and fifth longitudinal vein each with three or four macrosetae; R_s only a little longer than distance between fork and crossvein *r-m* (14.5:13). *Legs.*—

Subequal, of moderate length; front tibiae only slightly shorter than the hind tibiae, none of them with macrosetae; basitarsus of hind tarsi nearly twice as long as broad, with a ventral comb-scale.

Abdomen.—Dorsal connexivum with at least two transverse rows of setae near apex, anterior to tergum VII, never completely bare along entire midline, even in gravid females. Lateral lobes of tergum I+II with from 9–11 stout, long bristles and three to five finer, shorter setae below them (lectoholotype with a total of 16 setae). *Female:*

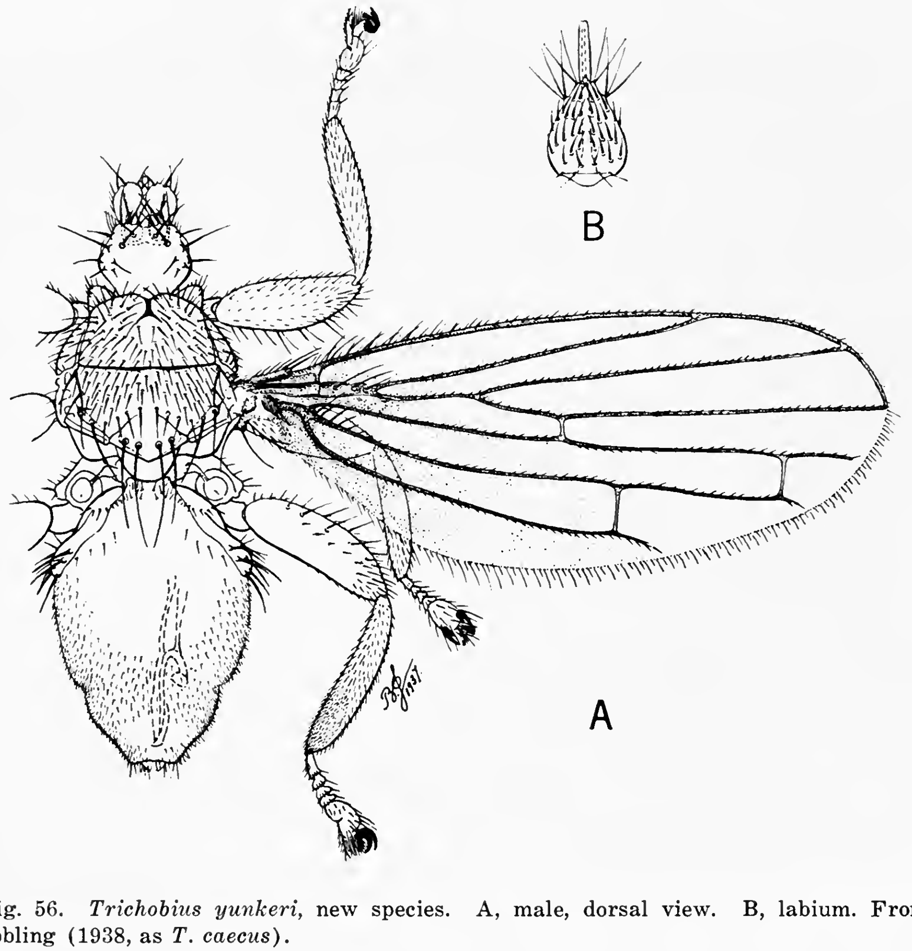


Fig. 56. *Trichobius yunkeri*, new species. A, male, dorsal view. B, labium. From Jobling (1938, as *T. caecus*).

Seventh tergum typically with a macroseta on each side and two, rarely four (holotype), short setae between them, these sometimes absent. Supra-anal plate with three apical macrosetae and two pairs of short, lateral setae (one pair each side). Seventh sternites usually with very short setae on outer half (except apical margin), the setae distinctly longer near mesal edge; apical margin with three, sometimes four, macrosetae (lectoholotype with longer setae on outer half on one sternite, as in *yunkeri*). *Male:* Sternum V feebly sclerotized, transverse, not divided, setae uniform throughout. Sternum VI present, relatively long, with a median, rounded bulge, with marginal and submarginal setae along posterior edge; dorsal surface of hypopygium with short, dense setae, these somewhat longer laterally and ventrally; setae also somewhat longer on tergum

IX, and becoming more so apically, those along apical margin being macrosetae; gonapophyses as in fig. 57C.

Measurements:	BL	TL	WL	WW
Male	1.48–1.51	0.54–0.55	1.36–1.43	0.55–0.70
Female	1.24–1.84	0.52–0.66	1.43–1.60	0.55–0.71

MATERIAL EXAMINED: Lectoholotype female and two lectoparatype females from Guacharo Cave, TRINIDAD, from the collection of British Museum (Natural History). From Tamana Caves, TRINIDAD, 1 male reared from pupa, together with case, 20 November 1957, T. H. G. Aitken, collector [TVL]; 2 males, 3 females, same locality, from "*Chilonycteris rubiginosa*" (*Pteronotus parnellii*), 11 November 1954, C. Colin Sanborn [CNHM]; 11 males (4 too badly damaged to preserve, except genital mounts on slides) and 6 females, from same host, Guanapo Heights cave, TRINIDAD, 9 September 1954, C. C. Sanborn [CNHM].

Trichobius yunkeri Wenzel, new species. Figures 56, 57D–F.

Trichobius caecus (not Edwards, 1918), Jobling, 1938, Parasitology, **30**: 358, 364, 371 (part.), fig. 4. Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418. Jobling, 1949, loc. cit., **39**: 316 (part.), fig. 1A.

Closely related to *T. caecus* Edwards, but separated from it by the characters given in the key, notably the shape of the female postgenital sclerite (fig. 57E), the presence of five or six (instead of three or four) macrosetae on the female seventh sternites, and the shape of the male gonapophyses (fig. 57F).

DESCRIPTION: With the characters of *T. caecus* except as follows: *Male:* Gonapophyses (fig. 57F) longer, more slender, and more angulately bent at apex than in *T. caecus* (fig. 57C). *Female:* Median pair (sometimes three) of setae on tergum VII usually well developed (minute or absent in *caecus*), usually about half as long as the macrosetae lateral to them, sometimes with an additional seta lateral to one of the macrosetae; supra-anal plate with three apical and two or three short, stout lateral setae on each side. Seventh sternites covered with short setae which become longer near mesal edge; apical margin typically with five or six macrosetae, rarely four. Postgenital sclerite (fig. 57E) wider than in *caecus* (fig. 57B).

Measurements:	BL	TL	WL	WW
Male	1.51–1.59	0.52–0.59	1.37–1.43	0.55–0.66
Female	1.54–1.96	0.56–0.69	1.54–1.59	0.65–0.77

TYPE MATERIAL: Holotype male (slide) from *Pteronotus parnellii fuscus* (host no. 4437) from a railroad culvert at Paraíso (Canal Zone), 15 September 1959, C. M. Keenan and V. J. Tipton, collectors. Allotype female (slide), same data as the type but from host no. 4386, 16 September 1959. In the collection of Chicago Natural History Museum.

Paratypes.—370 specimens from *Pteronotus p. fuscus* as follows: 46 flies (18 bats), same data as the allotype and 42 (14 bats), same data as the holotype; 135 (40 bats), same data as holotype, but 1 December 1959; 19 (4 bats), railroad culvert east of Summit Golf Club, 26 October 1959; 15 (7 bats), mine shaft, Coco Plantation, Gamboa (Canal Zone), 25 November 1959; 2 (1 bat), Galeta Island (Canal Zone), 19 November 1959; 22 (1 bat), Madden Airstrip (Panamá), 3 October 1961; and 22 (1 bat), same data but 23 May 1961; 6 (2 bats), Chilibrillo Caves (Panamá), 28 October 1959; 22 (4 bats), Almirante (Bocas del Toro), 28 January to 1 February

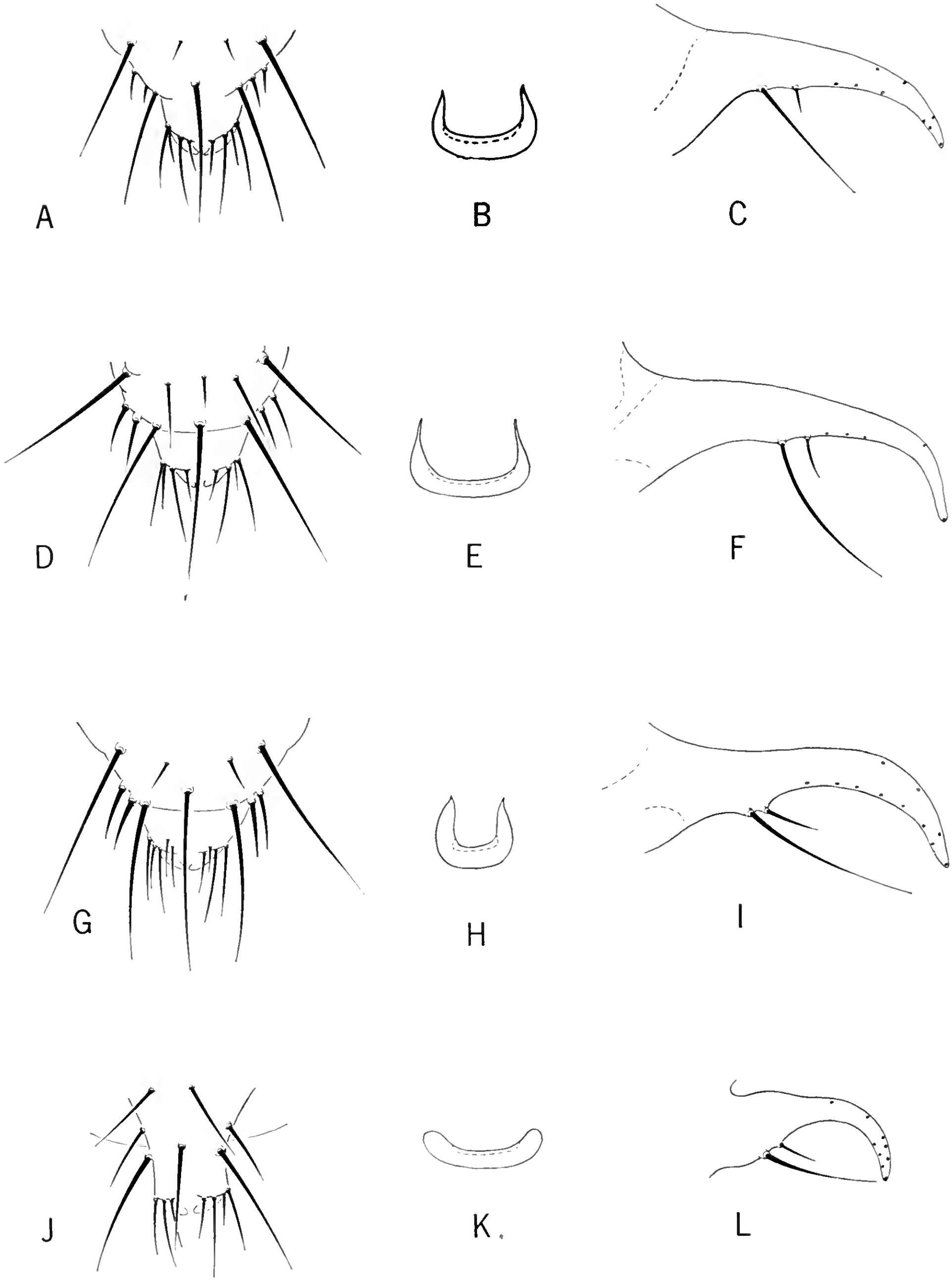


Fig. 57. Terminalia of *Trichobius caecus* group, including (from left to right) female terminal cone, female postgenital sclerite, and left male gonapophysis (lateral view). A–C, *Trichobius caecus* Edwards. D–F, *T. yunkeri* new species. G–I, *T. johnsonae*, new species. J–L, *T. galei*, new species.

1960; 13 (1 bat), Rio Chucunaque (Darién), 17 February 1958; 35 (6 bats), Guánico (Los Santos), 22 January, 13 February and 16 February 1962; 7 (2 bats), Cerro Hoya (Los Santos), 18 and 21 February 1962; 3 (3 bats), Buena Vista Caves (Colón), 3 September 1959; 7 (5 bats), same locality, 15 September 1959 and 16 (1 bat), 24 November 1959. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED (50 specimens): From *Lonchorhina aurita:* 6 (2 bats), 17 July and 25 November 1959. From *Pteronotus suapurensis:* 1 (1 bat), Fort Clayton (Canal Zone), 19 October 1960; 27 (1 bat), Natural Bridge, Madden Dam (Canal Zone), 27 August 1959; 1 (13 bats), Chilibrillo Caves (Panamá), 28 October 1959. From *Sturnira ludovici* (mist net): 1 (1 bat), 11 March 1962. From *Carollia perspicillata azteca:* 3 (12 bats), railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959; 5 (22 bats), Buena Vista Caves (Colón), 3 September, 15 September and 24 November 1959. From *Artibeus lituratus palmarum:* 6 (1 bat), Cerro Azul (Panamá), 25 January 1958, GML.

We have also seen hundreds of specimens from *Pteronotus parnellii* from GUATEMALA, MEXICO, COLOMBIA and VENEZUELA, which are tentatively assigned to this species.

REMARKS: *Pteronotus p. fuscus* seems to be the primary host of this species. However, *T. yunkeri* was found together with *T. johnsonae* in equal abundance on *P. suapurensis* at Natural Bridge, Madden Dam, and there is no indication in our records that *P. p. fuscus* occurred there with that host, though this may have been so. In all other instances excepting two, where a bat other than *P. p. fuscus* was the host of *yunkeri, P. p. fuscus* was also known to be present. The small numbers of *yunkeri* taken on them could indicate that they were either strays or contaminations. *T. yunkeri* and related species tend to occur in swarms in the roosting sites of the host, thus greatly increasing the chances for such stray associations. We believe that the record from *Artibeus lituratus palmarum* represents an error in host identification or association. Virtually all the specimens received from this locality and collecting trip have incorrect host associations. In the case of the specimens from *Sturnira ludovici,* the host bat was collected in a mist net. When bats are thus captured, their streblids often leave and land on other nearby bats in the net. The species referred to by Cooper (1941, pp. 126, 127) as *caecus* is probably *T. yunkeri.*

Trichobius yunkeri n. sp. is named in honor of Dr. Conrad Yunker of the Rocky Mountain Laboratory (Hamilton, Montana) and the Middle American Research Unit, Canal Zone, Panamá.

Trichobius johnsonae Wenzel, new species. Figures 55A, 57G–I.

Very closely related to and generally with the characters of *T. caecus* Edwards and *T. yunkeri* n. sp., but differing from them in having only six to nine (rather than 11–16) setae on the lateral lobes of syntergum I+II, the very minute setae of the female seventh sternites, and especially in the shape of the female postgenital sternite and the relatively heavy male gonapophyses.

DESCRIPTION: Lateral lobes of syntergum I+II (fig. 55A) with only six to nine coarse setae and sometimes several finer setae ventral to these. *Wings.*—R_s bare on about basal fourth, approximately twice as long as distance from fork to crossvein *r-m* (11.5:7). *Female:* Seventh sternites with extremely fine, short setae outwardly, these longer toward mesal margin. Postgenital sclerite narrow and heavy (fig. 57H). *Male:* Gonapophyses as in fig. 57 I.

Measurements:	BL	TL	WL	WW
Male	1.59–1.70	0.45–0.58	1.45–1.48	0.71–0.73
Female	1.63–1.86	0.52–0.65	1.59–1.65	0.77–0.80

TYPE MATERIAL: Holotype male and allotype female (slides) from *Pteronotus psilotis* (host no. 8772) Penonomé Cave (Coclé), 15 December 1961, C. M. Keenan and V. J. Tipton, collectors. In the collection of Chicago Natural History Museum.

Paratypes (278 specimens).—From *Pteronotus psilotis:* 66 (11 lots), same data as the holotype; 2, same data but 24 January 1962; 10 (1 lot), Armila (San Blas), 13 March 1963. From *Pteronotus suapurensis:* 26 (1 lot), Madden Dam (Canal Zone), 27 August 1959; 3 (1 bat), Casa Tilley, Cerro Punta (Chiriquí), 6 March 1962; 81 (7 lots), Penonomé Cave (Coclé), 15 December 1961; 62 (4 lots), Chilibrillo Caves (Panamá), 28 October 1959, and 20 (1 lot), same locality, 8 March 1960; 8 (2 lots), Armila (San Blas), 28 February 1963. From *wall of cave:* 461 (4 lots), Penonomé Cave (Coclé), 15 December 1961. The San Blas specimens were collected by C. O. Handley, Jr. and F. M. Greenwell. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED: 1 specimen from *Carollia perspicillata azteca,* Penonomé Cave (Coclé), 15 December 1961; 1 from *Lonchophylla robusta,* Chilibrillo Caves (Panamá), 2 August 1960.

REMARKS: We have seen a series of nine specimens, without host, labeled "Dominica, H. S. B.," sent to us by Dr. H. Oldroyd of the British Museum (Natural History). These had been determined by Kessel (1925) as *T. caecus,* but appear to be *johnsonae* or a new species closely related to it. They have an even heavier postgenital sclerite than do our specimens of *johnsonae* from Panama. We also have three lots, consisting of three males and two females, taken from *Pteronotus davyi fulvus* in Guatemala, which appear to be closely related to *johnsonae* but possibly represent a distinct new species.

Trichobius johnsonae is apparently restricted to *Pteronotus suapurensis* and *P. psilotis* in Panama. In most instances, both hosts were collected at the same localities. *Nycterophilia fairchildi* n.sp. occurs on the same hosts. The single records of *johnsonae* from *Carollia p. azteca* and *Lonchophylla robusta* are obviously of strays or contaminations. In both instances, the collections were from sites where *Pteronotus* were present.

T. johnsonae is named in honor of Dr. Phyllis Johnson, formerly of the Gorgas Memorial Laboratory, Panamá, and now at the University of California at Irvine.

Trichobius major group

As defined below, this group contains seven described species namely, *T. major* Coquillet, *hirsutulus* Bequaert, *corynorhini* Cockerell, *truncatus*

Kessel, *pseudotruncatus* Jobling, *sparsus* Kessel, and *sphaeronotus* Jobling. The first three are closely related, the others are provisionally assigned to the group. *T. sparsus* Kessel is the only species which has been collected in Panama. The following characters will serve to define the group.

Head.—Laterovertices and occipital lobes either not differentiated or very weakly sclerotized and poorly defined. *Abdomen.*—*Female:* Cerci united with the ventral arc of the terminal cone. *Male:* Sternum V divided into two sternites or with a longitudinal median groove which appears to divide it. Sternum VI absent. Gonapophyses with the accessory setae inserted anterior to the macrosetae.

Trichobius sparsus Kessel. Figures 42, 58.

Trichobius sparsus Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 15 (keyed), 17 (descr.), pl. 1. (fig. 7), pl. 2 (fig. 10)—Chilibrillo River, Panama ex "*Chilonycteris rubiginosa fusca*" (U. S. National Museum). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth. Wash., no. 155, p. 655. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479, fig. (Streblidae II.—6); 1935, Amer. Mus. Novit., no. 765, p. 9 (keyed). Jobling, 1938, Parasitology, **30**: 373–375, fig. 6. Bequaert, 1940, Rev. Acad. Colomb. Cien. Exact., Fis. y Nat., **3**: 418.

Trichobius sparsus is easily separated from the other species that occur in Panama by the distinctive mesonotal chaetotaxy (fig. 58B). To the characters given by Jobling (loc. cit.) the following may be added.

Head.—Palpi with setae on basal two-thirds of ventral surface, with microsetae on upper surface. *Thorax.*—Microsetae present along lateral margins of prescutum, posterior half of scutum, and anterior third of scutellum. *Abdomen.*—Tergum I+II with a median basal group of setae which extends obliquely posteriorly and ventrally on each side to join a cluster of about 14–16 setae on face of lateral lobe, anterior to the posterior cluster of macrosetae. Connexivum with four sets of minute segmental setae, the three anterior sets consisting of two pairs each (a pair on each side of middle), the posterior set a single pair. *Female:* Supra-anal plate with two apical macrosetae, two macrosetae at middle, a pair of shorter setae on each side at mid-length, and a short seta each side of middle at base. Seventh sternites large, each with about 21 bristles, including one macroseta that is nearly twice as long as next longest setae; connexivum with a long seta on each side, but not on margin, anterior to the seventh sternites. *Male:* Sternum V divided into two large transversely oval plates. Sternum VI absent. Gonapophyses (fig. 58C) straight in dorsal view, blade-like and moderately curved ventrally in lateral view; ventral macroseta very long and extending beyond apex of gonapophysis, the accessory seta inserted anterior to the macroseta; a row of minute submarginal setae along ventral margin distal to accessory seta, two or three on lateral face, and one close to dorsal edge near apex.

Measurements:	BL	TL	WL	WW
Male	1.65–2.01	0.60–0.75	1.60–1.87	0.66–0.88
Female	1.95–2.25	0.71–0.77	1.90–2.09	0.82–0.88

PANAMANIAN MATERIAL EXAMINED: 29 flies (13 lots) from 51 bats. From *Pteronotus parnellii fuscus*, 20 flies (10 lots) from 49 bats: 3 (2 bats), Almirante (Bocas del Toro), 29 January and 1 February 1960; 1, railroad culvert, Paraíso (Canal Zone), 16 September 1959; 4 (40 bats), same site and locality, 1 December 1959; 1, railroad culvert E. of Summit (Canal Zone), 26 October 1959; 1, Barro Colorado Island (Canal Zone), 12 January 1957 [USNM]; 3 (2 bats), Guánico (Los Santos), 13 and 16 February 1962; 8 (3 bats), Cerro Hoya (Los Santos), 14, 18 and 21 February 1962. From *Carollia perspicillata azteca:* 1, Almirante (Bocas del Toro), 31 January 1960. From *Artibeus lituratus palmarum:* 7, Cerro Azul (Panamá), 25 January 1958, Eustorgio Méndez [GML].

OTHER MATERIAL EXAMINED: The only other specimens we have seen were collected from *Pteronotus parnellii fuscus* in GUATEMALA.

The type of *sparsus* was collected from "*Chilonycteris rubiginosa rubiginosa*" (= *P. parnellii fuscus* of this paper). We believe this to be the

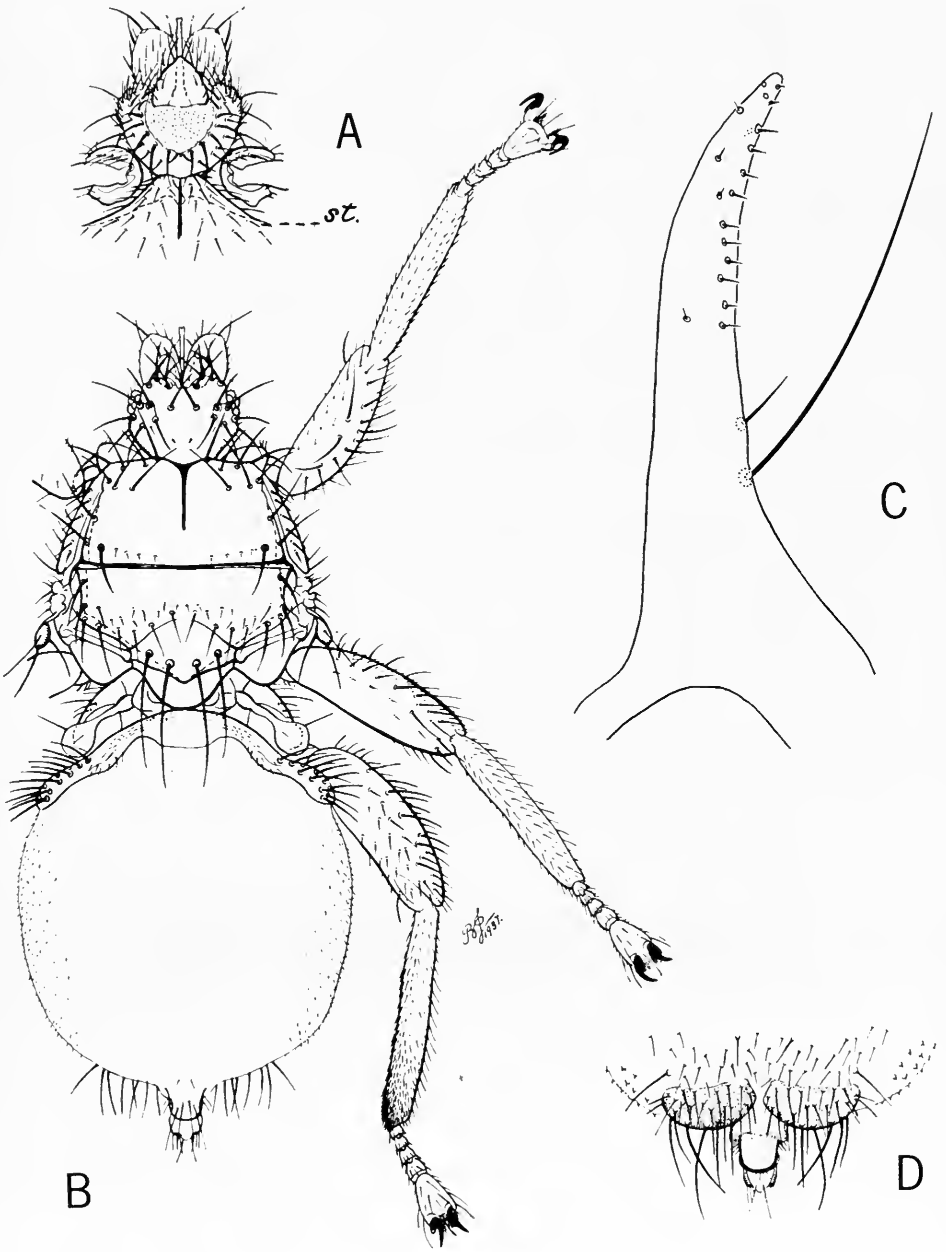


Fig. 58. *Trichobius sparsus* Kessel. A, underside of head and anterior part of thorax. B, dorsal view, female (wings removed). C, left male gonapophysis, lateral view. D, apex of abdomen, female, ventral view. A, B, D from Jobling (1938).

principal if not the only host of this species. The specimens listed for *Artibeus lituratus* from Cerro Azul were certainly labeled incorrectly. The vial in which they were contained included flies from at least seven different host species, including *Pteronotus p. fuscus.* Field records show that six of these host species were collected at that locality on the same date. None of the flies were parasites of *Artibeus.* The record from *Carollia* probably represents a stray.

Trichobius uniformis group

The species of this group have the following characters in common:

Small species, body 1.11–1.62 mm. long. *Head.*—With well-differentiated laterovertices and occipital plates, the laterovertices transverse, the occipital plates oblique; setae of laterovertices, genal and postgenal margins, and occipital plates borne on tubercles, the tubercles along margins of postgenae and occipital lobes very distinct. Eyes small, with about six facets. *Thorax.*—Setae of mesonotum relatively uniform in size and distribution, somewhat larger and sparser anteriorly; median mesonotal suture complete or nearly so, usually united with the transverse mesonotal suture which is usually complete though sometimes indistinct at middle. Sternopleura bluntly, not strongly produced anteriorly; posterior margin of pleurotrochantines slightly emarginate at middle, without a lobe. *Wings.*—All veins with macrosetae basally, those of R_1 extending a little more than halfway to apex of vein; setae of costa and R_1 borne on small tubercles, the setae becoming shorter apically toward junction; sixth longitudinal vein with setae nearly to base. *Legs.*—Short, the hind ones only slightly larger than fore- and midlegs. *Abdomen.—Female:* Tergum VII very feebly sclerotized, small, its setae minute. Cerci united with ventral arc of terminal cone. *Male:* Sternum V complete, undivided; VI present, very narrow. Gonapophyses with accessory seta inserted anterior to the macroseta.

Trichobius uniformis Curran. Figures 60B, 61B.

Trichobius uniformis Curran, 1935 (part.), Amer. Mus. Novit., no. 765, pp. 9 (keyed), 10 (descrip.), fig. 8. Paraíso (Canal Zone), Panamá, ex *Glossophaga s. leachii* (American Museum of Natural History).—Jobling, 1938 (part.), Parasitology, **30:** 364 (hosts), 365 (keyed); Bequaert, 1940 (part.), Rev. Acad. Colomb. Cienc. Exact., Fis. y. Nat., **3:** 418. Jobling, 1949 (part.), Parasitology, **39:** 316 ff. (hosts). Starrett and de la Torre, 1964, Zoologica, **49:** 57.

Curran's type series of *uniformis* included the holotype, allotype, and three paratypes from *Glossophaga s. leachii* and two paratypes from *Lonchophylla robusta.* The paratypes from *L. robusta* represent a distinct species, described below as *T. lonchophyllae* n. sp. *T. uniformis* may be distinguished by the characters given in the key. To the characters given by Curran (loc. cit.) and above, the following may be added:

Head.—Eyes distinctly removed from lateral margins of head. Innermost seta of posterior margin of occipital plate borne on a distinct, posteriorly projecting tubercle. *Thorax.*—Anterior margin of mesonotum straight, median suture usually indistinct posteriorly, often not united with the transverse suture. *Wings.*—R_1 parallel to costa for most of its length. Length of R_s approximately equal to distance between fork and crossvein *r-m*. *Abdomen.—Female:* Four minute setae of tergum VII arranged with the inner two smaller setae (occasionally absent) only slightly posterior to the outer pair, appearing as a transverse row. *Male:* Gonapophyses as in fig. 60B.

Measurements:	BL	TL	WL	WW
Male	1.18–1.24	0.43–0.47	0.95–1.18	0.44–0.51
Female	1.24–1.46	0.47–0.50	1.00–1.22	0.46–0.52

PANAMANIAN MATERIAL EXAMINED: 31 specimens (19 lots) from (19) *Glossophaga soricina leachii:* 2, Fort Davis (Canal Zone), 18 November 1959; 4, Fort Clayton (Canal Zone), 14 September and 13 October 1959; 2, Galeta Island (Canal Zone), 19 November 1959; 1, Fort Kobbe Beach (Canal Zone), 16 November 1959; 4 (holotype, allotype and 2 female paratypes), Paraíso (Canal Zone), 17 October 1930, L. H. Dunn [AMNH]; 3, San Lorenzo Cave, Fort Sherman (Canal Zone), 29 March 1960, and 2, cativo trees, Fort

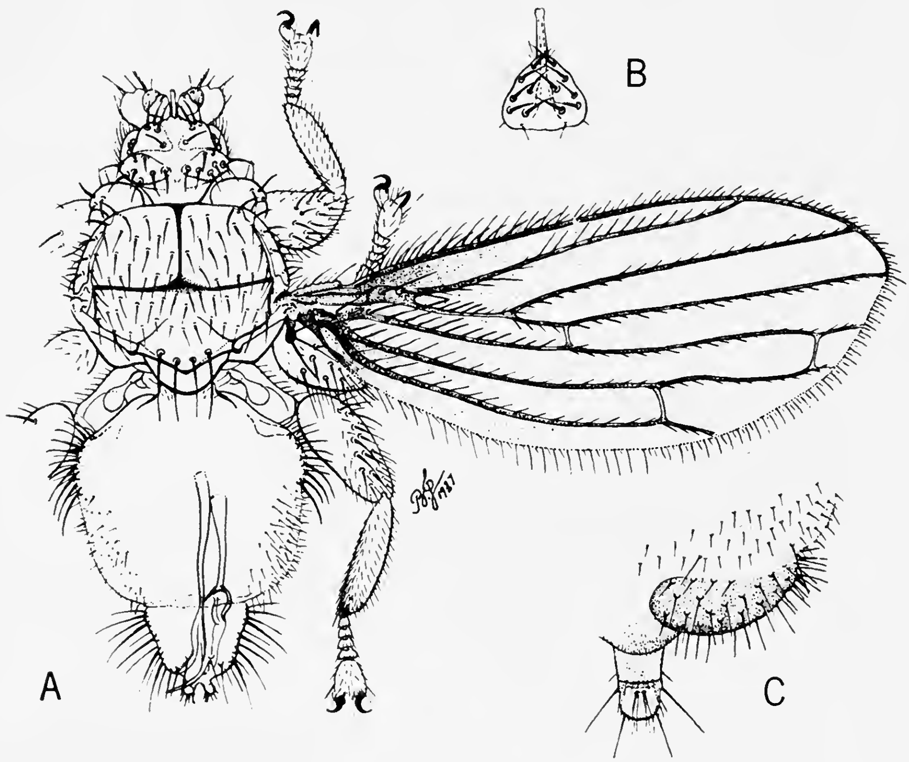


Fig. 59. *Trichobius lonchophyllae*, new species. A, dorsal view, male. B, labium. C, apex of abdomen, female, ventral view. From Jobling (1938, as *T. uniformis*).

Sherman, 4 December 1959; 4, Río Hato (Coclé), 22 October 1959; 8, Santa Clara (Coclé), 27 October 1959; 1, Cerro Hoya (Los Santos), 17 February 1962. From *Artibeus j. jamaicensis:* 1, Fort Clayton (Canal Zone), 19 October 1960. From *Desmodus r. murinus:* 1, Almirante (Bocas del Toro), 24 January 1960. The specimens from *A. jamaicensis* and *D. rotundus* were taken from bats collected in mist nets.

OTHER MATERIAL EXAMINED: Numerous specimens from GUATEMALA, COSTA RICA, BRITISH GUIANA, and PERU, all from *Glossophaga soricina* except the British Guiana specimens which are without host.

REMARKS: Curran's figure (loc. cit.) of this species is inaccurate in many respects, including the length of R_S. However, the shape of R_1 is clearly that of *uniformis* and agrees with the holotype. This species appears to be limited to *Glossophaga soricina*, though it is possible that it may occur on other species of the genus *Glossophaga*. Published records from other hosts probably represent contaminations, errors of host identification, or other related species of the *uniformis* group.

Trichobius lonchophyllae Wenzel, new species. Figures 59, 60D, 61A.

Trichobius uniformis (part., ex *Lonchophylla robusta*) Curran 1935, Amer. Mus. Novit., no. 765, pp. 9, 10. Jobling, 1938, Parasitology, **30**: 380 (descr., fig.). Bequaert, 1940, Rev. Acad. Colomb. Cien. Ex., Fis. y Nat., 3: 418. Jobling, 1949 (part.), Parasitology, **39**: 316 (hosts).

Although Jobling's (1938) records of *T. uniformis* refer in part to Curran's species, his description and figures are obviously based on specimens of *lonchophyllae* n. sp. Mr. Jobling informs us that "*T. uniformis* has been redescribed and illustrated from the two paratypes, a male and a female lent to me from the collection of the American Museum of Natural History." Through the courtesy of Dr. Paul Arnaud, the senior author has been able to re-examine the female paratype and determine it to be *lonchophyllae*. It differs from *uniformis* and related species by the characters given in the key. The following characters may be added to Jobling's description:

Head.—Relatively broad, the eyes conspicuously separated from sides. Innermost small seta of posterior margin of occipital plate borne on a distinct, posteriorly directed tubercle. *Thorax.*—Anterior margin of prescutum usually slightly projecting at middle; median suture connected with the transverse mesonotal suture, the latter straight or feebly anteriorly arcuate and not sharply defined on about middle third of width. *Wings.*—R_1 distinctly sinuate, the costal cell rather abruptly narrowed, but R_1 subparallel to costa from sinuation to juncture with costa; R_s distinctly longer (5.5:3.5) than distance between fork and crossvein *r-m*. *Abdomen.*—*Female:* Four minute setae of seventh tergum arranged in two transverse rows. Seventh sternite very broad, more than twice as long as broad. *Male:* Gonapophyses as in fig. 60D.

Measurements:	BL	TL	WL	WW
Male	1.18–1.21	0.44–0.49	1.09–1.15	0.52–0.57
Female	1.43–1.62	0.49–0.52	1.22–1.23	0.56–0.57

TYPE MATERIAL: Holotype male and allotype female (on slides) from *Lonchophylla r. robusta* (host no. 5081), Buena Vista Caves (Colón), 24 November 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *Lonchophylla r. robusta:* 5, same data as the type, and 1, same data but 3 September 1949; 5, Chilibrillo Caves, Chilibre (Panamá), 27 March 1958; 2, same locality but 20 October 1961, C. M. Keenan and R. L. Wenzel; 1 (paratype of *T. uniformis* Curran), same locality, 9 March 1933 (no. 16), L. H. Dunn [AMNH]; 2, La Laguna (Darién), 2900 feet elevation, 2 June 1963, C. O. Handley, Jr.; 1, Armila (San Blas), 14 March 1963, C. O. Handley, Jr.; 16, Isla Bastimentos (Bocas del Toro), 30 January to 5 February 1963, C. O. Handley, Jr.; 3 (2 bats), 23 and 31 January, C. O. Handley, Jr. Paratypes to be deposited in Chicago Natural History Museum, the United States National Museum, and the Environmental Health Branch, USAFSC, at Corozal (Canal Zone).

OTHER MATERIAL EXAMINED: 2 males from *Artibeus lituratus palmarum*, Cerro Azul (Panamá) 2000 feet elevation, 25 January 1958, GML.

REMARKS: The characteristic shape of wing vein R_1 and the broad seventh sternites of the female are clearly shown in the illustration (fig. 59) of *uniformis* Jobling, 1938 (not Curran).

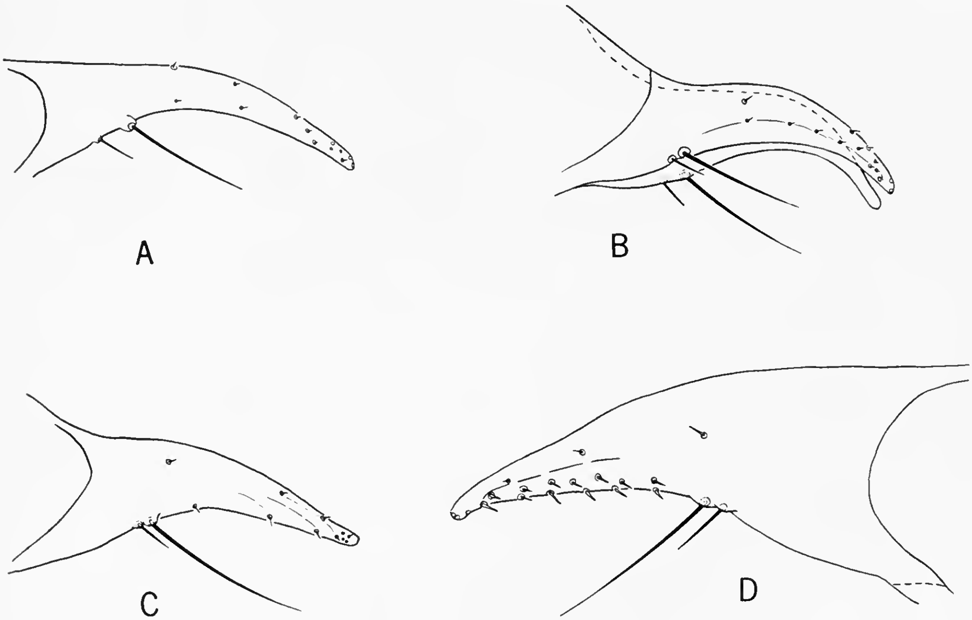


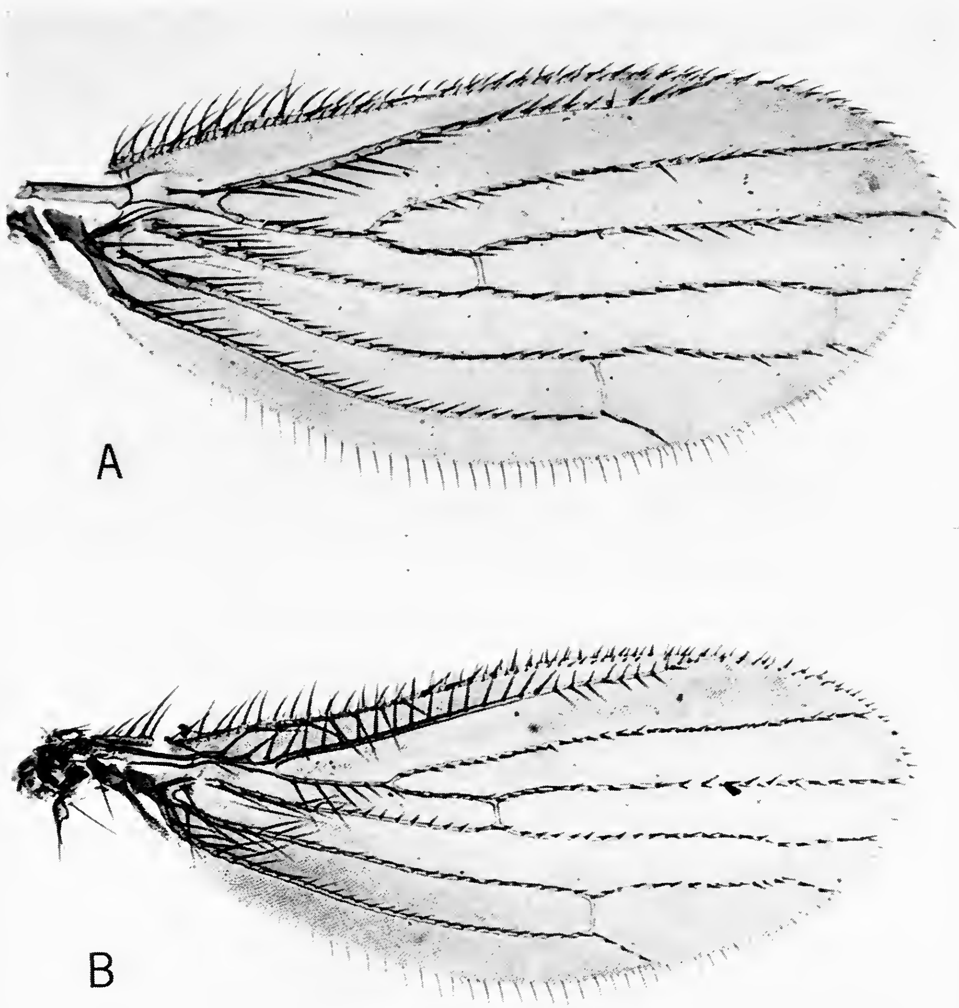
Fig. 60. *Trichobius uniformis* group. A–C, left male gonapophysis. A, *T. keenani*, new species, paratype from *Micronycteris megalotis* (no. 9208), Guánico (Los Santos). B, *T. uniformis* Curran, from *Glossophaga soricina leachii* (no. 4908), Santa Clara (Chiriquí). C, *T. lionycteridis*, new species, holotype. D, right gonapophysis, *T. lonchophyllae*, new species, holotype.

Thirteen of the 14 lots, including 36 of the 38 specimens, are from *Lonchophylla r. robusta*. However, we believe it may occur on other species of the genus *Lonchophylla*, too. The record from *Artibeus* is probably in error.

Trichobius keenani Wenzel, new species. Figure 60A.

Distinguished from related species by the characters given in the key.

DESCRIPTION: With the characters of the group and also the following. *Head.*—Not as broad as in other species of the group, the eyes projecting to or nearly to lateral margins of head; innermost small seta on posterior margin of occipital plates not borne on a conspicuous, posteriorly directed tubercle. *Thorax.*—Anterior margin of prescutum straight, median suture usually united with the transverse suture, sometimes slightly abbreviated. *Wings.*—R_s approximately as long as distance between fork and crossvein *r-m*. *Abdomen.*—*Female:* Four minute setae of seventh tergum arranged in a transverse row, the outer pair usually slightly anterior to the inner pair. Seventh sternites reniform, scarcely twice as broad as long. *Male:* Gonapophyses as in fig. 60A.



A

B

Fig. 61. Wing. A, *Trichobius lonchophyllae,* new species. B, *T. uniformis* Curran.

Measurements:	BL	TL	WL	WW
Male	1.12–1.18	0.38–0.42	0.99–1.02	0.48–0.50
Female	1.11–1.35	0.41–0.46	1.10–1.19	0.48–0.51

TYPE MATERIAL: Holotype male and allotype female (on slides) from *Micronycteris nicefori* (host no. 5544), Almirante (Bocas del Toro), 12 February 1960, V. J. Tipton and C. M. Keenan. In the collection of Chicago Natural History Museum.

Paratypes.—From *Micronycteris megalotis microtis:* 2, Camp Piña (Canal Zone), 1 April 1960; 3, culvert under Borinquen Highway near Empire Range (Canal Zone), 24 October 1961, C. M. Keenan and R. L. Wenzel; 3, same host, Guánico (Los Santos), 27 January 1962, C. M. Keenan and

V. J. Tipton. Paratypes deposited in the collections of Chicago Natural History Museum and the United States National Museum.

OTHER MATERIAL EXAMINED: From (2) *M. megalotis microtis:* 5 (destroyed accidentally), 24 October 1961, C. M. Keenan and R. L. Wenzel. From *Uroderma bilobatum:* 1, Fort Clayton (Canal Zone), 28 November 1960.

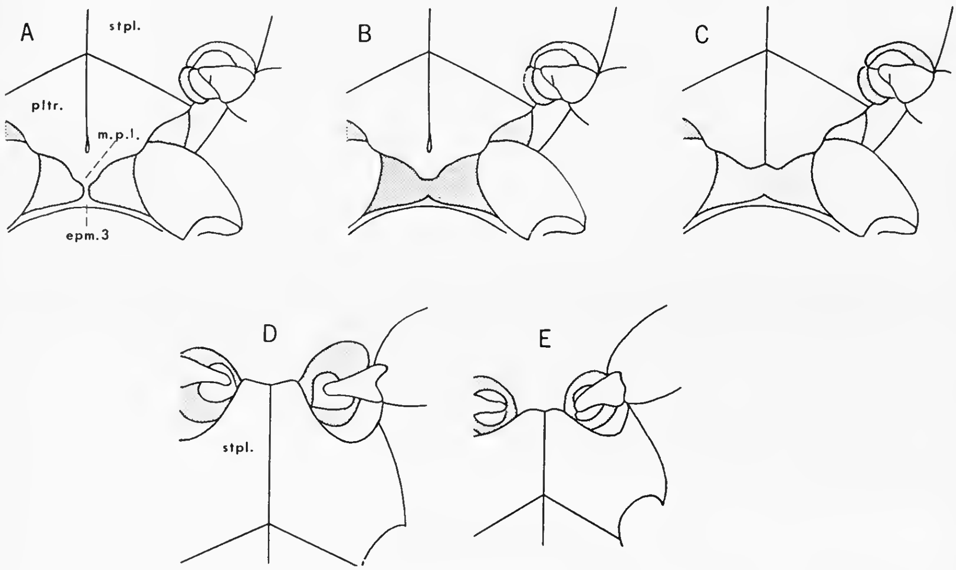


Fig. 62. A–C, posterior portion of venter of thorax showing condition in respect to median pleurotrochantinal lobe (*m.p.l.*): A, lobe united with metepimeron (*epm. 3*) as in *Trichobius longipes* (Rudow); B, lobe short and blunt, not united with metepimeron, as in *T. joblingi*, new species; C, lobe absent, as in *T. dugesioides*, new species. D, sternopleura, *Trichobius brennani*, new species. E, same, *T. longipes.*

Trichobius lionycteridis Wenzel, new species. Figure 60C.

Differing from related species by the characters given in the key.

DESCRIPTION: With the characters given for the group and also the following. *Head.*—Eyes only slightly separated from lateral margins of head. Innermost small seta on posterior margin of occipital plate not borne on a distinct, posteriorly directed tubercle. *Thorax.*—Anterior margin of prescutum slightly projecting at middle, median suture connected with the transverse mesonotal suture. *Wings.*—Length of R_s equal to or slightly shorter than distance from fork to *r-m*. *Abdomen.*—*Female:* Minute setae of seventh tergum arranged in two transverse rows; seventh sternite about twice as broad as long. *Male:* Gonapophyses as in fig. 60C.

Measurements:	BL	TL	WL	WW
Male	1.27	0.44	1.17	0.54
Female	1.40	0.49	1.29	0.62

TYPE MATERIAL: Holotype male from *Lionycteris spurrelli,* Armila (San Blas), 19 March 1963, C. O. Handley, Jr., collector. In the collection of the Chicago Natural History Museum. Paratype, a female from the same host.

east slope of the Andes, Quincemil, 13°15′S–70°35′W (Cuzco?), PERU, 2400 feet, 25 April 1947, John C. Pallister, collector. In the collection of the American Museum of Natural History.

Trichobius longipes group

Six species—*T. bequaerti* n. sp., *dybasi* n. sp., *mendezi* n. sp., *longipes* (Rudow) (=*mixtus* Curran), *costalimai* Guimarães, and *dunni* n. sp.—are included in this group. All except *T. dunni* n. sp. occur on species of *Phyllostomus* and *Tonatia,* related genera of the subfamily Phyllostominae (family Phyllostomidae). *T. dunni* was taken on *Molossus bondae* (family Molossidae). Several undescribed species that are related to *dunni* are known to us from other bats of the genus *Molossus.* The *longipes* group may be characterized as follows:

Head.—Laterovertices and occipital plates of head well differentiated. Median suture of mesonotum not forked. Eyes with 10–12 facets. *Thorax.*—Prescutal setae at middle of disk posterior to the median suture, denser and shorter than the lateral setae; antescutellar setae usually only slightly, if at all longer, than setae anterior to them. Pleurotrochantinal lobe dorsally reflexed and united with the metepimeron by a bar. *Wings.*—Sixth longitudinal vein lacking setae basally. *Abdomen.*—*Male:* Sternum V broad, undivided. Sternum VI very short, cord-like; gonapophyses curved to the left (in dorsal view), the accessory setae inserted posterior to the macrosetae. *Female:* Tergum VII very small, transverse, and feebly differentiated, if sclerotized at all; typically with four small setae arranged in one or two rows; postgenital sclerite not visible. Cerci free, not united with the ventral arc.

Trichobius longipes (Rudow). Figures 62A, E; 63F; 64.

Strebla longipes Rudow, 1871, Zeitschr. Ges. Naturw., (n.s.), **37:** 121; 1872, Ann. Mag. Nat. Hist. (4), **9:** 407—Without locality, from "*Phyllostoma hastatum*" (Zoologische Staatsinstitut und Zoologische Museum, Hamburg). Speiser, 1902, Zeitschr. Hymen. Dipt., Heft 3, p. 159 (synonymized with *T. parasiticus* Gervais, in error).

Trichobius dugesii (not Townsend, 1891), Kessel, 1925, Jour. N. Y. Ent. Soc., **33:** 16, pl. 1, fig. 1. Jobling, 1938, Parasitology, **30:** 383, fig. 12. Bequaert, 1940, Rev. Acad. Colomb. Cien. Exact., Fis. y Nat., **3:** 418 (part.). Cooper, 1941, Yearb. Amer. Phil. Soc., **1941:** 124, 126 (part.).

Trichobius mixtus Curran, 1935, Amer. Mus. Novit., no. 765, pp. 9 (keyed), 10 (descr.), fig. 10—Chilibrillo Caves, Panama, from *Phyllostomus hastatus panamensis* (American Museum of Natural History). Guimarães (part.), 1938, Rev. Mus. Paulista, **23:** 654 (descr.), 662 (keyed), figs. 1,2; 1941, Papeis Avulsos, **1:** 215. Bequaert, 1942, Bol. Ent. Venez., **1:** 87. Guimarães, 1944, loc. cit., **6:** 189–191, figs. 18, 19, pl. 1, figs. 2,3 (puparium). Jobling, 1949, Parasitology, **39:** 316 ff. (hosts), 326 (records), fig. 2A. Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., **122,** art. 3, pp. 238, 240. Starrett and de la Torre, 1964, Zoologica, **49:** 56. *New synonym.*

The unique female type of *Strebla longipes* Rudow which was originally mounted dry on a slide was kindly lent to us by Dr. Herbert Weidner of the Zoological Museum at Hamburg with permission to remount it. The specimen had been flattened from the pressure of the slip. We first treated it with trisodium phosphate, then with KOH, and remounted it in canada balsam. Though it is still not an ideal study specimen, it is possible to establish its identity with *Trichobius mixtus* Curran, which was treated by

Jobling (1938) as *T. dugesii.* To the description given by Jobling, we add the following:

Head.—Eyes with ± 11 facets. *Thorax.*—Microsetae present along upper edges of anepisterna, margins of prescutum along the longitudinal membranous cleft, the metanotum and the laterotergite. Median pleurotrochantinal lobe reflexed dorsally and united

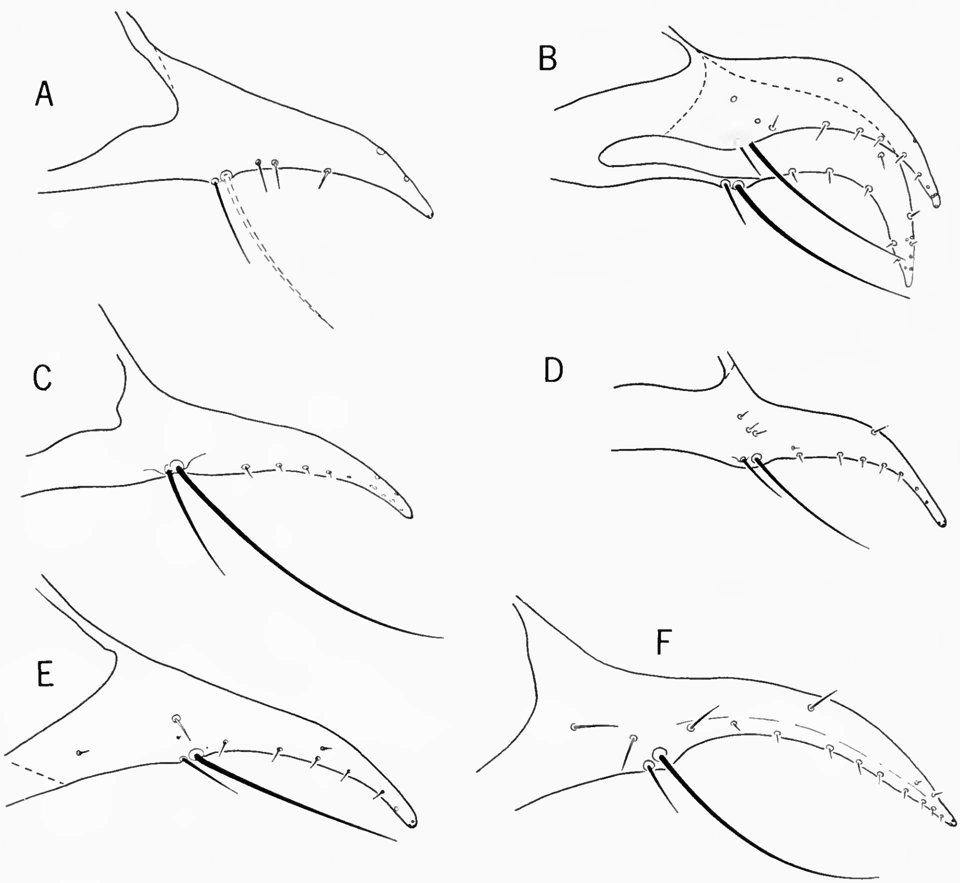


Fig. 63. Left male gonapophysis, *Trichobius longipes* group. A, *T. bequaerti,* new species, holotype. B, *T. dybasi,* new species, paratype from *Tonatia silvicola* (no. 11903), Armila (San Blas). C, *T. dunni,* new species, holotype. D, *T. mendezi,* new species, holotype. E, *T. costalimai* Guimarães. F, *T. longipes* (Rudow), from *Phyllostomus h. panamensis* (no. 4644), Chepo Road (Panamá).

by a bar to the metepimeron (fig. 62A). *Abdomen.*—Anterior face of tergum I+II with a single seta. Dorsal connexivum with two pairs of minute segmental setae. *Female:* Lateral connexivum with a cluster of six to eight setae coarser and longer than the other connexival setae, posterior to the lateral lobes of tergum I+II, and with a lateroventral subapical macroseta on each side, anterior to the seventh sternites. Tergum VII with a transverse row of four minute setae, the middle pair slightly posterior to the outer. Supra-anal plate with four apical macrosetae and a short seta at mid-length on each side. Sternum I+II setose in a broadly triangular area and on each posterior angle; setae of apical margin slightly longer than the discal setae, increasing in length toward the sides. Seventh sternites with about 11–12 setae, basal setae short, apical setae long, one a macroseta that is markedly longer than the others. *Male:* Gonapophyses slightly asymmetrical, both sinuate to left (in dorsal view), feebly curved apically in lateral view (fig. 63F).

Measurements:	BL	TL	WL	WW
Male	1.76–2.13	0.70–0.71	1.29–1.54	0.73–0.77
Female	1.87–2.35	0.78–0.82	1.59–1.92	0.73–0.85

PANAMANIAN MATERIAL EXAMINED: A total of 361 specimens (50 lots) from more than 90 bats. From *Phyllostomus hastatus panamensis,* 344 flies (48 lots) as follows: 35 (5 bats), Fort Kobbe (Canal Zone), 9 October 1959; 49 (19 bats), Fort Sherman (Canal Zone), 4 to 6 April 1960 and 30 July 1959; 3 (2 bats), Chágres River Cave, below Natural Bridge, Madden Dam (Canal Zone), 28 September 1959; 35 (6 bats), Natural Bridge, Madden Dam, 31 August 1959, and 9 (4 bats), same locality, 18 September 1959; 13, Farfan (Canal Zone), 19 December 1915, T Hallinan [AMNH]; 4, Culebra (Canal Zone), 29 October 1930, L. H. Dunn [AMNH]; 9 (1 bat), Camp Piña (Canal Zone), 29 January 1960; 1, Río Chilibrillo (Panamá), 27 August 1957; 26 (20 bats), Chilibrillo Caves, 17 July 1957, and 43 (10 bats), same locality, 28 October 1959; holotype, same locality, 4 August 1931, L. H. Dunn [AMNH]; 2, Pacora (Panamá), 24 April 1957 [USNM]; 9, Tapia (Panamá), J. R. Chapin [MCZ]. 1 (1 bat), Almirante (Bocas del Toro), 29 January 1960. From *Phyllostomus* sp.: 1, "Panama," 19 May 1957 [USNM]. From a mixed collection of *Phyllostomus* and *Pteronotus* spp.: 1, Río Chilibrillo (Panamá), 27 August 1957, R. M. Altman. From *Artibeus jamaicensis jamaicensis:* 11 (3 bats), Natural Bridge, Madden Dam (Canal Zone). From *Carollia perspicillata azteca:* 1, Miraflores (Canal Zone), Kenneth W. Cooper [MCZ]. *Without host:* 2, "Chiriqui," 21 December 1961, C. Yunker; 1, Chilibrillo Caves, 1 January 1916, T. Hallinan [AMNH]; 1, host K-16, Barro Colorado Island (Canal Zone), 2 December 1956 [USNM].

OTHER MATERIAL EXAMINED: We have seen about 70 specimens (25 lots) of this species from *Phyllostomus h. hastatus* and *P. h. panamensis,* from BOLIVIA, PERU, COLOMBIA, VENEZUELA, SURINAM, TRINIDAD, COSTA RICA, and GUATEMALA.

REMARKS: Although *Phyllostomus hastatus* appears to be its principal host, *T. longipes* has also been taken from *Phyllostomus discolor* in Trinidad (Jobling, 1949, p. 317). Guimarães (1938, p. 654) has recorded it from *P. hastatus* from Minas Gerãis and São Paulo, Brazil, but his record (loc. cit.) from "*Hemiderma perspicillatum*" may be of a different species, perhaps *Trichobius joblingi* n. sp. Hoffmann's record (1953: 186) of *T. mixtus* from Yucatan (from *Artibeus jamaicensis yucatanicus*) is probably of an undescribed species that is known to us from *Artibeus,* in Mexico, Guatemala, and the West Indies. In this undescribed species, which is very similar in appearance to *longipes,* the pleurotrochantinal lobe is not united with the metepimeron and the transverse mesonotal suture is strongly angulate.

One of the distinctive characters of *T. longipes* is the pronounced sexual dimorphism in mesonotal chaetotaxy (fig. 64). The three following species resemble *longipes* very closely in most characters, except as indicated in the key, but the mesonotal chaetotaxy is nearly identical in both sexes.

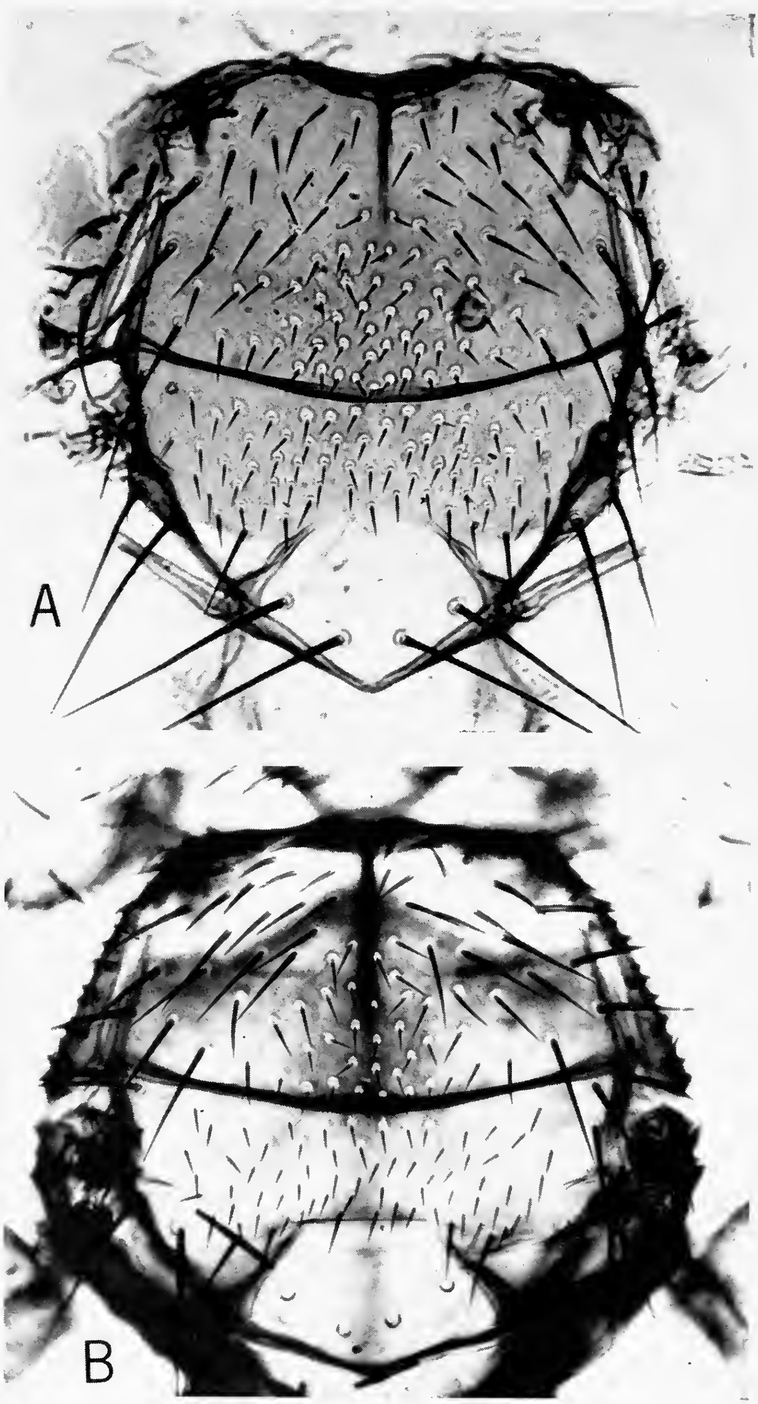


Fig. 64. *Trichobius longipes* (Rudow), thorax, dorsal view. A, male. B, female.

Trichobius mendezi Wenzel, new species. Figures 63D, 65B.

Very similar to *T. longipes* (Rudow) but smaller and in general with shorter setae, and differing in lacking a cluster of coarse connexival setae on each side behind the lateral lobes of tergum I+II in the female and in the distinctive male gonapophyses.

DESCRIPTION: *Head.*—Eyes with about 10 facets. *Thorax.*—Long prescutal setae, limited to sides, not extending inwardly to median suture anterior to the denser median discal setae; discal setae only slightly denser at middle, becoming gradually sparser laterally and anteriorly and not noticeably shorter than the setae on anterior half of prescutum on inner half of width. Median antescutellar scutal setae at middle about twice as long as the shortest scutal setae anterior to them. *Abdomen.*—Dorsal connexivum with three sets of minute segmental setae, the posterior set usually consisting of two pairs rather than one; connexivum posterior to lateral lobes of tergum I+II without cluster of coarser, longer setae. *Female:* Tergum VII with four very short setae, the anterior pair more widely separated and a little longer than the posterior pair. Supra-anal plate with four apical macrosetae and at mid-length on each side a shorter seta. Sternum I+II noticeably emarginate at middle, setae at apical margin only slightly longer than discal setae and not noticeably longer toward sides, extending around sides to about halfway to base. Seventh sternites with about 14 or 15 setae, the basal ones short, the apical ones long, two macrosetae conspicuously longer than the rest. Lateral connexivum, anterior to seventh sternites, with a conspicuous macroseta (as in *joblingi* etc.). *Male:* Sternum V with apical setae only a little longer than the discal setae, not conspicuously longer laterally. Gonapophyses (fig. 63D) very similar to those of *longipes* but smaller, more slender and curved apically.

Measurements:	BL	TL	WL	WW
Male	1.63–1.73	0.54–0.55	1.13–1.20	0.55–0.63
Female	1.59–1.71	0.55–0.62	1.15–1.32	0.60–0.69

TYPE MATERIAL: Holotype male from *Tonatia minuta* (host no. 11764), Armila (San Blas), 20 March 1963, C. O. Handley, Jr. and F. M. Greenwell, collectors; allotype female, same data (host no. 11916), but 26 March 1963. In the collection of Chicago Natural History Museum. Paratypes.—2 males (2 bats), same host as holotype, Sibube (Bocas del Toro), 17 January 1963, C. O. Handley, Jr.; 1 male, same host, Puerto Obaldía (San Blas), 3 April 1963, C. O. Handley, Jr. and F. M. Greenwell; 2 females, same host, Cerro Hoya (Los Santos), 26 February 1962, V. J. Tipton and C. M. Keenan. Paratypes to be deposited in the collections of the Chicago Natural History Museum and the United States National Museum, Washington, D. C.

REMARKS: These and other data indicate that *mendezi* is restricted to *Tonatia minuta.* This species is named after Mr. Eustorgio Méndez of the Gorgas Memorial Laboratory in recognition of his contributions to our knowledge of the ectoparasites of Panama.

Trichobius dybasi Wenzel, new species. Figures 63B, 65A.

Very closely related to *T. longipes* (Rudow) and *T. mendezi* n. sp., and differing from both in that the median discal mesonotal setae are not abruptly denser than the lateral and anterior setae. As in *mendezi,* the female lacks a cluster of conspicuously longer or coarser connexival setae on each side posterior to the lateral lobes of tergum I+II.

DESCRIPTION: With the characters of *T. longipes* except as follows. *Thorax.*—Prescutal setae becoming only slightly longer anteriorly along median suture, gradually longer laterally; median discal area not well defined. *Abdomen.*—*Female:* Connexivum

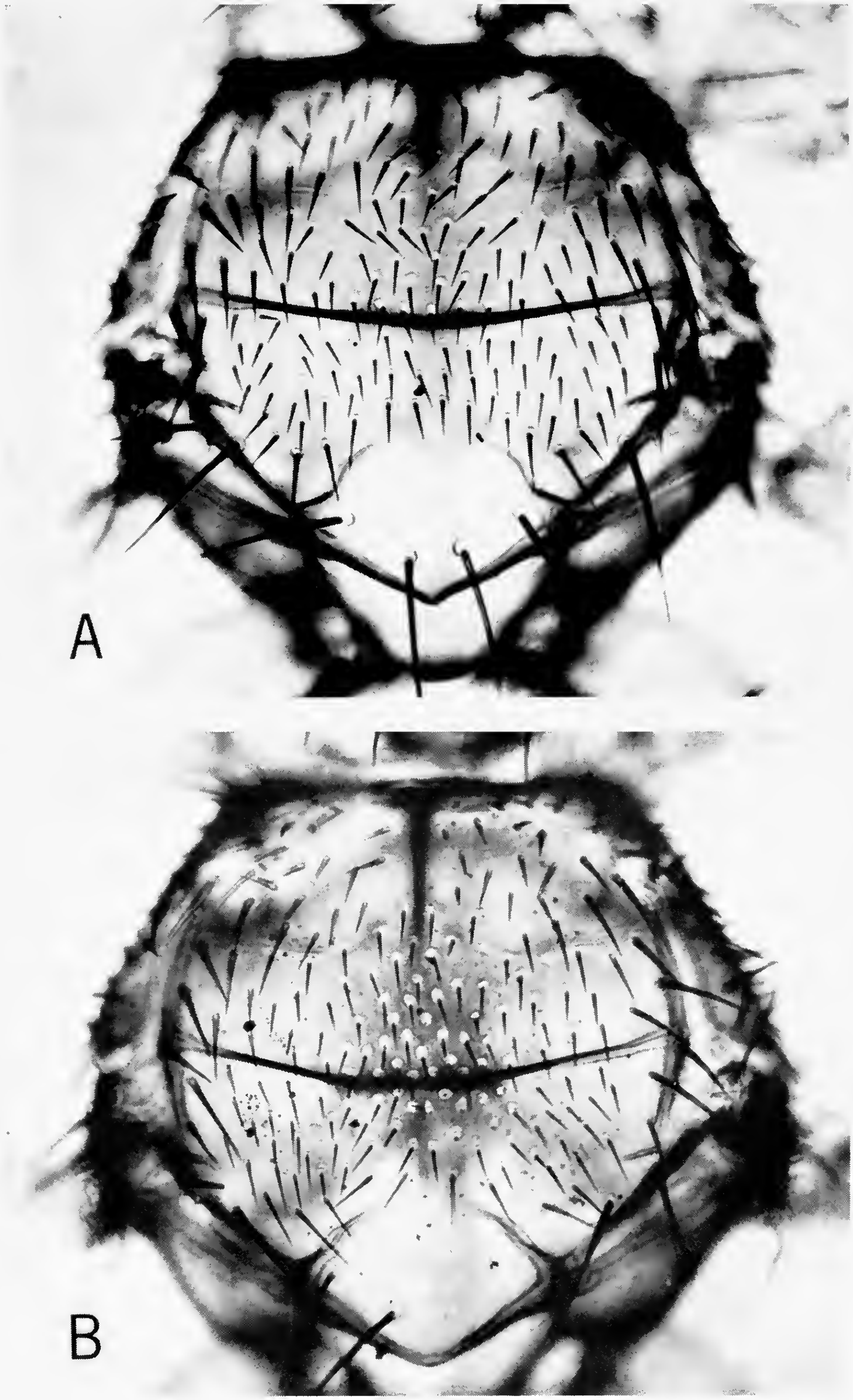


Fig. 65. Thorax, dorsal view. A, *Trichobius dybasi*, new species, allotype. B, *T. mendezi*, new species, female paratype from *Tonatia minuta* (no. 11916), Armila (San Blas).

without cluster of coarser setae on each side behind lateral lobes of tergum I+II. Seventh sternites with 11 setae. *Male:* Gonapophyses as in fig. 63B; sinuate to the left in lateral view and appearing very strongly, downwardly curved apically.

Measurements:	BL	TL	WL	WW
Male	1.46–1.63	0.54–0.58	1.15–1.26	0.60–0.66
Female	1.58–1.77	0.60–0.63	1.26–1.40	0.60–0.71

TYPE MATERIAL: Holotype male and allotype female from *Tonatia silvicola* (host no. 11903), Armila (San Blas), 25 March 1963, C. O. Handley, Jr. and Francis M. Greenwell, collectors. In the collection of Chicago Natural History Museum. Paratypes.—1 male, 3 females, same data as the holotype; 1 male, 3 females, same data, but 17 March 1963; 2 males, 1 female, same data, but 22 March 1963; 2 males, 1 female, same host and collectors, Puerto Obaldía (San Blas), 3 April 1963; 1 female, same host, Sibube (Bocas del Toro), 22 January 1963, C. O. Handley, Jr. Paratypes to be deposited in the collections of Chicago Natural History Museum; United States National Museum; the Gorgas Memorial Laboratory (Panamá); and the Environmental Health Branch, USAFSC, at Corozal (Canal Zone).

REMARKS: This species is named after Mr. Henry Dybas, Associate Curator of Insects, Chicago Natural History Museum, who earlier collaborated with the senior author in studying these flies.

Trichobius bequaerti Wenzel, new species. Figures 63A, 66A.

Very similar to *T. longipes* (Rudow), *dybasi* n.sp., and *mendezi* n.sp., but the patch of microsetae on each side of prescutum is not restricted to extreme lateral margin, the antero-median prescutal setae are as long as the laterals, and the male gonapophyses are heavier (fig. 63A).

DESCRIPTION (*Male*): With the characters of the group and the following. *Thorax.*—Discal mesonotal setae denser at middle, the mesonotal setae much longer apically and laterally. Microsetae of postero-lateral angles of prescutum extending inwardly from margin to second longitudinal row of setae (from margin), and anteriorly from transverse suture to second transverse row of setae (from suture). *Abdomen.*—With four pairs of minute dorsal segmental connexival setae. Gonapophyses (fig. 63A) not as strongly curved in lateral view and more wedge-shaped than in *T. longipes.*

Measurements:	BL	TL	WL	WW
Holotype male	1.65	0.58	1.40	0.71

TYPE MATERIAL: A unique holotype male (slide) from *Tonatia bidens* (host no. 5489) Almirante (Bocas del Toro), 28 January 1960, collected by V. J. Tipton and C. M. Keenan. In the collection of Chicago Natural History Museum.

REMARKS: This species is named after Dr. Joseph C. Bequaert, formerly Curator of Insects at the Museum of Comparative Zoology, Harvard University, in recognition of his outstanding contributions to our knowledge of the pupiparous Diptera.

Trichobius costalimai Guimarães. Figures 63E, 67B.

Trichobius costalimai Guimarães, 1937, Revista Mus. Paul., 23: 660 (descr.), 662 (keyed), pl. 3, fig. 10—from undetermined bat, Recife, Pernambuco (type depository not given). Jobling, 1938, Parasitology, 30: 368, fig. 14B. Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., 122, art. 3, p. 238.

T. costalimai is easily identified by the very distinctive mesonotal chaetotaxy (fig. 67B). It is the only species of the *longipes* group known to us in which the underside of the thorax and the hind coxae are microsetose. In addition to the characters listed in the original description, the following may be given:

Thorax.—Microsetose area of prescutum extending inwardly along transverse suture almost to fourth seta from lateral margin; elsewhere on basal half extending beyond the second row of setae, and on anterior half about two-thirds the distance to median suture; sternopleura and pleurotrochantines microsetose; sternopleural projection pointed. *Legs.*—Hind coxae microsetose below. Femora and tibiae, as well as procoxae and trochanters of middle legs with transverse lines; and with base of each seta on coxae and surrounded by a slightly elevated ring.

Abdomen.—Inner dorsal margin of lateral lobes of tergum I+II without a row or cluster of fine setae between apical coarse setae and base; one or two short setae on anterior face. Connexivum with two sets of dorsal segmental setae, the anterior set a single pair, the posterior set consisting of two pairs. Setae of sternum II subequal. *Female:* Connexivum without a cluster of coarser, longer setae on each side posterior to lateral lobes of tergum I+II. Tergum VII with two pairs of short subequal setae. Seventh sternites with about 11 setae. Supra-anal plate very short, with four apical macrosetae, as well as a short seta on each side and another at mid-length anterior to outer macroseta. *Male:* Sternum V with setae of apical margin only slightly longer than on disk. Gonapophyses as in fig. 63E.

Measurements:	BL	TL	WL	WW
Male	1.72–1.76	0.63–0.66	1.29–1.43	0.58–0.66
Female	1.76–1.77	0.68–0.71	1.51–1.54	0.71–0.74

PANAMANIAN MATERIAL EXAMINED: From *Phyllostomus d. discolor,* 19 (4 lots) as follows: 10, Río Tuira (Darién), 10 March 1958, P. Galindo [GML]; 2, Río Mandinga (San Blas), 29 May 1957, P. Galindo [GML]; 6, Armila (San Blas), 1 April 1963, C. O. Handley, Jr. and F. M. Greenwell; 1, Almirante (Bocas del Toro), 31 January 1960. From *Uroderma bilobatum:* 1, Puerto Obaldía (San Blas), 3 April 1963, C. O. Handley, Jr. and F. M. Greenwell. From *Desmodus rotundus:* 2, Guánico (Los Santos), 26 January 1962. From *Pteronotus p. fuscus:* 1, Guánico (Los Santos), 22 January 1962. From *Carollia p. azteca:* 1, Guánico (Los Santos), 27 January 1962. From *Artibeus l. palmarum:* 1, Puerto Obaldía, 4 April 1963, Handley and Greenwell; 2, Cerro Azul (Panamá), 25 January 1958, E. Méndez [GML].

OTHER MATERIAL EXAMINED: About 428 (24 lots) additional specimens, off *Phyllostomus discolor,* from GUATEMALA, EL SALVADOR, COLOMBIA, VENEZUELA, SURINAM, TRINIDAD, and PERU. Of these, 18 lots (402 flies) were from *Phyllostomus d. discolor* and *P. d. verrucosus.* One lot each was taken from *Phyllostomus elongatus* and *P. h. hastatus.* The remaining specimens were without host or dubious ones such as "*Didelphis*" (!) and *Sturnira.* Other streblids from the Surinam lot labeled as from *Sturnira* were *Strebla consocius* n. sp., a parasite characteristic of *P. h. hastatus.*

REMARKS: *Phyllostomus discolor* appears to be the principal host of *costalimai.* It is our opinion that the records from other hosts taken at Guánico and Cerro Azul, in Panama, are in error. As pointed out elsewhere, a substantial percentage of the specimens collected at these localities were obviously incorrectly associated. We suspect that most of these, as well as the specimens of *costalimai* from other hosts, were from bats collected with mist nets (see *Collecting hosts,* above).

Fig. 66. Thorax, dorsal view. A, *Trichobius bequaerti*, new species, holotype. B, *T. urodermae*, new species, female paratype from *Uroderma bilobatum* (no. 6958), Rodman Naval Base (Canal Zone).

Trichobius dunni Wenzel, new species. Figures 63C, 67A.

Superficially resembling *T. phyllostomae* Kessel and *T. longipes* (Rudow), but differing from these and all other described species of *Trichobius* by the large number of bristles (17–19, as opposed to 10–12) on the occipital lobes of the head and by the distinctive male gonapophyses. The female is unknown.

DESCRIPTION (*Male*): *Head.*—Occipital plates each with about 15 conspicuous setae and on inner posterior margin about three additional short, fine setae. Palpi horizontal, their ventral surface densely clothed with short fine setae. Eyes conspicuous, with 11–12 large facets. *Thorax.*—Mesonotum distinctly convex, the anterior margin outwardly rounded, feebly emarginate at middle; median suture extending posteriorly to slightly beyond middle; setae longest and rather evenly distributed anteriorly and along sides, shorter posteriorly along sides; median discal setae shorter and denser posterior to the median suture and on scutum; setae of antescutellar row two to three times as long as setae immediately anterior to them; scutellum with four setae. *Wings.*—Costa with both long and shorter setae, the long setae becoming shorter and of uniform size about halfway to junction with R_1, the junction situated beyond level of third crossvein but not as far as midpoint between second and third crossveins; base of R_1 with two or three long setae, base of fifth longitudinal vein with two. *Legs.*—Relatively short, the femora progressively longer, the hind femora from one-fourth to one-third longer than profemora; femora clothed with both long and short setae. Tibiae subequal, their setae short, dense, rather uniform. Tarsi rather strongly compressed antero-posteriorly, the claws relatively small. *Abdomen:* Lateral lobes of tergum I+II with numerous long setae, their inner dorsal margins each with one or two short setae. Connexivum dorso-laterally with moderately long setae anteriorly, becoming shorter apically and ventrally, the underside densely clothed with relatively short setae; three pairs of minute, dorsal, segmental setae present. Sternum V weakly sclerotized, the discal setae similar to those of ventral connexivum, but those along apical margin distinctly longer. Sternum VI very narrow, inconspicuous. Hypopygium clothed with long setae, these longest dorsally and apically, the apical ones being macrosetae. Gonapophyses as in fig. 63C.

Measurements:	BL	TL	WL	WW
Holotype male	1.84	0.72	1.54	0.69

TYPE MATERIAL: Holotype male from *Molossus bondae,* Río Chucunaque (Darién), L. H. Dunn (no. 841). In the collection of the Museum of Comparative Zoology at Harvard University.

REMARKS: *T. dunni* belongs to a small complex of closely related, undescribed species that are found on species of *Molossus.* The record of *Trichobius phyllostomae* (Curran, 1934, p. 523; Jobling, 1938, p. 377) from *Molossus obscurus* was probably based on one of these undescribed species. They appear to be the only New World Streblidae that occur on Molossidae. We have seen other undescribed species of this group from Mexico (*Molossus nigricans*), Guatemala (*Molossus* sp.), Venezuela (no host), Trinidad (*Molossus rufus*), and Brazil (no host).

Although the female of *dunni* is not known, it will very likely resemble those of the related undescribed species. In these, the seventh sternites are relatively much larger than in *longipes* and have numerous dense macrosetae. Although *dunni* has more numerous occipital setae than is usual in the genus, these setae are not as long and conspicuous as in the related, undescribed species.

Trichobius dunni is named after Major Lawrence H. Dunn, in recognition of his important contributions to medical entomology.

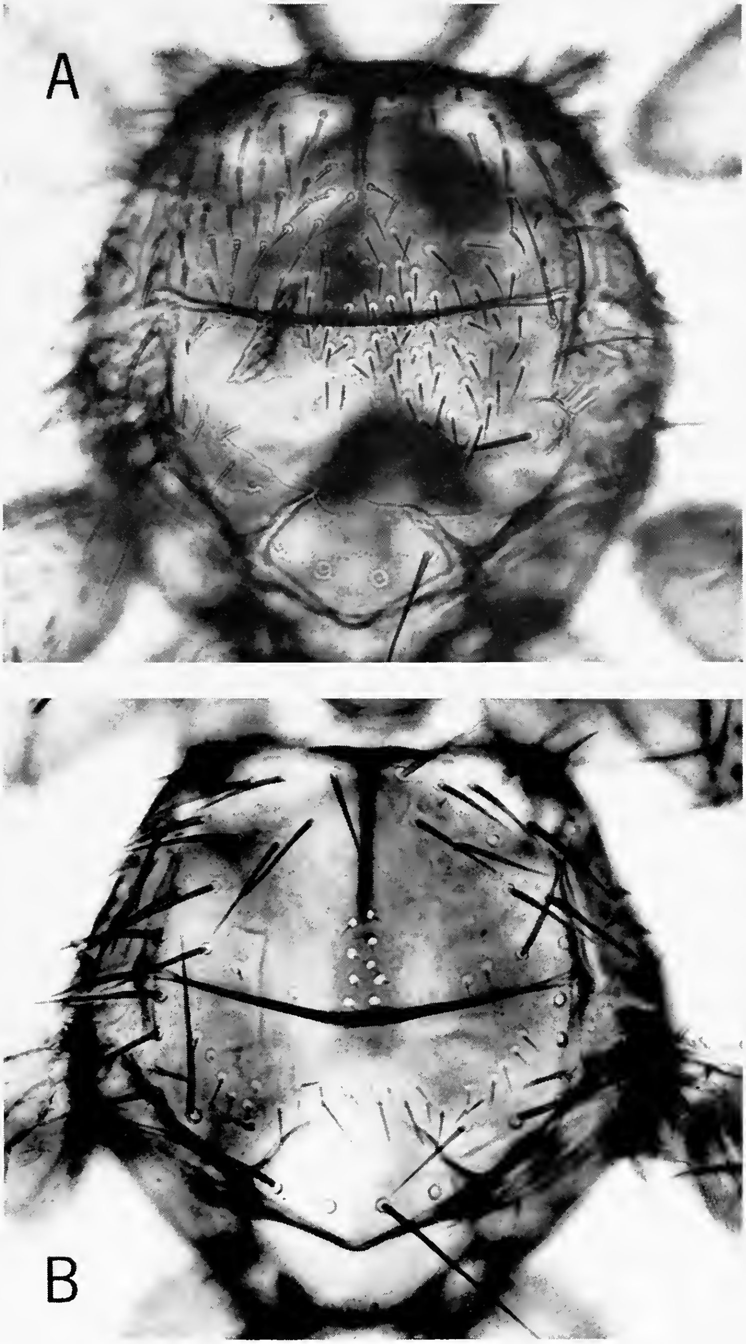


Fig. 67. Thorax, dorsal view. A, *T. dunni*, new species, holotype. B, *T. costalimai* Guimarães.

Trichobius dugesii group

The species of this group are closely related to and probably derived from those of the *longipes* group. They differ in that the median pleurotrochantinal lobe, if present, is not united with the metepimeron and sternum VI is absent in some species. As in the *longipes* group, the female cerci are not united with the ventral arc. The species may be segregated into two complexes. The median pleurotrochantinal lobe is present in one, absent in the other.

Trichobius dugesii complex

In the species of this complex, a blunt pleurotrochantinal lobe is present but is not united with the metepimeron and sternum VI is present in the males of all excepting *T. macrophylli* n. sp. The species occur on bats of four subfamilies of Phyllostomidae: *T. dugesii* Townsend on *Glossophaga soricina* (Glossophaginae) ; *T. joblingi* n. sp. on *Carollia perspicillata* (Carolliinae) and sometimes on *Trachops cirrhosus* (Phyllostominae) with which *perspicillata* often roosts; *T. macrophylli* n. sp. on *Macrophyllum macrophyllum* (Phyllostominae) ; *T. urodermae* n. sp. on *Uroderma bilobatum* (Stenoderminae).

Trichobius urodermae Wenzel, new species. Figures 66B, 68I.

Superficially resembling females of *Trichobius longipes* (Rudow) but differing markedly in that the median pleurotrochantinal lobe is not united with the metepimeron as in that species. From other species of the *dugesii* group that have a median pleurotrochantinal lobe, it may be distinguished by its larger size, the very long antero-lateral prescutal setae, and the distinctive male gonapophyses.

DESCRIPTION: *Head.*—Slightly wider than long. Laterovertices and occipital plates well differentiated, the occiput slightly elevated above the rest of the head. Eyes with about nine large convex facets. Palpi rounded-oval, ventral surface with short setae, upper surface microsetose. Theca pyriform. *Thorax.*—Anterior margin of prescutum slightly projecting at middle, the median suture incomplete, usually extending less than half the distance to transverse suture, the latter slightly angulate, not well-defined at middle. Mesonotum as illustrated (fig. 66B); with a median area of dense finer setae, separated from anterior margin by three rows of very long setae that are two to three times as long as median setae, and separated from lateral margin by two longitudinal rows of long setae; antescutellar setae at least twice as long as the scutal setae anterior to them; microsetae present along dorsal edge of anepisternum and along thickened pigmented lateral margin of prescutum and scutum. Median pleurotrochantinal lobe well developed, blunt, translucent, reflexed dorsally. *Wings.*—Costa with long macrosetae basally, these becoming progressively shorter apically, more or less uniform from about mid-length to apex; base of R_1 usually with three macrosetae, united with costa at a point approximately midway between second and third crossvein. *Legs.*—Fore- and midlegs typical of *longipes* group. Apical patch of dense fine setae on inner edge of hind tibiae not well defined. Tarsi compressed antero-posteriorly; hind tarsi (not including claws) about half as long as tibiae.

Abdomen.—Lateral lobes of tergum I+II each with lateral cluster of 12–15 coarse setae, the inner (upper) margin of each lobe, anterior to this cluster, with a row of one to three fine setae. Sternum I+II setose in a broad triangular area and along lateral margins near apex; the marginal setae slightly longer toward sides; posterior margin feebly emarginate. *Female:* Tergum VII a narrow transverse strip with a longer seta

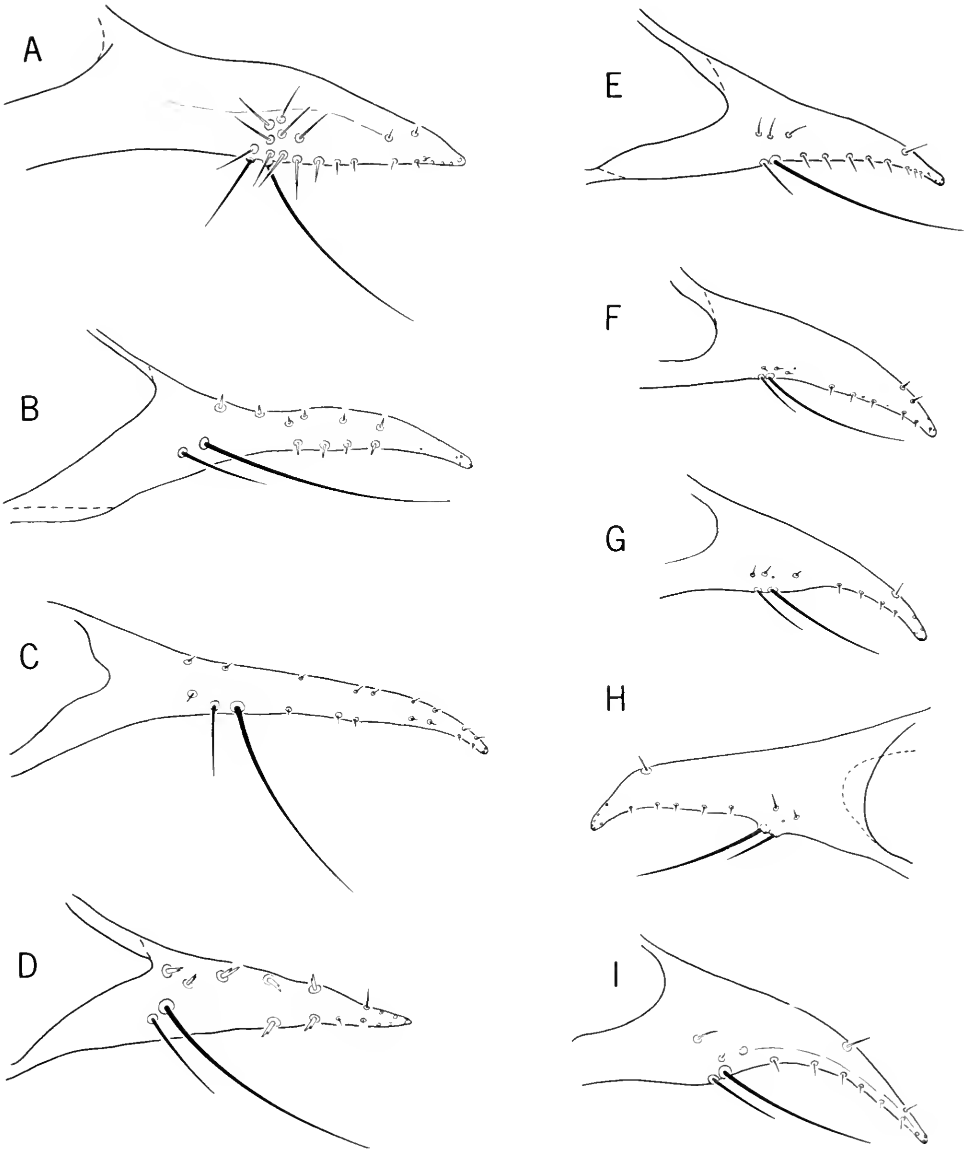


Fig. 68. Male gonapophyses (left, except as indicated), lateral view, *Trichobius dugesii* group. A, *T. parasiticus* Gervais. B, *T. diphyllae*, new species, holotype. C, *T. furmani*, new species, host unknown, Vitoc Valley (Junín), PERU. D, *T. dugesioides*, new species, holotype. E, *T. joblingi*, new species, composite, but based chiefly on holotype. F, *T. macrophylli*, new species, paratype from *M. macrophyllum* (no. 4741), Fort Davis (Canal Zone). G, left, and H, right gonapophyses, *T. dugesii* Townsend, from *Glossophaga s. leachii* (no. 5027) Fort Kobbe Beach (Canal Zone). I, *T. urodermae*, new species, paratype from *Uroderma bilobatum*, Almirante (Bocas del Toro).

on each side and a shorter pair medially and slightly posteriorly. Supra-anal plate with four apical macrosetae and two shorter setae on each side, one of these often inserted ventrad. Sternum I+II with weakly developed microsetae. Seventh sternites with about 17 setae, the apical setae longest, one conspicuously longer than the others. Subapical, ventro-lateral macroseta of connexivum absent. *Male:* Sternum I+II with distinct short transverse rows of microsetae. Discal setae of sternum V gradually longer toward apex, those of the apical margin considerably longer than the discals, those toward sides at least twice as long as the median setae. Sternum VI thread-like, barely visible. Hypopygium with numerous coarse setae. Gonapophyses as in fig. 68I; ventral macroseta not reaching apex, the accessory seta inserted immediately proximal to the macroseta; two or three smaller setae inserted above ventral pair, a row of extremely fine setae along ventral margin; dorsal margin with a seta at angulation and another minute one near apex.

Measurements:	BL	TL	WL	WW
Male	1.46–1.84	0.62–0.65	1.32–1.39	0.58–0.71
Female	1.62–2.17	0.66–0.71	1.52–1.59	0.66–0.77

TYPE MATERIAL: Holotype male (slide) from *Uroderma bilobatum* (host no. 5528), Almirante (Bocas del Toro), 5 February 1960, C. M. Keenan and V. J. Tipton. Allotype female, same host (no. 6958) and collectors, Rodman Naval Base (Canal Zone), 27 April 1961. In the collection of Chicago Natural History Museum.

Paratypes from *Uroderma bilobatum,* 22 (13 lots from 13 bats) as follows: 2 (2 bats), type locality, 26 and 28 January 1960; 8, Fort Clayton (Canal Zone), 28 November 1960; 1, Fort Davis (Canal Zone), 22 September 1960; 2 (2 bats), palm tree, Fort Randolph (Canal Zone), 6 October 1959; 1, Summit Gardens (Canal Zone), 11 September 1959; 2, Punta Piña (Darién), 24 March 1960; 6 (3 bats), Armila (San Blas), 18 March to 1 April 1963, C. O. Handley, Jr. and F. M. Greenwell. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; the Gorgas Memorial Laboratory, Panamá; the Environmental Health Branch (U. S. Army) at Corozal (Canal Zone); Departamento de Zoologia, Secretaria de Agricultura, São Paulo; and Facultad de Ciencias, Universidad Central de Venezuela, Caracas.

REMARKS: This species is known to us only from *Uroderma bilobatum* and is one of the relatively few species of *Trichobius* known from bats of the subfamily Stenoderminae.

Trichobius dugesii Townsend. Figures 68G,H; 69A.

Trichobius dugesii Townsend, 1891, Ent. News, 2: 106—Guanajuato, Mexico, ex *Glossophaga soricina* (Snow Entomological Museum, University of Kansas, Lawrence). Van der Wulp, 1903, Biol. Centr.-Amer., Ins. Dipt., 2: 432. Aldrich, 1905, Smiths. Misc. Coll., 46: 657 (part.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 14, 15 (part.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth. Wash., no. 155, p. 655 (part.). Guimarães, 1938, Revista Mus. Paulista 23: 656 (part.); 1941, Papeis Avulsos, 1: 213–214 (part.). Schuurmans Stekhoven Jr., 1941, Zool. Anz., 136: 79. Bequaert, 1942, Bol. Ent. Venez., 1: 87 (part.). Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 181, 186 (part.). Jobling, 1949, Parasitology, 39: 316 ff., 326 (part.). Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., 122: 245.

Trichobius blandus Curran, 1935, Amer. Mus. Novit., no. 765, pp. 9 (keyed), 10 (descr.), fig. 11—Paraíso [Canal Zone], Panama, ex *Glossophaga soricina leachii* (American Museum of Natural History). Jobling, 1938, Parasitology, 30: 358 (part., ex *G. soricina*). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 318 (part.). Schuurmans Stekhoven Jr., 1951 (and 1941?), Beiträge Fauna Perus, 3: 95.

At least six species have been confused under this name in the literature. Among these are *T. joblingi* n. sp., *T. dugesioides* n. sp., *T. longipes* (Rudow) (= *T. mixtus* Curran) and several undescribed species. It is nearly impossible to determine which published references should be assigned to this name. As indicated elsewhere, the species treated as *dugesii* by Jobling (1938) is *T. longipes,* while the species figured and described by him as *T. blandus* (not Curran, 1935) is *T. joblingi* n. sp. However, Jobling's records (loc. cit.) of *blandus* from *Glossophaga soricina* apply to *dugesii.*

Although closely related to some of the species listed above, *dugesii* is easily distinguished by the combination of: extremely short antescutellar setae (fig. 69A); its translucent, rounded, median pleurotrochantinal lobe; the distinctive gonapophyses and the presence of sternum VI, in the male.

PANAMANIAN MATERIAL EXAMINED: A total of 109 specimens in 63 lots. From *Glossophaga soricina leachii,* 103 flies (59 lots) from 63 bats, as follows: 1, San Lorenzo Cave, Fort Sherman (Canal Zone), 29 March 1960; 2, Fort Sherman, 4 December 1959; 1, Galeta Island (Canal Zone), 19 November 1959; 4, France Field (Canal Zone), 30 November 1959; 5, Fort Kobbe Beach (Canal Zone), 16 November 1959; 8, Coco Solo ammunition area (Canal Zone), 20 October 1959; 3, Empire Range (Canal Zone), 30 September 1959; 5, Fort Clayton (Canal Zone) 14 September and 5, same locality, 13 October 1959; 4, Fort Davis (Canal Zone), 18 November 1959 and 2, same locality, 20 September 1960; 2, Camp Chagres, Madden Dam (Canal Zone), 25 June 1963; 1 [holotype of *T. blandus* Curran], Paraíso (Canal Zone), 17 October 1930, L. H. Dunn #7 [AMNH]; 4, Chepo (Panamá), 24 May 1960; 2 (2 bats), Chilibrillo Caves (Panamá), 28 October 1959 and 2 August 1960; 1, Huile (Panamá), ? 24 October 1960; 2, west side of Taboga Island (Panamá), 24 September 1959; 3 [paratype females of *T. blandus* Curran], Bella Vista, near Panamá (Panamá), 25 June 1931, L. H. Dunn [AMNH]; 9, Guánico (Los Santos), 28 January 1962; 1, Cerro Hoya (Los Santos), 10 February 1962; 1, Santa Clara (Coclé), 27 October 1959; 8, Río Hato (Coclé), 22 October 1959; 18, Santa Clara (Coclé), 27 October 1959; 2, Río Tuira (Darién), 10 March 1958, Pedro Galindo [GML]; 7, Río Mandinga (San Blas), 30 May 1957, P. Galindo [GML]; 2, Almirante (Bocas del Toro), 1 February 1960.

From a mixed collection of (12) *Carollia p. azteca* and (6) *Glossophaga s. leachii:* 1, Huile (Panamá), October 1960. From *Carollia p. azteca* (?): 1, Gatun Tank Farm (Canal Zone), 19 November 1959. From *Trachops cirrhosus:* 6, Río Mandinga (San Blas), 30 May 1957, P. Galindo [GML].

OTHER MATERIAL EXAMINED: From *Glossophaga s. leachii:* 2, Mineral Montechristo (Moragan), EL SALVADOR, 18 June 1953, H. Felten [SM]; 2, near Santa Tecla (Libertad), EL SALVADOR, H. Felten [SM]; 4, Finca El Zapote, Zapote (Escuintla), GUATEMALA, 7 July 1948, L. de la Torre and R. D. Mitchell, CNHM Guatemala Zoological Expedition (1948). From *Glossophaga s. valens:* 1, from preserved bat collected at Vitoc Valley, Tarma Province (Junin), PERU, by F. Woytkowski [CNHM].

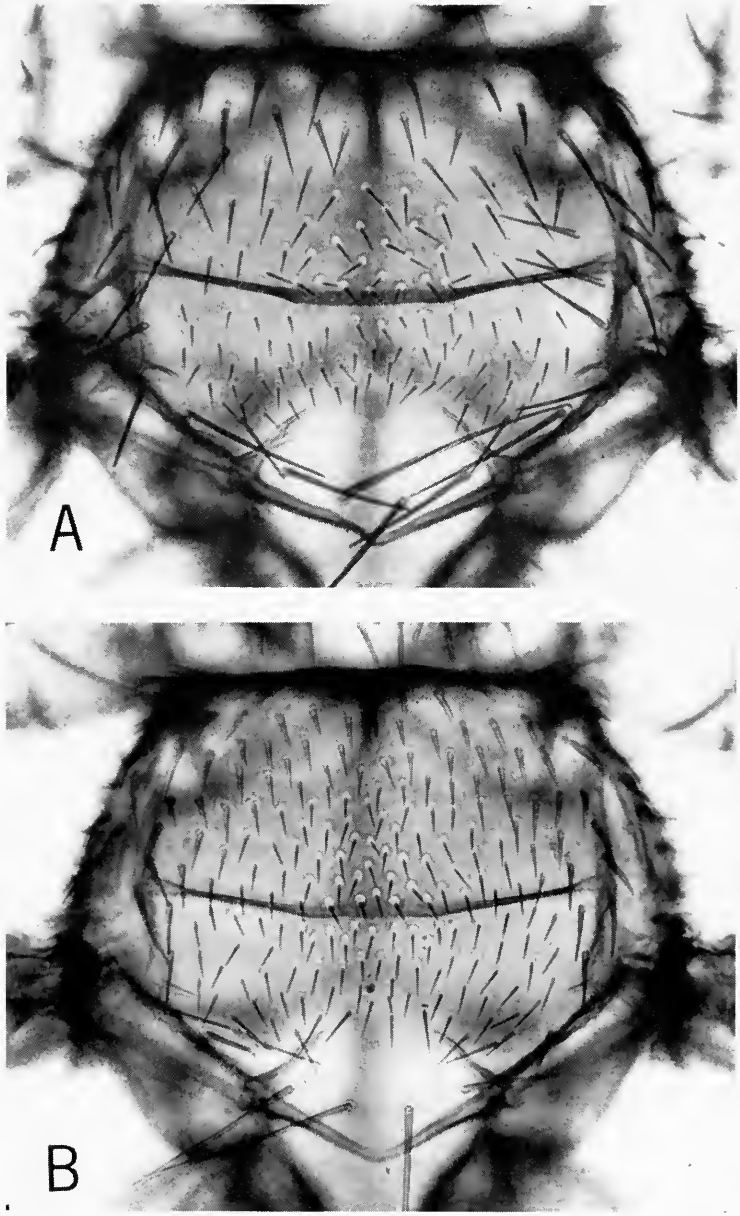


Fig. 69. Thorax, dorsal view. A, *Trichobius dugesii* Townsend; B, *Trichobius macrophylli*, new species; both from *Macrophyllum macrophyllum* (no. 4749), Fort Davis (Canal Zone).

REMARKS: *Trichobius dugesii* appears to be restricted to *Glossophaga soricina,* though it is possible that it may occur on other species of *Glossophaga.* None were obtained from numerous specimens of *G. commissarisi* collected in Panama. It is possible that *dugesii* may occasionally transfer to other hosts, but there is no evidence that this is so. Those collected in Panama from the mixed host series are probably from the specimens of *Glossophaga.* The specimens from *Carollia p. azteca* were doubtfully associated with the host by the collectors. Those taken from *Trachops* were a part of a collection that contained several obviously incorrect host associations, probably due to mislabeling.

It is obvious that Guimarães (1938), Bequaert (1942), Jobling (1938 and 1949), and Hoffmann (1953) treated *dugesii,* in part, but probably only the specimens they recorded from *Glossophaga soricina.* Guimarães (loc. cit., pl. 2, fig. 6) figured as *dugesii* a species with long antescutellar setae, from *Carollia perspicillata.* It was probably *T. joblingi* n.sp.

Trichobius joblingi Wenzel, new species, Figures 68E, 70.

Trichobius dugesii (not Townsend 1891), Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 16, pl. 1, fig. 1 (part.?); Curran, 1935, Amer. Mus. Novit., no. 765, p. 9 (part.?). Bequaert, 1942, Bol. Ent. Venez., **1**: 87 (part.?). Guimarães, 1938, Rev. Mus. Paulista, **23**: 656 (part.) pl. 2, fig. 6 (?). 1941, Papeis Avulsos, **1**: 215 (part.). Cooper, 1941, Yearb. Amer. Phil. Soc., **1941**: 124, 126 (part.?) Jobling, 1949, Parasitology, **39**: 316 ff., 326 (part.).

Trichobius blandus (not Curran, 1935), Jobling, 1938, Parasitology, **30**, pp. 365 (keyed), 385 (descr.), fig. 13. Bequaert, 1940, Rev. Acad. Colomb. Cienc. Ex., Fis. y Nat., **3**: 418 (part.) Starrett and de la Torre, 1964, Zoologica, **49**: 58.

T. joblingi n.sp. is closely related to *T. dugesii* Townsend and *T. macrophylli* n.sp. From *dugesii* it may easily be distinguished by: the long antescutellar setae, which in *joblingi* are from two and one half to three times as long as the scutal setae immediately anterior to them (subequal to scutal setae in *dugesii*) ; the presence in the female, posterior to the lateral lobes of tergum I+II, of a cluster of three to five setae which are coarser and longer than the others (none conspicuously longer in *dugesii*) ; the shorter setae of tergum VII (female) ; and by characters of the male gonapophyses. From *macrophylli* it may be separated by its longer antescutellar setae (less than twice as long as anterior scutal setae in *macrophylli*) ; the much smaller eyes and relatively longer occipital plate, the eyes viewed from above being shorter than greatest length of occipital plate (as long as or longer than occipital plate in *macrophylli*) ; and by having only three to five coarser lateral connexival setae in the cluster behind tergum I+II (10–13 in *macrophylli*).

In the following description, we have added characters not given by Jobling and emphasized others.

DESCRIPTION: Laterovertices, occipital plates, upper surface of palpi, upper edges of mesepisterna, outer edges of prescutum on basal third, and outer edges of scutum microsetose, in addition to the metanotum and laterotergites, connexivum of abdomen, and the abdominal sclerites (excepting tergum I+II). *Head.*—Eyes relatively small, shorter (viewed from above) than greatest length of occipital plate; with ± 10 small facets. *Thorax.*—Median discal setae rather abruptly shorter and denser than those lateral and anterior to them, limited on prescutum to basal half or less and separated from the lateral margins by about three rows of longer setae; antescutellar setae conspicuously and abruptly longer (usually two and one half to three times) than the scutal setae immediately anterior to them. Median pleurotrochantinal lobe rounded, translucent, slightly reflexed.

Abdomen.—Inner (dorsal) margin of each lateral lobe of tergum I+II (anterior to the cluster of coarse setae) with two or three fine setae in a single row. Dorsal connexivum of abdomen with three pairs of minute "segmental" setae. Sternum I+II well developed, broader than pleurotrochantines, with nearly uniform setae arranged in a broadly triangular area and, along lateral margins on basal half. *Female:* Connexivum on each side posterior to lateral lobes of tergum I+II, with a cluster of from three to five setae which are conspicuously coarser and/or longer than the others; on each side anterior to the seventh sternite is a latero-ventral apically directed macroseta. Tergum VII feebly differentiated but represented by two pairs of minute setae, the anterior pair slightly more widely separated, the posterior pair close behind them. Supra-anal plate with four apical macrosetae and on each side at middle, a shorter seta; occasionally an additional short seta is present on each side medial to the lateral seta. Seventh sternites with about ten setae of varying lengths, the basal ones short, the apical ones macrosetae, one twice as long as next longest setae. *Male:* Sternum V feebly sclerotized, as wide as abdomen, its posterior margin broadly and feebly emarginate, the setae rather uniform throughout, except along posterior margin where five or six bristles on each side are about twice as long as the others. Sternum VI present, thread-like. Hypopygium bluntly conical, with numerous macrosetae. Gonapophyses (viewed dorsally), asymmetrical and curved to the left; ventral margin appearing straight in lateral view (fig. 68E).

Measurements:	BL	TL	WL	WW
Male	1.21–1.48	0.47–0.49	1.00–1.07	0.45–0.55
Female	1.26–1.70	0.52–0.55	1.15–1.26	0.49–0.60

TYPE MATERIAL: Holotype male and allotype female (slides) from *Carollia perspicillata azteca* (host no. 4899), railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—1870 specimens (334 lots, 614 bats) from *Carollia perspicillata azteca:* 29 (10 bats), Brazoa Brook (Canal Zone), 6 October 1959; 56 (6 bats), Coco Solo (Canal Zone), 13 January 1960, and 2, same locality, 8 December 1960; 5 (8 bats), Curundu (Canal Zone), 14 September 1959; 105 (37 bats), Fort Davis, various dates, October and November 1959, and 14 (8 bats), same locality, various dates, September and November 1960; 2, Fort Clayton (Canal Zone), 14 September 1959; 16 (28 bats), Fort Gulick (Canal Zone), various dates, September and October 1959; Fort Randolph, 1 October 1959; 207 (174 bats), Fort Sherman (Canal Zone), various dates, March through December, 1959–61; 185 (67 bats), France Air Force Base (Canal Zone), various dates, August to November 1959; 9 (3 bats), Galeta Island (Canal Zone), 19 November 1959; 21 (8 bats), culvert, Gatun Tank Farm (Canal Zone), 19 November 1959; 36, hollow tree, 1 mi. from Gatuncillo (Canal Zone ?), 28 July 1960; 10, Farfan (Canal Zone), 19 December 1915, T. Hallinan; 274 (51 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September and 25 November 1959; 12 (1 bat), Navy By-Pass Road (Canal Zone), 8 October 1959; 5 (2 bats), Navy Tank Farm, 6 October 1959; 6 (3 bats), railroad culvert, Paraíso (Canal Zone), 15 and 16 September 1959; 270 (17 bats), railroad culvert, east of Summit Golf Club (Canal Zone), 26 October 1959; 46 (2 lots), Summit (Canal Zone), 17 April 1957, C. B. Koford [USNM]; 106 (34 bats), Sardanillo Caves, Summit (Canal Zone), 12 August 1961, C. Yunker [RML]; 41 (9 bats), culvert, Rousseau Road, 13 October 1959; 2, Piña Field range, 27 September 1960; 43, house, Camp Piña (Canal Zone), 26 October 1960; 17 (4 bats), Camp Chágres, Madden Dam (Canal Zone), 20 to 25 June 1963, GML; 41, Gamboa (Canal Zone), 1 May 1957 [USNM]; 14 (3 lots), Barro Colorado Island (Canal Zone), 2 January, 19 February, and 5 April 1957 [USNM]; 2, Arraiján (Panamá), 26 March 1961; 59 (27 bats), air-raid shelter, La Chorrera (Panamá), 18 September 1959; 135 (17 bats), culverts, Chepo Road (Panamá), 8 and 12 October 1959; 2 (2 bats), Chilibrillo Caves (Panamá), 28 October 1959; 2, same locality, 2 August 1960; 17 (29 bats), same locality, 18 August 1959; 3, same locality, 27 August 1944 [USNM]; 3, "Ft. Lorenzo, Panama" [USNM, det. as *T. dugesii* by Q. C. Kessel]; 15 (5 bats), Isla Taboga (Panamá), 24 September 1959; 61 (57 bats), various dates, September and November 1959, Buena Vista Caves (Colón); 1, culvert, Río Hato Road (Coclé), 22 October 1959; 16 (4 bats), Puenta de Cocos, Isla del Rey (Darién), 22 and 23 March 1960; 16, Piña Point (Darién), 23 and 24 March 1960; 9, Río Chucunaque (Darién), 19 February 1958, Pedro Galindo [GML]; 9 (3 bats), Río Tuira (Darién), 25 February to 2 March 1958; 1, Río Setegantí, February 1961; 27 (11 bats), Guánico (Los Santos), 21 to 28 January 1962; 10 (8 bats), near Río Guánico, Guánico, (Los Santos), 8 February to 1 March 1962; 6 (4 bats), Cerro Hoya, 10 to 25 February 1962; 80 (22 bats), Almirante (Bocas del Toro), 23 January to 1 February 1960. Paratypes in the collections listed on p. 410.

OTHER PANAMANIAN MATERIAL EXAMINED (272 specimens): From *Carollia castanea*, 78 flies (23 lots from 27 bats) as follows: 25 (8 bats), Sibube (Bocas del Toro), 17 to 26 January 1963, C. O. Handley, Jr.; 2, Río Tuira (Darién), 26 January 1958, P. Galindo [GML]; 2, Río Chucunaque (Darién), 17 February 1958, P. Galindo [GML]; 1, Tacarcuna (Darién), 19 June 1963, GML; 4 (2 bats), La Laguna (Darién), 2900 feet elevation, 3 and 9 June 1963 [GML]; 40 (15 bats), Armila (San Blas), 23 February to 29 March 1963, C. O. Handley, Jr. From *Carollia subrufa*, 44 flies (13 lots from 16 bats) as follows: 12 (2 bats), Sibube (Bocas del Toro), 22 and 23 January 1963, C. O. Handley, Jr.; 8 (1 bat), Isla Bastimentos (Bocas del Toro), 3 February 1963, C. O. Handley, Jr.; 26 (5 bats), Cayo Agua (Bocas del Toro), 12 and 16 February 1963, C. O. Handley, Jr.; 19 (7 bats), Armila (San Blas), 25 February to 20 March 1963, C. O. Handley, Jr.; 1, La Laguna (Darién), 2900 feet elevation, 29 May 1963, GML. From *Carollia* sp.: 1, Barro Colorado Island (Canal Zone), 13 February 1957 [USNM]; 7, Albrook Field (Canal Zone), 14 January 1963 [USNM]; 37, Cerro Tigre (Canal Zone), 15 January 1953 [USNM]; 1, Río Tuira (Darién), 25 February 1958, P. Galindo [GML]; 23, culvert, Chepo Road, near Pacora (Panamá), 11 April 1961, C. Yunker [RML]. From mixed collections of *Carollia p. azteca* and *Glossophaga s. leachii*: 60, Huile (Panamá), 24 October 1960; 21, San Lorenzo Cave, Fort Sherman (Canal Zone), 15 March 1961. From *Artibeus j. jamaicensis*: 2, Almirante (Bocas del Toro), 23 January and 18 February 1960; 3 (2 lots), cave, west side of Taboga Island, 24 September 1959. From *A. lituratus palmarum*: 6, Cerro Azul (Panamá), 25 January 1958, E.

Méndez [GML]. From *Chiroderma villosum jesupi:* 1, Almirante (Bocas del Toro), 23 January 1960. From *Desmodus rotundus murinus:* 1, Almirante (Bocas del Toro), 31 January 1960; 13 (2 bats), Guánico (Los Santos), 26 January and 1 February 1962. From *"Dirias":* 2 (2 lots), Summit (Canal Zone) 17 April 1957, C. B. Koford (USNM). From *Glossophaga soricina leachii:* 5 (4 bats), Almirante (Bocas del Toro), 26 to 30 January 1960; 9, Gamboa (Canal Zone), 17 April 1957, C. B. Koford [USNM]. From *Lonchophylla robusta:* 4 (16 bats), Buena Vista Caves (Colón), 16 June 1960. From *Lonchorhina aurita:* 6 (5 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959; 19 (11 bats), same locality, 25 November 1959; 4 (2 bats), railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959; 21, 2 miles north of Summit, 17 April 1957. From *Macrophyllum macrophyllum:* 6 (3 bats), Fort Gulick (Canal Zone), 15 September 1959; 1, Fort Davis (Canal Zone), dock 46, 13 October 1959. From *Micronycteris nicefori* [mist net]: 4 (2 bats), Armila (San Blas), 28 March 1963, C. O. Handley, Jr. From *Natalus stramineus mexicanus:* 3, San Lorenzo Cave, Fort Sherman (Canal Zone), 15 March 1961. From *Phyllostomus hastatus panamensis:* 1, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 9, Guánico (Los Santos), 26 January 1962; 3, Chilibrillo Caves (Panamá), 17 July 1959; 1, Farfan (Canal Zone), 19 December 1915, T. Hallinan. From *Pteronotus parnellii fuscus:* 1, culvert, Paraíso (Canal Zone), 1 December 1959; 1, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November, 1959; 11 (5 bats), railroad culvert east of Sumit Golf Club (Canal Zone); 1 Buena Vista (Colón), 3 September 1959; 7 [ex *"C.r. rubiginosa"*], Chilibrillo River (Panamá), 22 September 1923 [USNM]. From *Tonatia silvicola:* 1, Armila (San Blas), 22 March 1963, C. O. Handley, Jr. From *Trachops c. cirrhosus:* 14 (3 bats), culvert, Chepo Road (Panamá), 8 and 12 October 1959; 5 (2 bats), Río Mandinga (San Blas), 30 May 1957, P. Galindo [GML]. From *Uroderma bilobatum:* 1, Fort Randolph (Canal Zone), 6 October 1959. From *"bat":* 3 (2 lots), Gamboa (Canal Zone), 12 December 1961; 3, Buena Vista (Colón), 3 September 1959; 5, Curundu (Canal Zone), 7 October 1960. *Without specific host or locality:* 15, from "culvert of RR" [USNM].

NON-PANAMANIAN MATERIAL EXAMINED: We have examined more than 500 additional specimens of *joblingi,* mostly from *Carollia perspicillata,* taken at various localities in GUATEMALA, BRITISH HONDURAS, EL SALVADOR, COSTA RICA, COLOMBIA, VENEZUELA, TRINIDAD, TOBAGO, SURINAM, BRAZIL and PERU. Only a few specimens were from hosts other than species of *Carollia,* including: 3 from *Myotis* sp. (!) in Venezuela; 1 from *Rhogeesa io* (!) in Trinidad; 1 each from *Lampronycteris platyceps, Glossophaga s. soricina, Desmodus r. rotundus* and *Phyllostomus h. hastatus* in Trinidad; and 3 obviously mislabeled specimens from *Molossus major* in Surinam.

REMARKS: As noted above, *T. joblingi* n.sp. is the species figured by Jobling (1938) as *T. blandus* (not Curran 1935). Mr. Jobling informed us (*in. litt.*) that he redescribed *blandus* from two specimens collected by Dunn from *Glossophaga soricina* and *Carollia perspicillata* in the Canal Zone. His figure is of *joblingi* and not of *dugesii* Townsend (= *blandus*

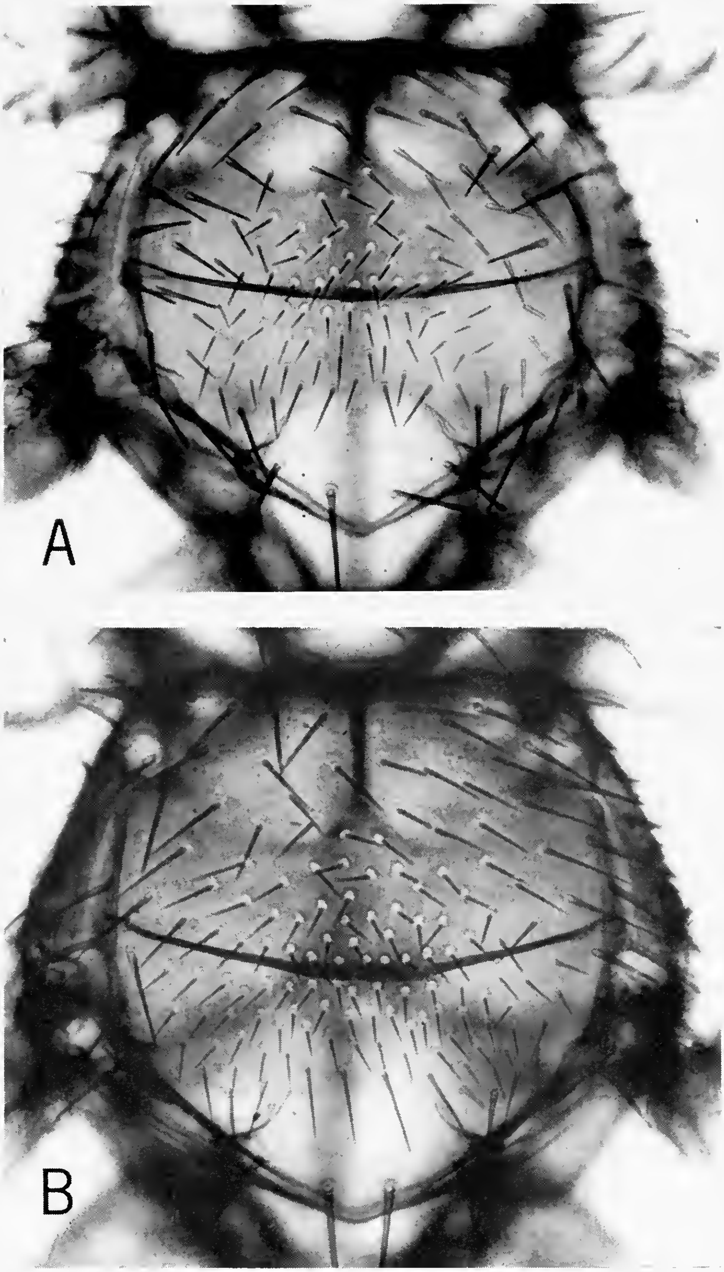


Fig. 70. *Trichobius joblingi,* new species. Thorax, dorsal view. A, male from unidentified discarded host (no. 4168), Buena Vista (Colón). B, female from *Carollia p. azteca* (no. 4628), Brazoa Brook (Canal Zone).

Curran). However, his specimen from *Glossophaga soricina* was probably *dugesii.* Most published records of *dugesii* from *Carollia perspicillata* are actually based on specimens of *joblingi.*

Jobling (op. cit.) described the posterior margin of sternum V as being "strongly emarginated in the middle." We have not found this to be true in the specimens examined by us, though idiosyncrasies of mounting may sometimes make it appear so in slide preparations.

T. joblingi appears to be primarily a parasite of bats of the genus *Carollia.* Records from other hosts seem for the most part to represent transitory associations, disturbance transfers, and contaminations. Some represent errors of association or labeling. Temporary associations with a number of hosts are to be expected of the parasites of a ubiquitous host like *C. perspicillata* which roosts with such a great variety of other bats. It is evident from the field data that, in most instances, the other hosts from which *joblingi* was taken in Panama were roosting in the same sites as *C. perspicillata.* We do not believe that it normally occurs on these hosts (with the possible exception of *Trachops*) in the absence of *Carollia.*

Carollia perspicillata is the most widely distributed, abundant and ubiquitous bat in Central and South America, and *Trichobius joblingi* n. sp. is the most abundant streblid parasite on that host. It constituted 74% of all Streblidae taken on *perspicillata.* It occurred on 76.7% of all individuals of this host collected and on 91.54% of all those parasitized by Streblidae. The average number of specimens taken per individual parasitized bat was 3.8.

Trichobius joblingi is named after Mr. B. Jobling, formerly of the Wellcome Institute of Tropical Medicine, in recognition of his outstanding contributions to the systematics and morphology of blood-sucking Diptera, especially of the Streblidae.

Trichobius macrophylli Wenzel, new species. Figures 68F, 69B.

Very similar to *T. joblingi* n. sp. and *T. dugesii* Townsend and, like them, possessing a blunt translucent median pleurotrochantinal lobe, but differing in possessing a more convex and rounded mesothorax and much more evenly distributed mesonotal setae, which become longer much more gradually towards sides and anterior margin. The antescutellar setae are intermediate in length between those of *joblingi,* and *dugesii.* In the female, posterior to lateral lobes of tergum I+II, there are 9–13 connexival setae that are coarser and longer than the others (three to five in *joblingi,* none conspicuously longer in *dugesii*).

DESCRIPTION: Nearly identical to *joblingi* but differing in the following characters: *Head.*—Eyes relatively large and conspicuous, as long as or longer than occipital plates (shorter in *joblingi*), with about 11 large convex facets. *Thorax.*—Mesonotal setae (fig. 69B), short at middle, becoming gradually longer toward sides and anterior margin; antescutellar setae less than twice as long as scutal setae immediately anterior to them. Median pleurotrochantinal lobe translucent, short, truncate or slightly emarginate at middle, feebly reflexed. *Wings.*—R_s, typically, slightly shorter than distance from fork to crossvein *r-m*. *Abdomen.*—Lateral lobes of tergum I+II with from two to five fine setae in a single row along inner (upper) margin. Dorsal connexivum with only one or two pairs of minute segmentally arranged setae. *Female:* Dorso-lateral and ventral connexival setae subequal; immediately posterior to lateral lobes of tergum I+II, with a lateral cluster of from 9–13 setae which are conspicuously coarser and/or longer than the others; a ventro-lateral subapical macroseta present. Tergum VII with one or two pairs of minute setae usually arranged in a transverse row, the inner pair sometimes slightly displaced posteriorly. Seventh sternites with 11–13 setae. *Male:* Dorso-lateral connexival setae longer than ventrals. Sternum V complete, the median apical marginal setae a little longer than the discals, those at sides conspicuously longer. Sternum VI absent. Gonapophyses as in fig. 68F.

Measurements:	BL	TL	WL	WW
Male	1.10–1.40	0.44–0.47	1.10–1.24	0.52–0.58
Female	1.10–1.57	0.47–0.55	1.26–1.40	0.55–0.66

TYPE MATERIAL (1185 flies in 46 lots from 79 *Macrophyllum macrophyllum*) : Holotype, male and allotype female (slides) from host no. 4741, dock 45, Fort Davis (Canal Zone), 13 October 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—787 (33 bats), same data as the holotype; 295 (3 lots, 28 bats), same locality, 7 and 29 January 1960; 89 (14 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 12 (2 bats), Chepo Road, culvert, 12 October 1959; 2, Armila (San Blas), 23 February 1963, C. O. Handley, Jr. and F. M. Greenwell. Paratypes deposited in the collections listed on page 410.

OTHER MATERIAL EXAMINED: From *Carollia perspicillata azteca:* 1, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 1, railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959. From *Lonchorhina aurita:* 1 (9 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November 1959. "*Sobre Chiroptera*": 37, Lago de Valencia, VENEZUELA, 25 August 1948, J. Racenis [FCUCV].

REMARKS: This fly is apparently restricted to *Macrophyllum macrophyllum.* The other two host records seem to represent strays or contaminations.

Trichobius parasiticus complex

In species of this complex, the pleurotrochantinal lobe is completely absent, sternum VI is absent in the male, and the male gonapophyses show greater modification in shape and chaetotaxy than in the *dugesii* complex. The mesonotal micropile is more extensive in several of the species than in any others of the *dugesii* group.

Four species occur on Desmodidae, including *T. diphyllae* n. sp. from *Diphylla ecaudata* in Mexico and Guatemala and Venezuela; an undescribed species from *Diaemus youngii* in Trinidad; *T. furmani* n.sp., from *Desmodus rotundus* and *Glossophaga soricina* in Amazonian Colombia, Paraguay, and Peru; and *T. parasiticus,* which appears to be primarily a parasite of *Desmodus rotundus,* from Mexico to Trinidad, Brazil and Peru. A fifth species, *T. dugesioides*—on *Trachops cirrhosus, Chrotopterus auritus* and *Carollia perspicillata*—is known to us from Guatemala to Panama. Within this complex, *T. dugesioides* has the least modified mesonotal chaetotaxy, while *parasiticus* and the undescribed species from *Diaemus* exhibit the greatest reduction of these setae. The male gonapophyses of *parasiticus* are the most highly modified of any known species of *Trichobius.*

Trichobius dugesioides Wenzel, new species. Figures 68D, 71.

Very similar in apearance, though apparently not closely related, to *T. joblingi* n. sp., and often occurring together with that species on the same host. Unlike *T. joblingi,* it lacks a median pleurotrochantinal lobe and lacks sternum VI (in the male). It also differs in shape and chaetotaxy of the male gonapophyses and in the length of wing vein R_s in relation to the distance between fork and crossvein *r-m.* In *dugesioides,* the gonapophyses are straight (not sinuate) in dorsal view and have short thorn-like setae (very fine short hair-like setae in *joblingi*). The mesonotal chaetotaxy differs in that the antescutellar scutal setae are not as a rule abruptly longer than the scutal setae immediately anterior to them, as they are in *joblingi.*

DESCRIPTION: *Head.*—Laterovertices and occipital plates well differentiated. Eyes with ± ten facets. *Thorax.*—Mesonotal chaetotaxy as shown in fig. 71, the antescutellar setae less than twice as long as the other scutal setae immediately anterior to them (two to three times as long in *joblingi*). Microsetae of prescutum extending inwardly from cleft to a little beyond first longitudinal row of setae along lateral margin. Pleurotrochantines without apical median lobe, instead slightly emarginate at middle with a conspicuous seta on each side of emargination. *Wings.*—R_s markedly shorter than distance between fork and crossvein *r-m* (subequal in *joblingi*).

Abdomen.—Tergum I+II very similar to that of *joblingi.* Sternum I+II with setae of apical margin markedly longer toward the sides (only very slightly longer in *joblingi*). Dorsal connexivum with four pairs of minute dorsal segmental setae. *Female:* supra-anal plate with four apical macrosetae, without short marginal or discal setae (a short seta on each lateral margin in *joblingi*); seventh sternites with 13–15 bristles. Dorso-lateral and ventral connexival setae subequal, excepting a cluster of conspicuously longer setae behind the lateral lobes of tergum I+II. A long latero-ventral macroseta on each side anterior to the seventh sternites. *Male:* Dorso-lateral connexival setae longer than ventral connexival setae. Sternum V with apical setae longer than discals and becoming conspicuously longer toward sides. Sternum VI absent. Gonapophyses not sinuate in dorsal view, narrowly wedge-shaped in lateral view, the ventral margin nearly straight; with numerous short thorn-like setae; accessory setae nearly half as long as macrosetae.

Measurements:	BL	TL	WL	WW
Male	1.26–1.40	0.49–0.55	1.07–1.15	0.52–0.60
Female	1.40–1.70	0.55–0.60	1.10–1.26	0.58–0.65

TYPE MATERIAL: 230 flies in 20 lots (35 bats), from *Trachops c. cirrhosus.* Holotype male, allotype female, Chepo Road (Panamá), 12 October 1959, V. J. Tipton and C. M. Keenan. In the collection of Chicago Natural History Museum. Paratypes.—105 (8 bats), same data but 8 and 12 October, and 94 (15 bats), 24 May 1960; 5 (3 bats), Cerro Hoya (Los Santos), 15 and 24 February 1962; 2, Río Mandinga (San Blas), 30 May 1957, GML; 2 (2 bats), Armila (San Blas), 16 March 1963, C. O. Handley, Jr. and F. M. Greenwell.

From *Carollia perspicillata azteca:* 124 specimens in 56 lots from 148 bats, as follows: 1, Camp Piña (Canal Zone), 26 October 1960; 10 (6 bats), air raid shelter, Fort Davis (Canal Zone), 6 October 1960, and 5 (7 bats), 29 October 1959; 1, same locality, 17 November 1960; 1, Fort Sherman (Canal Zone), 18 October 1960; 17 (30 bats), same locality, 2 and 4 December 1959; 3 (2 bats), San Lorenzo Cave, Fort Sherman, 15 and 29 March 1960; 22 (16 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959; 16 (14 bats), same locality, 25 November 1959; 1, culvert, Brazoa Brook, Navy Tank Farm (Canal Zone), 6 October 1959;

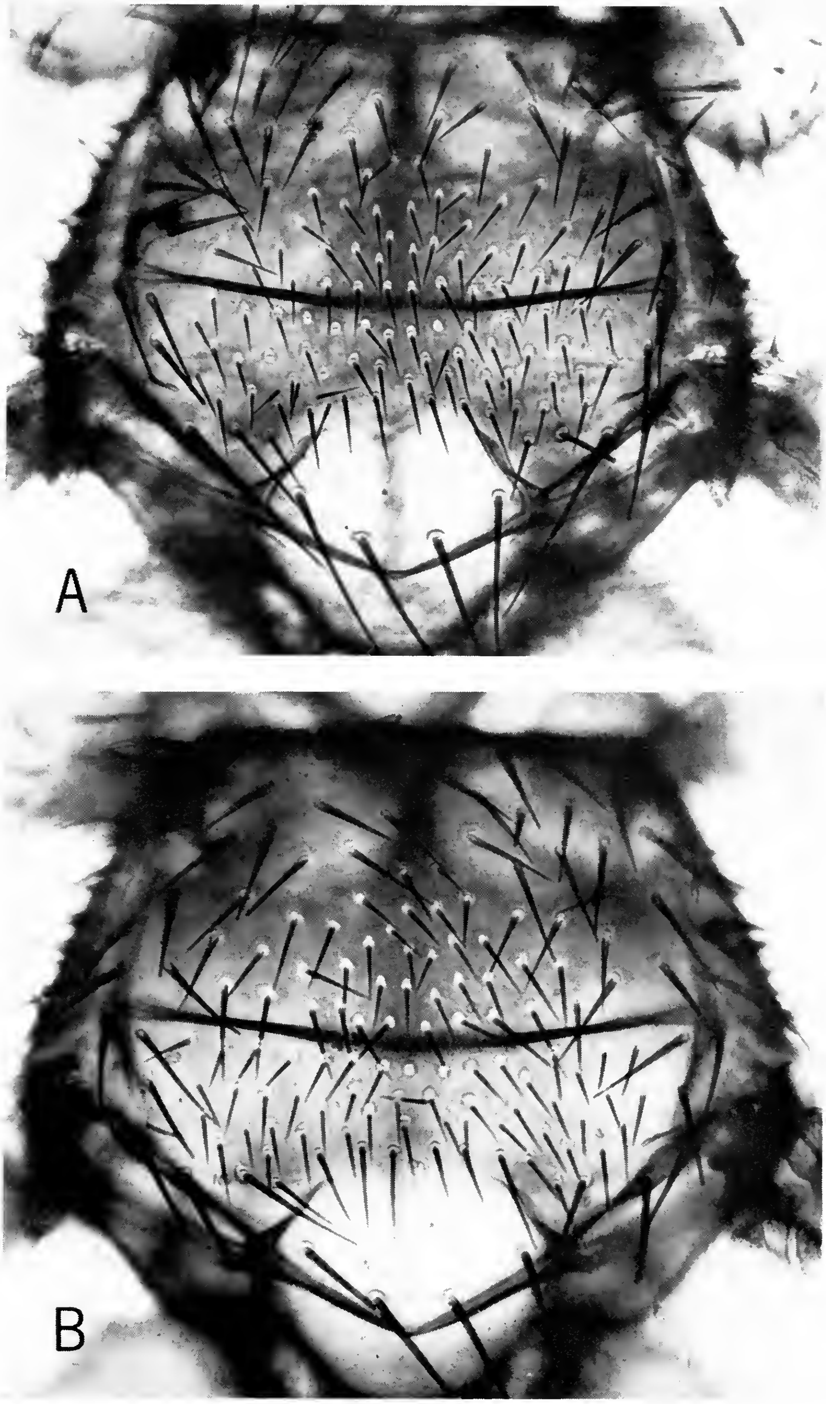


Fig. 71. *Trichobius dugesioides*, new species, thorax, dorsal view. A, male paratype (host no. 4639) and B, female paratype (host 4690), both from *Trachops c. cirrhosus*, Chepo Road (Panamá).

3, Juan Mina (Canal Zone), 28 July 1960; 1, Piña Field Range (Canal Zone), 27 September 1960; 3 (2 bats), Camp Chágres [Boy Scout Camp], Madden Dam (Canal Zone), 20 June 1963 [GML]; 1, Chilibrillo Caves (Panamá), 2 August 1960; 6 (29 bats), same locality, 18 August 1959; 1, culvert, Chepo Road (Panamá), 12 October 1959; 4 (3 bats), Buena Vista (Colón), 3 and 15 September 1959; 11 (20 bats), same locality, 24 November 1959; 5 (3 bats), Cerro Hoya (Los Santos), 8, 18, and 23 February 1962; 2, Río Setegantí (Darién), 5 February 1961; 2 (4 bats), Piña Point (Darién), 24 March 1960; 8 (3 bats), Almirante (Bocas del Toro), 28, 30, and 31 January 1960. Paratypes in the collections listed on p. 410.

OTHER PANAMANIAN MATERIAL EXAMINED.—From *Chrotopterus auritus:* 5 (3 bats), Armila (San Blas), 7, 15 and 19 March 1963, C. O. Handley and F. M. Greenwell. From *Lonchorhina aurita:* 1, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959; 6 (19 bats), same locality, 25 March 1959; 4, Rancho Mojica (Bocas del Toro), 4800 feet elevation, 8 September 1961. From a bat doubtfully identified as *Tonatia* sp.: 6, Tacarcuna (Darién), 4 September 1958, Pedro Galindo [GML]. From *Natalus stramineus mexicanus:* 1, Fort Sherman (Canal Zone), 17 March 1960. From mixed collections of (12) *Carollia p. azteca* and *Glossophaga s. leachii:* 1, Huile (Panamá), 24 October 1960; of (3) *C. p. azteca* and (7) *G. s. leachii:* 2, San Lorenzo Cave, Fort Sherman (Canal Zone), 15 March 1961; of *Natalus stramineus mexicanus* and *Carollia* sp.: 1, same locality and date. We have also seen specimens from NICARAGUA and GUATEMALA, which we refer to as *dugesioides.*

REMARKS: The records of *dugesioides* from hosts other than *Trachops cirrhosus, Chrotopterus auritus,* and *Carollia perspicillata* are probably in error or represent contaminations or transitory associations. In all likelihood, the true hosts are *Trachops* and *Chrotopterus,* closely related genera of Phyllostominae. *T. dugesioides* consistently occurs on *Carollia perspicillata,* which commonly roosts in the same places as *Trachops,* and it appears that these two bats "exchange" *Trichobius* to a considerable extent (see "Host-parasite Relationships," below.) On the other hand, *dugesioides* has not been taken from either *C. castanea* and only once from *C. subrufa,* species which are ecologically more restricted than *perspicillata.* The other streblids characteristic of *perspicillata* occur on all three hosts.

Trichobius furmani Wenzel, new species. Figures 68C, 72.

Superficially very closely resembling *joblingi,* especially in mesonotal chaetotaxy; differing from that species in that it lacks a median pleurotrochantinal lobe, by the absence of sternum VI in the male, and the male gonapophyses being straight rather than curved in dorsal view and long and feebly curved in lateral view rather than wedge-shaped. It may be easily separated from *dugesioides,* to which it is related, by the extremely long antescutellar bristles, some of which are three or four times as long as the scutal setae immediately anterior to them (less than twice as long in *dugesioides*); the extensive microsetose area on the prescutum; and the lack of thorn-like setae on the gonapophyses.

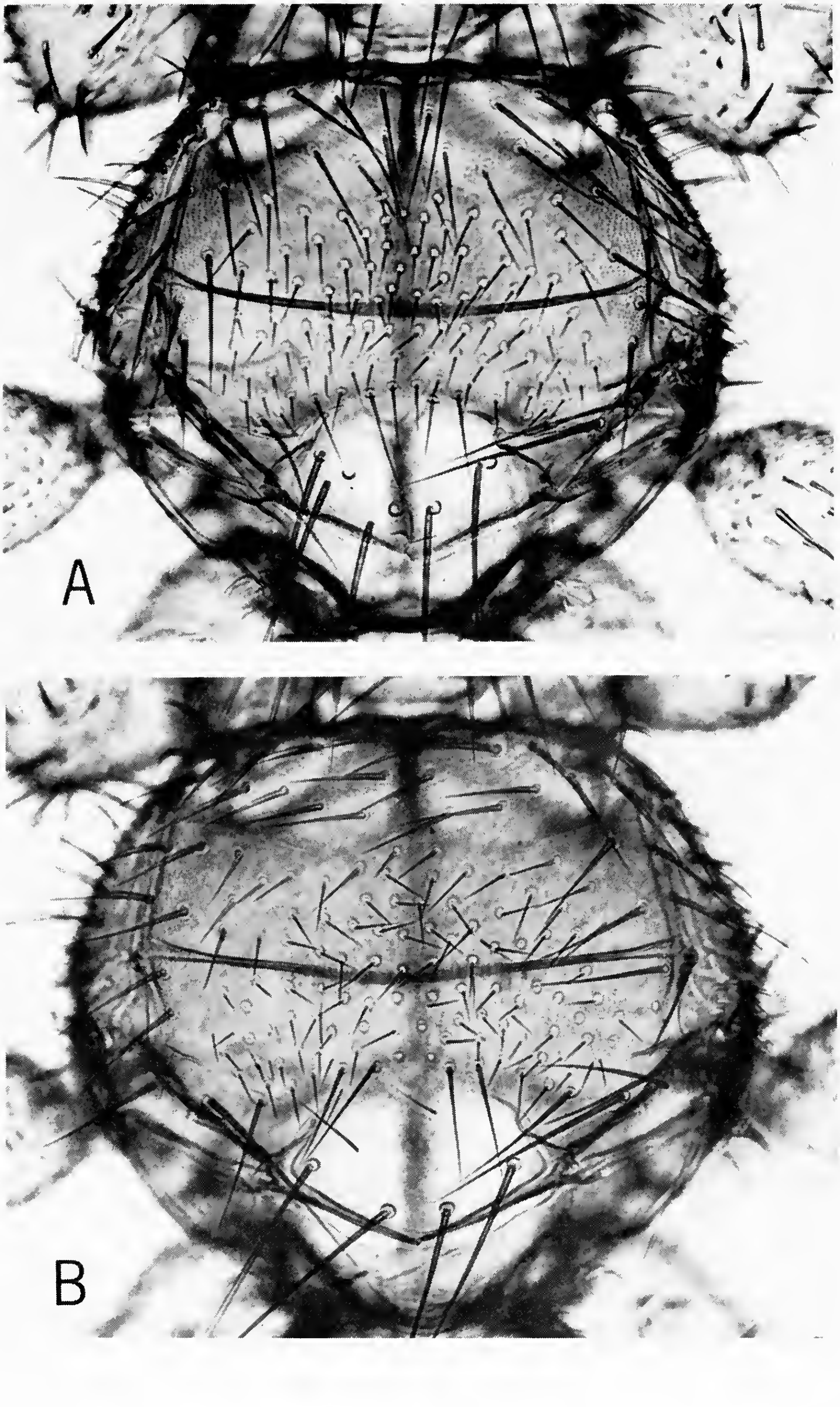


Fig. 72. *Trichobius furmani*, new species, thorax, dorsal view. A, male. B, female. From Vitoc Valley (Junín), PERU (host unknown).

DESCRIPTION: *Head.*—As in *joblingi* and related species. Theca cordiform. Eyes with ± 11 facets. *Thorax.*—Prescutum, with anterior margin slightly projecting at middle; sides and anterior half with very long bristles, the discal setae short and denser and longer than discal scutal setae; microsetose area extending inwardly on prescutum to second (longitudinal) row of setae, excepting along transverse suture where it is feebly developed nearly to fourth row of setae; on anterior half of prescutum the microsetae extend inwardly about halfway to the median suture, but are so feebly developed as to be detectible only under oil immersion or very high "dry" magnification. Antescutellar scutal bristles very long, the longest ones two and one-half to four times as long as the setae anterior to them. *Wings.*—R_s shorter than distance from fork to crossvein *r-m.*

Abdomen.—Tergum I+II with one to three short setae on anterior face on each side (between base and coarse setae of lateral lobe); inner dorsal margin of each lateral lobe with three to five fine setae in a single row. Abdominal connexivum with two pairs of dorsal segmental setae. Sternum I+II as in *T. dugesioides*. *Female:* Tergum VII with two pairs of setae; the outer, anterior pair a little less than half as long as apical macrosetae of supra-anal plate; the posterior pair close together, a little less than half as long as outer pair. Supra-anal plate with four apical macrosetae, without short setae on disk or lateral margins. Seventh sternites with about 15 setae. Connexivum with a ventro-lateral subapical macroseta on each side. *Male:* Sternum V as in *T. dugesioides*. Sternum VI absent. Gonapophyses (fig. 68C) long, straight in dorsal view, feebly curved apically in lateral view; ventral macrosetae very long, extending beyond apices of gonapophyses; accessory setae very short.

Measurements:	BL	TL	WL	WW
Male	1.26–1.40	0.48–0.51	1.07–1.55	0.52–0.60
Female	1.40–1.70	0.52–0.56	1.10–1.26	0.58–0.65

TYPE MATERIAL: Holotype male and allotype female from *Desmodus rotundus* (Sanborn field no. 2942), Segrario (Puno), PERU, 13 October 1941, C. C. Sanborn. In the collection of Chicago Natural History Museum.

Paratypes.—From *Desmodus rotundus*: 7, same data as the holotype. From specimens and wrappings containing a mixed collection of *Desmodus rotundus, Phyllostomus hastatus, Carollia perspicillata, Glossophaga soricina, Tonatia silvicola* and *Vampyrops fumatus:* 232, Vitoc Valley, Province Tarma (Junín), PERU, various dates, July to October 1940, F. Woytkowski. From *Diphylla ecaudata:* 4, Cerro de las Pinturas, upper Río Iniride (Vaupés), COLOMBIA, 2–3 February 1957, Fred Medem. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED: From *Glossophaga soricina soricina:* 1, Rückenau, Friesland Colony near Itacurubi del Rosario, PARAGUAY, 14 June 1960, S. L. Loewen.

REMARKS: Of the 232 specimens taken from the wrappings and specimens of the mixed lot of bats collected by F. Woytkowski, 220 are labeled as having been taken from the specimens of *Desmodus rotundus*. The records suggest that *furmani* may be a parasite of Desmodidae and may replace *T. parasiticus* on these bats in some parts of South America.

Trichobius furmani is named after Prof. Deane Furman, University of California at Berkeley, in recognition of his outstanding contributions to the study of ectoparasites.

Trichobius diphyllae Wenzel, new species. Figures 68B, 73A.

Apparently related to *dugesioides* and *furmani* and like them, having the male gonapophyses straight in dorsal view. As in *dugesioides* the gonapophyses have short thorn-like setae in addition to the two pairs of ventral setae. Also distinguished from other species of the group by the very minute, fine, discal mesonotal setae as well as by the very extensive microsetose area on the prescutum.

DESCRIPTION: *Head.*—Broader than long (to base of occiput), with well-differentiated laterovertices and occipital lobes. Eyes with ± 10 facets. Palpi short, roundly-oval. *Thorax.*—Microsetose area of prescutum extending inwardly from longitudinal membranous fissure to third longitudinal row of setae on basal half, and about two-thirds the distance to median suture on anterior half. Disk of prescutum and scutum with extremely fine, short setae; with long sparse setae (fig. 73A) laterally and anteriorly. Anterior projection of sternopleura truncate; posterior margin of pleurotrochantines without a median reflexed lobe. *Wings.*—Length of R_s only slightly shorter than distance between fork and crossvein *r-m*.

Abdomen.—Tergum I+II with a single short seta on anterior face; inner dorsal margin with about five fine setae between base and cluster of coarse setae on lateral lobe. Sternum I+II, with setae of apical margin only slightly longer laterally than medially; postero-lateral angles with extensive setose area. Dorsal connexivum with four pairs of minute segmentally arranged setae. *Female:* Dorso-lateral connexival setae conspicuously shorter than the ventrals; lateral connexival setae behind the lobes of tergum I+II a little longer than those posteriorly but not forming a conspicuous cluster; a subapical ventro-lateral macroseta present on each side. Tergum VII variable in shape, longer than broad, with a longer seta along each lateral margin at about mid-length, and a pair of shorter subapical more closely spaced setae. Seventh sternites with about 15 setae, the apical ones macrosetae. *Male:* Lateral connexival setae of about same size as ventrals. Sternum V, at middle, with apical marginal setae distinctly longer than discal setae and becoming more than twice as long as the discals toward the sides. Sternum VI absent. Gonapophyses as in fig. 68B. Aedeagus rod-shaped, finely pointed at tip.

Measurements:	BL	TL	WL	WW
Male	1.48–1.62	0.48–0.54	1.17–1.32	0.60–0.63
Female	1.37–1.73	0.51–0.55	1.21–1.37	0.62–0.69

TYPE MATERIAL: Holotype and allotype from *Diphylla ecaudata centralis* (CNHM host nos. 73191–94, 73345–46), San Lorenzo, four miles northeast of Volcan de Jumay (Jalapa), GUATEMALA, elevation 5700–5750 feet, 15 February 1952, Luis de la Torre, CNHM Guatemala Zoological Expedition (1951–52). In the collection of Chicago Natural History Museum.

Paratypes.—From *Diphylla ecaudata centralis:* 9, same data as the holotype; 1, same data but 13 February 1952; 9, Finca Recreo, Municipio Yepocapa (Chimaltenango), GUATEMALA, elevation 4400 feet, 11 May 1948, R. L. Wenzel and Luis de la Torre, CNHM Guatemala Zoological Expedition (1948); 62, same data but 25 October 1948, R. D. Mitchell and L. de la Torre. From *Diphylla ecaudata:* 1, Pueblo Nuevo Xcan (Quintana Roo), Yucatan Peninsula, MEXICO, 29 July 1962, Ticul Alvarez; 5, Felipe Carrillo Puerto (Quintana Roo), Yucatan Peninsula, MEXICO, 16 August 1962, J. Knox Jones, Jr.; 7, El Limon, Rancho Grande (Aragua), VENEZUELA, 30 March 1960, C. O. Handley, Jr. [USNM]. Paratypes to be deposited in the collections listed on page 410.

REMARKS: This fly was not taken from the specimens of *Diphylla ecaudata* that were collected in Panama. However, it was taken in Venezuela, Guatemala, and Mexico, and thus it seems reasonable to expect that it will also be found in Panama, as was *Strebla diphyllae* n.sp. (q.v.) a characteristic parasite of the same host.

Trichobius parasiticus Gervais. Figures 68A, 73B.

Trichobius parasiticus Gervais, 1844, Atlas Zool., p. 14, pl. 43.—"Guiane," from *Desmodus rufus*.—Costa Lima, 1921, Arch. Esc. Sup. Agric. Vet. Med., 5: 18–20 (part.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 14 (keyed), 15 (records). Speiser, 1900 (part.), Arch. Naturg., 66A, Bd. I, pp. 32 ff. (morph., etc.), 59–60 (discuss., synonymy), 62 (cit.), 65 (keyed), figs. 5–9; 1907, Ent. News, 18: 104 (cit.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., no. 155, p. 655. Curran, 1935, Amer. Mus. Novit., no. 765, pp. 8 (keyed), 11. Guimarães, 1938, Rev. Mus. Paulista, 23: 657 (synonymy, discuss.), 662 (keyed), figs. 7, 8. Jobling, 1938, Parasitology, 30: 364 (hosts), 365 (keyed), 381 (redescr.), fig. 11. Mazza and Jörg, 1939, Mis. Estud. Pat. Reg. Argent., Publ. no. 41, pp. 87–93, figs. 1–3, 5–6 (morph.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418. Jobling, 1949, loc. cit., 39: 316 ff. (hosts), 326 (records); 1951, Trans. Roy. Ent. Soc. Lond., 102: 215 (morph.). Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 181 (keyed), 186 (records), pl. 4, fig. 4. Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., 122: 223, 269 (records).

Trichobius kesseli Guimarães, 1938, Rev. Mus. Paulista, 23: 660, pl. 3, fig. 9. Schuurmans Stekhoven Jr., 1951 (and 1941?), Beiträge Fauna Perus, 3: 95 (part.?).

Apparently the type of *T. parasiticus* no longer exists, but the interpretation of Kessel (op. cit.), followed by Curran (1935), Guimarães (1938), and Jobling (1938) is probably correct. The type and principal host, *Desmodus rotundus* (= *Desmodus rufus*) may carry another species, *T. furmani* n. sp. (q.v.) in some parts of South America, but the type of *parasiticus* was probably from a locality not far removed from the coast of "Guiane" and hence is almost certainly the species treated here. We have no specimens from French Guiana. When specimens are available, a neotype should be designated.

As with several of the past authors, Speiser's concept (1900, p. 59) of *T. parasiticus* included several species, among them *Strebla wiedemannii* Kolenati 1862 (= *Kolenatia wiedemannii* Rondani 1878, p. 169) and *T. dugesii* Townsend. His specimens from Cuba could not possibly be *parasiticus,* nor could *Trichobius parasiticus* of Newstead (1909–1910, p. 468) nor *Strebla wiedemannii* Kolenati 1862, because neither *parasiticus* nor its hosts occur in the Greater Antilles. Speiser (1902, p. 159) later erroneously synonymized *T. longipes* (Rudow) under *parasiticus.* Costa Lima's figure (1921, pl. 1, fig. 1) of a wing of *parasiticus* probably applies to a species of the *uniformis* group, if the setae of the sixth longitudinal vein are correctly shown.

The specimens identified as *parasiticus* by Bau (1929, p. 12), Dunn (1929, p. 504) and Bequaert (1933) have not been re-examined. Bau's record is without locality or host data. Dunn's record does not include a host identification. Bequaert's specimens from Yocat, Yucatan were from *Diphylla centralis* and thus could have been either *parasiticus* or *diphyllae* n.sp., though we doubt that he could have mistaken *diphyllae* for *parasiticus.*

T. parasiticus is easily recognized by the distinctive mesonotal chaetotaxy (fig. 73B) and male gonapophyses (fig. 68A). To the characters given by Jobling (1938), the following may be added.

Thorax.—Microsetose area of mesonotum extending from posterior margin of scutum to anterior margin of prescutum and inwardly to enclose the outer row of long prescutal setae and the setae of humeral callus. *Abdomen.*—Dorsal connexivum with four sets of

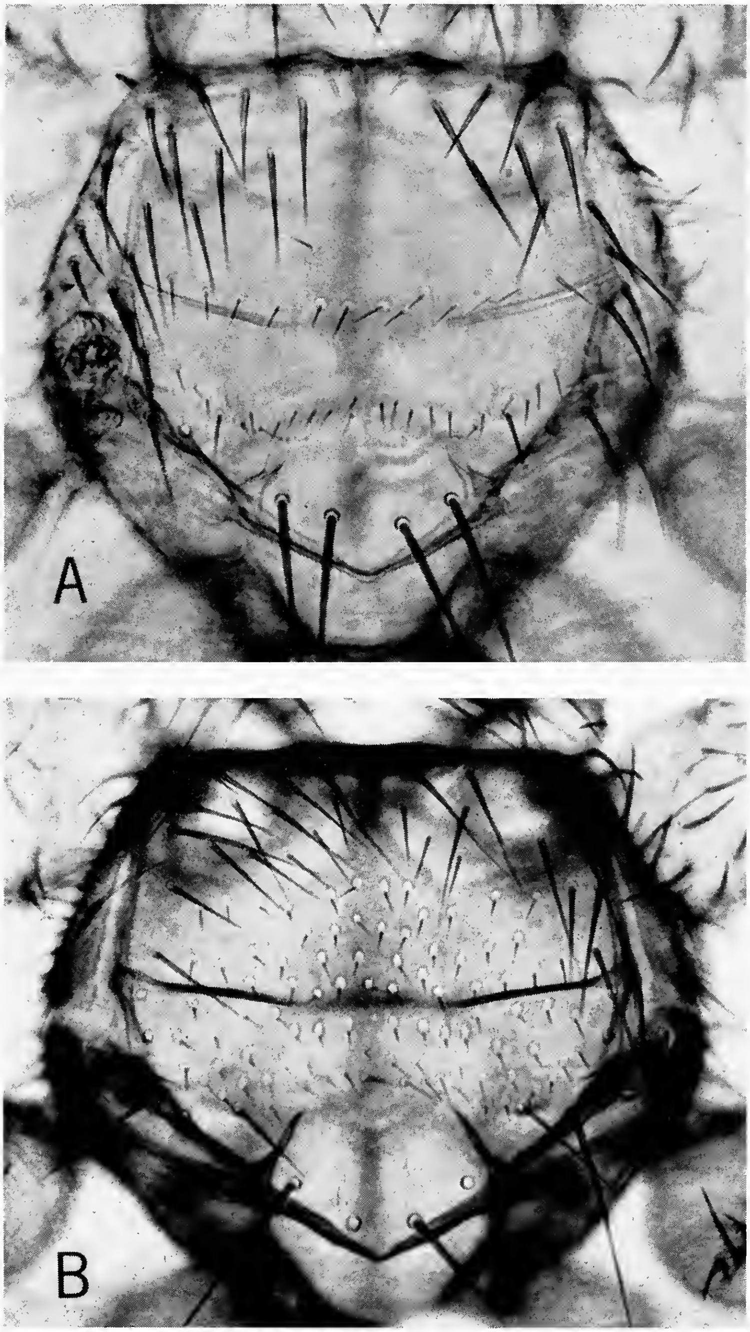


Fig. 73. Thorax, dorsal view. A, *Trichobius parasiticus* Gervais, male from *Desmodus r. murinus* (no. 9259) Guánico, (Los Santos). B, *Trichobius diphyllae*, new species, male paratype from *Diphylla ecaudata centralis*, Felipe Carrillo Puerto, Quintana Roo, MEXICO.

minute segmental setae, the anterior set consisting of two pairs, the three posterior sets of a single pair each. Upper inner margin of tergum I+II typically with two fine setae. Setae of sternum II extending anteriorly more than half the distance to base along lateral margins. *Female:* Tergum VII with two distal pairs of setae, the lateral pair coarse, about three times as long as inner pair and slightly anterior to them. Supra-anal plate with four apical macrosetae and, at mid-length, two to six short setae; when only two short setae are present, they are situated on each side near lateral margin (six short setae noted in only one specimen, taken from *Diaemus*). Seventh sternites with 16–17 setae, two or three of them macrosetae, one much longer than the others. Connexivum posteriorly with a ventro-lateral macroseta on each side; a cluster of about 20 setae is present on each side behind lateral lobes of tergum I+II distinctly longer than other dorso-lateral and lateral connexival setae, which are shorter than ventral connexival setae. *Male:* Apical margin of sternum V with setae about three times as long as discal setae, except for median pair, which are about twice as long as discals.

Measurements:	BL	TL	WL	WW
Male	1.42–1.57	0.45–0.49	1.10–1.11	0.58–0.60
Female	1.52–1.70	0.52–0.55	1.22–1.29	0.60–0.63

PANAMANIAN MATERIAL EXAMINED.—From *Desmodus rotundus murinus:* 258 specimens in 41 lots from 74 bats, as follows: 24, Casa Lewis, near Cerro Punta (Chiriquí), 5 February 1960; 11 (8 bats), hollow tree, Casa Tilley, near Cerro Punta, 6 February 1962; 8 (24 bats), same locality, 23 January 1960; 23 (12 bats), same locality, 6 and 11 March 1962; 167 (11 bats), Guánico (Los Santos), 26 January to 25 February 1962; 13 (6 bats), Almirante (Bocas del Toro), 23–31 January 1960; 11, Changuinola (Bocas del Toro), 27 February 1960; 25 (10 bats), Red Tank (Canal Zone), 27 January 1960; 1, Chilibrillo Caves (Panamá), 2 May 1957 (USNM). From *Diaemus youngii:* 2, Armila (San Blas), 4 March 1963, C. O. Handley, Jr. and F. M. Greenwell. From *Phyllostomus hastatus:* 1, Guánico (Los Santos), 26 January 1962. From *"Vampire Bats":* 1, Chilibrillo Caves (Panamá), 14 July 1945.

OTHER MATERIAL EXAMINED: Hundreds of specimens representing many lots from MEXICO, GUATEMALA, EL SALVADOR, COSTA RICA, COLOMBIA, VENEZUELA, SURINAM, TRINIDAD, BRAZIL and PERU. With few exceptions, these were taken from *Desmodus rotundus*, but *parasiticus* was taken together with *T. diphyllae* n.sp. on *Diphylla ecaudata* in Mexico and was found on *Diaemus youngii* in Panama.

REMARKS: As noted, *T. parasiticus* is primarily a parasite of *Desmodus rotundus* though it may occur on other Desmodidae, too. Records from other bats almost certainly represent strays, contaminations, or transitory associations. *Desmodus* often roosts near other bats.

Trichobius phyllostomae group

We have assigned four species to this group. They are *Trichobius phyllostomae* Kessel, *T. brennani* n.sp., *T. vampyropis* n.sp., and an undescribed species. Of these, *brennani* and *vampyropis* occur in Panama. The other two are known to us only from Brazil. The group may be characterized as follows:

Head.—Laterovertices and occipital plates differentiated. Eyes multi-faceted, with from 26 to 32 facets. *Thorax.*—Anterior margin of prescutum distinctly projecting at middle. Median discal mesonotal setae dense, inserted in distinct thecae. Stenopleural projection very strong, truncate. Median pleurotrochantinal lobe tapered and dorsally reflexed. *Legs.*—Relatively long; hind legs longest, the femora about as long as thorax; dorsal setae of tibiae conspicuous, two to three times as long as the other tibial setae. *Abdomen.—Female:* Cerci not united with the ventral arc. *Male:* Sternum V well developed, with very long apical macrosetae, these progressively longer laterally. Sternum VI absent. Gonapophyses dissimilar, the macroseta and accessory seta inserted distinctly more distad on the left gonapophysis than on the right.

Jobling (1938) referred *T. phyllostomae* to the group of species without well-differentiated laterovertices and occipital plates. In all our material of this group, these plates are differentiated, but are not as widely separated as in some other species.

Trichobius brennani, new species. Figures 62D, 74A, 75A, B.

Closely related to *T. phyllostomae* Kessel and differing from that species as follows: posterior margin of each occipital plate with only two minute setae rather than three or four; inner margin of lateral lobes of tergum I+II with only one row of short setae instead of two irregular rows; tergum VII (female) with only a single pair of minute setae, rather than two pairs medial and apical to the macrosetae; male gonapophyses curved apically and with only a few submarginal microsetae (fig. 75A, B), rather than wedge-shaped with a row of distinct marginal setae (fig. 75D).

DESCRIPTION: *Head.*—Funnel-shaped, viewed from above, slightly elevated behind, with laterovertices and occipital lobes differentiated (sometimes not appearing so in slide mounts because of clearing and because of the presence of microsetae on the postvertex and between the laterovertices and occipital lobes); laterovertices with seven bristles; occipital lobes with from 12–14 coarse setae and at middle of posterior margin two minute setae, one about twice as long as the other. Eyes prominent, extending slightly beyond margin, with 17–20 facets. Palpi horizontal, oval, microsetose on dorsal surface, ventral surface covered with setae, distal macroseta nearly twice as long as palpus. Theca cordiform, with about 20 setae, four to six along apical margin, four along basal margin, and ten on disk.

Thorax.—Mesonotum and chaetotaxy as shown in fig. 74A. Sternopleural projection strong, wide, truncate or feebly emarginate (fig. 62D), slightly reflexed dorsally. Median pleurotrochantinal lobe narrow, tapered distally, strongly reflexed dorsally. *Wings.*—As in *T. phyllostomae;* R_1 united with costa at a point just proximal to level of second crossvein; R_s shorter than distance between fork and crossvein *r-m*. *Legs.*—Relatively long, the fore-, mid-, and hindlegs, progressively longer. Femora and tibiae of each pair subequal, hind femora approximately as long as thorax. Femora nearly covered with setae, but bare along ventral tibial "groove" and basally on inner face of hind femora; with long fringing setae along dorsal and ventral outer margins, and along inner ventral margin as well on midfemora; setae elsewhere short, becoming gradually longer toward apices. Tibial setae distinctly longer dorsally than they are laterally and ventrally; denser along inner edge of hind tibiae but not forming a well-defined patch. Hind tarsi slender, about half as long as tibiae, first segment longer than broad; second and third segments subequal; fourth segment antero-posteriorly compressed dorsally; last segment somewhat compressed laterally, elongate, narrow, sides subparallel.

Abdomen.—Connexivum without setae along middle of dorsum except for four pairs of short, segmental setae; with short setae laterally and ventrally. Each lateral lobe of tergum I+II with about 19 strong setae and, along lower margin, about five short setae; inner upper margin with a row of four or five fine setae extending medially and anteriorly from the cluster of macrosetae. Sternum I+II slightly wider than pleurotrochantines, the setae distributed in a roughly triangular area; posterior margin with longer setae. *Female.*—Tergum VII short, nearly as wide as supra-anal plate, feebly sclerotized, with a macroseta situated on each lateral margin and a pair of short setae (one-third length of macrosetae) slightly medial and posterior to macrosetae. Supra-anal plate with four apical macrosetae, a short seta on each side, and another pair of widely separated short setae on disk at mid-length. Seventh sternites relatively small, nearly rounded, each with about 17–18 setae of varying lengths, one a conspicuously longer macroseta. *Male:* Sternum V well developed; setae progressively longer toward apex; with about 12 macrosetae along apical margin and usually two or more long sub-apical setae. Sternum VI absent. Gonapophyses (fig. 75A,B) very slender; downwardly curved apically, right gonapophysis a little more strongly so than the left, its ventral macroseta inserted at about basal third, the accessory seta at about mid-length; left gonapophysis with macroseta inserted slightly beyond middle, the accessory seta immediately anterior to it. Aedeagus flagelliform.

Measurements:	BL	TL	WL	WW
Male	2.03–2.17	0.66–0.82	1.82–2.03	0.77–0.88
Female	2.07–2.39	0.77–0.78	1.98–2.25	0.85–0.91

TYPE MATERIAL (from *Sturnira ludovici*): Holotype male and allotype female (slides), from host no. 10469, Casa Tilley, 5300 to 5600 feet elevation, near Cerro Punta (Chiriquí), 14 March 1962, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—47, as follows: 7, same data and host specimen as holotype and allotype; 2, same locality, 15 February and 23 April 1960; 7 (6 bats), same locality 6 and 11 March 1962; 4 (4 bats), Casa Lewis, near Cerro Punta, 5600–5700 feet elevation, 5 (5 bats), Bambito, near Cerro Punta, 5000–6000 feet elevation, 7 March 1962; 2 (2 bats), Rancho Caballero (Bocas del Toro), 5000 feet elevation, 11 September 1961; 5 (1 bat), Cerro Malí (Darién), 4100–4800 feet elevation, 9 February 1964, C. O. Handley, Jr.; 2, same locality and collector, 31 May 1963; 12 (3 bats), Cerro Tacarcuna (Darién), 4100–4800 feet elevation, 29 February, 4 and 7 March 1964, C. O. Handley, Jr. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; The Museum of Comparative Zoology; the American Museum of Natural History; Gorgas Memorial Laboratory; Environmental Health Branch at Corozal (Canal Zone); British Museum (Natural History); Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil; and the Faculdad de Ciencias, Universidad Central de Venezuela, Caracas.

REMARKS: This is one of the few Streblidae collected only above 4000 feet. It was taken only from *Sturnira ludovici.* The type of *T. phyllostomae* (Kessel, 1925: p. 17) is "a female in the British Museum, off *Phyllostoma,* Humboldt, Brazil, July, 1916, W. Erhardt—1921–200." Through the courtesy of Dr. Harold Oldroyd, we received a female specimen from the same locality ("Humboldt, Sta. Cath., 7-VII-1918") from the collection of the British Museum (Natural History). It is a female and compares well with a male specimen in our collection taken from "*Artibeus j. literatus,*" at Joinville, Santa Catharina, Brazil. In both of these, as in the holotype, the upper inner margins of the lateral lobe of abdominal tergum I+II have an irregular double row of setae. In *T. brennani* n. sp. and in the undescribed species from Therezopolis (Rio de Janeiro), Brazil, there is only a single row. The specimen from Therezopolis was taken from a species of *Sturnira.*

It seems very doubtful that the type of *T. phyllostomae* was actually taken from a species of *Phyllostomus.* In one of the vials of specimens col-

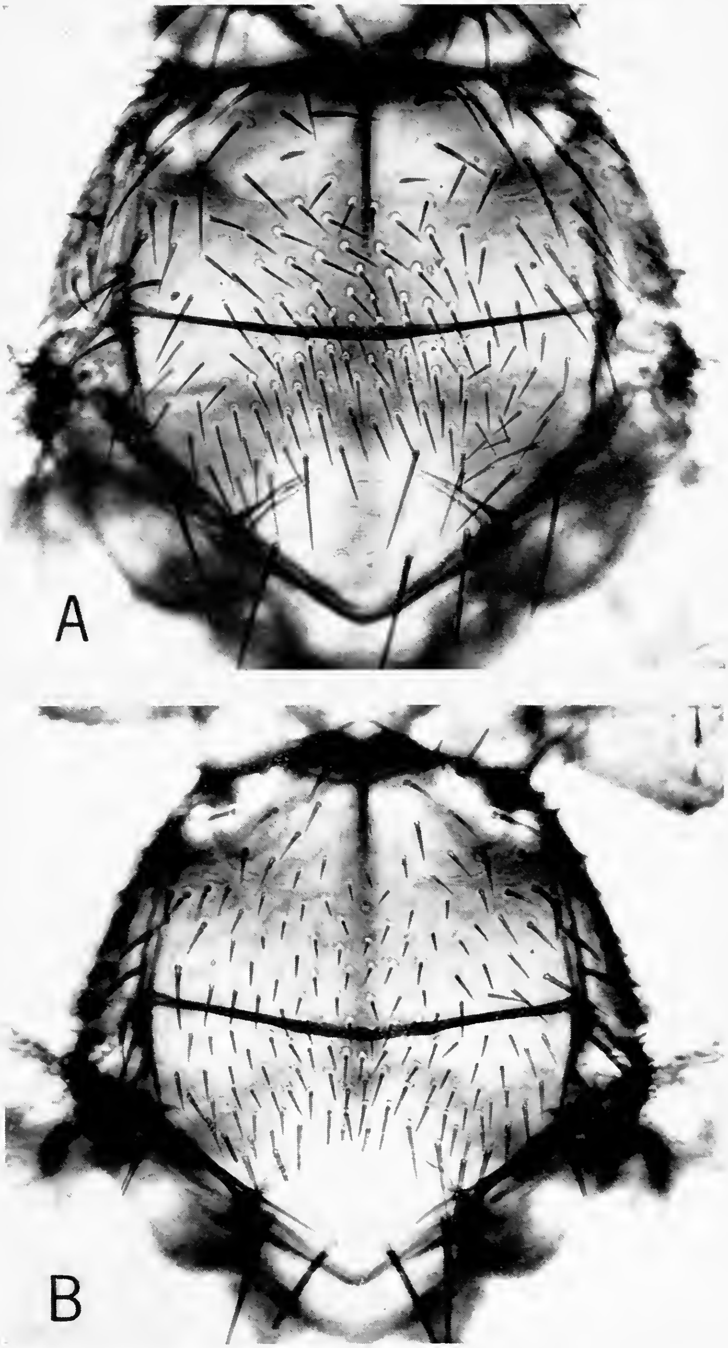


Fig. 74. Thorax, dorsal view. A, *Trichobius brennani*, new species, holotype male. B, *T. vampyropis*, new species, allotype female.

lected by Ehrhardt which contained *T. phyllostomae,* were examples of a species of *Megistopoda* and of *Aspidoptera phyllostomatis* (q.v.). These streblids appear to be restricted to *Artibeus* and *Sturnira.* The name *Phyllostomus* was loosely applied to phyllostomid bats until early in the Twentieth Century. The host of *T. phyllostomae* was probably a species of *Artibeus* or *Sturnira.*

T. brennani n.sp. is named after Dr. James Brennan of the Rocky Mountain Laboratory in grateful appreciation of many courtesies and in recognition of his contributions to our knowledge of the chigger mites.

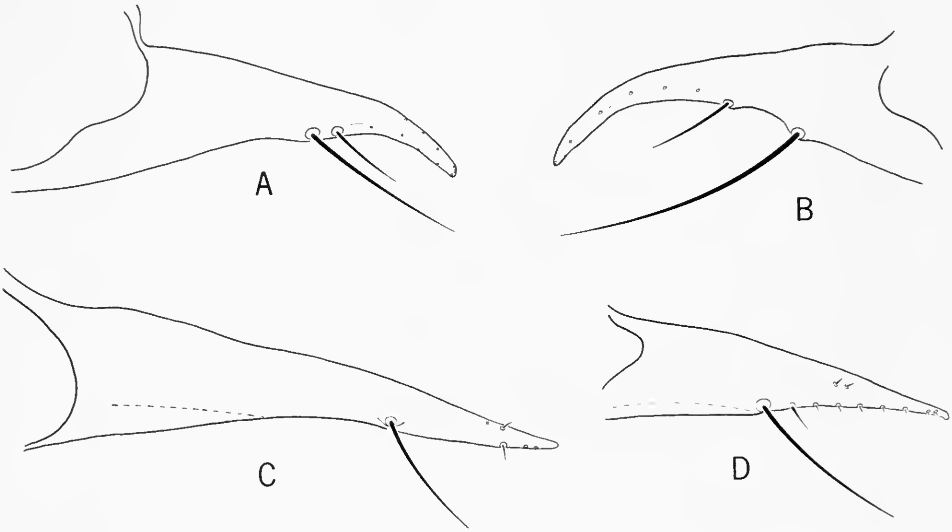


Fig. 75. Male gonapophyses (left unless otherwise noted), *Trichobius phyllostomae* group. A, and B (right gon.), *T. brennani,* new species, paratype from *Sturnira ludovici* (no. 8028), Rancho Mojica (Bocas del Toro). C, *T. vampyropis,* new species, paratype from *Vampyrops vittatus* (no. 8115), near Mojica (Bocas del Toro). D, *T. phyllostomae* Kessel, from "*Artibeus j. literatus,*" Joinville (Santa Catharina), BRAZIL.

Trichobius vampyropis Wenzel, new species. Figures 74B, 75C.

Distinctive in the very large number of eye facets (30–32), as in *brennani* n. sp. and *phyllostomae* Kessel (26–30) ; the very strongly projecting anterior margin of the prescutum; the markedly divergent fifth and sixth longitudinal wing veins; the very small female seventh sternites; the relatively narrow and long male sternum V with very long apical macrosetae; the distinctive male gonapophyses; the truncato-emarginate projection of the sternopleura and the very long, tapered, strongly reflexed median pleurotrochantinal lobe. Most nearly resembling *brennani* and *phyllostomae,* but in these smaller species the mesothorax is not as long and is more nearly quadrate; the anterior margin of the prescutum is less strongly projecting; the anterior margin of the sternopleura is truncate but not emarginate; the pleurotrochantinal lobe is short, translucent, and slightly bent but not ascending; the fifth and sixth longitudinal veins are not divergent; the setae of the tibiae are conspicuously longer; and the tarsi are less compressed antero-posteriorly.

DESCRIPTION: *Head.*—Funnel-shaped, convex. Eyes conspicuous, convex, projecting beyond margins of genae, with 30–32 facets. Laterovertices and occipital lobes well defined, separated; occipital lobes with 11 or 12 setae, the anterior ones conspicuously long macrosetae, the posterior setae shorter but coarse, excepting two minute setae near mesal edge of posterior margin. Palpi oval, horizontal, sparsely setose below. Theca pyriform. *Thorax.*—Sides distinctly converging anteriorly; anterior margin of prescutum strongly produced at middle, and distinctly emarginate at midline; median suture not reaching middle; mesonotal chaetotaxy as in fig. 74B. Sternopleura strongly produced anteriorly, the anterior margin relatively broad and distinctly, angulately emarginate. Median pleurotrochantinal lobe long, tapered, strongly reflexed dorsally and slightly overlapping the metapleuron, so as to appear united with it, though it is not. *Wings.*—Long, costal setae rather long basally, becoming shorter apically, of uniform length to apex from about middle of costal cell; R_1 united with costa opposite midpoint between second and third crossveins; R_s as long as or slightly longer than distance between fork and *r-m;* base of R_1 with three macrosetae, base of fourth longitudinal vein with one, of fifth with five or six; fourth and fifth veins diverging apically. *Legs.*—Fore- and midlegs subequal, the hind legs distinctly longer, though not markedly elongated. Tibiae uniformly clothed with short setae; femora with long and short setae, the macrosetae best developed on upper edges. Tarsi antero-posteriorly compressed, claws stout.

Abdomen.—Connexivum rather uniformly covered with relatively short setae, except along mid-dorsum, the setae borne on small, circular, sclerotized plaques. Lateral lobes of tergum I+II with numerous, heavy macrosetae. *Female:* Connexivum with four sets of minute dorsal segmental setae, the anterior three consisting of a single pair each, the posterior one of two pairs; without a ventro-lateral subapical macroseta. Tergum VII small, transverse, with four setae in a transverse row, the outer pair macrosetae, the inner pair a third or fourth as long as the outer. Supra-anal plate with four apical macrosetae and a single shorter seta on each side at mid-length. Seventh sternites small, each with about 13 setae of varying lengths, including several macrosetae, one of these twice as long as the next longest seta. *Male:* Sternum V relatively long, conspicuously narrower than abdomen, clothed with setae similar to those of connexivum, but with longer setae, including eight macrosetae, along apical margin; sternum VI absent. Sternum VII+VIII not well developed, with about eight dorso-lateral setae, including one very long macroseta on each side. Tergum IX with two transverse rows of macrosetae dorso-laterally and a third row between these ventrad. Gonapophyses as in fig. 74B.

Measurements:	BL	TL	WL	WW
Male	2.20–2.40	0.77–0.91	2.06–2.19	0.93–1.07
Female	2.31–2.65	0.82–0.95	2.25–2.31	1.03–1.06

TYPE MATERIAL: Holotype male and allotype female (on slides) from *Vampyrops vittatus* (host no. 8115) near Rancho Mojica (Bocas del Toro), 13 September 1961. In the collection of Chicago Natural History Museum. Two male paratypes, same data as the holotype; one male paratype, same host and collectors, Rancho Mojica, 12 September 1961; one male paratype, same host and collectors, Río Changena Camp (Bocas del Toro), 22 September 1961; three male paratypes from *Artibeus lituratus palmarum,* 22 miles south of Changuinola (Bocas del Toro), 7 September 1961. All specimens collected by C. M. Keenan, V. J. Tipton, and other personnel of the Environmental Health Branch. One each deposited in the collections of the United States National Museum, the Environmental Health Branch at Corozal (Canal Zone), and the Gorgas Memorial Laboratory, Panamá (Panamá).

REMARKS: The fact that many Streblidae have been collected from *Artibeus lituratus* in Panama and elsewhere without otherwise recovering this species suggests that the paratypes from Changuinola may have been mislabeled as to host.

The median pleurotrochantinal lobe is so long that in preserved specimens it reaches to or even slightly overlaps the metapleuron, and the abdomen of alcohol-preserved specimens must be manipulated in order to determine that the two structures are not united. In slide-mounted specimens, it may appear to be united with the metapleuron, even when the slide is viewed from an angle using a binocular dissecting microscope.

T. vampyropis is structurally intermediate between other members of the *phyllostomae* group and a complex of three genera—including *Paratrichobius, Neotrichobius,* and *Megistopoda*—which, like the *phyllostomae* group occur on bats of the subfamilies Stenoderminae and Sturnirinae. The male gonapophyses are intermediate as regards the insertion of the paired ventral setae. Sternum V is similar in all of the above flies, in shape and chaetotaxy; it has exceptionally long macrosetae along apical margin.

Genus **Anatrichobius** Wenzel, new genus

Type-species: *Anatrichobius scorzai* Wenzel, new species.

Closely related to *Joblingia,* with very similar head structure and like it, having the accessory setae of the male gonapophyses inserted anterior to the macrosetae. Differing from *Joblingia* in its much smaller size and relatively short legs and in the following characters: both the lateral and vertical membranous clefts of the thorax are open (longitudinal cleft closed and indicated by a dark suture in *Joblingia*) ; the median suture of the mesonotum does not extend beyond the transverse suture (to the scutellum in *Joblingia*) ; sternum V is present and divided into two sternites (absent in *Joblingia*) ; tergum VII absent or a single, median, very short, transverse, setose sclerite in the female (represented by a vertical, elongated, very feebly sclerotized, setose area with associatd spiracle on each side of hypopygium in *Joblingia*) ; female seventh sternum divided into two longitudinal sternites (a single median sclerite, though strongly emarginate anteriorly and posteriorly in *Joblingia*) ; finally, the thorax is very high and is dorsally strongly convex in *Joblingia,* whereas it is distinctly wider than high and only feebly convex above in *Anatrichobius.*

Anatrichobius is also superficially similar to *Aspidoptera* but differs in that it has elongate, foliaceous palpi rather than transverse nearly vertical ones; the anterior thoracic spiracles are very small and inconspicuous (relatively large and conspicuous in *Aspidoptera*) ; sternum V (male) is divided into two sclerites rather than undivided; and the accessory setae of the male gonapophyses are inserted anterior rather than posterior to the macrosetae.

DIAGNOSIS: Medium sized species with dorsum of body and legs clothed with long setae. *Head.*—Convex, oval, sides subparallel. Laterovertices and occipital plates differentiated, the laterovertices subquadrate. Eyes small, faceted. Palpi leaf-like, longer than broad. *Thorax.*—Short above, wider than long. Anterior margin of prescutum broadly emarginate, pronotum narrowly emarginate behind the head. Spiracles small.

inconspicuous. Median mesonotal suture not extending beyond the transverse suture. Scutum very short and wide. Scutellum small. Vertical longitudinal cleft extending nearly to mesocoxal cavity. Venter elongated, slightly longer than wide, sternopleura only slightly longer than pleurotrochantines. *Wings.*—Brachypterous, venation essentially complete but variable. *Legs.*—Moderately developed, the middle legs shortest, the hind legs longest, metafemora about half again as long as mesofemora. Hind coxae large. Tarsi short; tarsomeres 1–4 strongly compressed antero-posteriorly, 5 large, conspicuous.

Abdomen.—Dorsal connexivum densely clothed with long setae. *Female:* Tergum VII very short and wide, or absent. Supra-anal plate cordiform, pointed at apex. Cerci articulated to supra-anal plate by a short process, united ventrally with the ventral arc. Seventh sternites elongated, their inner apical margins flange-like and strongly sclerotized, articulated with the median lobe of the ventral arc as well as with a pregenital sclerite (VIII ?). Sternum IX visible externally. *Male:* Hypopygium broadly conical. Sternum V divided into two transverse, oval, feebly sclerotized sternites. Sternum VI absent. Gonapophyses blade-like, the accessory setae situated anterior to the macrosetae.

Anatrichobius scorzai Wenzel, new species. Figures 76–78.

DESCRIPTION: Chaetotaxy as illustrated. Micropile present on upper surface of palpi, head, mesonotum (except a broad median area), and abdomen including setose area of sternum II, and upper setose areas (at least apically) of femora. Intervals between femoral and some coxal setae may appear scabrous in slide preparations. *Head.*—Broadly pyriform, the dorsum convex. Laterovertices with about 20 setae, most of the anterior setae shorter; occipital lobes with about 25–30 setae. Eyes small, horizontal, with seven or eight small facets. Genae and postgenae densely setose, the dorsal and apical setae longest. *Thorax.*—Median suture usually united with the transverse suture, sometimes extending only a little beyond middle; transverse suture usually complete, occasionally poorly defined at middle. Prescutum with 38–40 setae on each side of median suture. Scutum with about 24–26 setae. Scutellum with four scutellar macrosetae in a transverse row and two additional ones at middle of apical margin. Mesepisterna clothed with dense long setae above. *Wings.*—Brachypterous, as shown in fig. 76, venation variable. *Legs.*—Hind tibiae with denser short setae along inner apical face, but not forming a dense patch. Last tarsomere about as long as 1–4 combined. *Abdomen.*—Connexivum in both sexes dorsally clothed with long setae; lateral connexival setae shorter, the ventral setae minute. *Female:* Lateral lobes of tergum I+II longer than in the male, the posterior part of the lobe (viewed from the side) bare; the dorsal margin (near midlength) with a cluster of 12–14 longer setae which are continued anteriorly and across middle of margin by a row of short setae. Dorsal connexivum clothed with long setae, these more prominent laterally; setae of lateral connexivum shorter, those of venter very short, except for segmentally arranged pairs of long setae. Tergum VII curved posteriorly on each side, with from 12–20 setae, some of these often displaced and situated on connexivum. Supra-anal plate with from 10–12 setae. Seventh sternites with numerous macrosetae apically, shorter setae basally. *Male:* Lateral lobe of tergum I+II posteriorly with numerous discal and marginal setae, these shorter ventrally. Dorsal connexivum with a mixture of long and shorter setae, the long ones shorter than in female. Setae of sternum V similar to those of ventral connexivum, the anterior ones a little shorter. Hypopygium with numerous long macrosetae dorsally and short setae ventrally. Gonapophyses (fig. 78C) nearly alike.

Measurements:	BL	TL
Male	2.42–2.64	0.52–0.55
Female	2.99–3.30	0.60–0.77

TYPE MATERIAL: Holotype male (host no. 7459) and allotype female (host no. 7468), both in alcohol, from *Myotis* sp., Cueva Lara (Chiriquí), 5600 feet elevation, 3 May 1961, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

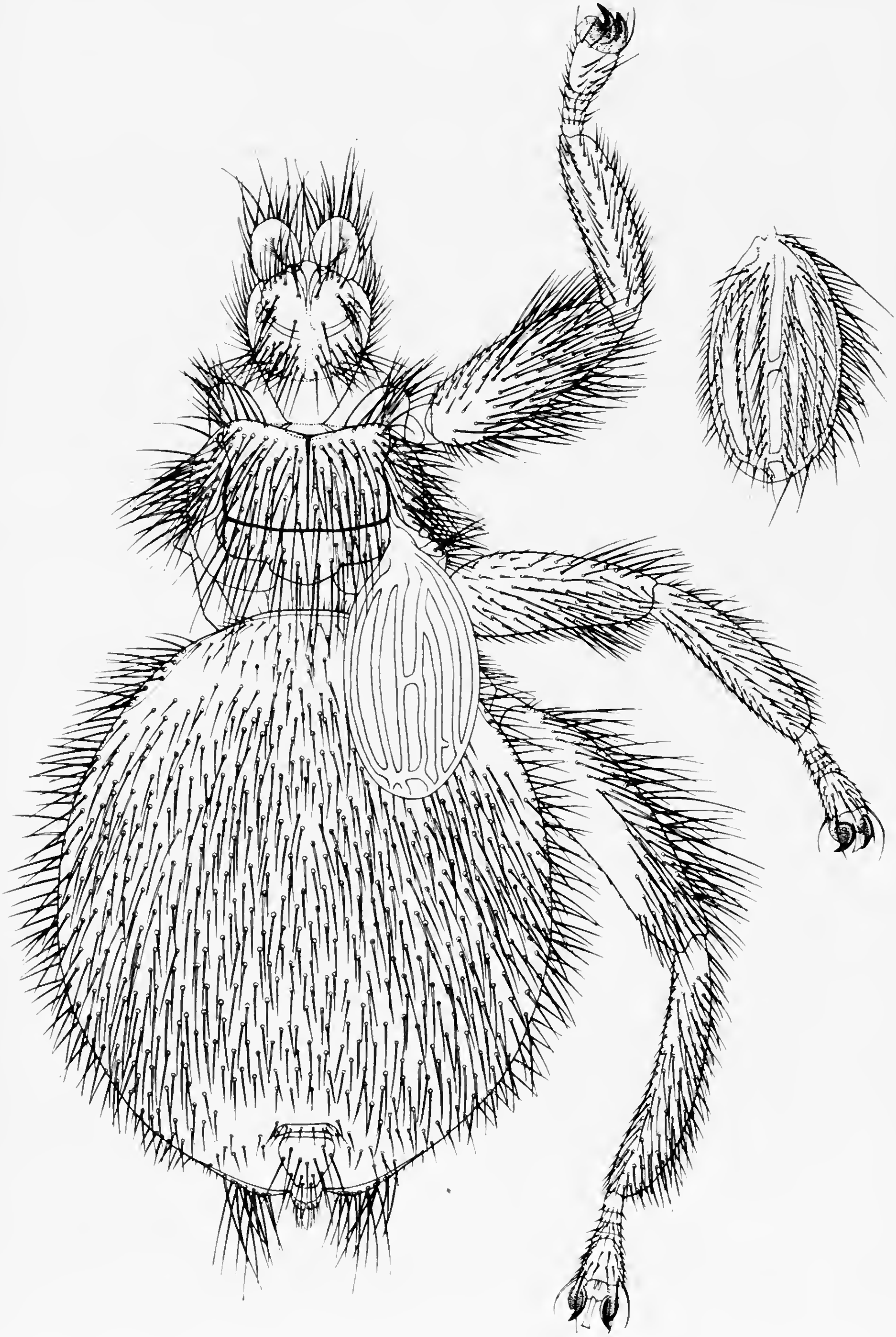


Fig. 76. *Anatrichobius scorzai*, n. gen., n. sp. Female paratype, dorsal view, and right wing. Made from specimens taken from a mixed collection of *Myotis n. nigricans* and *M. chiloensis*, at Cueva Lara, Casa Tilley, Cerro Punta (Chiriquí).

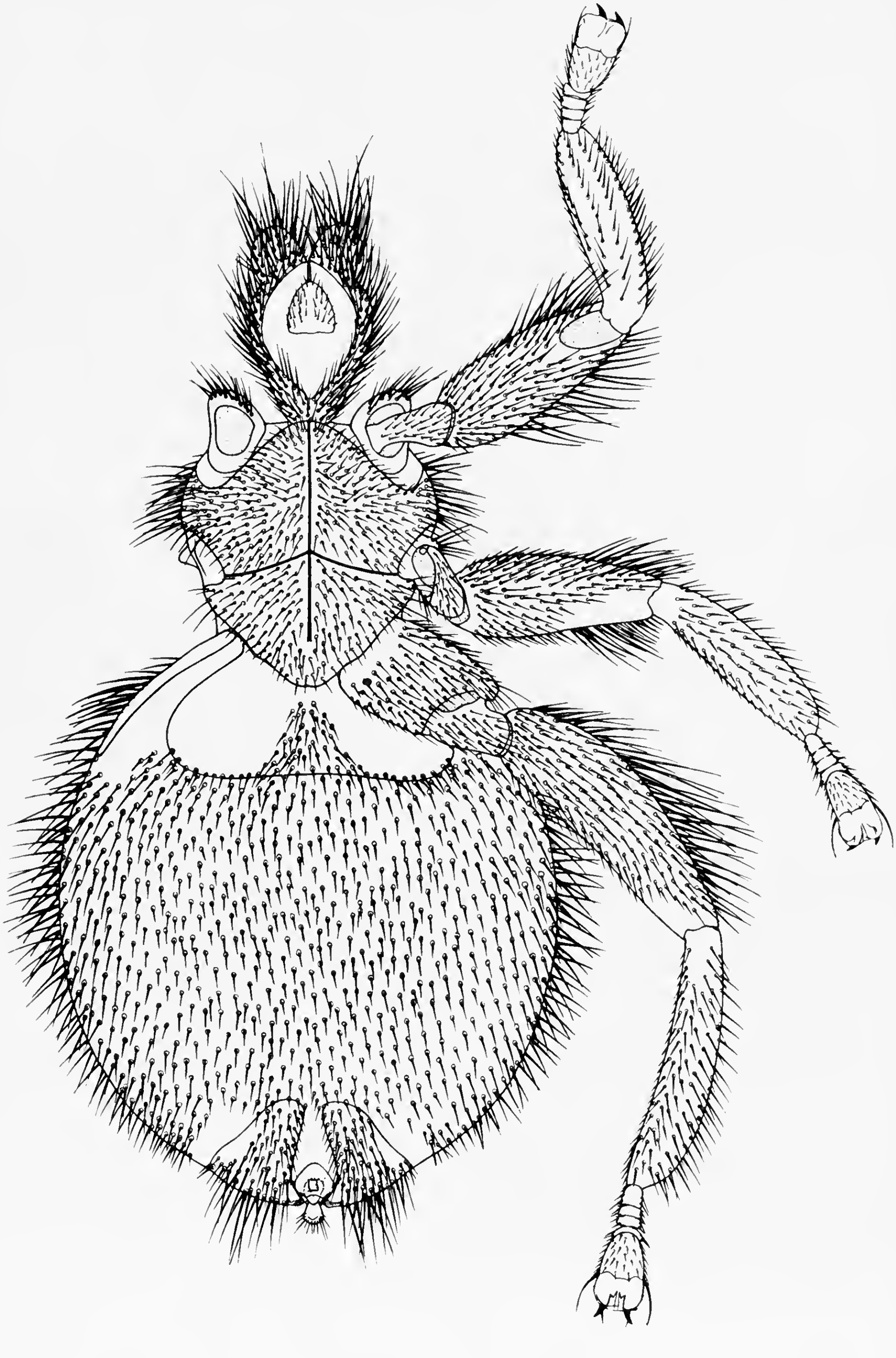


Fig. 77. *Anatrichobius scorzai*, n. gen., n. sp., female. Ventral view. From same specimens as fig. 76.

Paratypes.—From *Myotis* sp.: 1, same data as holotype; 1, Casa Lewis, Cerro Punta (Chiriquí), 5600 feet elevation, 4 May 1960; 1, same data but 12 March 1962. From *Myotis nigricans:* 4, Cave, Finca Lara, (Chiriquí), over 5800 feet elevation, 5 May 1961; 3, Lara's Cave, Cerro Punta (Chiriquí), 6 March 1962; 1, Cerro Hoya (Los Santos), 21 February 1962. From *Myotis chiloensis:* 1, Lara's Cave, Cerro Punta (Chiriquí), 5600 feet elevation, 6 March 1962. From a mixed collection *Myotis nigricans* and *M.*

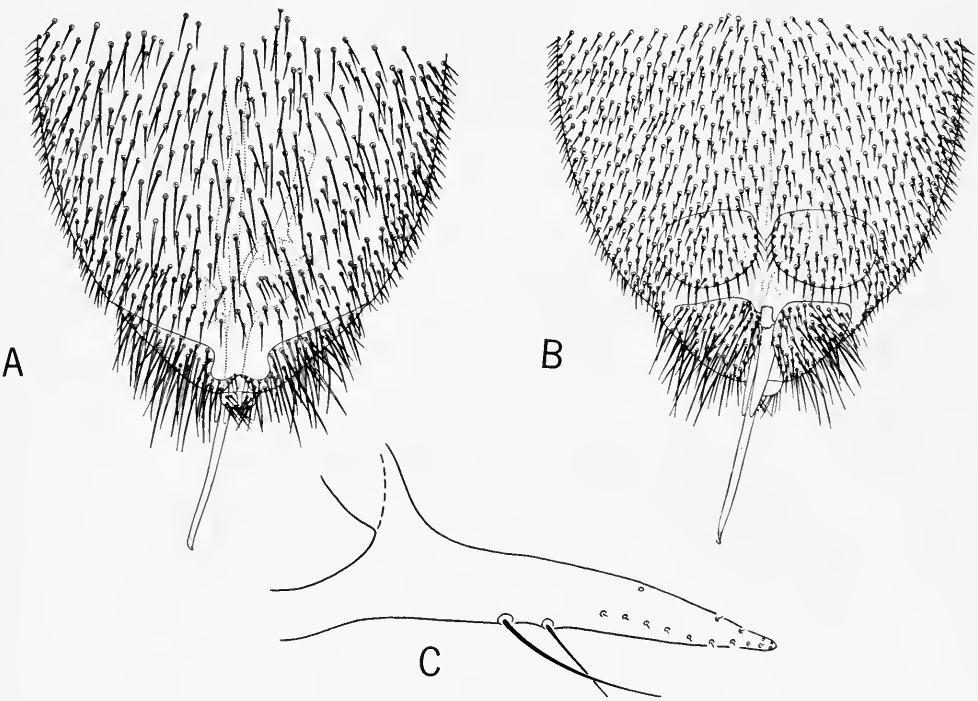


Fig. 78. *Anatrichobius scorzai* n. gen., n. sp., male abdomen. A, dorsal, and B, ventral views. C, left gonapophysis, lateral view. Data as for female (fig. 76).

chiloensis: 47 (3 lots), Lara's Cave, Cerro Punta (Chiriquí), 6 March 1962. From *bat guano:* 1, Lara's Cave, Cerro Punta (Chiriquí), 6 March 1962. *Without host:* 2, Cerro Azul (Panamá), elevation about 2000 feet, 25 and 27 January 1958.

From *Myotis n. nigricans:* 30, from a room of old building of Biological Station, Rancho Grande (Aragua), VENEZUELA, 7 July to 30 September 1962, C. and A. Machado, R. Antequera and M. Ramirez [FCUCV]. From *Myotis nigricans:* 3, San Antonio, San Agustín (Huila), COLOMBIA, 2350 meters elevation, 18 October 1951, P. Hershkovitz, CNHM Colombia Zoological Expedition (1948–52). From *Myotis chiloensis oxyotis:* 3, Hacienda Cadena, Marcapata (Cuzco), PERU, 1000 meters elevation, 19 February 1949, Celestino Kalinowski. From *Lonchophylla robusta* (!) : 1, Rancho

Grande (Aragua) VENEZUELA, Wm. T. Beebe [MCZ]. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; Museum of Comparative Zoology at Harvard University; the Gorgas Memorial Laboratory, at Panamá (Panamá); the Environmental Health Branch (United States Army) at Corozal (Canal Zone); and the Universidad Central de Venezuela, Caracas.

REMARKS: *Anatrichobius scorzai* is named in honor of Dr. José Vicente Scorza, Head of the Department of Parasitology, Escuela de Biología, Facultad de Ciencias, Universidad Central de Venezuela. The puparium of this species will be described later by Machado-Allison. The female specimen illustrated (figs. 76, 77) was distorted by pressure on the slide. In gravid females, the abdomen is never quite as broad and rounded as shown. Tergum VII of the specimen illustrated has fewer setae than is typical.

An undescribed species of *Anatrichobius* is known to us from Peru and Brazil. It differs strikingly from *scorzai* in that tergum VII is absent in the female and the chaetotaxy of the supra-anal plate is reduced to from four to six setae.

Genus **Joblingia** Dybas and Wenzel

Joblingia Dybas and Wenzel, 1947, Fieldiana, Zool., **31**: 149. Jobling, 1949, Parasitology, **39**: 322 (keyed).

Undescribed genus, Bequaert, 1942, Bol. Ent. Venez., **1**: 86 (notes).

Type-species: *Joblingia schmidti* Dybas and Wenzel, 1947.

Until the Panamanian collections were obtained, the type-species of *Joblingia* was known only from the unique female holotype. Both males and females were collected in Panama, and it is now possible to give the characters of the male and to correct several errors in the original diagnosis of the genus and description of the species. The following may be added to the diagnosis of the genus.

Head.—Laterovertices and occipital plates differentiated, but weakly sclerotized, connected by a narrow sclerotized strip along inner margins. Eyes small, vertical. *Thorax.*—Height greater than dorsal width. Mesonotum strongly convex; median suture extending posteriorly to scutellum. Longitudinal membranous cleft closed, the line of fusion marked by a dark pigmented suture. Vertical membranous cleft reaching about halfway to coxal cavity. *Abdomen.—Female:* Seventh tergum represented by a vertical elongate setose area (which encloses the spiracle VII) on each side of the hypopygium. Sternum VII a single median plate which is emarginate along mid-line both anteriorly and posteriorly. Cerci united with the ventral arc, the latter not united with the supra-anal plate. Both dorsal and ventral anal sclerites present. *Male:* Sterna V and VI absent, VII and VIII fused with IX. Hypopygium broadly conical. Gonapophyses with accessory setae inserted anterior to the macrosetae.

Joblingia schmidti Dybas and Wenzel. Figures 79, 80.

Joblingia schmidti Dybas and Wenzel, 1947, Fieldiana, Zool., **31**: 152, figs. 25–27—Guatemala: Chocoyos (Chimaltenango), from *Myotis n. nigricans* (Chicago Natural History Museum). Jobling, 1949, Parasitology, **39**: 316 ff, fig. 3G, H.

The following characters are added to the original description:

Legs.—Proportionally shorter in males than in females. *Abdomen.—Female:* Tergum I+II with dorsal and ventral groups of short bristles anteriorly and numerous very

Fig. 79. *Joblingia schmidti* Dybas and Wenzel, female. Dorsal view. From Dybas and Wenzel (1947), with corrections.

short rather stout bristles on posterior margin of lateral lobe. Tergum VII represented on each side lateral to the terminal cone by a vertical elongate area (with shorter setae than connexivum) which encloses seventh spiracle. Seventh sternum not divided, though it is emarginate anteriorly and posteriorly and the setae are arranged as on two sternites, with a median smooth area between two extensive groups. *Male:* Lateral lobes of tergum I+II densely clothed with long and short bristles, these shorter along dorsal and ventral margins. Connexivum between lateral lobes with dense setae of moderate length, else-

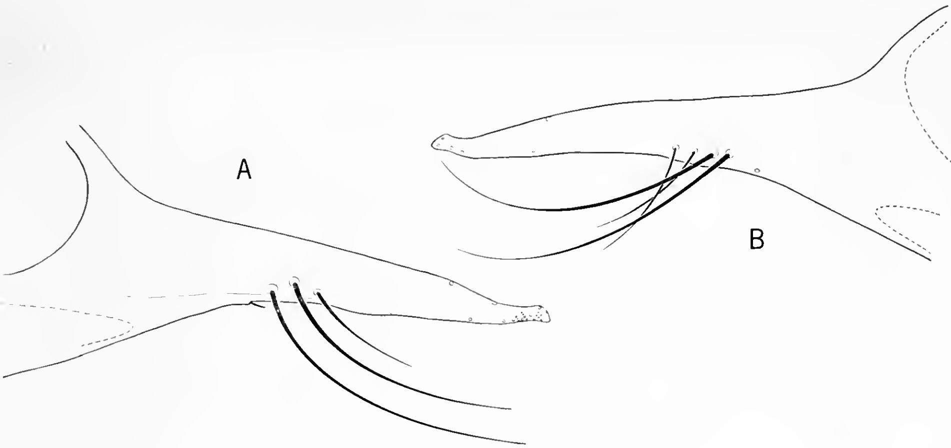


Fig. 80. *Joblingia schmidti* Dybas and Wenzel. A, left, and B, right male gonapophyses, lateral view. From *Myotis nigricans* (no. 7466), Cueva Lara, Casa Tilley, Cerro Punta (Chiriquí).

where (dorsally and ventrally) except along mid-line near apex, with minute setae borne on small plaques. Hypopygium broadly conical, densely clothed with setae, these very long macrosetae posteriorly, shorter anteriorly and ventrally. Sternum II less strongly emarginate at middle than in female. Gonapophyses as in fig. 80.

Measurements:	BL	TL
Male	3.96–4.06	1.04–1.07
Female	4.97–5.50	1.03–1.16

MATERIAL EXAMINED: 31 specimens (10 lots), all from Cueva Lara, Casa Tilley, Cerro Punta (Chiriquí), elevation 5600 feet.—From *Myotis nigricans:* 10 (4 bats), 3 May 1961. From *Myotis* sp.: 1, 5 May 1961. From *Myotis chiloensis:* 1, 3 May 1961. From mixed collection of *M. nigricans* and *M. chiloensis:* 7 (3 lots), 6 March 1962. From *bat guano:* 8, 6 March 1962.

REMARKS: The original figures of Dybas and Wenzel (op. cit.), showed the laterovertices and occipital lobes as poorly defined areas. These were poorly pigmented and defined in the female holotype. The figure is reproduced here (fig. 79) with corrections.

Trichobioides Wenzel, new genus

Type-species: *Trichobius perspicillatus* Pessôa and Galvão, 1937.

Trichobioides closely resembles *Trichobius*, but differs as follows: palpi without setae on ventral surface (present in *Trichobius*); upper surface of palpi with a longitudinal tuberculate ridge near mesal margin (absent in *Trichobius*); costa and R_1 united opposite third crossvein (beyond level of third crossvein in *Trichobius*); palpi and theca (when retracted) co-

Fig. 81. *Trichobioides perspicillatus* (Pessôa and Galvão). Thorax, dorsal view, of male from *Phyllostomus d. discolor* (TVL nos. 1142–46), Santa Cruz, TRINIDAD.

apted with apices of genae to form a vertical shield across the front of the head (not so in *Trichobius*); laterovertices with an oblique dark line which divides them into two parts (absent in *Trichobius*); and the female seventh sternites and the connexivum forming prominent apical lobes (not so in *Trichobius*).

DIAGNOSIS: *Head.*—Co-apted with and nearly as broad as the bisinuate anterior thoracic margin. Laterovertices and occipital lobes well defined, the laterovertices divided into two parts by an oblique, dark line (most conspicuous in alcohol specimens). Postvertex sclerotized, without setae, continuous with the occipital lobes. Palpi broad, with few setae, these restricted to margins; ventral surface bare, upper surface microsetose; upper surface with a sharp longitudinal bituberculate ridge near mesal margin, each tubercle bearing a short seta. Eyes conspicuously separated from lateral margins of head. *Thorax.*—Broad, narrowing anteriorly; prescutum very long, more than twice as long as scutum. *Wings.*—Relatively short; setae of veins conspicuous; costa and R_1 with macrosetae from base to juncture, opposite the third crossvein. *Legs.*—Short, middle and hind legs subequal, the hindlegs slightly longer; femora stout, with both macrosetae and short setae; tibiae with very short, fine setae only; tarsi short.

Abdomen.—Sternum I+II broad, as wide as abdomen. *Female:* Tergum VII very short. Cerci not united with the heavily sclerotized ventral arc. Seventh sternites long, produced apically as subconical lobes, which extend as far as or beyond apex of proctiger. *Male:* Hypopygium prominent, broadly conical. Sternum V short and broad, not divided. Sternum VI present as a very fine thread-like band. Gonapophyses with paired setae inserted on lateral face, the accessory seta below or slightly posterior to macroseta.

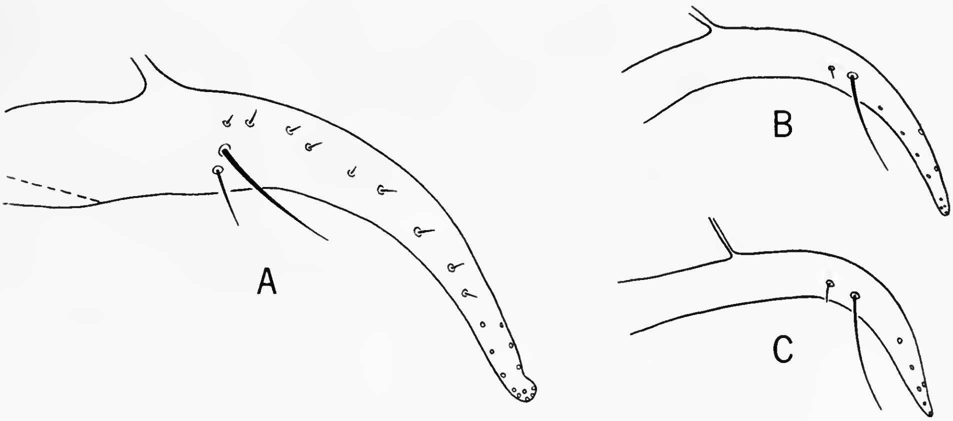


Fig. 82. Left male gonapophysis, lateral view. A, *Trichobioides perspicillatus* (Pessôa and Galvão), from *Phyllostomus d. discolor* (no. 6348), Río Mandinga, (San Blas). B, *Mastoptera minuta* (Costa Lima), from *Tonatia silvicola* (no. 9477) Guánico (Los Santos). C, *Mastoptera guimaraesi*, new species from *Phyllostomus h. panamensis* (no. 4644), Chepo Road (Panamá).

Trichobioides perspicillatus (Pessôa and Galvão), *new combination.* Figures 81, 82A.

Trichobius perspicillatus Pessôa and Galvão, 1937, Folia Clin. Biol., São Paulo, **9**: 1, figs. 1–3—"Bahia," from undet. host and *Hemiderma perspicillatum* (Laboratorio de Parasitologia, Faculdade de Medicina, Universidade de São Paulo). Guimarães, 1938, Rev. Mus. Paulista, **23**: 655 (notes), 662 (keyed), fig. 4. Jobling, 1938, Parasitology, **30**: 386, fig. 14A; 1949, ibidem, **39**: 316 ff. (hosts), 326.

This remarkable species is easily recognized by the very distinctive mesonotal chaetotaxy (fig. 81). The female is also distinctive in the lobes formed by the seventh sternites.

Measurements:	BL	TL	WL	WW
Male	1.00–1.54	0.49–0.51	0.93–1.10	0.49–0.55
Female	1.59–1.84	0.53–0.58	1.10–1.15	0.55–0.60

PANAMANIAN MATERIAL EXAMINED: 12 specimens in (5 lots) from 6 bats. From *Phyllostomus d. discolor:* 8 (2 bats), Río Mandinga (San Blas), 18 and 29 May 1957, E. Méndez [GML]; 1 (probably this host), Cerro Azul (Panamá), about 2000 feet elevation, 25 January 1958, E. Méndez [GML]. From *Sturnira lilium parvidens:* 1, Río Tuira (Darién), 25 February 1958,

P. Galindo [GML]. From *Desmodus rotundus murinus:* 2 (2 bats), Guánico (Los Santos), 26 January 1962.

OTHER MATERIAL EXAMINED: More than 100 specimens from GUATEMALA, EL SALVADOR, COSTA RICA, COLOMBIA, VENEZUELA, SURINAM, TRINIDAD, and PERU. Nearly all of these are from *Phyllostomus d. discolor* and *P. d. verrucosus,* except one record from *Phyllostomus elongatus* (COLOMBIA) and one from a bat doubtfully identified in the field as *Phyllostomus h. hastatus* (SURINAM).

REMARKS: The primary host of this fly appears to be *Phyllostomus discolor,* though it probably occurs on other species of *Phyllostomus.* The Panamanian records from *Sturnira* and *Desmodus* may represent transitory associations or errors in field labeling. As noted elsewhere, a number of the flies collected in Los Santos were incorrectly associated with the hosts.

Mastoptera Wenzel, new genus

Type-species: *Aspidoptera minuta* Costa Lima, 1921.

The species of *Mastoptera* superficially resemble those of the genus *Aspidoptera* but differ in having mouthparts and genae co-apted (in repose) becoming a frontal shield, as in *Trichobioides;* the posterior extension of the median mesonotal suture nearly to the scutellum; the closure of the vertical membranous cleft without evident suture; the reduced wing venation and the apical digitiform process at apex of the wing; the presence of flanges on the ventral arc (female) and numerous other characters. Actually, *Mastoptera* is closely related to the macropterous *Trichobioides* and possesses many characters of that genus, including the co-apted mouthparts; the palpal flange; the posteriorly strongly widened thorax; similar male gonapophyses (though the paired ventral setae are inserted more distally); the broadly conical hypopygium, the presence of flanges on the ventral arc of the female, and the conspicuously long macrosetae of the apex of the abdomen. Easily separated from all other genera by the extraordinarily widely separated hind coxae, and by the digitiform process at the apex of the wings.

DIAGNOSIS: Minute dorso-ventrally somewhat flattened brachypterous species, 0.73–1.29 mm. long. *Head.*—Sides of head converging posteriorly, the posterior margin and anterior edge of the prescutum co-apted. Laterovertices and occipital plates distinct. Theca short, wider than long, vertical when retracted and co-apted with palpi and genae to form a frontal "shield." Palpi vertical, subtriangular, apices broadly truncate; ventral surface with setae on basal half only; upper surface microsetose on distal half, with a longitudinal submarginal flange near inner edge. Eyes minute, with one or two facets.

Thorax.—Anterior margin of prescutum strongly emarginate, on a little more than middle third of width. Median suture extending posteriorly to or near the scutellum; transverse suture absent or indistinct, represented by pigmentation only, though sometimes distinct at middle. Posterior margin of scutellum emarginate. Longitudinal membranous cleft open, short; vertical membranous cleft closed, without evidence of a suture. Spiracles small, rosette-like. Mesepisterna broad and setigerous dorsally, widest posteriorly. *Wings* (fig. 83C).—Brachypterous, venation indistinct; each wing with a digitiform process (rarely two ?) at apex. Anterior margin of sternopleura truncate, feebly projecting. Posterior margin of pleurotrochantines nearly straight, very broad, approximately as wide as hind femora are long. *Legs.*—Short, subequal. Hind coxae widely separated. Femora with long sparse setae antero-dorsally, in addition to short ones on antero-ventral or posterior faces. Tibiae with very short setae arranged in rows, tibiae and tarsi subequal. Tarsomeres 1–4 progressively shorter, 4 rather strongly compressed antero-posteriorly; sides of last tarsomere subparallel.

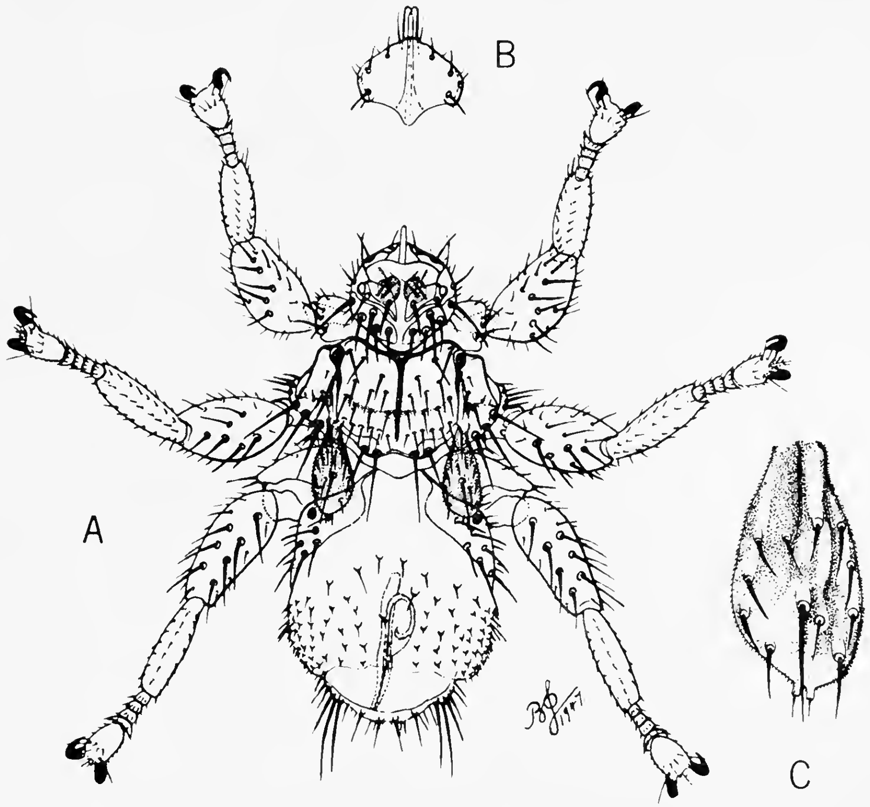


Fig. 83. *Mastoptera guimaraesi*, new species. A, dorsal view, male. B, labium. C, wing. From Jobling (1957, as *Aspidoptera minuta*).

Abdomen.—Tergum I+II membranous along mid-line, nearly to base; lateral lobes conspicuous, usually about half as long as abdomen and bearing conspicuous macrosetae. Connexival setae borne on conspicuous plaques. *Female:* Tergum VII and supra-anal plate together forming a broad terminal cone; tergum VII feebly sclerotized, but apparently subquadrate and about twice as broad as long; supra-anal plate short and transverse; seventh sternites small, slightly produced posteriorly as lobes. Cerci free, not united with the ventral arc, the latter with flange-like projections. *Male:* Sternum V present, short and broad. Sternum VI absent. Hypopygium very broadly conical. Gonapophyses curved; paired setae inserted near mid-length, the macroseta anterior to the accessory seta; gonapophyseal apodeme trough-like. Adeagus flagelliform.

At present we are able to distinguish two species of this genus: *M. minuta* (Costa Lima) from bats of the genus *Tonatia* and from *Phyllos-*

tomus hastatus, and *M. guimaraesi* n.sp. from *Phyllostomus hastatus panamensis*. It is possible that careful study of adequate material may show that each species of *Tonatia* harbors a separate species of *Mastoptera*, as is true for the streblids of the genera *Pseudostrebla*, *Trichobius*, and *Strebla*.

KEY TO SPECIES OF *MASTOPTERA*

Males

Tergum I+II with seven to nine conspicuous, long to moderately long bristles, and, along lateral margin, five to seven short ones; longest seta followed distally by one long bristle, lateral to which is a very short bristle (fig. 84A). Gonapophyses more strongly curved, with dorsal margin feebly sinuate before apex (fig. 82C). Host: *Phyllostomus hastatus panamensis* .... *guimaraesi* n.sp.

Tergum I+II with nine to twelve conspicuous bristles and, along lateral margin, two or three very short ones; longest seta followed distally by two shorter but conspicuous, long bristles (fig. 85B). Gonapophyses with dorsal margin evenly curved before apex (fig. 82B). Hosts: *Tonatia* spp., *Phyllostomus hastatus* (? subsp. *hastatus*) .... *minuta* (Costa Lima)

Females

Lateral lobes of tergum I+II very long, nearly as long as hind coxa and femur combined. Dorsal abdominal connexivum with from one to three setae which are conspicuously longer and coarser than the others, on each side medial and slightly posterior to apices of lateral lobes of tergum I+II (fig. 84A). Sternum II nearly as long as venter of thorax; seventh sternites with setae along inner and distal margins only, elsewhere microsetose .... *guimaraesi* n.sp.

Lateral lobes of tergum I+II only slightly longer than hind femora. Dorsal abdominal connexivum lacking conspicuously coarser and longer setae medial to apices of lateral lobes of tergum I+II. Sternum II only a little more than half as long as venter of thorax; seventh sternites with setae throughout, in addition to microsetae .... *minuta* (Costa Lima)

Mastoptera guimaraesi Wenzel, new species. Figures 82C, 83, 84.

Aspidoptera minuta (not Costa Lima, 1924), Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 417; 1942, Bol. Ent. Venez., 1: 88 (records). Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), 18: 142 (part.), fig. 4; 1949, Parasitology, 39: 316–317 (part.), fig. II.

Very similar to *M. minuta* (Costa Lima), but differing by the characters given in the key (and noted below). As indicated above, the description and figure given by Jobling (1949) apply to this species, except for the record from *Tonatia amblyotis* (= *T. silvicola*). In addition to characters given by Jobling, the following diagnostic features may be noted.

DESCRIPTION: *Head.*—Eyes with two indistinct facets (one in *minuta*). *Abdomen: Male.*—Tergum I+II with seven to nine conspicuous long bristles and five to seven short ones along the lateral margin; longest macroseta followed distally by one shorter but long, conspicuous seta lateral to which may be a short seta. Gonapophyses with upper margin slightly sinuate before apex (fig. 82C). *Female:* Tergum I+II very long, nearly as long as hind femur and coxa combined. Connexivum dorsally with from one to three coarse bristles longer than the others, medial and slightly apical to apex of lateral lobes of tergum I+II. Sternum II nearly as long as underside of thorax. Seventh sternites with setae restricted to distal and inner margins, the rest of the surface microsetose only.

Measurements:	BL	TL
Male	1.00–1.10	0.27–0.29
Female	1.23–1.29	0.29–0.33

TYPE MATERIAL: Holotype male (slide) from *Phyllostomus hastatus* *panamensis* (host no. 4644), hollow tree, Chepo Road (Panamá), 8 October 1959, C. M. Keenan and V. J. Tipton; allotype female (slide), same data but host no. 4641; both in the collection of Chicago Natural History Museum.

Paratypes.—From *Phyllostomus hastatus panamensis,* 284 in 30 lots from 68 bats, as follows: 1, Madden Dam (Canal Zone), 31 August 1959; 75 (19 bats), Fort Sherman (Canal Zone), 4 and 6 April 1960; 2, Fort Clayton (Canal Zone), 20 June 1960; 2, Farfan (Canal Zone), 19 December 1915, T. Hallinan [AMNH]; 161 (18 bats), same data as the holotype; 2 (2 bats), Chilibrillo Caves (Panamá), 28 October 1959, and 12 (20 bats), same locality, 17 July 1959; 1, same locality, 28 May 1931, L. H. Dunn no. 22 [AMNH]; 2, same locality, without data [MCZ]; 2, Tapia (Panamá), 25 July 1923, J. P. Chapin [MCZ]; 1, "Panama," [USNM]; 5 (1 bat), Almirante (Bocas del Toro). From *Phyllostomus* sp.: 6 (2 bats), Camp Piña (Canal Zone), 26 October 1960; 1, Guánico (Los Santos), 22 January 1962. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED: PANAMA.—From *Carollia p. azteca:* 1, culvert, Chepo Road (Panamá). *Without host:* 1, Chilibrillo Caves (Panamá), 17 July 1959; 2, same locality [MCZ]; 1 (slide), "Canal Zone, Busck, April 30" [USNM, det. as *A. minuta* by Q. C. Kessel]. COLOMBIA.—Several lots taken from *Phyllostomus hastatus* in the Departments of Huila and Bolivar, by P. Hershkovitz, CNHM Colombian Zoological Expedition 1948–52.

REMARKS: Jobling indicated that this species had a single eye facet, but our material indicates that there are two indistinct facets. In *minuta,* there appears to be only one. Jobling's figure (see fig. 83) is of a specimen from *Phyllostomus h. panamensis* taken at Chilibrillo Caves (Panamá). It is somewhat inaccurate or atypical in several respects. The anterior margin of the prescutum is not broadly emarginate, as shown, but straight on each side and emarginate at middle only. The wing is shown with two setigerous digitiform processes at apex. We have not seen more than one such process in the specimens examined by us.

This species is named for Dr. Lindolpho Guimarães of the Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil, in recognition of his many valuable contributions to our knowledge of ectoparasites, and especially his outstanding studies on the New World batflies, both Streblidae and Nycteribiidae.

Mastoptera minuta (Costa Lima), *new combination.* Figures 82B, 85.

Aspidoptera minuta Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 21–22 (descr., keyed), 29 (cat.), pl. 2, fig. 2—Brazil: Matto-Grosso, from *Tonatia amblyotes* [*sic!*] (? Museu Nacional do Rio de Janeiro). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 26, pl. 2, fig. 13 (? part.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (fig., Streblidae II.—4). Jobling, 1949, Parasitology, 39: 316–317 (part); 1949, Proc. Roy. Ent. Soc. Lond., (B), 18: 136 (keyed), 142 (part., record from *Tonatia* only).

This species may be separated from *guimaraesi* by the characters given

Fig. 84. *Mastoptera guimaraesi*, new species, base of abdomen, dorsal view. A, male (host no. 4644) and B, female (host no. 4641) paratypes from *Phyllostomus h. panamensis*, Chepo Road (Panamá). *ms*=dorsal connexival macroseta.

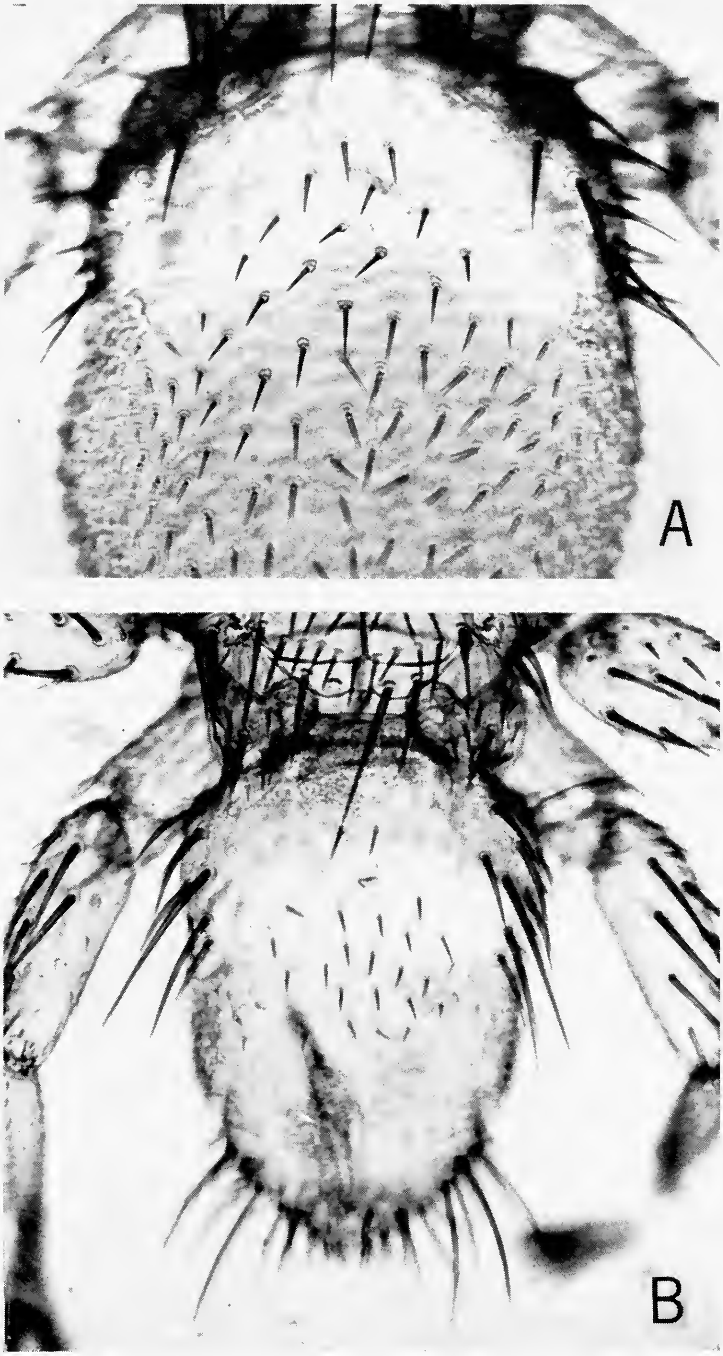


Fig. 85. *Mastoptera minuta* (Costa Lima). A, female, base of abdomen, dorsal view, paratype from *Tonatia silvicola* (no. 11698) Armila (San Blas). B, abdomen, male, dorsal view, paratype from *T. silvicola* (no. 9477), Guánico (Los Santos).

in the key. As can be seen from the following measurements, it is distinctly smaller than that species.

Measurements:	BL	TL
Male	0.73–0.96	0.19–0.30
Female	0.83–1.06	0.24–0.29

PANAMANIAN MATERIAL EXAMINED: 58 specimens (21 lots from 21 bats). From *Tonatia minuta,* 22 (6 bats) as follows: 3, Fort Sherman (Canal Zone), 2 December 1959; 2, Almirante (Bocas del Toro), 26 February 1960; 12 (2 bats), Sibube (Bocas del Toro), 17 and 24 January 1963, C. O. Handley, Jr.; 1, Las Palmitas (Los Santos), 24 January 1962; 5 (2 bats), Cerro Hoya (Los Santos), 24 January and 26 February 1962. From *Tonatia silvicola,* 35 (14 bats) as follows: 2, Sibube (Bocas del Toro), 22 January 1963, C. O. Handley, Jr.; 11 (5 bats), Guánico (Los Santos), 27 January to 1 March 1962; 21 (6 bats), Armila (San Blas), 1 to 29 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 3, Puerto Obaldía (San Blas), 3 April 1963, C. O. Handley, Jr.; 1, Cerro Malí (Darién), 8 February 1964, C. O. Handley, Jr. From *Phyllostomus* sp. (!) : 1, Chilibrillo Cave, 2 May 1957, Koford and Handley [USNM].

OTHER MATERIAL EXAMINED: About 250 specimens, mostly from various species of *Tonatia,* from COLOMBIA, SURINAM, ECUADOR, PERU and BOLIVIA are referred to this species. Five lots (28 specimens) taken from *Phyllostomus hastatus* in Amazonian COLOMBIA, by Kjell von Sneidern, were also examined.

REMARKS: We suspect that the specimens taken on *Phyllostomus hastatus* (subsp. ? *hastatus*) in Amazonian Colombia represent a third species, but to date we have not been able to distinguish between these and specimens from bats of the genus *Tonatia.* If these actually are *minuta,* then we must conclude that this species is able to live on bats of the genus *Tonatia* throughout the range of that genus, but on *Phyllostomus hastatus* only in Amazonian South America, and that it is replaced by *guimaraesi* on *P. h. panamensis* in northern South America and Central America.

Genus **Paratrichobius** Costa Lima

Paratrichobius Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Veter., Nictheroy, 5: 20 (diagn.), 25 (keyed), 28 (cat.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 12 (keyed), 19 (diagn.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 655. Curran, 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed), 7 (discuss.). Jobling, 1936, Parasitology, 28: 359 ff. (morph.). Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, 12: 265, 267 (discuss.). Jobling, 1939, Parasitology, 31: 490 (diagn.). Bequaert, 1940, Rev. Acad. Colomb., Cienc. Exact., Fis. y Nat., 3: 417 (keyed) ; 1942, Bol. Ent. Venez., 1: 86 (keyed). Jobling, 1949, Parasitology, 39: 321 (keyed). Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 177 (keyed), 187. Maa, 1965, Jour. Med. Ent., 1: 389 (cit., cat.).

Type-species: *Trichobius longicrus* Miranda Ribeiro, 1907.

Paratrichobius, and the related genera, *Neotrichobius* and *Megistopoda* appear to have been derived from the *phyllostomae* group of the genus *Trichobius.* All of these occur on fruit-eating bats of the subfamilies Stenoderminae or Sturnirinae. They share a number of characters, including the large multi-faceted eyes; the presence of a female postgenital sclerite, similar to that found in the *caecus* group of *Trichobius;* the fusion of the cerci to the ventral arc in the female; and the distal insertion on at least one gonapophysis (male) of at least one of the ventral, paired gonapophyseal setae. In addition, *Paratrichobius, Neotrichobius,* and *Megistopoda* have a very similar shield-like thoracic venter. *Paratrichobius* appears to be the least, and *Neotrichobius* the most specialized genus.

The species of *Paratrichobius* have presented us with some of the most difficult taxonomic problems in the current study. Unfortunately, the paucity of material has prevented us from resolving many of these problems. Only two species, *P. longicrus* (M. Ribeiro) and *P. dunni* (Curran), have been described, but it is obvious from our material that a number of species, or other segregates, occur on various genera and species of the host bats. In Panama, the most confusing complex, taxonomically, is a series of segregates related to *P. longicrus* that occur on *Artibeus toltecus, A. aztecus, A. jamaicensis, A. lituratus palmarum,* and *Vampyrops vittatus.* They are very similar in chaetotaxy, but they differ, some conspicuously, in relative and absolute length of the wings and hind femora, and some in the number of setae present on sternum II and on the female seventh sternites. Our series are too small to permit significant analysis of these differences. Further, it appears that there may have been some contamination, temporary transfers, and misidentifications of hosts, which complicate analysis of the data.

The *Paratrichobius* from *A. jamaicensis* and *A. lituratus* (fig. 88A) differ from the others in having less strongly curved male gonapophyses, which are nearly identical in both samples. Their measurements, too, are very similar, though the specimens from *A. jamaicensis* appear to be slightly smaller and to have shorter wings in the male than do those from *lituratus.*

The segregates from *A. aztecus, A. toltecus,* and *Vampyrops vittatus* have more strongly curved male gonapophyses (fig. 88B–D). As can be seen in fig. 89, the specimens from *V. vittatus* have longer wings than do any others excepting those from *A. aztecus,* and they differ significantly from all others in the small number of discal and submarginal setae on sternum II. The specimens from *A. toltecus* have shorter hind femora than do any others of this complex, and in this respect they approach *dunni* (Curran), *salvini* n. sp., *lowei* n. sp., *sanchezi* n. sp., and species A and B from *Chiroderma villosum* and *Vampyrops helleri,* respectively. The least reliable measurements are those of the hind femora. These appear to be bowed more than normally under certain conditions of preservation, especially after treatment with KOH, and mounting on slides.

It is our opinion that at least some of these segregates are either cryptic species or populations that are now speciating on the Stenoderminae. Interestingly, the taxonomic complexities in the *longicrus* complex roughly parallel those of their hosts. It would seem that the hosts and their parasites are at the various levels of taxonomic differentiation to be expected in groups that are rapidly evolving. However, it is also possible that the segregates of the *longicrus* complex represent different developmental responses to different hosts or ecological situations, or represent local popu-

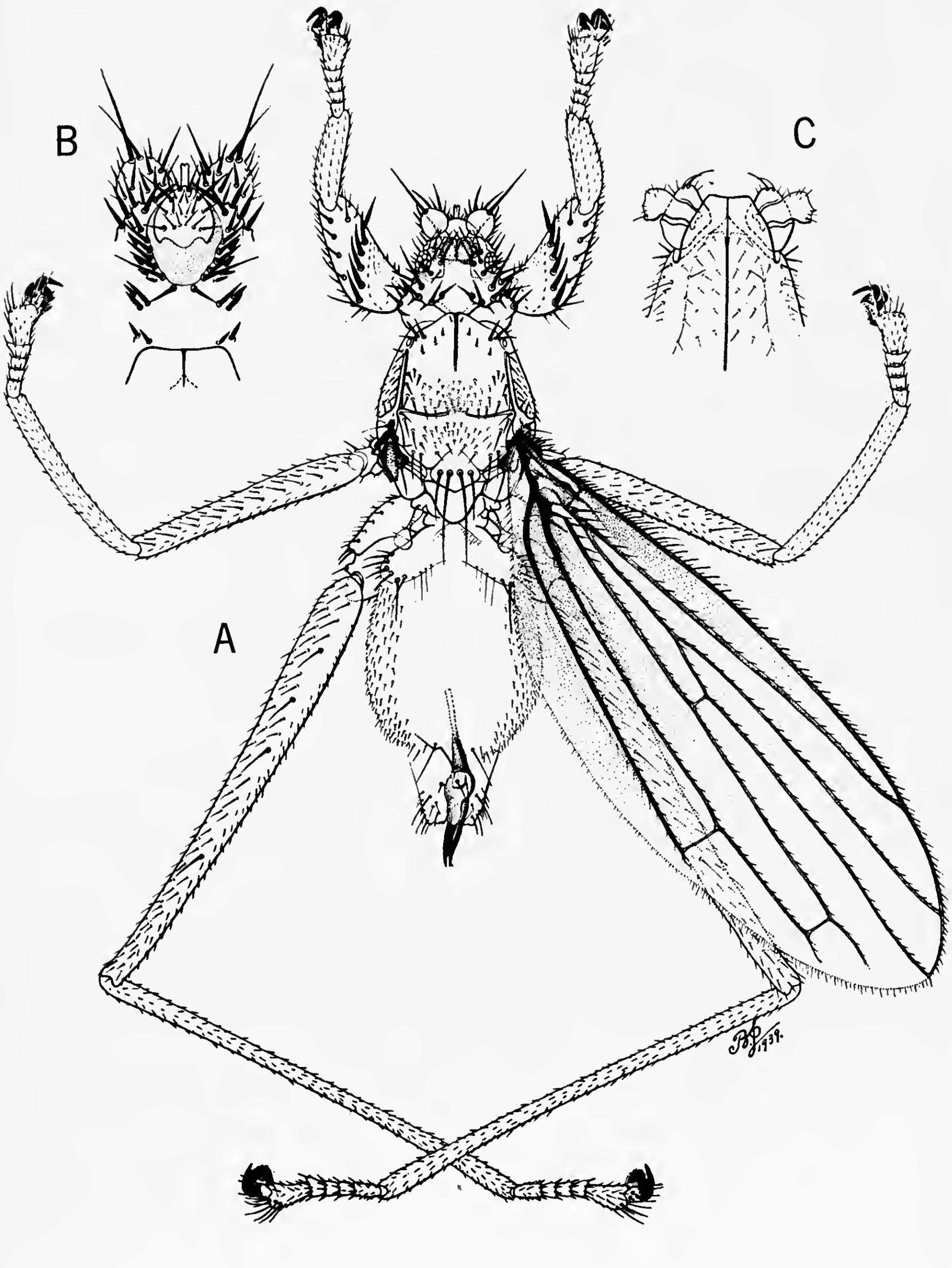


Fig. 86. *Paratrichobius longicrus* (M. Ribeiro), male from *Artibeus j. palmarum*, TRINIDAD. A, dorsal view. B, underside of head. C, anterior portion of venter of thorax. From Jobling (1939a).

lation differences in gene frequency. Much more material and biological information are needed in order to pursue these problems further. The altitudinal distribution of the hosts should be noted (fig. 89) in evaluating the differences between the flies.

Paratrichobius longicrus (Miranda Ribeiro). Figure 89.

Trichobius longicrus Miranda Ribeiro, 1907, Arch. Mus. Nac., Rio de Janeiro, **14**: 236, pl. 25—Quinta da Boa Vista [Rio de Janeiro], Brazil, from *Artibeus jamaicensis* (? Museu National de Rio de Janeiro).

Paratrichobius longicrus Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 20, pl. 1, fig. 3 (wing). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 656 (cat.). Pessôa and Guimarães, 1937 (part. ?), Ann. Fac. Med. São Paulo, **12**: 265 (cit. host records). Jobling, 1939, Parasitology, **31**: 492 (part., record from *A. jamaicensis*, Brazil only). 1949, ibidem, **39**: 327 (part., records from *A. jamaicensis*, Brazil only).

We provisionally accept the determination of the type host of *P. longicrus* as *A. jamaicensis,* though it may have been incorrect.[10] The type host was later given by Jobling (loc. cit.) following Stiles and Nolan (1931), as *A. j. jamaicensis.* This is an obvious error. The nominate race of *jamaicensis* does not occur in southern Brazil.

We assign the Panamanian specimens taken from *A. j. jamaicensis* to *P. longicrus.* However, it is possible that *A. jamaicensis* is parasitized by a different species of *Paratrichobius* in southern Brazil than it is in Panama. It is our opinion that this bat does not normally harbor a species of *Paratrichobius,* but instead harbors *Megistopoda aranea* (Coquillet). Of 103 Panamanian specimens of *A. j. jamaicensis* that were parasitized by Streblidae, 56 (54.4%) carried *M. aranea* and only 4 (3.8%) carried a *Paratrichobius* sp. (a total of 5 specimens). Other typical parasites of *jamaicensis,* such as *Aspidoptera busckii* and *Metelasmus pseudopterus* occurred on 49.5% and 20.4% of the parasitized hosts, respectively. Only parasites that were obvious transients or contaminants, like *Trichobius joblingi* n.sp. or *Strebla vespertilionis* showed as low an incidence of parasitization as did *Paratrichobius longicrus.* This suggests that *A. jamaicensis* is acquiring its *Paratrichobius* from another lowland host, possibly *A. lituratus palmarum.* The only specimens which show close concordance in their measurements with those from *jamaicensis* are those from *A. lituratus.* However, in spite of the small number of specimens measured, the differences between individuals from the two hosts lead us to treat them separately until further data permit clarification of their status. The average number of discal setae on sternum II was 14 in both sexes, with a range of 12–16.

PANAMANIAN MATERIAL EXAMINED: From *Artibeus j. jamaicensis,* 5 (4 bats), as follows: 2, Almirante (Bocas del Toro), 28 January 1960; 1, Fort Kobbe (Canal Zone), 13 October 1960; 1, Guánico (Los Santos), 12 January 1962; 1, La Laguna (Darién), 17 June 1963, GML.

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[10] The taxonomy of the genus *Artibeus* has been much confused. A revision by C. O. Handley, Jr. is in press.

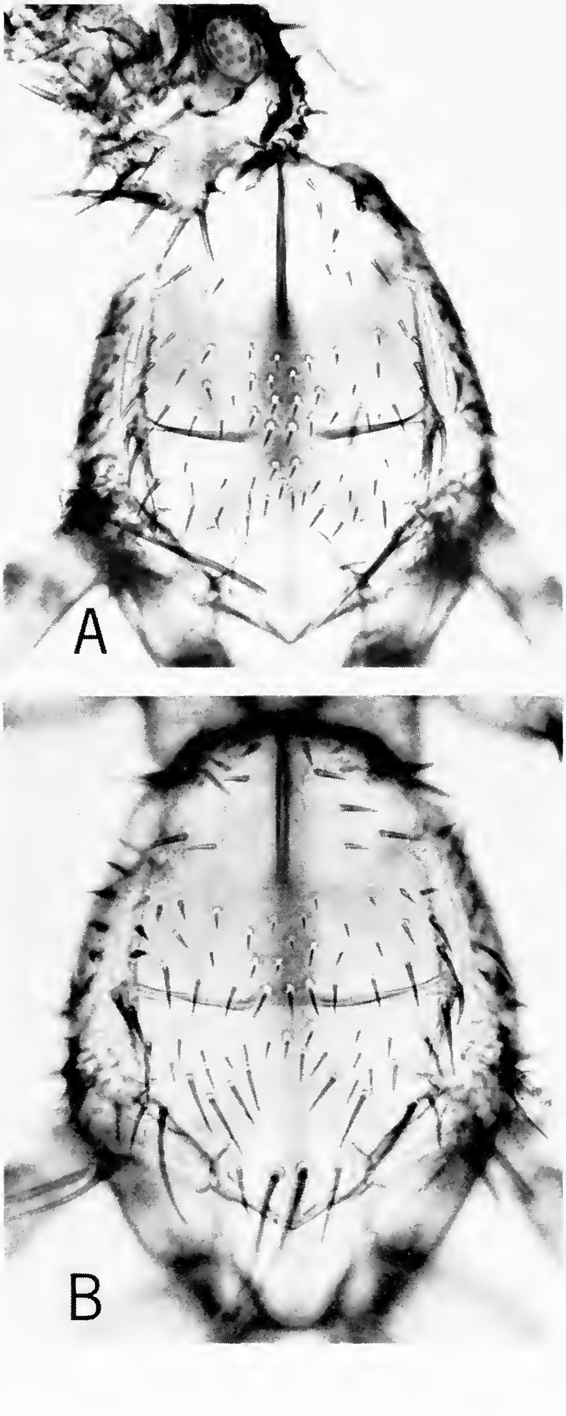

Fig. 87. Thorax, dorsal view, *Paratrichobius* spp. (*longicrus* complex). A, male from *Vampyrops vittatus* (no. 8612) Río Changena Camp (Bocas del Toro). B, male from *Artibeus aztecus* (no. 10344), Casa Tilley, Cerro Punta (Chiriquí).

Paratrichobius sp. (? *longicrus* M. Ribeiro) from *Artibeus lituratus palmarum.* Figures 86, 88A, 89, 91B.

Paratrichobius longicrus (? not M. Ribeiro, 1907). Jobling, 1939, Parasitology, **31**: 490–92, (part., from *A. jamaicensis palmarum*), fig. 2. Bequaert, 1942, Bol. Ent. Venez., **1**: 88. Jobling, 1949, loc. cit., **39**: 316–317 (part., from *A. jamaicensis palmarum*), fig. 1B, C. Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., **122**: 261. Starrett and de la Torre, 1964, Zoologica, **49**: 61.

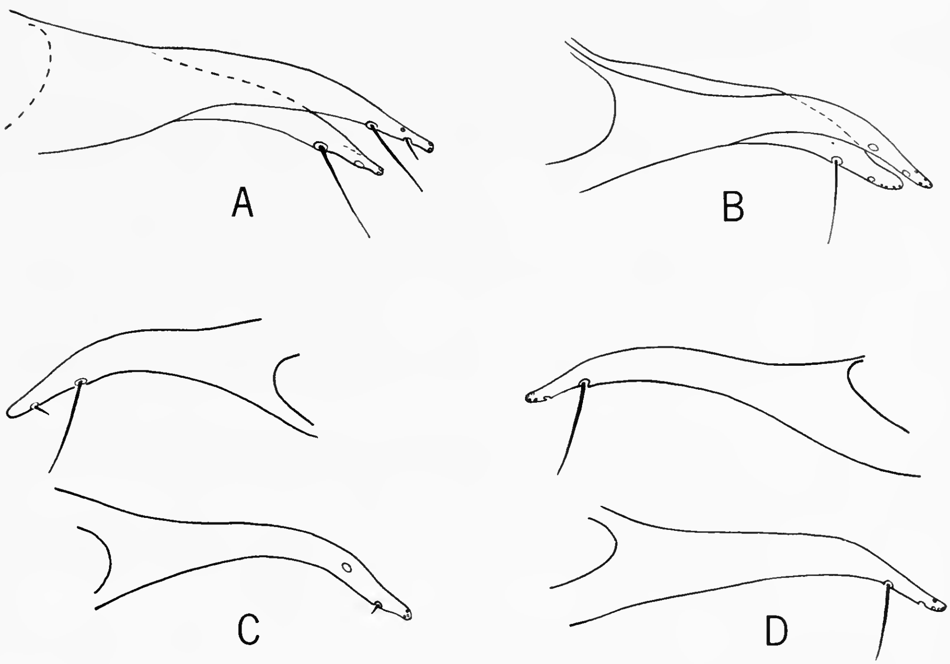

Fig. 88. Male gonapophyses, *Paratrichobius* spp. (*longicrus* complex). A, *P. longicrus* (M. Ribeiro), left gonapophysis, specimen from *Artibeus lituratus* (CNHM no. 94666), Morretinho (São Paulo), BRAZIL. B, left gonapophysis, specimen from *Artibeus aztecus* (no. 10344), Casa Tilley, Cerro Punta (Chiriquí). C, right (upper) and left (lower) gonapophyses of specimen from *A. toltecus* (no. 8116), near Mojica (Bocas del Toro). D, same of specimen from *Vampyrops vittatus* (no. 8612) Río Changena Camp (Bocas del Toro).

Mr. B. Jobling informed us (pers. comm.) that the specimen figured by him (1939, 1949) as *P. longicrus* is from *Artibeus jamaicensis palmarum* (= *A. lituratus palmarum*).

The small numbers of *A. lituratus palmarum* and its parasites that were collected and examined in Panama make it difficult to analyze the parasites of this host. It may be that *palmarum* is normally parasitized only by *Paratrichobius.* These were recovered from 12 (70.6%) of 17 host bats parasitized by Streblidae. A single specimen of *Aspidoptera phyllostomatis* was also taken from them as were two *Megistopoda aranea.*

Although the sample is small, the wing measurements (fig. 89) of the specimens from *A. lituratus palmarum* suggest that two categories of wing lengths are represented. The "long-winged" males and females are from Bocas del Toro (22 mi. S. of Changuinola), while all of the "short-winged" forms except one (from Sibube, Bocas del Toro) are from San Blas. The short-winged forms have fewer discal setae on sternum II, 9–11 in the male, as opposed to 16–18 in the long-winged forms.

Among various possibilities, it may be suggested the long and short-winged forms could represent contaminations, geographic segregates, dimorphism, or different host segregates. The latter should not be overlooked in view of the complex taxonomic problems in the genus *Artibeus*. Extensive and geographically representative collections are needed to clarify the status of the *Paratrichobius* on *A. lituratus*.

PANAMANIAN MATERIAL EXAMINED: From *Artibeus lituratus palmarum* (18 flies in 9 lots from 7 bats) as follows: 7, 22 miles south of Changuinola (Bocas del Toro), 7 September 1961; 1, Sibube (Bocas del Toro), 27 January 1963, C. O. Handley, Jr.; 2 (1 bat), railroad area south of Paráiso (Canal Zone), 5 November 1959; 5 (1 bat), Kobbe Beach (Canal Zone, 12 November 1956; 3 (3 bats), Barro Colorado Island (Canal Zone), 11 and 12 December 1956 and 12 January 1957.

Paratrichobius sp. (*longicrus* complex), from *Vampyrops vittatus*. Figures 87A, 88D, 89.

Specimens from this host differ rather markedly from the others in the small number of discal setae on sternum II. The number ranged from 7–13, with a mean of 10, in 22 specimens checked.

PANAMANIAN MATERIAL EXAMINED: 22 males and 10 females in 22 lots from 22 bats, as follows: 1, Rancho Caballero (Bocas del Toro), 11 September 1961; 2 (2 bats), Rancho Mojica (Bocas del Toro) and 1, near Rancho Mojica, 9 to 13 September 1961; 13 (9 bats), Río Changena Camp (Bocas del Toro), 28 September 1961; 6, Cerro Malí (Darién), elevation 4800 feet, 1 May and 1 to 6 June 1963, GML; 3, same locality, 4 February 1964, C. O. Handley, Jr.; 5, Cerro Tacarcuna (Darién), 4 and 7 March 1964.

REMARKS: Males were present on 20 of the 22 *Vampyrops vittatus* parasitized by *Paratrichobius,* whereas females were present on only eight. Seventeen bats had only a single fly; in 13 instances, these flies were males. Most of the hosts were collected in mist nets. We are not in a position to explain these sex ratios. It is possible that the females may leave the host more readily when disturbed, than do the males, or that a smaller percentage of them stay with the host bats when they leave the roost. It hardly seems likely that this differential represents the number of females that are off the host depositing pupae at any one time.

Paratrichobius sp. (*longicrus* complex) from *Artibeus aztecus*. Figures 87B, 88B, 89.

The wings of this form are the longest, in relation to the length of the hind femora, of any examined. The number of discal setae on sternum II

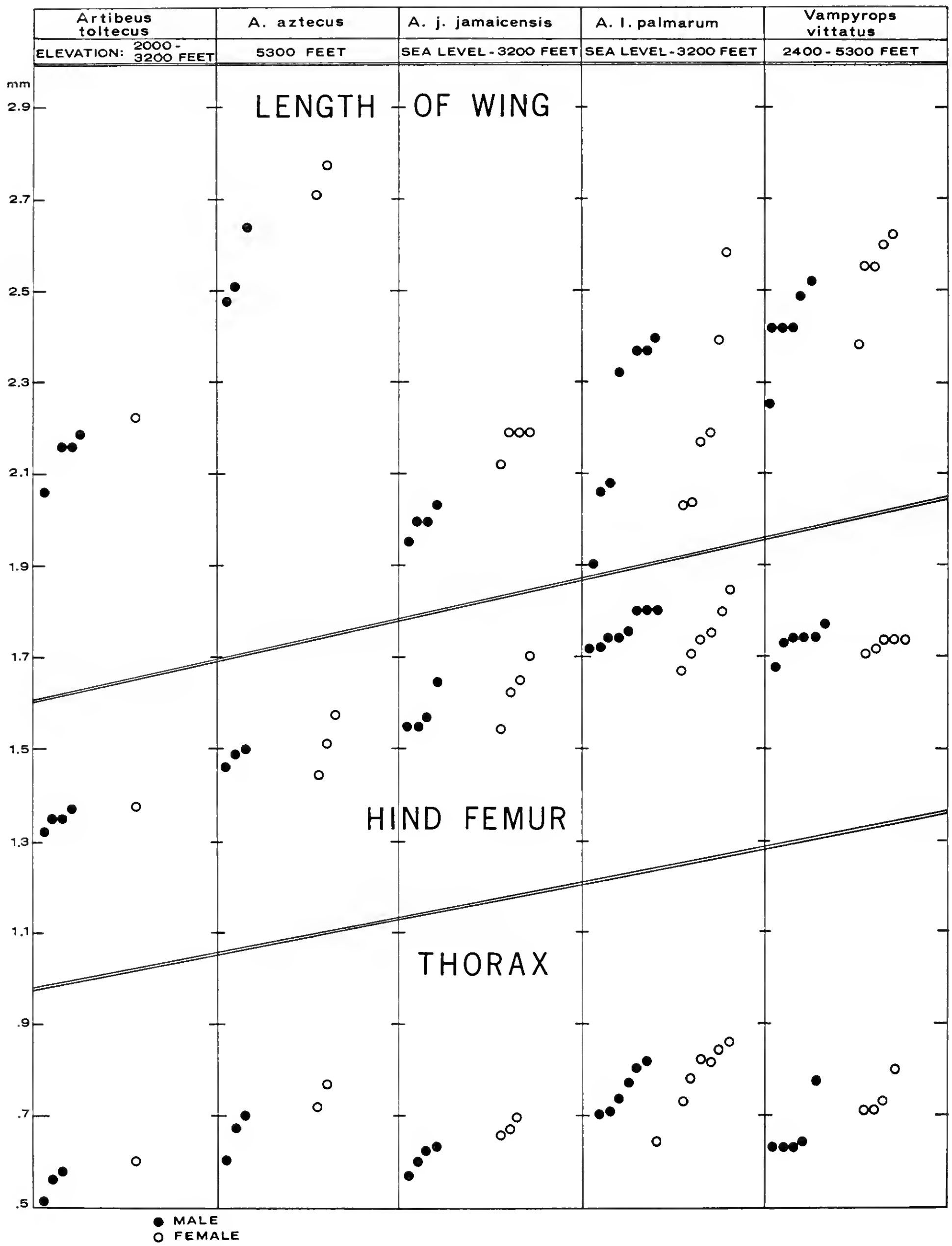

Fig. 89. *Paratrichobius longicrus* complex. Measurements of length of wing, hind femur, and thorax of specimens from hosts indicated at head of columns. All measurements are for specimens collected in Panama.

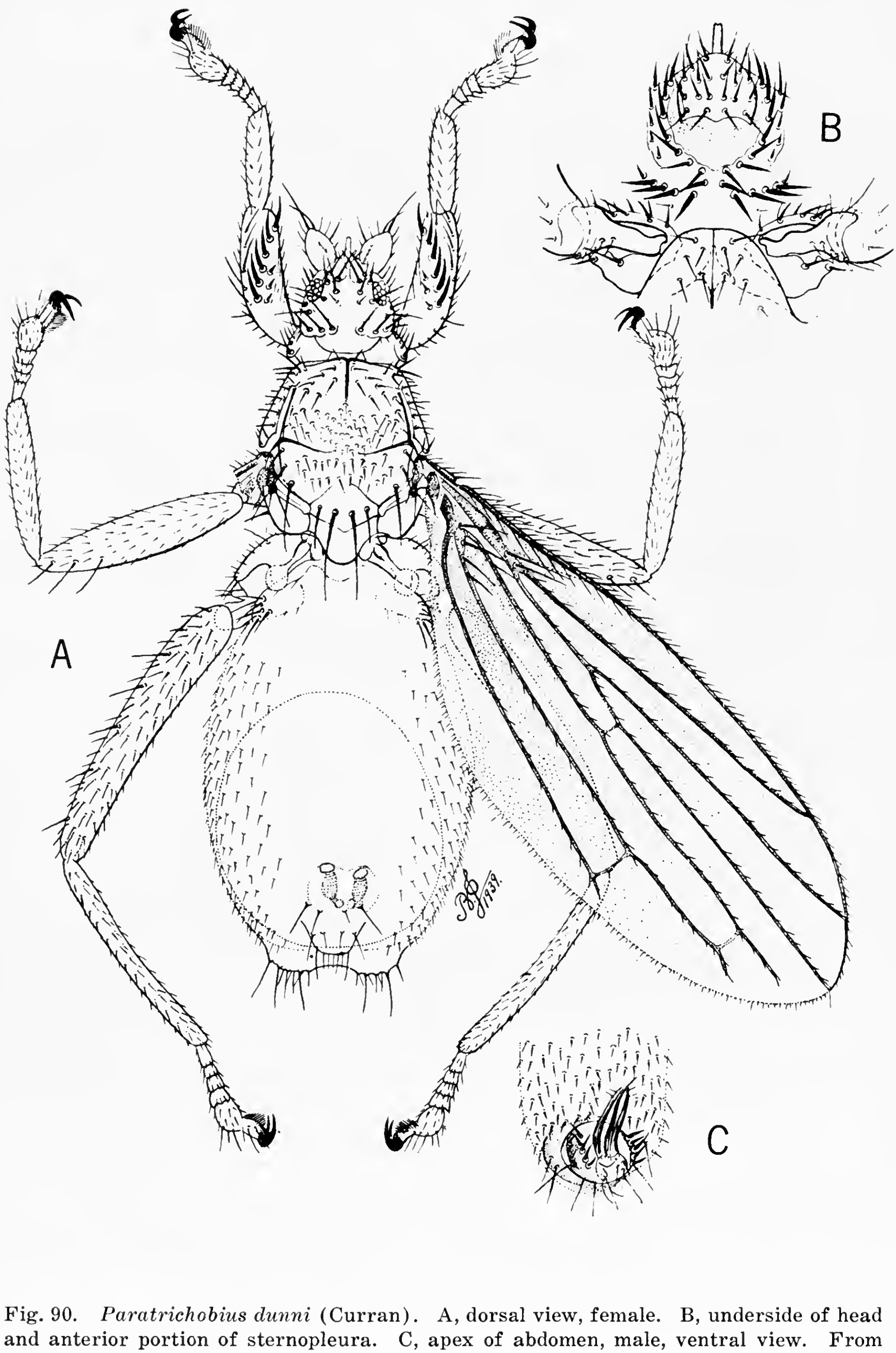

Fig. 90. *Paratrichobius dunni* (Curran). A, dorsal view, female. B, underside of head and anterior portion of sternopleura. C, apex of abdomen, male, ventral view. From Jobling (1939a).

was 11, 12, 16, and 17 in the four males, and 15 and 18 in the two females.

MATERIAL EXAMINED: 5 (1 bat), Casa Tilley (Chiriquí), 11 March 1962; 1, same locality, 1 May 1960.

Paratrichobius sp., from *Artibeus toltecus.* Figures 88C, 89.

Measurements could be made on only four of the six specimens taken from *A. toltecus.* These flies are smaller than any of the others, but have proportionately longer wings. The number of discal setae on sternum II ranged from 11–15 (12 on the single female), with a mean of 13 for the four males.

MATERIAL EXAMINED: 6 (6 bats): 2, Rancho Mojica (Bocas del Toro), 13 September 1961; 1, Río Changena Camp (Bocas del Toro), 20 September 1961; 2, Casa Lewis (Chiriquí), 1 and 5 February 1960; 1, Casa Tilley, Cerro Punta (Chiriquí), 24 April 1961.

Paratrichobius dunni (Curran). Figures 90, 91A, 92A.

Speiseria dunni Curran, 1935, Amer. Mus. Novit., no. 765, p. 7, fig. 6—El Real, Panama, from either "*Pteropteryx* [sic!] *canina* or *Uroderma bilobatum*" (American Museum of Natural History).

Paratrichobius dunni Jobling, 1939, Parasitology, 31: 492–494, fig. 3A–C. Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418.

This distinctive species appears to be restricted to *Uroderma bilobatum.* It is related to *salvini,* but differs markedly in that the males possess spine-like setae along the ventro-apical margins of tergum IX (fig. 91A). It also differs in having more extensive prescutal chaetotaxy.

There can be little doubt that the type host of *P. dunni* was *Uroderma bilobatum,* since the species of *Paratrichobius* are apparently restricted to Stenoderminae. *Peropteryx* is a genus of Emballonuridae. The only streblid we have seen from *Peropteryx* is an undescribed species of *Trichobius.* Curran's two paratypes of *dunni* were taken from *U. bilobatum* at Summit (Canal Zone).

Measurements:	BL	TL	WL	WW	FL
Male	1.54–1.76	0.56–0.62	1.21–1.22	0.60	0.48
Female	1.59–1.76	0.59–0.63	1.35–1.59	0.63–0.69	0.49

PANAMANIAN MATERIAL EXAMINED: From *Uroderma bilobatum,* 146 flies in 41 lots (57 bats), as follows: 32 (17 bats), Summit Gardens (Canal Zone), 11 September 1959; 8, same locality, 31 May 1960; 17 (4 bats), palm trees, Fort Randolph (Canal Zone), 6 October 1959; 5, France Field, 3 August 1960; 9 (2 bats), Fort Davis (Canal Zone), 14 and 22 September 1960; 24 (11 bats), Fort Clayton (Canal Zone), 28 November 1960; 1, Almirante (Bocas del Toro), 28 January 1960; 1, Sibube (Bocas del Toro), 26 January 1963, C. O. Handley, Jr.; 1, Escobal (Colón), 28 September 1960; 9 (4 bats), Punta de Cocos, Isla del Rey (Darién), 22 and 25 March 1960; 7 (5 bats), Punta de Piña (Darién), 24 March 1960; 8 (7 bats), Puerto Obaldía (San Blas), 3 and 4 April 1963, C. O. Handley, Jr. and F. M. Greenwell; 24, Armila (San Blas), 29 March and 1 April 1963, same collectors.

REMARKS: A single specimen was labeled as from *Vampyressa* sp., Río Mandinga (San Blas), GML, 29 May 1957. *Uroderma bilobatum* was collected on the same day and it is possible that the specimen of *dunni* was a stray from *Uroderma.*

Paratrichobius lowei Wenzel, new species. Figures 92B, 93.

Superficially resembling *P. dunni* (Curran) in size and mesonotal chaetotaxy and, like it, having spine-like setae along ventro-apical margin of tergum IX. It differs in having an irregular oblique double row of setae, the upper two or three minute but distinct, medial and parallel to the row of

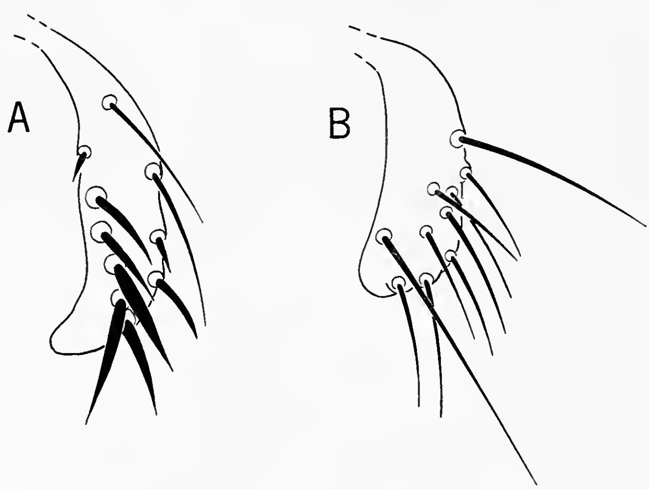

Fig. 91. Left side of tergum IX (of male hypopygium), ventral view of ventro-apical margin. A, *Paratrichobius dunni* (Curran), from *Uroderma bilobatum,* Summit Gardens (Canal Zone). B, *P. longicrus* (M. Ribeiro), from *Artibeus lituratus* (same data as fig. 88A).

heavy profemoral setae in *dunni* this row is incomplete and two or three of the upper setae are short spines. It also differs from *dunni,* and from all other known species of the genus, in that the usual profemoral spines are only strong setae.

DESCRIPTION: *Head.*—Eyes with 25–27 facets. Laterovertices with six setae, all strong, except for a very short weak seta in postero-lateral angle. Occipital lobes with about six strong long marginal setae plus a very long one (about as long as head) on antero-lateral lobule; posterior and ventral to these a row of six to eight shorter but strong subspiniform setae; one or two of marginal occipital setae are conspicuously longer macrosetae, one at medial edge, another one-third from inner margin. Postgenae on each side behind oral cavity with four or five short spinelets in a transverse row; posterior to the outer spinelets are two or three shorter, finer ones.

Thorax.—Anterior margin of prescutum biconcave for reception of occipital lobes, projecting at middle; median suture extending to about middle, transverse suture interrupted at middle; a spiracular and prespiracular bristle present; anterior half of prescutum with 13–14 additional stronger setae; basal half with similar setae laterally, setae becoming fine and dense at middle. Scutum with long strong setae along sides, these continued medially as a W-shaped antescutellar row whose bristles are slightly shorter and finer medially, two or three at middle conspicuously shorter; scutum elsewhere with dense fine short setae. Mesepisternum above with 16–20 bristles.

Median pleurotrochantinal lobe long, apically narrowed, sharply reflexed dorsally but not united with the metepimeron. *Wings.*—R_s varying in length from slightly less to slightly more than twice distance from fork to crossvein *r-m;* R_1 with setae to base. *Legs.*—Inner (anterior) face of profemora with a diagonal row of six stout bristles rather than spines, ventral to these an irregular row of six or seven short setae, the basal one minute; ventral half of inner face with numerous short bristles. Bristles of submarginal row on outer face of hind femur distinctly projecting beyond ventral margin of femur throughout its length.

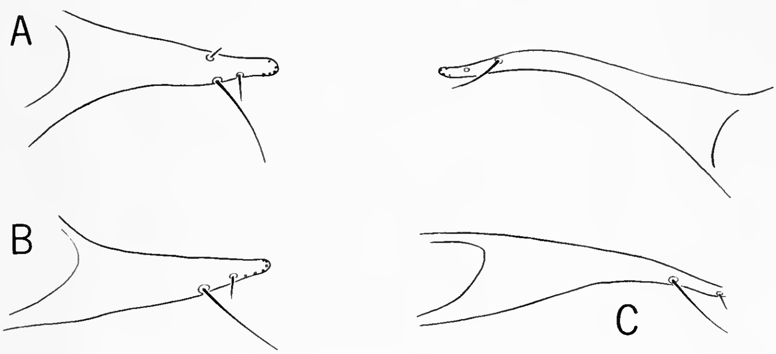

Fig. 92. Male gonapophyses of species of *Paratrichobius.* A, left gonapophysis, *P. dunni* (Curran), from *Uroderma bilobatum* (no. 6591), Fort Clayton (Canal Zone). B, same, *P. lowei,* new species, paratype from *Artibeus cinereus* (no. 11428), Armila (San Blas). C, right (upper) and left (lower) gonapophyses, *P. sanchezi,* new species, paratype from *Enchisthenes hartii* (MA no. 389), Rancho Grande (Aragua), VENEZUELA.

Abdomen.—Lateral lobes of tergum I+II each with three or four fine shorter bristles along inner dorsal margin; posterior margin with a double row of about 12–13 coarse bristles, those of anterior row longest; setae becoming shorter ventrally. Sternum I with three spine-like bristles on each lateral lobe. Sternum II with 30–34 discal setae in a median triangular area; posterior margin with 20–22 bristles, those near middle of about same length as discals, the outer ones a little longer. Dorsal connexivum bare, with four pairs of minute segmental setae; lateral and ventral connexivum covered with nearly uniform, short, conspicuous setae, these slightly longer basally on ventral connexivum. Mesepimeron (above) with 16–20 bristles. *Female:* Tergum VII transverse, its anterior margin slightly emarginate at middle; with a pair of lateral macrosetae and between and slightly posterior to these a pair of short setae. Supra-anal plate with four apical macrosetae and on each side near mid-length, a short seta. Seventh sternites with 9–12 setae, one a conspicuously long macroseta. *Male:* Sternum V with setae of apical margin mostly of about the same size as discals, excepting a pair of macrosetae on each side. Hypopygium dorsally with a postero-lateral macroseta and a shorter seta on each side of sternum VII+VIII; tergum IX apically with a row of about six fine macrosetae, and on each inner ventro-apical margin a row of about five stout setae, the three middle ones spine-like; a short seta anterior to these. Gonapophyses as in fig. 92B.

Measurements:	BL	TL	WL	WW	FL
Male	1.48–1.73	0.36–0.38	1.50–1.58	0.63–0.66	0.82–0.85
Female	1.76–1.95	0.41–0.44	1.59–1.74	0.66–0.71	0.80–0.91

TYPE MATERIAL: Holotype male (slide) from *Artibeus cinereus watsoni* (host no. 11964), Armila (San Blas), 27 March 1964, Charles O. Handley and Francis M. Greenwell. Allotype female, same locality, collectors and host (no. 11678), 16 March 1963; in the collection of Chicago Natural

Fig. 93. Thorax, dorsal view, *Paratrichobius lowei*, new species, holotype.

History Museum. Paratypes.—5, same data as the holotype, but 28 February to 4 March 1963; 2, same host, Río Tuira (Darién), 8 March 1958, P. Galindo [GML]. Paratypes in the collections of Chicago Natural History Museum, the United States National Museum, and the Gorgas Memorial Laboratory, Panamá, Panamá.

REMARKS: This species is named for Mr. Wilbur Lowe, in appreciation of his valuable assistance in the laboratory of the Environmental Health Branch, at Corozal.

Paratrichobius sanchezi Wenzel, new species. Figures 92C, 94.

Similar in size and appearance to *P. dunni* but differing markedly in having a row of seven to eight short setae parallel to the stout spines on the inner face of the profemur and in lacking stout spine-like setae along inner ventro-apical margins of tergum IX. Also resembling *P. lowei* n.sp., but in *lowei* the usual prefemoral spines are represented by strong setae; as in *dunni*, the ventro-apical margins of tergum IX have spinelike setae.

DESCRIPTION: Head.—Eyes large, with ±25 facets. Laterovertices with six setae, the most anterior ones very short, the most postero-medial seta as well developed as most others, but the seta immediately anterior to it a conspicuously long macroseta. Occipital lobes narrow, posterior margin festooned with six stout marginal setae and, postero-ventral to these, five or six short spine-like setae; antero-laterally is a much

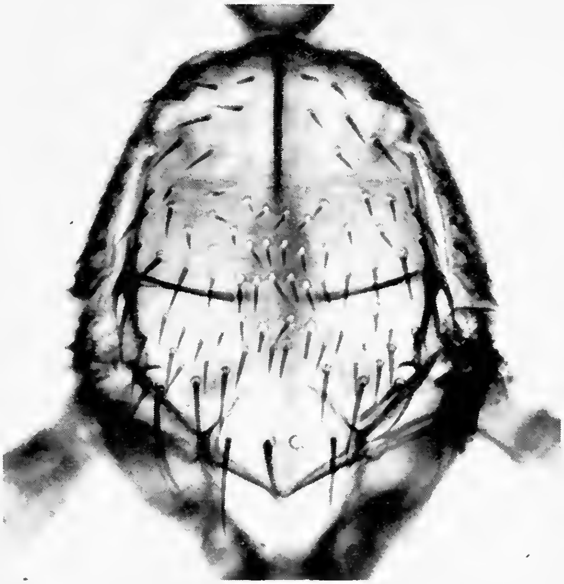

Fig. 94. Thorax, dorsal view, *Paratrichobius sanchezi*, new species, paratype female from *Enchisthenes hartii* (MA no. 326), Rancho Grande (Aragua), VENEZUELA.

longer macroseta that is conspicuously longer than the head. Postgenae, posterior to oral cavity, with one or two short black thorn-like setae on each side, and posterior to these, two others, followed by four or five fine stout setae.

Thorax.—Prescutum about as long as broad; anterior margin biconcave for reception of occipital lobes, slightly but distinctly produced at middle. Median suture extending posteriorly beyond middle; transverse suture indistinct at middle. Prescutum with eight or nine setae on each side of anterior half, the three antero-lateral bristles coarser and longer, one small bristle each side of median line on anterior projection; posterior half with two or three bristles along margin of longitudinal cleft, and about 10 in front of transverse suture, these becoming shorter and finer medially; anterior to these an irregular transverse band of 15–22 fine shorter setae. Scutum with a W-shaped row of 12–14 coarse bristles and anterior to these an irregular W-shaped row of 14–18 shorter bristles, similar to median setae in front of transverse suture. Mesepisternum with about 21 bristles in an irregular double row along dorsal and posterior margin, these coarser and longer along dorsal edge. Venter with scattered fine setae; a short angulate pleurotrochantinal lobe present. *Wings.*—R_s about twice as long as distance from fork to *r-m*. All longitudinal veins except costa with extensive bare areas basally, those of fifth and sixth veins twice as long as the others. Profemora as in *dunni* but with a row of seven or eight short setae medial to and paralleling the oblique row of six stout spines. Hind femora and tibiae slightly bowed, the femora clothed with short semi-recumbent setae except along inner face on basal third; about six conspicuously longer setae on dorsal margin and a lateral one near apex; ventral submarginal row projecting below margin and visible in profile for entire length.

Abdomen.—Inner dorsal margins of lateral lobes of tergum II each with three or four fine setae, posterior margin with 9–12 coarse setae, the most dorsal of these longest. Connexivum bare dorsally along middle except for four pairs of well-developed segmental setae; lateral connexivum with very short setae, the ventral setae conspicuously longer. Sternum I with two or three spines on each side. Sternum II with 10–12 discal and ±14 marginal setae. *Female:* Tergum VII with a macroseta on each side and medial and posterior to these a pair of short setae. Supra-anal plate with four apical macrosetae and a short seta on each side near mid-length. Seventh sternites with 10–13 setae, most of them rather short, two or three much longer, one a conspicuously long macroseta. *Male:* Hypopygium with a macroseta on each side on sternum VII+VIII; tergum IX fringed apically with nine or ten macrosetae; IX also with six or seven shorter setae ventro-laterally on each side. Gonapophyses as in fig. 92C, slender, sinuate above near apex.

Measurements:	BL	TL	WL	WW	FL
Male	1.54–1.99	0.66–0.68	1.81–1.99	0.71–0.73	1.07–1.15
Female	1.70–1.78	0.60–0.67	1.90–2.03	0.71–0.80	1.08–1.17

TYPE MATERIAL: PANAMA.—Holotype male from *Enchisthenes hartii* (GML host no. 400,370), Cerro Malì (Darién), elevation 4800 feet, 6 June 1963, GML; allotype female same host (no. 9807-B), Cerro Hoya (Los Santos), 8 February 1962, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum. Paratype.—A female, same data as the allotype, but 9 February 1962.

VENEZUELA.—Paratypes, from *Enchisthenes hartii:* 2, Biological Station, Rancho Grande (Aragua), 1090 meters elevation, 10 August 1962, C. Machado and R. Antequera; 4, same locality but 21 August 1962, J. V. Scorza and C. Machado; 8, same locality, 29 August 1962, J. V. Scorza and C. and A. J. Machado. Paratypes in the collections of the United States National Museum; Chicago Natural History Museum; Faculdad de Ciencias, Universidad Central de Venezuela; and the Gorgas Memorial Laboratory, Panamá, Panamá.

REMARKS: This species is named for Mr. Pantaleon Sanchez, of the Environmental Health Branch at Corozal, in appreciation of his valuable assistance in the field work in Panama.

Paratrichobius salvini Wenzel, new species. Figures 95, 96C.

Similar to *P. dunni* (Curran); like it having only a couple of spinelets and a bristle medial and parallel to upper end of oblique row of profemoral spines, rather than a complete row of setae; differing from *dunni* in having a longer thorax and less dense and extensive mesonotal chaetotaxy; and in having normal rather than spine-like setae along ventro-apical margins of tergum IX.

DESCRIPTION: Head.—Dorsum as in *lowei;* the seta in postero-median angle of laterovertices very short, weak. Postgenae with a row of about five spinelets on each side behind oral cavity, the outer ones shorter; above and posterior to these another small spinelet and several fine short setae. *Thorax.*—Prescutum on anterior half with spiracular and prespiracular and about 12 other semi-erect or erect bristles, separated from semi-recumbent setae of posterior half by a bare transverse area; setae at sides of posterior half longer and stronger than those at middle, which form a small dense patch.

Scutum with an irregular W-shaped row of minute setae in front of the antescutellar row. Mesepisternum with about 14 bristles along dorsal margin. Pleurotrochantinal lobe long, tapered, sharply reflexed dorsally, not united with metepisternum. *Wings.*—R_s about twice as long as distance from fork to crossvein *r-m*. *Legs.*—Inner (anterior) face of profemora with a minute bristle and two short spinelets medial to upper end of

Fig. 95. Thorax, dorsal view, *Paratrichobius salvini*, new species, female from *Chiroderma salvini* (GML no. 300,079), Tacarcuna (Darién).

oblique row of seven spines and another one or two very short but stout setae near apex of row; last spine of oblique row curved; inner face medial to these otherwise without setae except four or five very short ones near base. The hind femora not markedly swollen basally; setae of ventral submarginal row very short and inconspicuous apically, not projecting beyond lower edge of femur.

Abdomen.—Lateral lobes of tergum I+II with about three or four very fine setae on inner dorsal margin and a double row of about 12–14 coarse setae on posterior margin, these shorter ventrally. Connexival setae short, slightly longer ventrally; mid-dorsum bare except for four pairs of minute segmental setae. *Female:* Tergum VII transverse, narrowly elliptical; chaetotaxy of VII and supra-anal plate as described for *lowei* and *sanchezi*, the macrosetae fine. Sternum II with about 23–27 discal and 14–16 evenly distributed marginal setae, these shorter posteriorly, both on disk and along margin;

seventh sternites with about 10 setae, one or two conspicuously long. Discal and lateral marginal setae a little heavier, a pair of long slender setae each side of middle, separated by a pair of short setae. *Male:* Sternum II with 14–28 discal and 18–26 marginal setae. Sternum V feebly sclerotized, only about half as wide as sternum II; setae rather uniformly short except for setae of apical margin which are slightly longer and become

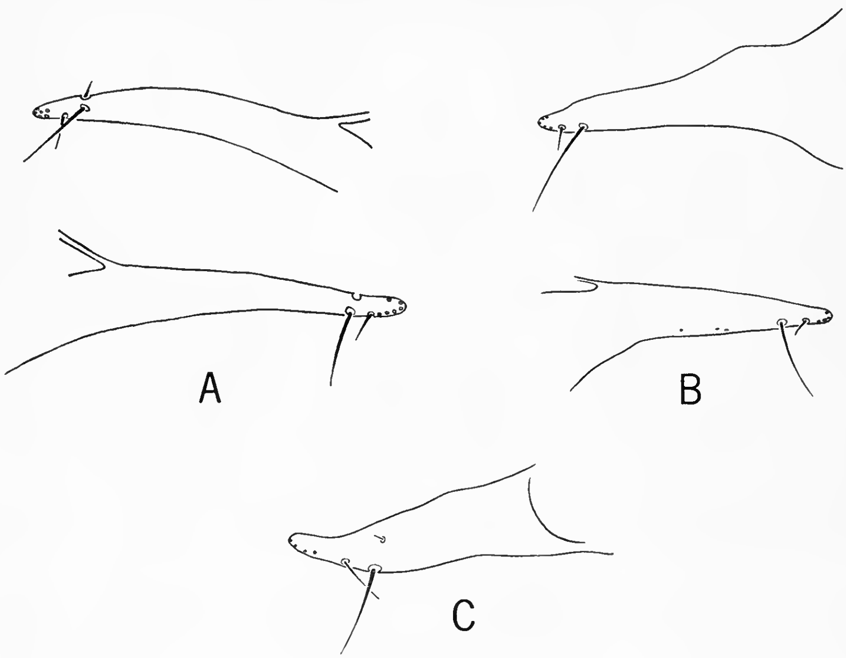

Fig. 96. Male gonapophyses of species of *Paratrichobius*. A, right (upper) and left (lower) gonapophyses of specimen from *Chiroderma villosum jesupi* (no. 12211), Puerto Obaldía (San Blas). B, same, of specimen from *Vampyrops helleri* (no. 10004), Cerro Hoya (Los Santos). C, right gonapophysis, *Paratrichobius salvini*, paratype from *Chiroderma salvini* (no. 12990), Cerro Tacarcuna (Darién).

longer laterally, two or three long setae on each side near outer margin, one a conspicuously long macroseta. Hypopygium with a dorso-lateral macroseta and a short seta on each side of sternum VII+VIII; tergum IX with an apical row of about eight macrosetae, four or five shorter setae along ventro-apical margin, and two others anterior to these.

Measurements:	BL	TL	WL	WW	FL
Male	1.61–1.93	0.67–0.77	1.92–2.16	0.84–0.85	1.04–1.15
Female	2.06–2.32	0.63–0.80	2.19–2.32	0.85–0.88	1.26–1.32

TYPE MATERIAL: Holotype male and allotype female from *Chiroderma salvini* (host no. 12990), Cerro Tacarcuna (Darién), 8 March 1964, C. O. Handley, Jr. In the collection of Chicago Natural History Museum. Paratypes.—1 male, same data as the holotype; 1 male, same data but 6 March 1964. In the collections of the United States National Museum and Chicago Natural History Museum.

OTHER MATERIAL EXAMINED: 1 female, from *Chiroderma salvini* (?), Tacarcuna (Darién), elevation 2000 feet, 15 July 1963 [GML no. 300,079].

REMARKS: The female taken on 15 July 1963 is only tentatively associated with this species, because we were unable to verify the identification of the host. The specimen differs from the allotype in possessing a pair of discal macrosetae at mid-length on the supra-anal plate. We have not seen females from *Chiroderma villosum* (see below) to determine whether or not they possess such setae. If the host is correctly identified, then this character is probably variable as it is in some other streblids.

Paratrichobius sp. A. Figure 96A.

This appears to be a distinct species with shorter male gonapophyses than those of *P. salvini* n.sp., but we are unwilling to name it until additional material, including females, is available for detailed comparison with *salvini.*

MATERIAL EXAMINED (From *Chiroderma villosum jesupi*): 3 males, Puerto Obaldía (San Blas), 3 and 4 April 1963, C. O. Handley, Jr. and F. M. Greenwell; 1 male, Armila (San Blas), 17 March 1963, same collectors.

Paratrichobius sp. B. Figure 96B.

This appears to be a distinct species, similar to species A, but with gonapophyseal macrosetae inserted farther distad. Again, we are unwilling to name this in the absence of more extensive comparative material. The occurrence on *Vampyrops* of a species related to *dunni* and *salvini* is interesting. All other specimens from *Vampyrops* (sp., *dorsalis,* and *vittatus*) that we have examined are related to *Paratrichobius longicrus.*

MATERIAL EXAMINED (From *Vampyrops helleri*): 1 male, Cerro Hoya (Los Santos), 24 February 1962.

PROVISIONAL KEY TO THE PANAMANIAN SPECIES OF *PARATRICHOBIUS*

1. Inner face of profemora with only two or three short spinelets and/or setae medial and parallel to upper end of oblique row of spines or heavy setae (figs. 90, 95) 2
   Inner face of profemora with a complete row of setae medial and parallel to the oblique row of spines or strong setae (figs. 86, 93) 3
2. Mesonotal chaetotaxy as in fig. 90A. *Male:* Inner ventro-apical margins of tergum IX (of hypopygium) with spine-like setae (fig. 91A). Host: *Uroderma bilobatum* .... *dunni* Curran
   Mesonotal chaetotaxy as in fig. 95. *Male:* Inner ventro-apical margins of tergum IX with normal setae as in *P. longicrus* (fig. 91B). Hosts: *Chiroderma* spp., *Vampyrops helleri* .... *salvini* n.sp. (and species A, B)
3. Inner face of profemora with seven spines or stout setae in a diagonal row, the apical one curved. Hind femora short, no more than 1.26 mm. long 4
   Inner face of profemora with six stout spines, the apical one not curved. Hind femora longer, 1.32–1.77 mm. long .... *longicrus* complex
4. Inner face of profemora with stout spines. Mesonotal chaetotaxy as in fig. 94. *Male:* Inner ventro-apical margins of tergum IX with normal setae. Host: *Enchisthenes hartii* .... *sanchezi* n.sp.
   Inner face of profemora with strong setae, not spines, in diagonal row on inner face. Mesonotal chaetotaxy as in fig. 93. *Male:* Inner ventro-apical margins of tergum IX with stout spine-like setae as in *dunni* (fig. 91A). Host: *Artibeus cinereus* .... *lowei* n.sp.

Neotrichobius Wenzel and Aitken,[11] new genus

Type-species: *Neotrichobius stenopterus* Wenzel and Aitken, new species.

Very similar to both *Paratrichobius* and *Megistopoda* in the greatly elongated hind legs and in the structure of the underside of the thorax, which, though much narrower, is reminiscent of that of the Nycteribiidae. *Neotrichobius* resembles *Megistopoda* in possessing stenopterous wings, but in that genus the body is strongly, laterally compressed; the occipital lobes of the head are strongly elevated; the profemora lack spines on the inner face; and the paired ventral setae of the male gonapophyses are situated anterior to middle rather than subapically. *Neotrichobius* is more closely related to and possibly derived from *Paratrichobius,* which it resembles *inter alia* in the structure of the male gonapophyses (the paired ventral setae are subapical in both); in having a row of stout spines or setae on inner face of profemora; and in possessing strong spine-like setae on the dorsal sclerites of the head as well as on the theca and along sides of oral cavity. It differs from *Paratrichobius* in being stenopterous; in having subcylindrical profemora; and in that the dorsal abdominal connexivum is entirely covered with setae. *Neotrichobius* differs further from both *Megistopoda* and *Paratrichobius* in having the median suture bifurcate posteriorly; the scutum small and not separated laterally from the prescutum; a very small scutellum; and the mesopleuron traversed by a longitudinal membranous suture just dorsal to mesocoxal cavity.

DIAGNOSIS: *Head.*—Very similar to that of *Paratrichobius.* Laterovertices and occipital plates differentiated but much reduced in size and not strongly sclerotized; with strong spine-like setae. Palpi irregularly oval, ventral surface with a mixture of spines and normal setae; theca with spines and setae; sides of oral cavity margined with spine-like setae. *Thorax.*—Mesonotum longer than head. Anterior margin of prescutum produced at middle, emarginate on each side of projection, to accommodate occipital lobes of head. Median suture bifurcate posteriorly. Scutum not separated from prescutum laterally. Scutellum very small. Each mesopleuron divided into dorsal and ventral regions by a second longitudinal membranous fissure similar to that which separates the prescutum and episternum. Underside of thorax shield-like, the anterior and posterior margins rounded, the anterior sternopleural margin dorsally bent upwards like a ski. Pleurotrochantines not projecting as an angulate process on each side between meso- and metacoxae. *Wings.*—Stenopterous, venation greatly reduced, only three longitudinal veins basally, two apically. *Legs.*—Middle and hindlegs progressively much longer than the short forelegs; hindlegs greatly elongated, the hind femora extending beyond apex of abdomen; all femora with some macrosetae, in addition to short setae; middle and hind femora slightly bowed; profemora very stout, subcylindrical (much as in *Paradyschiria*), inner face armed with very heavy spines. Hind trochanters with spines along inner margin; hind coxae armed with spines above and below; hind tibiae bowed. Protarsi strongly compressed antero-posteriorly; middle and hind tarsi elongated, the first tarsomere twice as long as wide, as long as second and third combined.

Abdomen.—Lateral lobes of tergum I+II with strong spine-like setae on postero-lateral margins. Sternum I with spine-like setae at sides. Sternum II medially with both spine-like and normal discal setae; posterior margin, with spine-like setae, forming a pseudo-ctenidium. Connexivum entirely covered with setae, without a bare dorsal

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[11] Thomas H. G. Aitken, Trinidad Regional Virus Laboratory, Port-of-Spain, Trinidad.

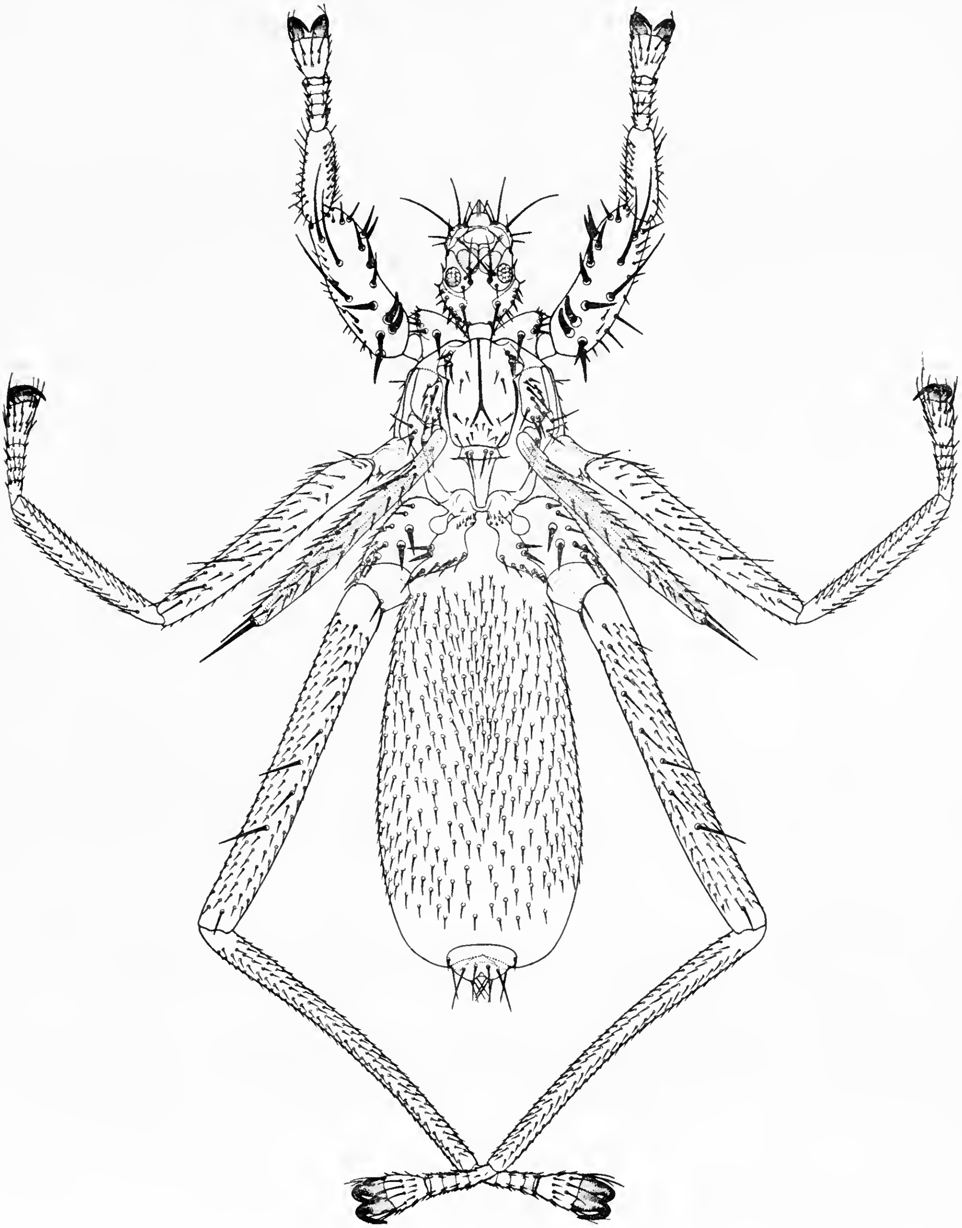

Fig. 97. *Neotrichobius stenopterus*, n. gen., n. sp. Female (allotype), dorsal view.

median longitudinal area; setae of upper and ventral sides similar in both sexes; lateral setae of connexivum shorter. *Female:* Tergum VII not evident. Supra-anal plate very short. Cerci united with ventral arc. Seventh sternites very small. *Male:* Hypopygium not strongly developed, but distinct. Sternum V present, transverse. Sternum VI absent. Gonapophyses as in *Paratrichobius*, the paired ventral setae subapical in position, the macroseta not strongly developed, the accessory seta anterior to macroseta.

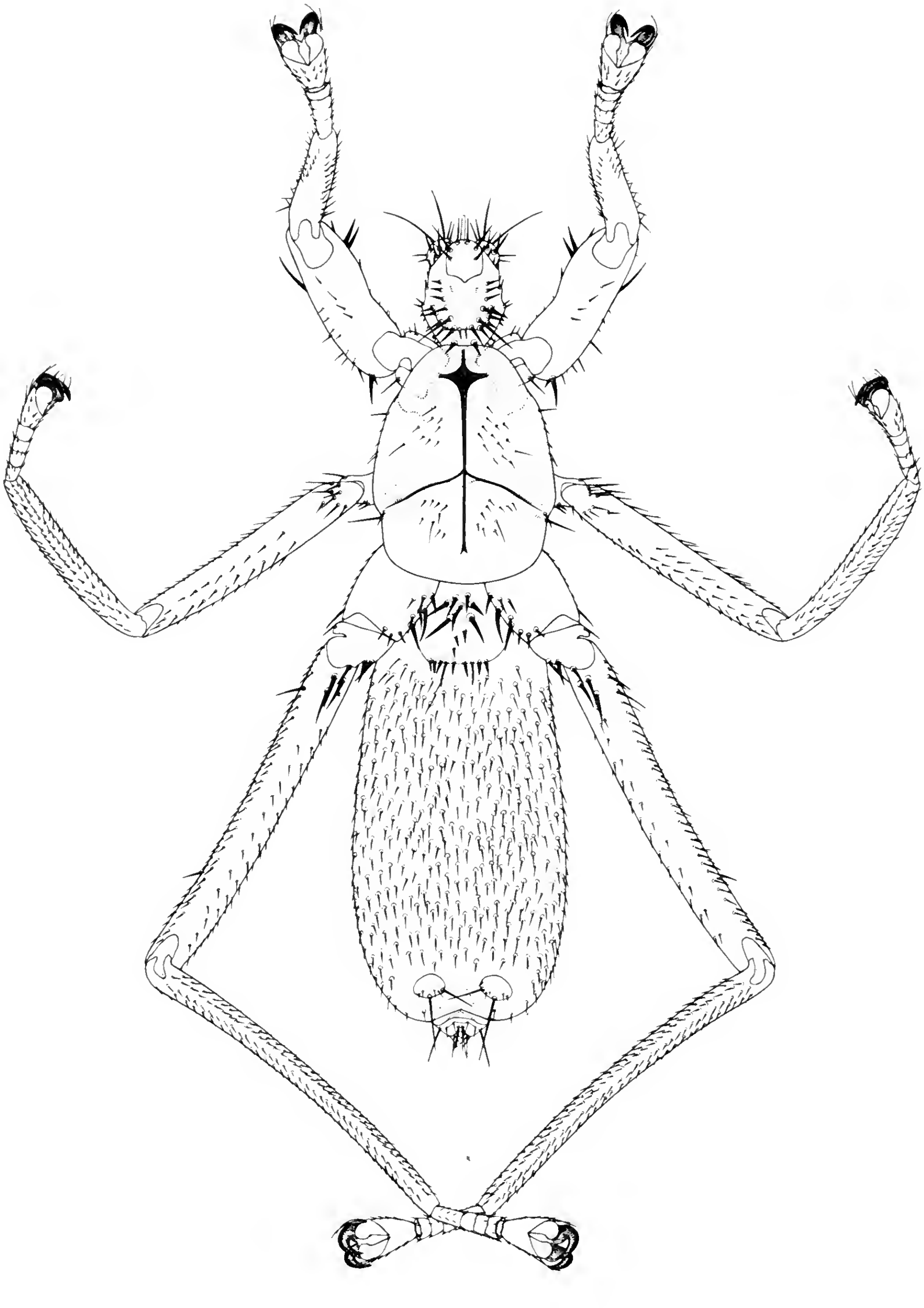

Fig. 98. *Neotrichobius stenopterus*, n. gen., n. sp. Female (allotype), underside.

Neotrichobius stenopterus Wenzel and Aitken, new species. Figures 97–99.

DESCRIPTION: *Head.*—More or less horizontal, longer than broad. Genae with a few short spine-like setae. Laterovertices microsetose, each with one macroseta, another seta about two-thirds as long, an intermediate-size seta, and two short setae; occipital plates not microsetose, with a very stout long macroseta and five very short spine-like setae; mediovertex microsetose, membranous. Posterior margin slightly emarginate at

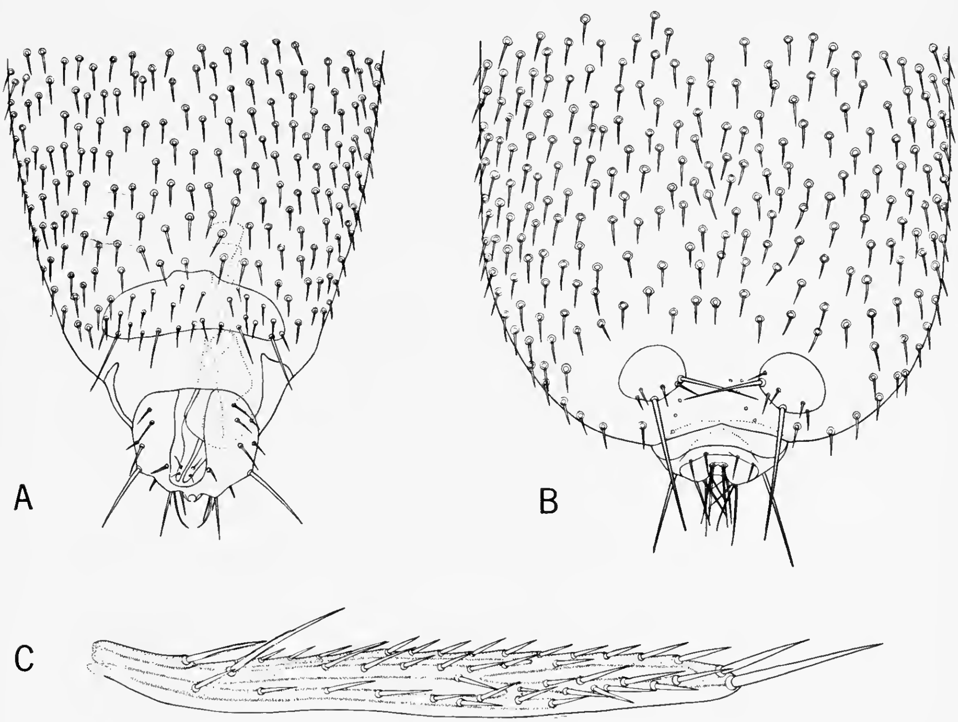

Fig. 99. *Neotrichobius stenopterus*, n. gen., n. sp. A, apex of abdomen, male (holotype), ventral view. B, same, female (allotype). C, wing.

middle for reception of median prescutal projection. Eyes relatively conspicuous, with ±11 facets. Palpi irregularly oval, apical macroseta very long, ventral surface with six to eight setae, most of them spine-like. Theca with a pair of fine setae at apex and two spines on each side on apical half. Margin of oral cavity bordered with spine-like setae. *Thorax.*—Prescutum with two supraspiracular bristles, one or two short discal setae anterior to middle, and a pair near posterior margin. Scutum with eight to ten short bristles, and a long bristle at each lateral angle. Scutellum with a median pair of very long bristles and a shorter bristle on each side. Mesepisternum, above, with two or three long and five or six short bristles. *Wings* and *Legs* as illustrated.

Abdomen.—Tergum I+II with a transverse basal cluster of short setae; inner and posterior margins poorly defined, side margins of lateral lobes with a row of strong spine-like setae. Each lateral lobe of sternum I with two spine-like setae. Sternum II with two pairs of heavy spine-like setae and four or five short spine-like setae between them, followed on apical half by three to five short stout setae; apical margin with six to eight stout spine-like setae, and a pair of slender setae. Connexivum similar in both sexes, rather uniformly covered throughout with moderately heavy, fairly short setae, these shorter along sides, especially apically. *Female* (figs. 97, 98, 99B): Supra-anal plate as illustrated. Seventh sternites small, chaetotaxy as figured. *Male* (fig. 99A): Hypopygium without dorsal setae; a long slender seta on apical margin on each side, and lateral to it a short seta and a heavy macroseta; a short seta also present each side near base; ventral chaetotaxy as illustrated. Gonapophyses as in *Paratrichobius*, paired ventral setae subapical; macroseta only slightly longer than accessory seta.

Measurements:	BL	TL
Male	1.70–1.92	0.55–0.56
Female	2.03–2.09	0.49–0.58

TYPE MATERIAL: Holotype male and allotype female (slides) from *Uroderma bilobatum* (host no. 5492), Almirante (Bocas del Toro) 28 January 1960, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *Artibeus cinereus:* 3 (2 bats), Río Changena Camp (Bocas del Toro), elevation 2600 feet, 18 September 1961; 1, Cerro Hoya (Los Santos), 12 February 1962; 5 (4 bats), Armila (San Blas), 24 to 27 February 1963, C. O. Handley, Jr. and F. M. Greenwell. From *Artibeus j. jamaicensis:* 1, Cerro Hoya (Los Santos), 9 February 1962. From *Vampyressa pusilla:* 1, Armila (San Blas), 18 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 1, La Laguna (Darién), 17 June 1963, elevation 2900 feet, GML. From *Noctilio leporinus mexicanus:* 1, Guánico (Los Santos), 13 February 1962. Non-Panamanian paratypes.—From *Artibeus cinereus:* 1, Track to Tree Station, Rio Grande Forest, Sangre Grande, TRINIDAD, 30 January 1957, T. H. G. Aitken. From *Phyllostomus hastatus:* 1, Kaiserberg Airstrip, east of Zuid River, SURINAM, 16 October 1960, elevation 900 feet, H. A. Beatty, CNHM Guianan Zoological Expedition 1960–1962. Paratypes to be deposited in the collections of Chicago Natural History Museum; United States National Museum; Trinidad Regional Virus Laboratory; Gorgas Memorial Laboratory, Panamá, Panamá; and the Environmental Health Branch at Corozal, Canal Zone.

REMARKS: We believe the primary host of this species to be *Artibeus cinereus.* Eight of the 14 lots known to us are from this host. About one-third of the specimens collected are females. Although the host records from *Artibeus, Uroderma,* and *Vampyressa* seem to be valid, we are reluctant to accept those from *Noctilio* and *Phyllostomus.* There were a number of dubious host associations in the material from Los Santos. Much of this material was collected from hosts caught in mist nets. The record from *Phyllostomus* is one of several dubious host associations in the material collected in Surinam.

Genus **Megistopoda** Macquart

Megistopoda Macquart, 1852, Ann. Soc. Ent. Fr., (2), **10**: 332. Kolenati, 1863 (*Megistopodia,* sic!), Hor. Soc. Ent. Ross., **2**: 89. Bigot, 1885, Ann. Soc. Ent. Fr., (6), **5**: 235 (as Nycteribiidae). Speiser, 1900, Arch. Naturg., **66A**, Bd. I. pp. 32, 57 (char.), 62 (cit.), 65 (keyed). Coquillet, 1900, Proc. U. S. Nat. Mus., **37**, art. 1719, p. 566. Aldrich, 1905, Smiths. Misc. Coll., **46**: 657 (as Nycteribiidae). Williston, 1906, Man. N. Am. Dipt., 3rd ed., p. 385. Speiser, 1907, Ent. News, **18**: 104 (cit.). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 26 (keyed), 30 (cit.). Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 13 (keyed), 28. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28: 356 (status). Bequaert, 1940, Revista Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418 (keyed); 1942, Bol. Ent. Venez., 1: 86 (keyed). Jobling, 1949, Parasitology, 39: 315. Maa, 1965, Jour. Med. Ent., 1: (4), p. 385 (synonymizes *Pterellipsis*).

Pterellipsis Coquillet, 1899, Can. Ent., 31: 333; 1910, Proc. U. S. Nat. Mus., 37, no. 1719, p. 597. Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 25 (keyed), 29 (cit.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 13 (keyed), 25. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth. Wash., no. 155, p. 657. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28: 357 ff. (morph.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418 (keyed); 1942, Bol. Ent. Venez., 1: 86 (keyed). Jobling, 1949, Parasitology, 39: 321; 1952, ibidem, 42: 134, fig. 2A. Grandi, 1952, Introd. Stud. Ent., 2: 478. Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 177 (keyed), 187. [Type species: *P. aranea* Coquillet, 1899].

Type-species: *Megistopoda pilatei* Macquart, 1852.

It is remarkable that the identity of *Megistopoda pilatei* has remained unresolved since 1852, when Macquart described and figured this remarkable streblid from Mexico (Teapa). The absence of wings seemed to preclude its being identifiable with any other streblid known. Although the very sketchy illustrations showed a close resemblance to *Pterellipsis,* it was difficult to accept it as such, because of the absence of wings. Though very much reduced in *Pterellipsis,* the wings are nevertheless quite conspicuous and would hardly have been overlooked (see Speiser, 1900a). Indeed, some authors, e.g., Bigot (1885) and Kolenati (1963) placed *Megistopoda* in the family Nycteribiidae, not only because of the absence of wings, but because Macquart's figure illustrated the head as thrown back over the mesonotum, much as it is in members of that family. In *Pterellipsis,* the head is more vertical than in most other Streblidae, and the anterior portion of the mesonotum is somewhat declivious, so that with due allowances for deficiencies of Macquart's figures, these characters should not be given any serious consideration. In fact, Speiser, in describing *desiderata* (=*Pterellipsis aranea* Coquillet) assigned it to the genus *Megistopoda* and separated it from *M. pilatei* because it possessed wings.

There is always the possibility that a wingless species might yet be found that will answer Macquart's description. During the last 27 years, the senior author has identified approximately twenty or twenty-five thousand streblids from the New World tropics, including several thousand from Mexico, Guatemala and El Salvador, without finding any wingless species that would answer to the description of *M. pilatei.* However, in the Panama collection, there is a "wingless" male specimen of *Pterellipsis aranea* Coquillet from *Artibeus jamaicensis* (GML host no. 300,084), Tacarcuna (Darién), elevation 2000 feet, 20 June 1963. The wings are reduced to such minute vestiges that they cannot be detected except under very high magnifications (ca. ×150). This specimen would correspond closely to the description and figure of *Megistopoda pilatei,* and it is suggested that Macquart's type was such a wingless specimen of *Pterellipsis.* It is not at all surprising that wingless individuals would appear within a species which normally has vestigial wings. I believe it is reasonable to assume that the species *P.*

aranea Coquillet and *M. pilatei* Macquart are synonymous. *Megistopoda proxima* (Séguy) and *M. theodori* n.sp., though closely related to *aranea*, differ *inter alia* in having noticeably shorter legs. The figure of *Megistopoda pilatei* shows very long hind legs, as in *aranea*.

One can reasonably argue that the identity of *pilatei* is not settled, but we believe there is no longer any doubt concerning the identity of the genus *Megistopoda*. We agree with Maa (1965, p. 385) in considering *Pterellipsis* to be a synonym.

KEY TO THE SPECIES OF *MEGISTOPODA*

1. Wings narrow (fig. 100D). Legs very long, hind femora 1.54–1.81 mm. long, as long as or nearly as long as entire body. Prescutum with very weak setae along median suture; the lateral margins along longitudinal membranous suture, with one or two stronger setae. Hosts: *Artibeus jamaicensis, A. lituratus palmarum* .... *aranea* (Coquillet)
   Wings broader (fig. 101E). Legs shorter, hind femora 0.99–1.43 mm. long, only a little longer than abdomen. Prescutum with short but strong setae basally along median suture, the lateral margin along longitudinal membranous suture usually with four strong setae. Hosts: *Sturnira* spp. 2
2. *Male:* Gonapophyses (figs. 100C, 101D) with ventral margin nearly straight in lateral view, with a row of translucent thorn-like setae between macroseta and apex. Macroseta of right gonapophysis inserted at about basal third, that of left anterior to it. Host: *Sturnira lilium* .... *proxima* (Séguy)
   Male: Gonapophyses (fig. 100B) with ventral margin distinctly curved in lateral view; thorn-like setae few in number, restricted to lateral face and one on both dorsal and ventral margins apically; macrosetae of right gonapophysis inserted only slightly posterior to that of left, which is inserted well beyond middle. Host: *Sturnira ludovici* .... *theodori* n.sp.

Megistopoda aranea (Coquillet). Figure 100A, D.

Pterellipsis aranea Coquillet, 1899, Can. Ent., **31**: 334 (U. S. National Museum, type no. 4208); 1900, Proc. U. S. Nat. Mus., **22**: 270 (records). Speiser, 1900, Zool. Anz., **23**: 154 (synonymizes *Megistopoda desiderata* Speiser under *P. aranea*.). Aldrich, 1905, Smiths. Misc. Coll., **46**: 658. Coquillet, 1910, Proc. U. S. Nat. Mus., **37**, no. 1719, p. 597 (as type-species of *Pterellipsis*). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 23 (records), 30 (cit.), pl. 2, fig. 3 (wing). Wolcott, 1923, Jour. Dept. Agric. Porto Rico, **7**: 235. Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 25, pl. 2, fig. 15. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 477 (fig.), 479 (fig., Streblidae II.–5). Jobling, 1936, Parasitology, **28**: 359 (wing structure). Cooper, 1941, Yearb., Amer. Phil. Soc., **1941**: 126 (chromosome no.). Bequaert, 1942, Bol. Ent. Venez., **1**: 88 (records). Jobling, 1949, Parasitology, **39**, pp. 316 ff., 327, fig. 2C (with *P. proxima* Séguy as syn., in error); 1952, ibidem, **42**: 134, fig. 2A. Grandi, 1952, Introd. Stud. Ent., **2**: 478. Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 183, 187 (records), pl. 3, fig. 1.

Megistopoda aranea Maa, 1965, Jour. Med. Ent., **1**: 385.

Megistopoda desiderata Speiser, 1900, Arch. Naturg., **66A**, Bd. I, pp. 37, 42, 57–59 (descr.), 63, 65 (keyed), pl. 3, figs 6–8.

PANAMANIAN MATERIAL EXAMINED: 213 specimens in 88 lots from more than 104 bats. From *Artibeus j. jamaicensis:* 188 (76 lots) as follows: 9 (2 bats), Fort Clayton (Canal Zone), 19 and 20 October 1960; 7 (4 bats), Fort Kobbe (Canal Zone), 24 and 31 July, 12 and 27 October 1960; 16 (5 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 3, Summit (Canal Zone), 5 August 1930, L. H. Dunn No. 6 [AMNH]; 23 (4 lots), Barro Colorado Island (Canal Zone), 22 November 1956 and 3 to 12 January 1957 [USNM]; 18, Miraflores (Canal Zone), K. W. Cooper [MCZ]; 3, Arraiján (Canal Zone), 26 March 1961; 19 (7 bats), Almirante (Bocas del Toro), 23 January to 5 February 1960; 6, Isla Colón (Bocas del Toro), 18 February 1960; 4 (3 bats), Río Changena Camp (Bocas del Toro), 19 to 27 September 1961; 12 (18 bats), Cerro Hoya (Los Santos), 11 to 24 February 1962; 1, Armila (San Blas), 1 April 1963; 38 (9 bats), Punta de Piña (Darién), 23 to 24 March 1960; 5 (4 bats), Río Seteganti (Darién), 1 to 5 February 1961; 10 (4 bats), La Laguna (Darién), 9 to 17 June 1963, GML; 17 (12 bats), Tacarcuna (Darién), 20 June to 15 July 1963, GML; 3 (2 bats), Río Mono Camp (Darién), 24 and 25 July 1963.

From *Artibeus lituratus palmarum,* 4 (4 lots) as follows: 1, Fort Clayton (Canal Zone), 20 October 1960; 1, Barro Colorado Island (Canal Zone), 6 December 1956; 1, Sibube (Bocas del Toro), 25 January 1963; 1, La Laguna (Darién), 6 June 1963, 2900 feet elevation, GML. From *Carollia perspicillata azteca:* 3 (3 bats), Almirante (Bocas del Toro), 23 to 31 January 1960 (mist nets). From *Desmodus rotundus murinus:* 1, Almirante (Bocas del Toro), 25 January 1960 (mist net). From *Phyllostomus discolor:* 1, Tacarcuna (Darién), 5 September 1958. From mixed hosts (*Artibeus cinereus, A. j. jamaicensis,* and *Carollia subrufa*): 1, Río Changena Camp (Bocas del Toro). *Without host:* 3 (2 lots) Barro Colorado Island (Canal Zone), 4 November 1956, K15 and K16 [USNM].

OTHER MATERIAL EXAMINED: Numerous specimens, chiefly from *Artibeus jamaicensis,* from PUERTO RICO, MEXICO, GUATEMALA, EL SALVADOR, COSTA RICA, COLOMBIA, VENEZUELA, SURINAM, and BRAZIL.

REMARKS: This species appears to be a parasite primarily of *Artibeus jamaicensis,* though it has occasionally been taken on *Artibeus lituratus palmarum.* Records from other hosts for the most part probably represent contaminations, disturbance transfers, and errors of association, though there certainly are some that represent valid associations. *M. aranea* was taken from approximately 54.4% of all *Artibeus jamaicensis* that were parasitized by Streblidae, but on only 7.69% of *A. lituratus palmarum.* Its analogue on that host seems to be *Paratrichobius longicrus.*

Megistopoda proxima (Séguy). Figures 100C, 101.

Pterellipsis proxima Séguy, 1926, Ency. Ent., (B), II, Dipt. 3: 194–196, figs. 2–6—Argentina: "Misiones: environs de San Ignacio: Villa Lutecia," from an unidentified bat (Museum National d'Histoire Naturelle, Paris). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Jobling, 1949, Parasitology, 39: 327 (as syn. of *P. aranea* Coquillet, in error); 1952, ibidem, 42: 134, 135, fig. 4B (restored to specific status).

Megistopoda proximum Maa, 1965, Jour. Med. Ent., 1: 385.

In the collection of Chicago Natural History Museum is a male specimen of *Megistopoda,* taken on *Sturnira* sp., 5 miles north of Therezopolis, Brazil. This fly appears to be identical with the species described as *proxima* by Séguy, as well as with specimens taken from *Sturnira lilium parvidens* in Panama. Although Séguy's illustration of the gonapophyses (fig. 101D) is

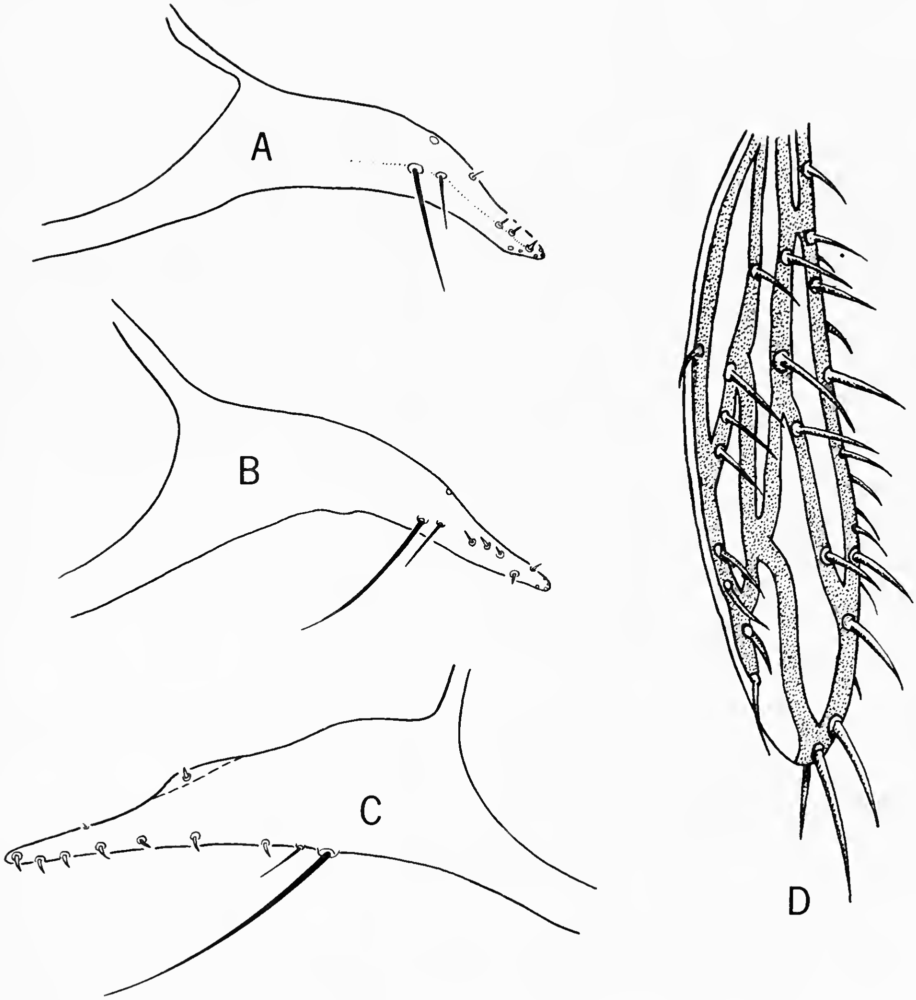

Fig. 100. A–C, left male gonapophysis of species of *Megistopoda*. A, *M. aranea* (Coquillet), from *Artibeus j. jamaicensis* (no. 6110), Piña Point (Darién). B, *M. theodori*, new species, paratype from *Sturnira ludovici* (no. 6181), Casa Tilley (Chiriquí). C, *M. proxima* (Séguy), from *Sturnira lilium* (no. 6351), Río Mandinga (San Blas). D, wing, *M. aranea* (=*desiderata* Speiser), after Speiser (1900).

made from quite a different view than ours (fig. 101C), it shows the macroseta of the right gonapophysis inserted far posteriorly, as in our specimens, and also the characteristic row of short thorn-like setae along the ventral margin. Therefore, we assign our specimens to *M. proxima*.

Measurements:	BL	TL	FL
Male	1.84–1.98	0.44–0.49	1.07–1.18
Female	1.76–2.09		0.99–1.21

PANAMANIAN MATERIAL EXAMINED: 34 species in 18 lots from (18) *Sturnira lilium parvidens* as follows: 10 (5 bats), Guánico (Los Santos), 21

January to 8 February 1962; 4 (2 bats), Cerro Hoya (Los Santos), 24 and 26 February 1962; 1, Isla Bastimentos (Bocas del Toro), 3 February 1963. 2 (2 bats), Río Tuira, 25 February 1958, P. Galindo [GML]; 1, Cerro Tacarcuna (Darién), 3 March 1964, C. O. Handley, Jr.; 3 (3 bats), Tacarcuna (Darién), 2000 feet elevation, 20 June and 7 July 1963, GML; 1, Armila (San Blas), 27 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 12 (4 bats), Río Mandinga (San Blas), 26 to 30 May 1957, P. Galindo [GML].

REMARKS: This species appears to be restricted to *Sturnira lilium*, at least in Panama. We have seen a few specimens from this host, from Paraguay and Venezuela, which appear to be this species. *M. proxima* occurred on approximately 86% of the *Sturnira l. parvidens* that were parasitized by Streblidae (nearly 100%), and averaged two specimens per bat.

Megistopoda theodori Wenzel, new species. Figure 100B.

With the characters of *M. proxima* (Séguy), and apparently differing from that species only in its somewhat larger size and in the structure of the male gonapophyses (fig. 100B), which are very distinctive. In *M. proxima* (fig. 100C) both gonapophyses are very similar except that the paired ventral setae are inserted further basally on the right than on the left; the ventral margin of the gonapophyses appear nearly straight in lateral view; the paired ventral setae are inserted further posteriorly; and a row of distinct thorn-like setae (coarser than in *theodori*) is present along ventral margin. In *theodori*, the right gonapophysis is not sinuate along dorsal margin and thus appears heavier; the ventral margins are distinctly curved in lateral view, the paired ventral setae are inserted at middle or beyond; and the fine thorn-like setae are finer, fewer in number, and most are inserted on the lateral face rather than the ventral margin. *M. theodori* also differs in host and altitudinal distribution. *M. theodori* was taken on *Sturnira ludovici* together with *Trichobius brennani*, at elevations of from 4800–5600 feet, while *M. proxima* occurred on *Sturnira lilium parvidens*, together with *Aspidoptera delatorrei* n.sp., at elevations ranging from sea level to 2000 feet.

DESCRIPTION: *Head.*—Occipital lobes with eight to nine setae of varying lengths, two of them conspicuously long macrosetae. Laterovertices with about six setae. Eyes with ±7 facets. Prescutum on each side with two spiracular bristles and 15–23 others including about four strong setae along margin of longitudinal membranous cleft and posteriorly a patch of from five to seven shorter bristles along median suture. Scutum with 13–14 bristles, the anteromedian ones usually noticeably shorter than the others. Mesepimeron with 13–17 bristles in two irregular rows, the marginal ones mostly longer and coarser. *Wings.*—Broader than in *aranea*, and with venation as in *proxima* (fig. 101E). *Legs.*—As in *proxima*.

Abdomen.—Lateral lobes of tergum I+II with from 13–20 bristles, the three or four along inner dorsal margin fine, the posterior ones long and coarse, shorter ventrally. Connexivum covered with relatively short, moderately heavy bristles, these much shorter along sides, a little longer apically. Sternum I with two or three spines on each side. Sternum II subquadrate, typically with 9–14 discal setae and on posterior margin five to eight spiniform setae on each side, separated by two pairs of finer setae, the outer pair long. *Female:* Tergum VII and supra-anal plate united at middle for part of their width; VII transverse, with a conspicuous macrosetae at each side and one or two shorter ones between them; supra-anal plate with four apical macrosetae and on each side a pair of fine short setae. Connexivum with a long subapical latero-ventral macroseta. Seventh

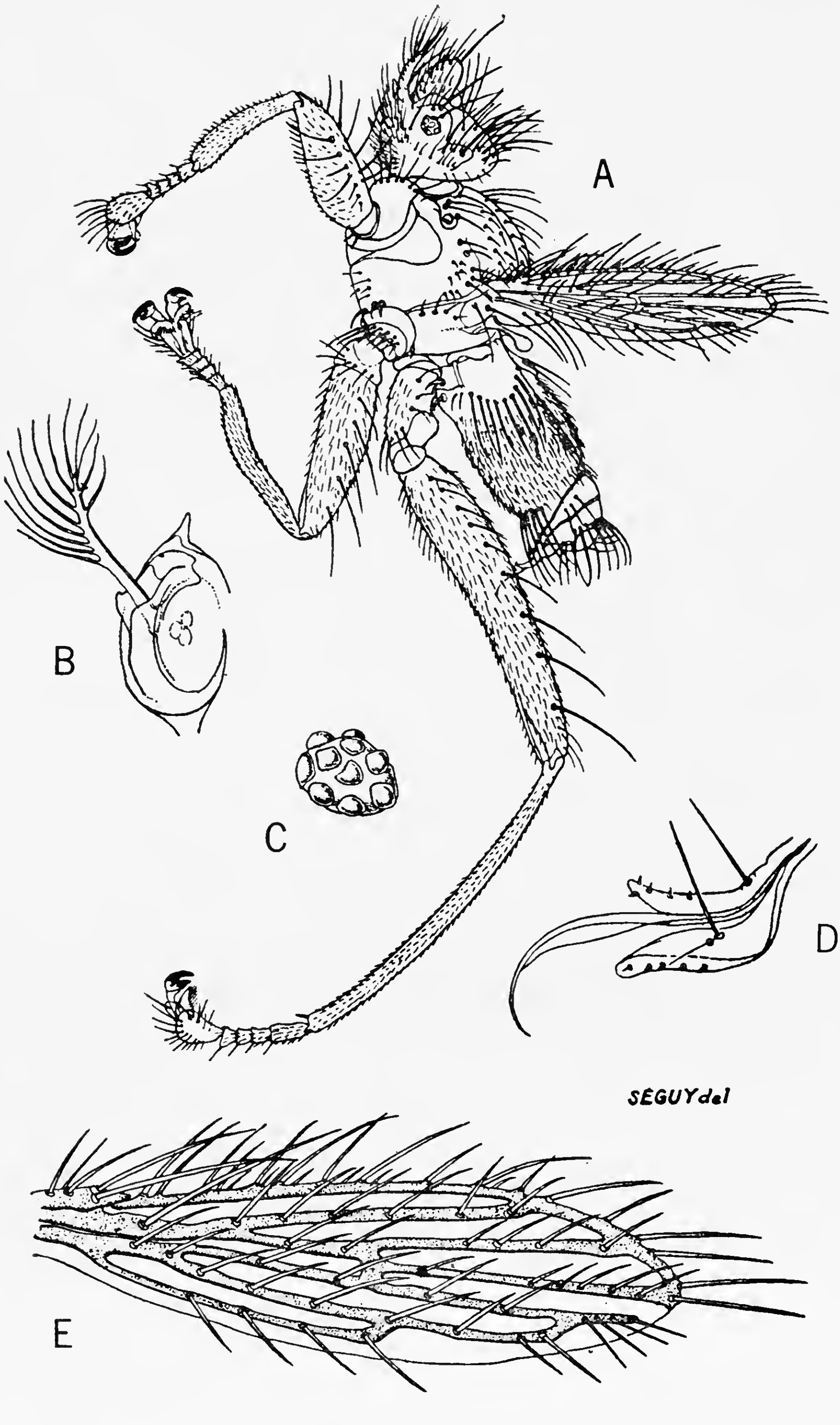

Fig. 101. *Megistopoda proxima* (Séguy). A, male, lateral view. B, antenna. C, eye. D, male gonapophyses (spread out), ventral view. E, wing. From Séguy (1926).

sternites with 11–15 setae, several of them macrosetae, one conspicuously longer than the others. *Male:* Hypopygium with two or three dorso-lateral macrosetae basally (on VII+VIII), about eight apical macrosetae and four or five latero-ventral setae on tergum IX. Sternum V with discal setae of about the same size as those of connexivum; apical margin with six to eight macrosetae, alternating with one or two shorter but strong setae, two to four shorter strong setae at middle. Gonapophyses distinctly curved in lateral view (ventral margin nearly straight in *proxima*), dorsal margin of the left gonapophysis sinuate near apex; paired ventral setae of left gonapophysis inserted distal to middle, those of right gonapophysis slightly posterior to them; right gonapophysis slightly heavier than left, without dorsal sinuation; each gonapophysis, anterior to paired ventral setae, with several extremely fine translucent, thorn-like setae along lateral face and ventral margins (one also seems to be present on dorsal margin above paired setae, though only the theca is visible in specimens examined).

Measurements:	BL	TL	FL
Male	1.98–2.16	0.49–0.52	1.13–1.43
Female	2.17–2.47	0.55	1.18–1.35

TYPE MATERIAL: Holotype male and allotype female from *Sturnira ludovici* (host no. 10469), Casa Tilley, Cerro Punta (Chiriquí), elevation 5300 feet, 14 March 1962, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—37, same data as the holotype; 7 (29 bats), same locality but 6 to 11 March 1962; 79 (26 bats), same locality, 23 April to 4 May 1960; 5 (2 bats), Lava Flow, El Hato (Chiriquí), 5 May 1960; 9 (5 bats), Casa Lewis, Cerro Punta (Chiriquí), 5600 feet elevation, 3 and 4 May 1960; 15, same locality, 1 and 2 February 1960; 9 (6 bats), Rancho Mojica (Bocas del Toro), elevation over 4800 feet, 8 and 9 September 1961; 2 (2 bats), Rancho Caballero (Bocas del Toro), elevation 6000 feet, 11 September 1961; 1, Cerro Malí (Darién), 9 February 1964, C. O. Handley, Jr.; 3 (2 bats), same locality, 4800 feet elevation, 31 May and 3 June 1963, GML; 19 (4 bats), Cerro Tacarcuna (Darién), 29 February to 7 March 1964, C. O. Handley, Jr. Paratypes to be deposited in the collections listed on p. 410.

REMARKS: We have studied *M. theodori* n. sp. and *M. proxima* (Séguy) in considerable detail, without finding any external characters that could be used for routine identification. In *theodori,* the number of mesonotal setae (excluding the spiraculars) was distinctly higher in the females (median 44) than in the males (median 38); in *proxima,* the number was only slightly higher in the females (median 33) than in the males (32). In *theodori,* the number of setae on the lateral lobes of tergum I+II ranges from 13–17 (median 14.5) in the females and 15–20 (median 16.5) in the males; in *proxima* it is nearly identical (14–19, median 17) in the two sexes. The number of setae on each of the female seventh sternites ranges from 11–16 (median 13.5) in *theodori* and from 8–17 (median 12) in *proxima.* The sample measured included about thirty of each species. There is such a broad overlap in the above ranges that, while bimodality is evident, the setal counts cannot be used for identification of individual specimens, nor for small series.

This species is named for Prof. Oskar Theodor, of the Hadassah Medical School, Hebrew University, Jerusalem, Israel, in recognition of his outstanding contributions, especially to our knowledge of the pupiparous flies and of the Phlebotominae (Psychodidae).

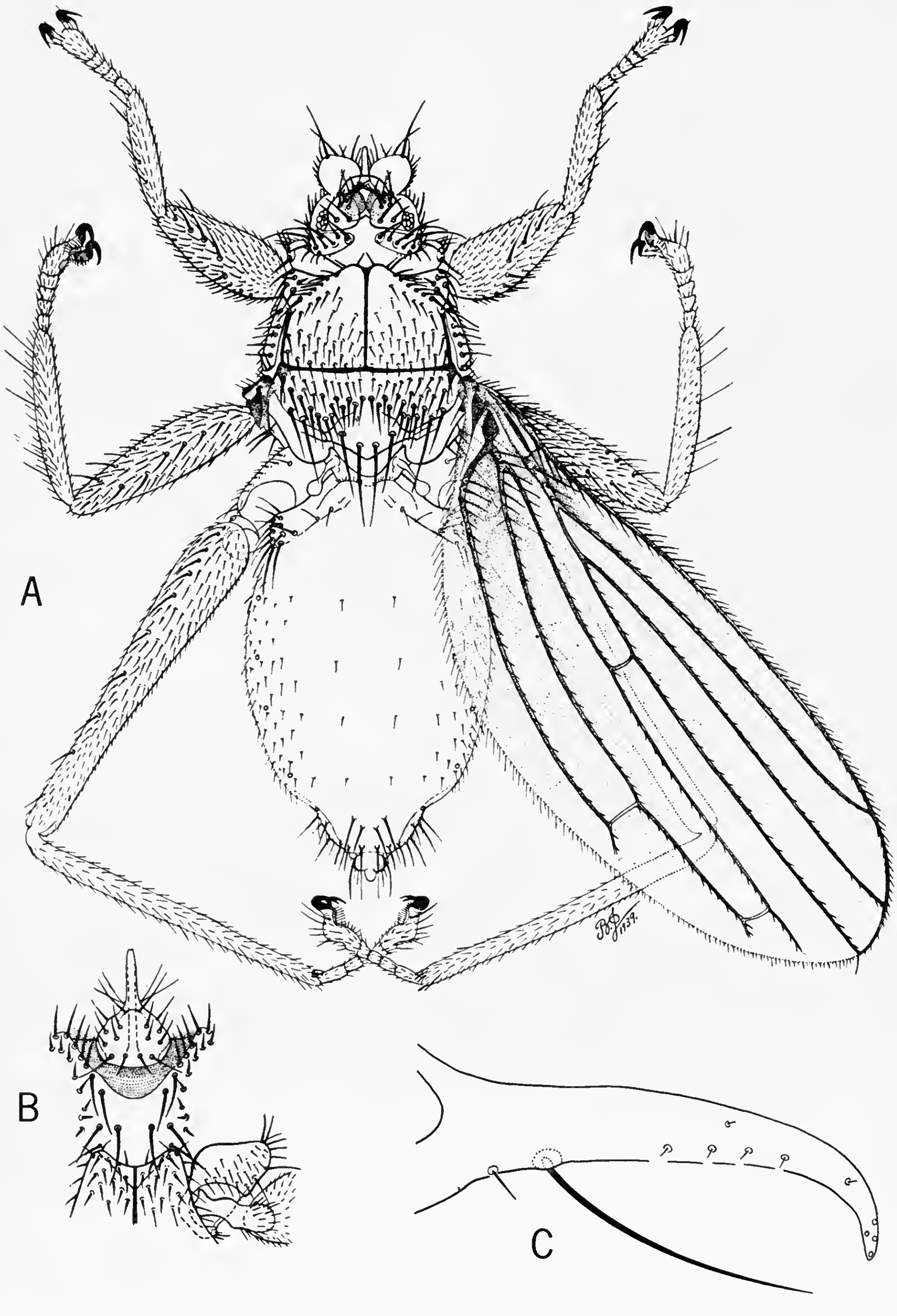

Fig. 102. *Speiseria ambigua* Kessel. A, female, dorsal view. B, posterior margin of head and anterior portion of sternopleura, ventral view. C, left male gonapophysis, specimen from *Carollia perspicillata azteca* (no. 3940), Fort Sherman (Canal Zone). A and B from Jobling (1939a).

Genus **Speiseria** Kessel

Speiseria Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 13 (keyed), 19 (diagn.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 656. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, pp. 6 (keyed), 7. Jobling, 1936, Parasitology, **28**: 359 ff. (morphology). Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, **12**: 265. Jobling, 1939, loc. cit., **31**: 487–488 (as syn. of *Synthesiostrebla*, in error). Bequaert, 1940, Rev. Ent. Venez., **1**: 86 (keyed). Jobling, 1947, Proc. Roy. Ent. Soc. Lond., (B), **16**: 39; 1949, Parasitology, **39**: 321 (keyed). Hoffmann, 1953, Mem. Cong. Cient. Mex., **7**: 177 (keyed), 188.

Synthesiostrebla (not Townsend, 1913), Jobling, 1939, Parasitology, **31**: 487. Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 417 (keyed). Schuurmans-Stekhoven Jr., 1951, Beitr. Fauna Perus **3**: 96 (part.).

Type-species: *Speiseria ambigua* Kessel, 1925.

The genus that was keyed out under the name *Speisseria* [*sic!*] by Curran (1934b, p. 522) was probably *Pseudostrebla* (see *S. ambigua,* below). Like the preceding three genera, *Speiseria* appears to be related to the species of the *Trichobius phyllostomae* group and is similar in the female genital characters (See *Paratrichobius*). However, the males differ from all of these in having the accessory gonapophyseal setae inserted posterior rather than anterior to the macrosetae. On the anterior face of the profemora (fig. 102) is a row of strong setae, which appear to be homologous with the spines of *Paratrichobius* and *Neotrichobius.*

Speiseria ambigua Kessel. Figure 102.

Speiseria ambigua Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 20, pl. 1 (figs. 1, 2). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 656. Curran, 1935, Amer. Mus. Novit., no. 765, p. 7. Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, **12**: 265, fig. 17 (in legend as fig. 16, in error). Cooper, 1941, Yearb. Amer. Phil. Soc., **1941**: 126 (chromosome no.). Bequaert, 1942, Bol. Ent. Venez., **1**: 88 (syn. notes). Jobling, 1947, Proc. Roy. Ent. Soc. Lond., (B), **16**: p. 39; 1947, Parasitology, **39**: 315 ff., 327, fig. 2B. Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 183, 188.

Synthesiostrebla amorphochili (not Townsend, 1913), Jobling, 1939, Parasitology, **31**: 488–489. Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 418. Schuurmans-Stekhoven, Jr., 1951, Beitr. Fauna Perus, **3**: 96 (part.).

Paratrichobius anduzei Matheson, 1945, Jour. Parasit., **31**: 191, fig. 1a–e. Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), **18**: 144 (synonymizes *P. anduzei*).

The record of Curran (1934b, p. 523) was probably of a species of *Pseudostrebla* rather than of *Speiseria ambigua.* His specimen was from *Tonatia bidens,* host of a species of *Pseudostrebla.* To our knowledge *Speiseria ambigua* has never been taken on bats of the genus *Tonatia.*

PANAMANIAN MATERIAL EXAMINED: From *Carollia p. azteca:* 395 specimens in 139 lots, from more than 391 bats, as follows: 7 (3 bats), Camp Chágres, Madden Dam (Canal Zone), 20 to 25 June 1963, GML: 4 (2 bats), Camp Piña (Canal Zone), 11 and 26 October 1960; 2 (2 bats), bridge, Coco Solo (Canal Zone); 5 (4 bats), culvert, Gatun Tank Farm (Canal Zone), 19 November 1959; 1, culvert, Brazoa Brook, Navy Tank Farm (Canal Zone), 6 October 1959; 50 (28 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959 and 24 (18 bats), same locality, 25 November 1959; 1, Natural Bridge, Madden Dam (Canal Zone), 31 August

1959; 20 (12 bats), air-raid shelter, Fort Davis (Canal Zone), 6 October 1959, and 5 (6 bats), same locality and site, 29 October 1959; 1, Fort Gulick, 15 October 1959; 2 (2 lots), Battery Pratt, Fort Sherman (Canal Zone), 16 March 1960; 6, same data but 30 July 1959; 3, same data but 23 November 1959; 1, Battery Kilpatrick, same locality, 22 October 1959; and 34 (30 bats), from bats in cativo trees same locality, 2 and 4 December 1959; 6, tunnel, runway, France Field, 25 August 1959; 1, culvert, same locality, 22 September 1959; 1, magazine, same locality, 8 October 1959; 3 (3 bats), Gold Hill, same locality, 20 October 1959; 4 (34 bats), culvert, same locality, 23 November 1959, and 1 (3 bats), same locality, 30 November 1959; 27 (34 bats), Sardanillo Caves, Summit (Canal Zone), 12 August 1961, C. Yunker [RML]; 4 (2 lots), Summit, 17 April 1957, C. B. Koford [USNM]; 1, Gamboa (Canal Zone), 1 May 1957, C. B. Koford [USNM]; 1, RR culvert, Paraíso (Canal Zone), 16 September 1959; 17 (19 bats), RR culvert, east of Summit Golf Club (Canal Zone), 26 October 1959; 5, hollow tree, 1 mile from Gatuncillo (?Canal Zone), 28 July 1960; 1, culvert, Chepo Road (Panamá), 12 October 1959; 2, air-raid shelter, La Chorrera (Panamá), 18 September 1959; 9 (29 bats), Chilibrillo Caves (Panamá), 18 August 1959; 33, same locality, K. W. Cooper [MCZ]; 4, same locality, 27 August 1944 [USNM]; 5 (22 bats), Buena Vista Caves (Colón), 3 September 1959; 5 (4 bats), same locality, 15 September 1959; 32 (20 bats), same locality, 24 November 1959; 1, Porto Bello (Colón), 7 August 1923 [USNM]; 11 (10 bats), Guánico (Los Santos), 12 January to 13 February 1962; 1, Cerro Hoya (Los Santos), 25 February 1962; 9 (5 bats), Cocos Point, Isla del Rey (Darién), 22 and 24 March 1960; 2, Río Chucunaque (Darién), 19 February 1958, P. Galindo, [GML]; 5 (3 lots), Río Tuira (Darién), 25 February to 8 March 1958, P. Galindo [GML]; 1, Tacarcuna Village (Darién), 2 September 1958, P. Galindo [GML]; 32 (13 bats), Almirante (Bocas del Toro), 24 January to 1 February 1960; 2, "Panama," L. H. Dunn [MCZ]. From *Carollia castanea:* 3 (4 bats), Sibube (Bocas del Toro), 21 to 26 January 1963, C. O. Handley, Jr.; 3, Río Chucunaque (Darién), 17 February 1958, P. Galindo [GML]. From *Carollia subrufa:* 1, Río Changena Camp (Bocas del Toro), elevation 2300 feet, 21 September 1961; 1, Sibube (Bocas del Toro), 23 January 1963, C. O. Handley, Jr.; 1, Isla Bastimentos (Bocas del Toro), 3 February 1963, C. O. Handley, Jr., and F. M. Greenwell; 1, Armila (San Blas), 19 March 1963, same collectors. From *Carollia* sp.: 2, Cerro Azul (Panamá), elevation 2000 feet, 27 January 1959, E. Méndez [GML]; 1, Fort Clayton (Canal Zone), 9 January 1953, F. Blanton.

From mixed collections of *Carollia p. azteca* and *Glossophaga s. leachii:* 3, Huile (Panamá), 24 October 1960; 2, San Lorenzo Cave, Fort Sherman (Canal Zone), 15 March 1961. From *Desmodus rotundus murinus:* 5 (2 bats), Guánico (Los Santos), 26 January 1962. From *Glossophaga s. leachii:* 1, Armila (San Blas), 5 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 1, Almirante (Bocas del Toro), 28 January 1960; 1, cativo trees, Fort Sherman (Canal Zone), 4 December 1959. From *Lonchophylla robusta:* 1, Buena Vista Cave (Colón), 16 June 1960. From *Lonchorhina aurita:* 1, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9

September 1959, and 3 (2 lots, 10 bats), same locality, 24 and 25 November 1959; 4, two miles north of Summit (Canal Zone), 17 April 1957 [USNM]. From *Natalus stramineus mexicanus:* 1, Fort San Lorenzo, Fort Sherman (Canal Zone), 17 March 1960; 1, San Lorenzo Cave (Canal Zone), 15 March 1961. From *Phyllostomus hastatus panamensis:* 1, Guánico (Los Santos), 26 January 1962; 4 (20 bats), Chilibrillo Caves (Panamá), 17 July 1959. From *Pteronotus parnellii fuscus:* 1 (3 bats), Buena Vista Cave (Colón), 3 September 1959; 2, Almirante (Bocas del Toro), 29 January 1960; 1 (4 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November 1959. From *Trachops cirrhosus:* 1, culvert, Chepo Road (Panamá), 12 October 1959; 1, Battery Pratt, Fort Sherman, 23 November 1959; 1 (2 bats), Cerro Hoya (Los Santos), 15 February 1962. From *Vampyrops vittatus:* 1, Río Changena Camp (Bocas del Toro), elevation 2500 feet, 27 September 1961. *Without host:* 1, railroad culvert at tower 34–12H, Summit (Canal Zone), L. H. Dunn 181A [MCZ]; 8, Chilibrillo Caves (Panama), L. H. Dunn 277 [MCZ]; 2, same locality, no further data [CU]; 1, culvert between Miraflores and Pedro Manuel, W side of Canal (Canal Zone), L. H. Dunn [MCZ]; 2, Barro Colorado Island (Canal Zone), 2 December 1956, Koford no. 19 [USNM].

REMARKS: *Speiseria ambigua* is an unusually excitable species and leaves the host readily when disturbed.

Genus **Aspidoptera** Coquillet

Aspidoptera Coquillet, 1899, Can. Ent., 31: 334. Speiser, 1907, Ent. News, 18: 104 (synonymizes *Lepopteryx* Speiser). Williston, 1908, Man. N. Am. Dipt., 3rd ed., p. 385. Coquillet, 1910, Proc. U. S. Nat. Mus., 37, no. 1719, p. 511 (type-species). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 25 (keyed), 28 (cit.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 13 (keyed), 25, 26 (char., key to spp.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 55, p. 658. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28: 357 ff. (morph., syst. pos.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418 (keyed); 1942, Bol. Ent. Venez., 1: 86 (keyed). Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), 18: 135–144 (rev.); 1949, Parasitology, 39: 322 (keyed); 1951, Trans. Roy. Ent. Soc. Lond., **102**: 216 (morph.). Hoffmann, 1953, Mem. Cong. Cient. Mex., 7: 177 (keyed).

Lepopteryx Speiser, 1900, Arch. Naturg., **66A**, Bd. I, pp. 42, 53 (diagn.), 62, 65 (keyed). [Type-species: *Lipoptena phyllostomatis* Perty].

Lipoptena (not Nitsch, 1818), Kolenati, 1863, Hor. Soc. Ent. Ross., 2: 103 (keyed). Bigot, 1885, Ann. Soc. Ent. Fr., (6), 5: 226 (part).

Type-species: *Aspidoptera busckii* Coquillet, 1899.

Jobling (1949a) recognized four species of *Aspidoptera,* namely, *megastigma* Speiser, *minuta* Costa Lima, *clovisi* Pessôa and Guimarães, and *phyllostomatis* (Perty). It has long been apparent to the senior author that these were convergent types representing the independent evolution of small size and reduced wings. We have re-assigned the first three to new genera, *Mastoptera, Exastinion,* and *Noctiliostrebla,* respectively. Only one of these (*Exastinion*) appears to be monotypic.

As restricted by us, *Aspidoptera* now includes those minute brachypterous species with the following characters:

DIAGNOSIS: *Head.*—Laterovertices and occipital plates well differentiated. Laterovertices without a longitudinal or oblique dark suture; occipital plates rounded posteriorly, without a posterior lobe or flap. *Thorax.*—With a complete median suture which is united with the transverse mesonotal suture. Longitudinal and vertical membranous clefts open. Sternopleura not strongly produced anteriorly, sides oblique. Pleurotrochantines with a blunt reflexed median lobe, this not united with the metepimeron. *Legs.*—Subequal. *Wings.*—Brachypterous but with essentially complete venation. *Abdomen.*—Tergum I+II and sternum II without any distinctive characters. *Female:* Tergum

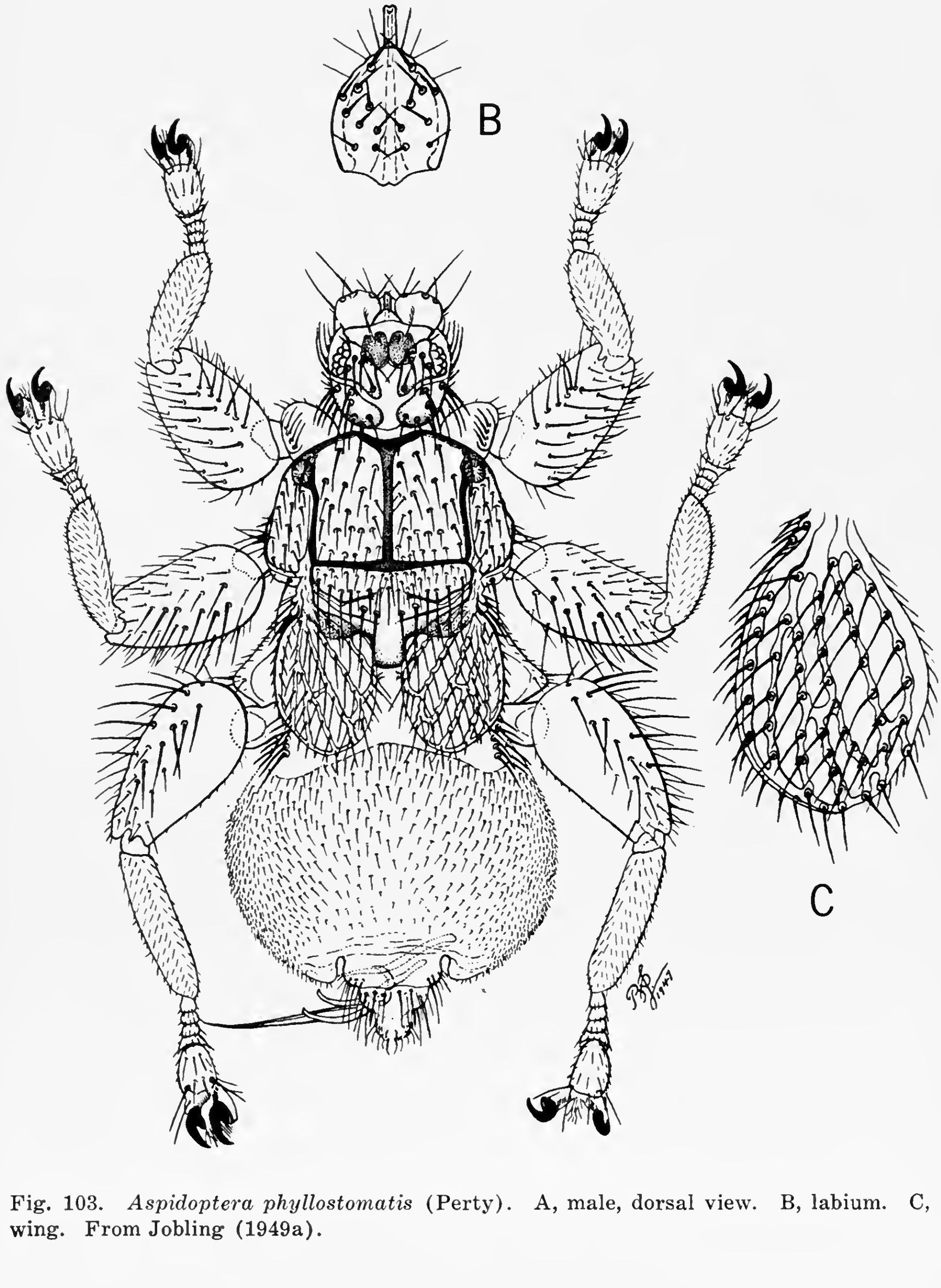

Fig. 103. *Aspidoptera phyllostomatis* (Perty). A, male, dorsal view. B, labium. C, wing. From Jobling (1949a).

VII very weakly sclerotized, with a transverse row of two to four short setae. Supra-anal plate short. Seventh sternites small. Cerci free, not united with ventral arc. *Male:* Sterna V and VI absent. Gonapophyses curved laterally and downwardly at apex; accessory seta inserted posterior to the macroseta.

We tentatively segregate four species of *Aspidoptera: busckii* Coquillet, *phyllostomatis* (Perty) (*sensu* Jobling 1949a), *delatorrei* n. sp., and an undescribed species from Brazil. Two of these are known to us from Panama.

Aspidoptera phyllostomatis (Perty). Figures 103, 104E.

Lipoptena phyllostomatis Perty, 1833(?), Delect. Anim. Artic., fasic. 3, p. 190, pl. 37, fig. 16—"in Phyllostomatis specie brasiliensis, indeterminata" (type apparently lost). Westwood, 1840, Introd. Mod. Class. Ins., 2: 585. Kolenati, 1856, Parasiten d. Chiropteren, p. 48, pl. 4, fig. 48a, b; 1863, Hor. Soc. Ent. Ross, 2: 98 (notes), 103 (keyed).

Leptotena phyllostomatis Macquart, 1835, Hist. Nat. Ins. Dipt., 2: 645.

Lepopteryx phyllostomatis Speiser, 1900 (part., female), Arch. Naturg., 66A, Bd. I, pp. 32, 53–54 (descr.), 62, 65 (keyed), pl. 3, figs. 3, 4.

Aspidoptera phyllostomatis Speiser, 1900 (part.), Zool. Anz., 23: 153 (synonymizes *A. busckii* Coquillet). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 20 (discuss.), 22 (keyed), 28 (cit.), pl. 1, fig. 4 (wing). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Jobling, 1936, Parasitology, 28: 359 (wing struct.); 1949, ibidem, 39: 315 ff., fig. 1G; 1949, Proc. Roy. Ent. Soc. Lond., (B), 18: 136 (keyed), 137 (redescr.), fig. 1 (with *busckii* Coq. as synonym).

The type of *Lipoptena phyllostomatis* Perty, 1833, is apparently lost. Presumably, it was deposited in the Munich Museum (Zoologische Sammlung des Bayerischen Staates) along with the other insects Perty described from the material collected in Brazil by Spix and Martius. Speiser (1900a, p. 53) inquired about the type and was told that it was lost. Dr. T. C. Maa (pers. comm.) has informed us that he saw nothing in European collections that could be regarded as the type, though he had not studied either the collection at Munich or the Perty collection at the Natural History Museum in Bern.

At our request, Dr. W. Forster of the Munich Museum has kindly searched for the type again without success. He wrote (pers. comm.):

"Leider wurde in früheren Zeiten das nicht als solches bezeichnete Typen-Material teilweise in der Schausammlung gezeigt, sodass auf diesem Wege manche Verluste eingetreten sind. Auch ein erheblicher Teil der Perty'schen Typen ging damals zugrunde. Ich glaube also, Sie können, falls nötig, es ohne weiteres verantworten einer Neotypus aufzustellen und zu publizieren."

Dr. H. D. Volkart, Curator of Invertebrates at the Natural History Museum at Bern searched for the type in the collection of that institution without success. He wrote:

"Der Typus von *Lipoptena phyllostomatis* Perty befindet sich leider nicht in unseren Sammlungen. Wohl ist die Sammlung Perty hier im Museum, aber sie kamseinerseit leider in schlecht erhaltenem Zustand hierher und ist heute nicht mehr vollständig. Es ist daher nicht mehr möglich, festzustellen, ob sich der Typus von *phyllostomatis* in Perty's persönlicher Sammlung befand; wir besitzen heute kein Exemplar dieser Art."

We agree with Dr. Forster that a neotype should be established. Unfortunately, there is little basis for interpreting Perty's *phyllostomatis*.

The type locality is Brazil, the type host "in phyllostomatis specie brasiliensis indeterminata." The name *Phyllostomus* was applied to many bats of the family Phyllostomidae even until the early Twentieth Century. Bats of the genus *Phyllostomus* are parasitized by *Mastoptera minuta* (Costa

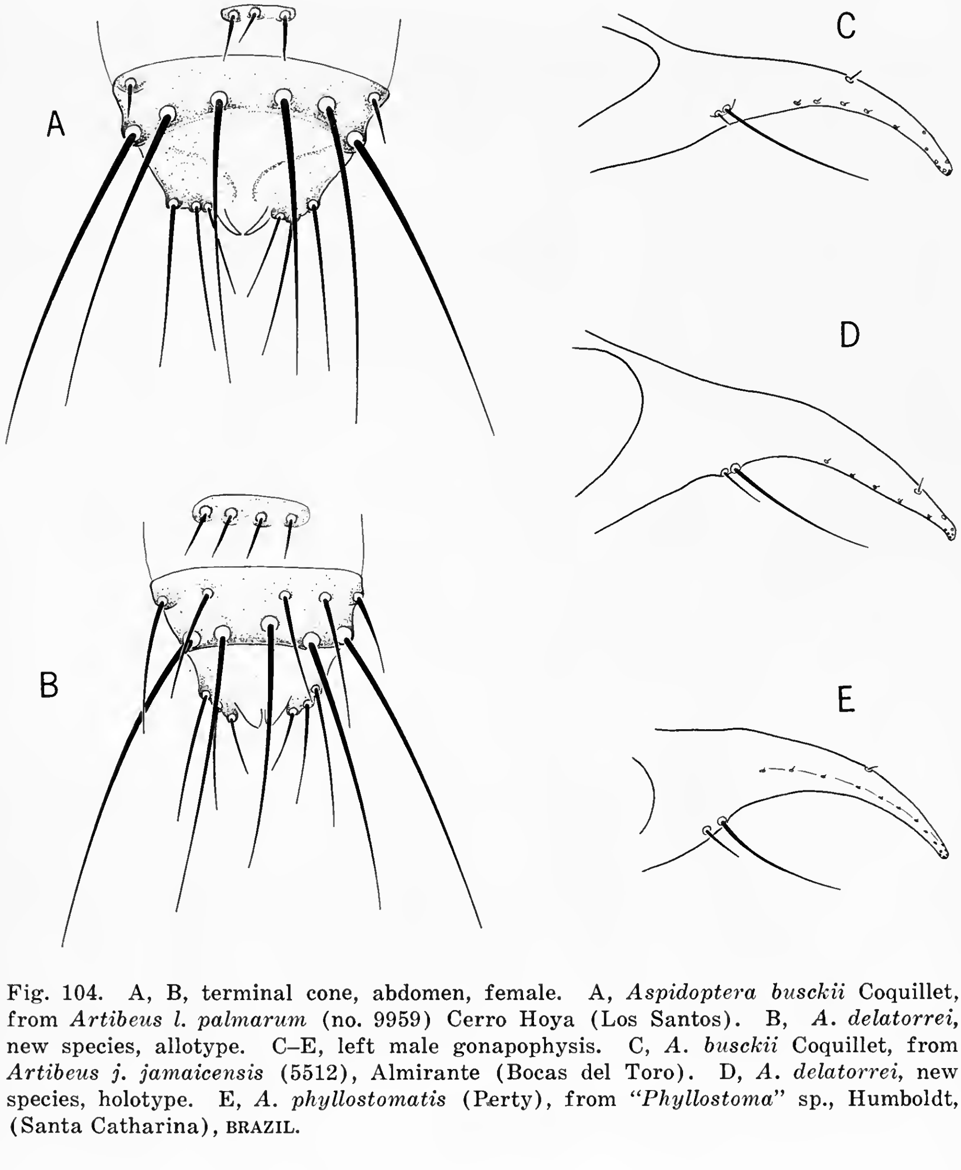

Fig. 104. A, B, terminal cone, abdomen, female. A, *Aspidoptera busckii* Coquillet, from *Artibeus l. palmarum* (no. 9959) Cerro Hoya (Los Santos). B, *A. delatorrei*, new species, allotype. C–E, left male gonapophysis. C, *A. busckii* Coquillet, from *Artibeus j. jamaicensis* (5512), Almirante (Bocas del Toro). D, *A. delatorrei*, new species, holotype. E, *A. phyllostomatis* (Perty), from "*Phyllostoma*" sp., Humboldt, (Santa Catharina), BRAZIL.

Lima) in Brazil (see "Remarks," p. 516). However, Perty's illustration, poor as it is, could hardly be of that species, but rather of a fly more nearly like that interpreted as *phyllostomatis* by both Speiser (1900) and Jobling (1949a). We follow Jobling's interpretation of *phyllostomatis*.

Jobling's description and figure are based on a slide-mounted specimen collected from *Phyllostomus* sp. at Humboldt, Sta. Catharina, Brazil, by Ehrhardt. The host was obviously not a *Phyllostomus*. Jobling's specimen was from one of several lots, apparently collected by Ehrhardt from the same host species, which contained *Trichobius phyllostomae* Kessel (including the holotype) and a species of *Megistopoda*, as well as the *Aspidoptera*. This assemblage indicates that the host was either an *Artibeus* or a species of *Sturnira*. A specimen of *T. phyllostomae* in the collection of Chicago Natural History Museum was taken from "*Artibeus literatus jamaicensis*" at Joinville (Santa Catharina). A new species of the *phyllostomae* group but more closely related to *brennani* n.sp. (from *Sturnira ludovici*) than to *phyllostomae* was taken from *Sturnira* sp. at Therezopolis, BRAZIL, with a species of *Aspidoptera* that is related to *delatorrei* n.sp. (from *Sturnira lilium*), rather than to *phyllostomatis, sensu* Jobling. It seems likely, then, that the host of Jobling's *phyllostomatis* was an *Artibeus*.

We designate as the neotype of *phyllostomatis* the specimen (noted above) upon which Jobling based his description and illustration, in the collection of the British Museum (Natural History). We have seen an additional specimen, from the same host and locality, which was kindly sent to us by Dr. Harold Oldroyd of that museum.

Jobling's figure (fig. 103) indicates that the dorsal surface of the mesepisterna have uniform, rather short setae, but in the Humboldt specimen before us, the outer (lower) setae are short and the inner (upper) setae are long. When specimens are studied and illustrated from slide preparations, the apparent length of the setae is often deceptive because of foreshortening.

As noted by Maa (1963), Westwood (1840, vol. 1, p. 585) refers *Lipoptena phyllostomatis* to Nitzsch ("Voyage Prince Maximilian of Bavaria") as well as to Perty. We have been unable to find the Nitzsch reference in any bibliographic sources, and thus cannot determine whether or not his use of the name antedates that of Perty.

Aspidoptera busckii Coquillet. Figure 104A, C.

Aspidoptera buskii Coquillet, 1899, Can. Ent., **31**: 335—"Bayamon, Porto Rico," from *Artibeus* sp. (U. S. National Museum, no. 4210); 1900, Proc. U. S. Nat. Mus., **22**: 270 (record). Aldrich, 1905, Smiths. Misc. Coll., **46**: 657. Coquillet, 1910, Proc. U. S. Nat. Mus., **37**, no. 1719, p. 511 (as type-species of *Aspidoptera*). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 22 (status), 28 (cit.). Wolcott, 1923, Jour. Dept. Agric. Porto Rico, **7**: 235. Kessel, 1925, Jour. N. Y. Ent. Soc., **33**:26. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Jobling, 1936, Parasitology, **28**: 359 (wing characters); 1949, Parasitology, **39**: 315 (syn. note). Cooper, 1941, Yearb. Amer. Phil. Soc., **1941**: 126 (chromosome no.). Grandi, 1952, Introduz. Stud. Ent., **2**: fig. 439.

Lepopteryx phyllostomatis (not Perty, 1833), Speiser, 1900 (part.,), Arch. Naturg. **66A**, Bd. I, pp. 32, 53 (keyed), pl. 3, fig. 3.

Aspidoptera phyllostomatis Speiser, 1900 (part.), Zool. Anz., **23**: 153 (with *busckii* as synonym); 1907, Ent. News, **18**: 104. Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), **18**: 138 (part., Antillean records only).

The name *busckii* is revived for the species of *Aspidoptera* that parasitizes *Artibeus jamaicensis* and *A. lituratus* as well as bats of some closely related genera, in the West Indies, Central America, and northwestern South America. We are unable at this time to give characters that will separate females of *phyllostomatis* and *busckii.* The males appear to be distinct in the structure of the gonapophyses (fig. 104C, E). The specimens recorded below from *Vampyressa* and *Chiroderma* appear to be the same species as from *Artibeus jamaicensis* and *A. lituratus.* Specimens from Panama seem to be identical with those on *Artibeus jamaicensis* in the West Indies. This is interesting, because *Artibeus jamaicensis parvipes* (Greater Antilles) and *A. j. yucatanicus* (in Mexico, Guatemala) are parasitized by an undescribed species of *Trichobius,* while *Artibeus j. jamaicensis* in Panama is not. A few additional characters that apply to both *busckii* and *phyllostomatis,* not included in Jobling's description, follow.

A heavily pigmented species. *Head.*—Ventral face of palpi with sparse setae on a little more than basal half. Postgenae with a row of rather heavy setae dorsal and parallel to ventral margin of oral cavity, dorsal to these, a row of very short setae. *Thorax.*—Spiracles large. Sutures heavy, transverse suture nearly straight. Mesepisterna dorsally with several rows of setae, the outer ones conspicuously shorter.

Abdomen.—Lateral lobes of tergum I+II with two longitudinal rows of about six heavy long bristles each, the most posterior ones of the inner (marginal) row shorter; ventral to these a group of seven to nine shorter bristles. *Female:* Supra-anal plate with six apical or subapical macrosetae and on each side near mid-length a short submarginal bristle. Seventh sternites small, roundly oval, with nine to ten setae. *Male:* Gonapophyses as shown in fig. 104C.

Measurements:	BL	TL
Male	1.85–2.03	0.56–0.60
Female	2.03–2.25	0.60–0.63

PANAMANIAN MATERIAL EXAMINED: From *Artibeus j. jamaicensis:* 34 (32 bats), Almirante (Bocas del Toro), 22 January, 18 February 1960; 17, Rio del Puente, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 1, same locality, 5 April 1933, L. H. Dunn no. 25 [AMNH]; 1, cave, west side of Taboga Island (Panamá), 24 September 1959; 20 (8 bats), Piña Point (Darién), 24 March 1960; 6 (3 bats), Río Seteganti (Darién), 4–5 February 1961, P. Galindo [GML]; 3 (1 bat), Río Tuira (Darién), 10 March 1958, P. Galindo [GML]; 13 (11 bats), La Laguna (Darién), 2900 feet elevation, 2–15 June 1963; 21 (12 bats), Tacarcuna (Darién), 2000 feet elevation, 20 June to 12 July 1963, GML; 14 (9 bats), Cerro Hoya (Los Santos), 8 to 16 February 1962; 1, Guánico (Los Santos), 12 January 1962. From *Artibeus lituratus palmarum:* 1, Summit (Canal Zone), K. W. Cooper [MCZ]. 3 (3 lots), Barro Colorado Island (Canal Zone), 1 lot each, 4 November 1956, 6 December 1956, and 3 January 1957 [USNM]; 1, Cerro Hoya (Los Santos), 21 February 1962; 1, Río Mandinga (San Blas), 15 May 1957, P. Galindo [GML]. From *Chiroderma villosum jesupi:* 1, Almirante (Bocas del Toro), 24 January 1960. From *Vampyressa nymphaea:* 4 (1 bat), Río Mono Camp (Darién) 25 July 1963, GML. From *Carollia p. azteca* (mist net): 2, Almirante (Bocas del Toro), 26 and 31 January 1960. From *Phyllostomus discolor* (mist net): 1, Almirante (Bocas del Toro), 30 January 1960.

NON-PANAMANIAN MATERIAL EXAMINED: From *Artibeus jamaicensis parvipes:* 1, CUBA, Dethier [MCZ]. From *Artibeus jamaicensis:* about a dozen lots from various localities in MEXICO, GUATEMALA and COLOMBIA.

REMARKS: We have seen numerous specimens that are either *busckii* or *phyllostomatis* from Venezuela and Peru. We have not studied them sufficiently to identify them at this time.

Aspidoptera delatorrei Wenzel, new species. Figure 104B, D.

Similar to *A. phyllostomatis* (Perty), and *busckii* Coquillet but differing from both in that the bristles of all rows on the dorsal surface of the mesepisterna are long (setae of outer rows short in *busckii* and *phyllostomatis*); the supra-anal plate (female) has a transverse row of four to six shorter setae across middle (fig. 104B), rather than only one on each side, in addition to the apical macrosetae; and the short dorsal bristle of the male gonapophyses is inserted near apex rather than near middle.

DESCRIPTION: Smaller, more lightly pigmented, and on the whole more densely setose than *busckii* Coquillet and *phyllostomatis* (Perty). *Head.*—Ventral surface of palpi with numerous short setae distributed from base nearly to apex. Genae densely setose, bristles along dorsal margin long, gradually shorter ventrad; postgenae with bristles along margin of oral cavity; parallel and dorsal to these are two or three rows of subequal bristles. *Thorax.*—Spiracles small. Transverse suture distinctly sinuate on each side. Dorsal surface of mesepisterna with three longitudinal rows of long subequal bristles.

Abdomen.—Tergum I+II with 23–24 bristles arranged in three or four irregular longitudinal rows, most of the bristles long, but the most anterior bristle of upper row short, as are two or three ventral ones. *Female:* Tergum VII very small, feebly sclerotized and indistinct, typically with four, sometimes three, bristles. Supra-anal plate usually with six (rarely, four or five) apical or subapical macrosetae and anterior to these, a transverse row of five or six shorter setae; the latter often divided into two lateral groups by the foreward displacement of the median pair of subapical macrosetae.

Measurements:	BL	TL
Male	1.65–1.90	0.48–0.49
Female	1.70–2.36	0.49

TYPE MATERIAL (from *Sturnira lilium parvidens*): Holotype male and allotype female (slides, host no. 9406), Guánico (Los Santos), 13 February 1962, C.M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum. Paratypes.—1, same data as holotypes; 3, same locality but 8 February 1962; 3 (2 bats), Río Tuira (Darién), 25 February and 10 March 1958, P. Galindo [GML]; 5 (2 bats), Río Mandinga (San Blas), 26 and 27 May 1957, P. Galindo [GML]. Non-Panamanian paratypes.—3, Finca El Zapote, Zapote (Escuintla), GUATEMALA, 2400 feet elevation, 14 July 1948, R. D. Mitchell and Luis de la Torre, CNHM Guatemala Zoological Expedition (1948); 2, La Catarina, 2 miles north of Ciudad Guzman (Jalisco), MEXICO, 9 December 1954, L. de la Torre, CNHM Mexican Zoological Field Trip (1954). Paratypes in the collections of Chicago Natural History Museum; the United States National Museum; Gorgas Memorial Laboratory, Panamá, Panamá; Environmental Health Branch (U. S. Army) at Corozal (Canal Zone); Departmento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil; Faculdad de Ciencias, Universidad Central de Venezuela; and Bernice P. Bishop Museum, Honolulu.

OTHER MATERIAL EXAMINED: From *Carollia p. azteca:* 1, Río Tuira (Darién), 5 March 1958, P. Galindo [GML].

REMARKS: This species is named for Dr. Luis de la Torre, College of Pharmacy, University of Illinois, Chicago. Dr. de la Torre has added much to our knowledge of ectoparasites of mammals, especially bats, through his collecting in Mexico and Guatemala.

KEY TO THE PANAMANIAN SPECIES OF *ASPIDOPTERA*

All dorsal setae of mesepisterna long. Tergum I+II with three or four rows of conspicuous, long bristles, in addition to the short bristles present near inner anterior margin and ventrally. *Female:* Supra-anal plate (fig. 104B) with five or six very long apical or subapical setae and a transverse row of six shorter setae across middle, this row sometimes separated into two lateral groups of three setae each by an anterior displacement of the median pair of macrosetae. *Male:* Gonapophyses as in fig. 104D. . . . . *delatorrei* n. sp.

Outer setae of dorsal surface of mesepisterna short. Tergum I+II with only two rows of long bristles, in addition to a group of short ventral bristles. *Female:* Supra-anal plate (fig. 104A) with five or six apical macrosetae and, on each side near mid-length, a short submarginal seta. *Male:* Gonapophyses as in fig. 104C. . . . . *busckii* Coquillet

Exastinion Wenzel, new genus

Type-species: *Aspidoptera clovisi* Pessôa and Guimarães, 1936.

Resembling *Aspidoptera* but differing conspicuously in several characters: each occipital lobe is produced as an oblique flap (fig. 105C), with crenated inner margin (posterior margin of head rounded in *Aspidoptera*); the longitudinal and vertical membranous thoracic clefts are closed, the line of fusion marked by dark pigmented sutures; the median mesonotal suture is bifurcate anteriorly; the dorsal abdominal connexivum is bare except toward sides; and sternum V is present in the male.

DIAGNOSIS: Minute species, 1.2–1.8 mm. long. *Head.*—Flattened. Theca cordiform. Palpi roughly oval, slightly longer than wide, anterior margins obliquely truncated, with setae along margins, and on ventral surface with fine setae on slightly more than basal half, the upper surface microsetose. Laterovertices and occipital plates differentiated, both microsetose, setae on laterovertices restricted to antero-lateral portions, laterovertices each with a long, posteriorly directed process, oblique occipital plates with a feebly sclerotized, posteriorly directed flap on each side, their posterior margins pigmented, crenated, with long bristles, and overlapping the anterior portion of the prescutum. Mediovertex unsclerotized, projecting downward as a minute process between the occipital flaps. Genae with long setae along dorsal margin, but ventral to these are numerous, shorter, thorn-like setae. Postgenae, below, with a large oval, lightly sclerotized transverse area on each side of the oral cavity. Eyes minute, indistinctly faceted, with four to six facets.

Thorax.—Mesonotum flat; median suture of prescutum bifurcate anteriorly, united posteriorly with the sinuate transverse suture; scutum very short, less than a third as long as prescutum. Mesipisterna prominent and flattened above, longitudinal and vertical membranous clefts closed, represented by rigid, pigmented sutures. Sternopleura broadly projecting and emarginate between the procoxae. Posterior margin of pleurotrochantines with a median, rounded, slightly reflexed lobe. *Wings.*—Brachypterous, with venation essentially normal, except that second and third crossveins are absent. *Legs.*—Short, subequal, femora stout, femora and tibiae subequal in length, clothed with long setae on antero-dorsal surface of fore- and midlegs, and on dorsal surface of hindlegs, the setae elsewhere shorter to very short. Tarsi short, tarsomeres 1–4 progressively wider and more strongly anteroposteriorly compressed, the fourth nearly as wide as the fifth, the latter broad, posteriorly rounded; claws large.

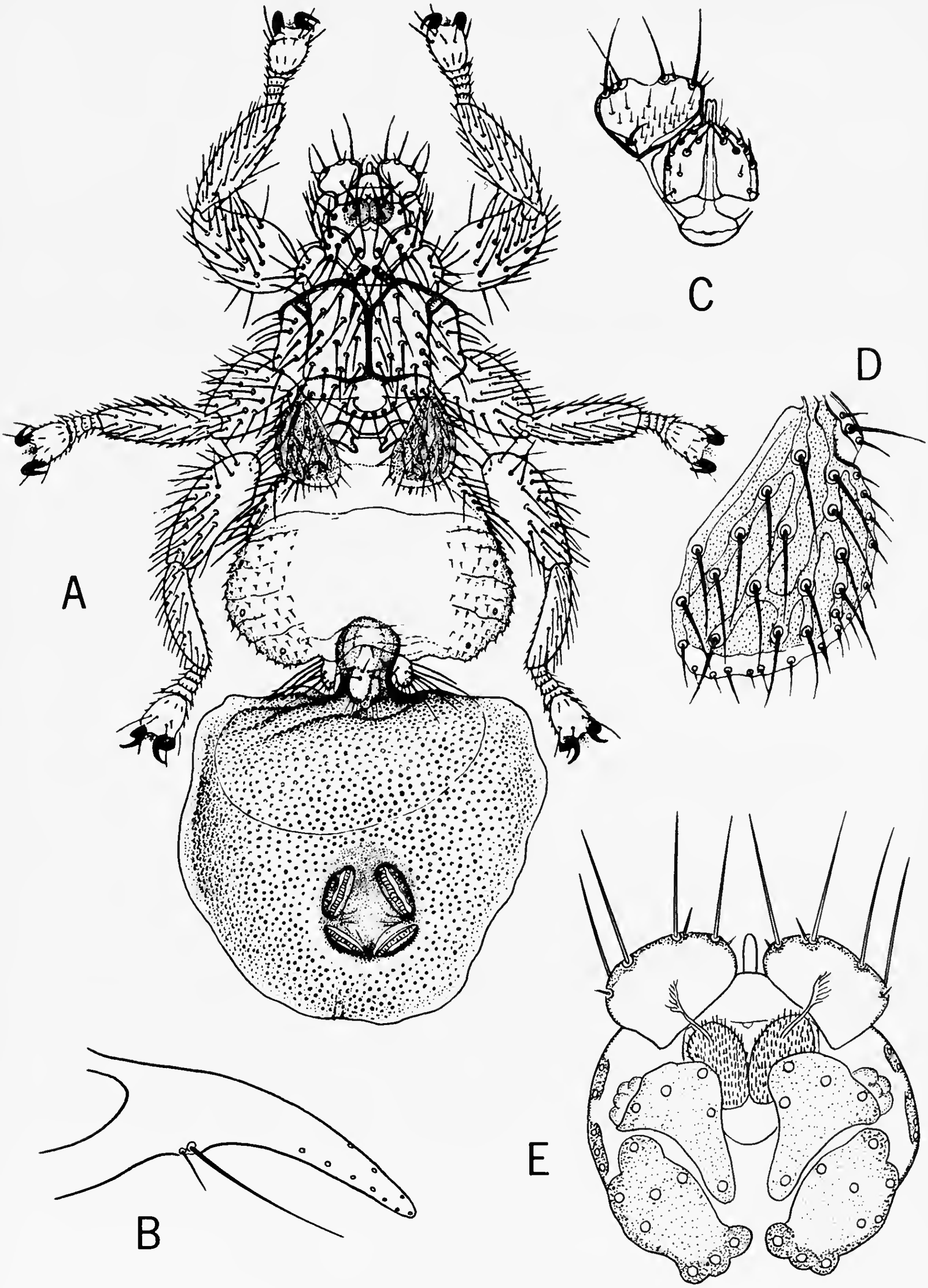

Fig. 105. *Exastinion clovisi* (Pessôa and Guimarães). A, female, with pupa extruding, dorsal view. B, left male gonapophysis, specimen from *Anoura cultrata* (no. 8593), Río Changena Camp (Bocas del Toro). C, head, dorsal view (setae of laterovertices and occipital lobes omitted). D, wing. E, mouthparts. A, D, and E from Jobling (1949a), based on specimen from *Anoura g. geoffroyi*, Aripa Cave, TRINIDAD.

Abdomen.—Dorsal connexivum bare except toward sides; paired dorsal segmental setae absent; sides and venter with fine, short setae. Tergum I+II very short at middle, with conspicuous, posteriorly directed lateral lobes. Sternum II well developed, setose in a median triangular area and along posterior margin, the setae borne in minute thecae, these, in turn, on a translucent plaque. *Female:* Tergum VII a small, feebly sclerotized, translucent, transverse plate, bearing two short setae. Supra-anal plate very short, transverse. Seventh sternites short and transverse. Cerci free, not united with the ventral arc. *Male:* Sternum V very short and broad; VI not distinguishable as a sclerite, though it seems to be represented by a thread-like, translucent band. Hypopygium very short. Gonapophyses as in *Trichobius.*

The name of the genus is derived from the Greek *exastis* (rough edge or fringe) + *inion* (back of head, occiput).

Exastinion clovisi (Pessôa and Guimarães), *new combination.* Figure 105.

Aspidoptera clovisi Pessôa and Guimarães, 1936, Ann. Fac. Med. São Paulo, 12, fasc. 2, pp. 262–263, figs. 5–6—Ipiranga, São Paulo, Brazil, from *Anoura geoffroyi* (?Laboratorio de Parasitología, Faculdade de Medicina, Universidad de São Paulo); 1940, Arq. Inst. Biol., São Paulo, **11**: 424, fig. 1. Guimarães, 1944, Papeis Avulsos, São Paulo, **6**: 187, figs. 10–14 (descr. of "larva"). Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), **18**: 138 (redescr.), 136 (keyed), fig. 2; 1949, Parasitology, **39**: 316 ff. (hosts), 327 (records), fig. 1J; 1951, Trans. Roy. Ent. Soc., Lond., **102**: 216. Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 183, 188 (records).
Aspidoptera phyllostomatis (not Perty, 1833), Bequaert, 1940, Rev. Acad. Colomb. Cienc. Ex., Fis. y Nat., **3**: 418. Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 26 (part.).

PANAMANIAN MATERIAL EXAMINED: 53 specimens (9 lots) from 11 bats at localities from 2500–5300 feet. From *Anoura geoffroyi lasiopyga:* 4 (2 bats), Rancho Mojica (Bocas del Toro), 12 September 1961; 7 (3 bats), Casa Lewis, Cerro Punta (Chiriquí), 1 to 5 February 1960, and 1, same locality, 4 May 1960; 11 (2 bats), Cerro Hoya (Los Santos), 11 February 1962. From *Anoura cultrata:* 3 (1 bat), Cerro Punta (Chiriquí), 12 March 1962; 18 (2 bats), Río Changena Camp (Bocas del Toro), 27 September 1961.

OTHER MATERIAL EXAMINED: We have examined about 175 other specimens from *Anoura aculeata* (VENEZUELA) and from subspecies of *Anoura geoffroyi* from TRINIDAD, VENEZUELA, COLOMBIA, ECUADOR and GUATEMALA.

REMARKS: Jobling (1949a, p. 138, fig. 2B) indicated that the eyes of *A. clovisi* were not faceted and so figured one. All of our specimens show five to six minute facets in slide preparations (fig. 105C). The palpus figured by Jobling (fig. 105E) is lying in an oblique plane and appears to be transverse. Actually, the palpi are very slightly longer than broad. The setae on sternum II are quite uniform in size in the male, though one or two at each postero-lateral angle may be a little longer. In the female there is a group of conspicuously longer setae within these angles.

This may be a composite species, but to date we have not been able to distinguish between specimens from different species of *Anoura* or from different geographic areas.

Noctiliostrebla Wenzel, new genus

Type-species: *Lipoptena dubia* Rudow, 1871.

Superficially resembling species of *Aspidoptera, Exastinion, Mastoptera,* and *Paradyschiria* but not closely related to any of these. Easily separated from them by the characters given in the key and distinctive in the following: longitudinal and vertical membranous clefts closed, the mesepisternum and prescutum, and the mesepisternum and mesepimeron completely fused without evidence of a suture (!); tergum VII of female represented by paired transverse sclerites; male gonapophyses "free" anteriorly, articulated ventrally by short processes to forks of the gonapophyseal apodeme; sterna V and VI absent in male; hind tibiae along inner apices with a mixture of normal setae and extremely fine, translucent, flattened setae, the latter so closely placed as to appear to be branched when examined under low magnifications.

DIAGNOSIS: Small louse-like species. *Head.*—Nearly round, viewed from above; elevated posteriorly, viewed in profile; with well-defined laterovertices and occipital lobes, each laterovertex divided by an oblique, dark suture. Palpi irregularly rounded, with marginal setae only, ventral surface lacking setae. Theca subcordiform.

Thorax.—Anterior margin of prescutum feebly emarginate but slightly projecting at middle; median suture strong, complete, united with the transverse suture, to form an inverted "Y". Spiracular openings large, doughnut-shaped, very conspicuous. Prescutum without discal setae, the setae restricted to sides and anterior margin. Longitudinal and vertical membranous clefts absent, the prescutum and pleura completely fused, without evidence of a suture. Dorsal and ventral surfaces of thorax often with conspicuous irregular lighter areas in the cuticle. *Wings.*—Very short, oval, pointed, with marginal bristles, veins indistinct, very much reduced in number, usually three, sometimes four. *Legs.*—Short, subequal. Tibial setae sparse, arranged in rows; dense setae along inner margin of metatibiae on about distal fifth, a mixture of normal setae, and extremely fine flattened setae, which in profile appear almost filamentous under oil immersion. Tarsi stout, about three-fourths as long as tibiae; tarsomeres 1–4 antero-posteriorly compressed, the last tarsomere with subparallel sides, about as long as 1–4 combined; claws large, conspicuous.

Abdomen.—Spiracles much smaller than thoracic spiracles but conspicuous and "doughnut-shaped." Abdominal connexivum transversely wrinkled, the setae relatively short and borne on feebly sclerotized plaques. Tergum I+II very well developed, emarginate at middle. *Female:* Tergum VII represented by a pair of transverse sclerites. Supra-anal plate short. Ventral arc about the same size as supra-anal plate, the two forming an annulus. Cerci free, not united with ventral arc. *Male:* Hypopygium greatly developed, conspicuous, obconical. Sterna V and VI absent. Gonapophyses short and blade-like, free and separate, not arising from a gonapophyseal sheath but each articulated ventrally by a process to the forked gonapophyseal apodeme and posteriorly to the recurved base of the aedeagus; aedeagus strongly laterally compressed, blade-like in lateral profile, its posterior end curved, but not coiled.

The species of *Noctiliostrebla* and *Paradyschiria* do not appear to be at all closely related, but the presence in both genera of the peculiar, heavy, transversely wrinkled abdominal connexivum (with setae borne on conspicuous plaques) and the conspicuous spiracles, suggest that these characters are of adaptive value to parasites of the fish-eating bats. One might speculate that they are concerned with water regulation. The bats not only scull the water surface for food, but it is known that, at least in the case of *Noctilio leporinus,* the bats can swim when necessary. Protective adaptations that would insure survival of these parasites would be of considerable importance, especially to the parasites of *leporinus,* a bat which frequently fishes in salt water. Another peculiarity of the parasites of these bats lies in the chaetotaxy. The bristles are strong, sparse, and semi-erect in all of the streblidae of *Noctilio,* including a species of an undescribed genus, which superficially resembles a large *Trichobius.* The fur of Noctilionidae has unusually short hairs (Benedict, 1957). Perhaps the strong semi-erect bristles give the flies additional purchase in the short pelage.

When we first studied our material of this genus, it appeared that there was only one species, *megastigma* (Speiser), that it occurred on both species of *Noctilio,* and that *N. dubia* (Rudow) was a synonym. As the picture of host-parasite specificity in Panamanian Streblidae developed, it no longer seemed reasonable that two bats that are as isolated ecologically as *Noctilio labialis* and *N. leporinus* should have the same species of parasite. We restudied both our Panamanian and other material and found that there were two species in Panama, one on each species of *Noctilio.* Our non-Panamanian material, too, seemed to segregate into these two forms. However, we were puzzled by the fact that the species which occurred on *N. labialis* in Panama seemed to replace the other species on *N. leporinus* in Venezuela, Trinidad, and Amazonian South America. We could understand that it might be possible for the parasite of *N. labialis* to occur on *N. leporinus* in areas to which the parasite of *leporinus* had not been able to disperse. However, if the parasite of *labialis* could live on both *labialis* and *leporinus* in some areas, it did not seem reasonable that it should be restricted to *labialis* in Central America, Cuba, and Peru, where the parasite of *leporinus* also occurred. That is, it did not seem reasonable unless a factor such as competitive exclusion were operating. This we were not willing to accept until we had eliminated another alternative, namely that we were dealing with a complex of closely related species rather than just two. Study of nearly all available additional material confirmed the latter suspicion.

We now know that there are about seven to nine species of *Noctiliostrebla,* five or six of them on *N. leporinus* and two or three on *N. labialis.* They may be separated into two groups. In the species of Group A, the aedeagus lacks a recurved dorsal subapical spine, while in Group B, the aedeagus possesses such a spine. Species of Group A apparently occur only on *N. leporinus;* one species (*N. aitkeni* n.sp.) of Group B occurs on *leporinus,* the others on *N. labialis.* It was the apparently anomalous occurrence of *aitkeni* on *N. leporinus leporinus* which caused us to re-examine our material. We are not yet in a position to revise the species in detail, but restrict our treatment to such species as necessary to enable us to apply names to the Panamanian species.

There are few records of flies of this genus occurring on bats other than Noctilionidae. Some of these undoubtedly represent contaminations and errors of association; however, some probably represent temporary transfers to other hosts, such as *Molossus,* with which the Noctilionidae sometimes roost.

The distributions of the species that occur on *Noctilio leporinus* seem to roughly correspond to those of subspecies of the host. This raises a number of interesting problems. Mr. Philip Hershkovitz tells us that these are "nominal" subspecies that do not bear close scrutiny. If these are interbreeding, intergrading populations of bats, it is quite possible that some of the species of *Noctiliostrebla,* too, will be shown to intergrade, as additional material becomes available. On the other hand, if such is not the case, one may raise the question as to whether or not the "subspecies" of *Noctilio leporinus* may actually be distinct species. While we recognize that speciation of host and parasite need not proceed at the same rate, nonetheless, the data suggest that a careful restudy of the Noctilionidae and their parasites, based on larger and more extensive geographic samples than are presently available, is in order.

The two species groups of *Noctiliostrebla* may be characterized as follows:

Female: Supra-anal plate with one or two long strong bristles on each side at mid-length (fig. 107D); sternum II very large, long, emarginate at middle of posterior margin (fig. 106B). *Male:* Aedeagus lacking a dorsal subapical spine (fig. 107B). Posterior margin of sternum II outwardly rounded or angulately projecting, the marginal setae at middle generally forming a false ctenidium (fig. 106A). .... Group A

Female: Supra-anal plate with one or two short bristles on each side at mid-length (fig. 107C). Sternum II shorter, strongly transverse, not emarginate at middle of posterior margin (fig. 109B). *Male:* Aedeagus with a dorsal subapical spine (fig. 107A). Posterior margin of sternum II straight or feebly arcuate, the bristles along middle of posterior margin not forming a false ctenidium (fig. 109A). .... Group B

Group A

In addition to the characters given above, it may be noted that all the species of this group, excepting one, lack setae near middle of the median wing vein; the species of Group B typically have one or two, but an undescribed species from Brazil has from two to five.

Noctiliostrebla dubia (Rudow), *new combination.*

Lipoptena dubia Rudow, 1871, Zeitschr. gesammte Naturwiss., 37, (n. s., 3), p. 122; 1872, Ann. Mag. Nat. Hist., (4), 9: 407—Venezuela, from *Noctilio dorsatus* [= *N. leporinus*]—(Zoologische Museum, Hamburg). Speiser, 1902, Syst. Hymen. Dipt., 2: 159–160 (synonymizes *Paradyschiria fusca* Speiser 1900 with *dubia*, in error).

Aspidoptera megastigma (not Speiser, 1900) Bequaert, 1942, Bol. Ent. Venez., 1, (4), p. 88.

Speiser (1902) synonymized his *Paradyschiria fusca* (Speiser, 1900) under *dubia* Rudow, 1871. He did so on the assumption that Rudow based his description of *dubia* on a mixed series containing three specimens of what Speiser regarded as his own *Lepopteryx megastigma* and a single specimen of his *Paradyschiria fusca.* This may have been true. According to Speiser (op. cit.) Rudow's series contained two specimens of *megastigma* in a Canada balsam mount and one each of *megastigma* and *Paradyschiria fusca* in alcohol. However, Speiser further attempted to demonstrate that Rudow based his description of *dubia* primarily on the specimen of *Paradyschiria.*

While it is apparently true that Rudow did have a mixed series, he certainly did not base his description on the single specimen of *Paradyschiria,* as Speiser maintained. This is clear from both the German (1871) and English (1872) versions of his paper. For example, in referring to the median and transverse mesonotal sutures, Rudow says "mit einigen bogenförmigen, quer und winkligen Längsfurchen von rother Farbe verse-hen." This obviously refers to the condition in *Noctiliostrebla*, since these sutures are largely membranous in *Paradyschiria*.

In 1962, Dr. T. C. Maa examined the Rudow types (slides only) of *Lipoptena dubia* and informed the senior author (pers. comm.) that they were the same as *Lepopteryx megastigma* Speiser. Because our studies of *Noctiliostrebla* indicated that a number of species had been confused under the name *megastigma*, it was important that the types both of Rudow's *dubia* and Speiser's *megastigma* be re-examined. Prof. Herbert Weidner of the Hamburg Museum kindly sent the slide of the male and female *Lipoptena dubia* Rudow with permission to remount them.

These were not in Canada balsam as stated by Speiser (1902) but mounted dry and pressed flat between slide and coverslip. The specimens were remounted after long immersion in a solution of trisodium phosphate followed by treatment with KOH and the usual dehydration, clearing and mounting in Canada balsam. The specimen had been preserved dry so long that it was not possible to restore the telescoped abdomen of the female to normal condition. The male proved to be unusually brittle, and in dissecting the male terminalia, the abdomen was damaged. However, it is now possible, we believe, to determine the specific status of this species, and it will be re-described in a later paper. It differs conspicuously from *traubi* n.sp. (q.v.) in the characters of sternum II of the male. In *dubia*, the bristles of the posterior margin of sternum II do not form a ctenidial-like structure; they are somewhat thorn-like and shorter than those toward the sides; the discal setae are sparse, about eight in number.

The species probably does not occur in Panama. Unfortunately the exact type locality is unknown, but we believe that *dubia* occurs on an Amazonian race of *Noctilio leporinus*.

Noctiliostrebla megastigma (Speiser), *new combination*.

> *Lepopteryx megastigma* Speiser, 1900, Arch. Naturg., 66A, Bd. I, pp. 54–55, pl. 3, fig. 2—Type locality unknown, off *Noctilio dorsatus* [=*N. leporinus*]—(Zoologisches Museum der Humboldt Universität, Berlin).
>
> *Aspidoptera megastigma* Speiser, 1900, Zool. Anz., 23: 154; 1902, Zeitschr. Hymen. Dipt., 2: 159.

We have not examined the types of this species. Speiser had five dry specimens at the time he described it. According to Dr. T. C. Maa (pers. comm.) two are males and three are females. The country of origin is unknown. The host was given as "(*N*)*octilio* (*d*)*orsatus*" (=N. *leporinus*).

Early in our studies, we sent copies of figs. 106 and 109 to Dr. H. Schumann of the Zoological Museum at Humboldt University, Berlin, with the request that he compare these with the type of *megastigma*. His reply indicated that sternum II of the female was of the type found in *traubi* n.sp. and *dubia* Rudow, i.e., long and with the posterior margin emarginate at middle. On the other hand the male apparently has a simple type sternum II, i.e., with posterior margin relatively straight and without a false ctenidium. We have seen two species with this combination of male and female characters of sternum II. However, until we are able to examine and dissect a male of the type series, it is not possible for us to settle the identity of *megastigma*. It is clear that it is distinct from *traubi*, but it remains to be seen whether it is the same as *dubia* or is another species known to us from Amazonian Brazil.

Noctiliostrebla traubi Wenzel, new species. Figures 106; 107B, D.

Closely related to *N. dubia* (Rudow), 1871, and differing from it chiefly in that the posterior margin of sternum II is strongly produced at middle in the male, the marginal setae here more closely placed than they are laterally, subspiniform, distinctly longer than the discal setae, and forming a false

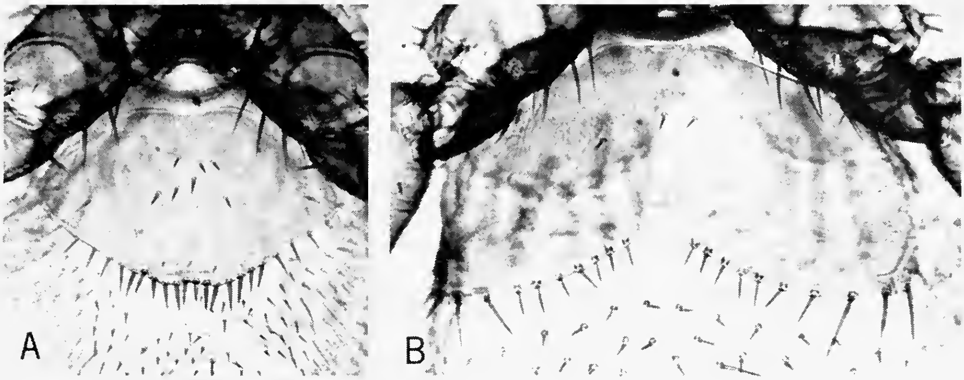

Fig. 106. *Noctiliostrebla traubi*, new species, sternum II. A, male holotype and B, female allotype from *Noctilio leporinus mexicanus* (no. 5113), Fort Sherman.

ctenidium (fig. 106A). In *dubia*, the posterior margin of sternum II is apparently straight at middle in the male and the median marginal setae are scarcely if any longer than the discal setae and do not form a false ctenidium. In the female of both species the first sternum is emarginate at middle, unlike that of *N. maai* n.sp. and *N. aitkeni* n.sp. The head and thorax are nearly identical throughout the genus and are not described below.

DESCRIPTION: *Wings.*—Tips subacuminate; apices with a coarse and a fine distal seta; outer margin with about four stronger submarginal and seven or eight marginal setae, inner margin with three or four marginals and four or five submarginals; middle vein without bristles near mid-length; vein along posterior margin usually divided into two veins which anastomose anteriorly and posteriorly. *Legs.*—Similar to those of *maai* and *aitkeni*. *Abdomen.*—*Female:* Lateral lobes of tergum I+II each with about 17 coarse setae, four to six of these (anteriorly and laterally) relatively short, being less than or only slightly more than half as long as the longest setae; inner margins on each side of mid-line, with four to eight additional small setae in a double row. Dorsal and lateral connexivum on each side posterior to tergum I+II with a cluster of about 10 setae that are coarser than the others but less than half as long as longest macrosetae of tergum I+II, and no more than twice as long as other dorsal connexival setae; a transverse row of setae between sixth spiracles slightly longer than other connexival setae near them. Tergum VII a thin transverse strip with four minute setae. Supra-anal plate as on other members of group A (fig. 107D), with four apical macrosetae and a shorter but strong seta on each lateral margin. Setae of lateral connexivum minute; setae of ventral connexivum of about the same size as dorsals, except for a few long setae of four segmental series. Sternum II (fig. 106B) very long, emarginate at middle with very few discal setae, marginal setae longer toward sides, but short along lateral margins. Seventh sternites very small, irregularly oval, usually with three or four shorter but conspicuous setae along apical margin, three long coarse setae just anterior to them and two to four very short (often thorn-like) setae anteriorly. *Male:* Tergum I+II generally similar to that of female, but macrosetae not as long; short setae along inner margin relatively

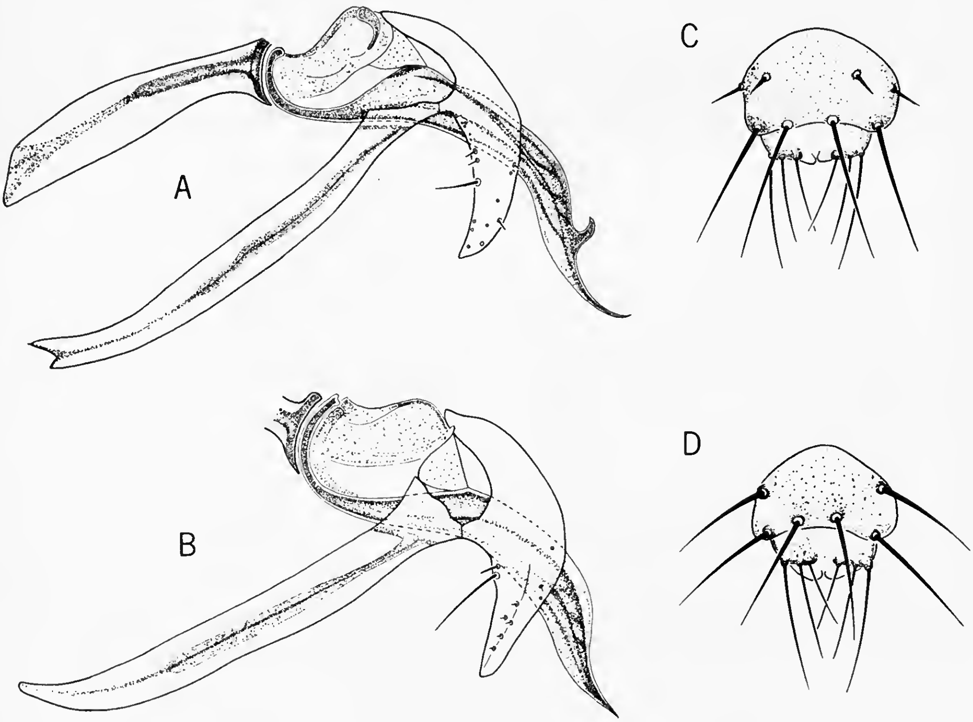

Fig. 107. Terminalia of species of *Noctiliostrebla.* A and B, male genital apparatus, lateral view: A, *Noctiliostrebla maai,* new species, paratype from *Noctilio l. labialis* (no. 6376), Río Tuira (Darién); B, *N. traubi,* holotype. C and D, terminal cone, female abdomen: C, *Noctiliostrebla aitkeni,* new species, female paratype from *Noctilio l. leporinus,* Manzanilla, TRINIDAD; D, *N. traubi,* new species, female from *Noctilio leporinus,* (CNHM 81166), Huásimo (Tumbes), PERU.

longer than in the female. Sternum II (fig. 106A) posteriorly strongly produced or rounded at middle, with few discal setae, the median marginal setae longer than the median discal setae and more closely placed than the marginals towards the sides so as to form a false ctenidium. Gonapophyses (fig. 107B) shorter, more strongly curved than in *maai* and *aitkeni,* the aedeagus strongly laterally compressed as in those species but without a dorsal recurved subapical spine.

Measurements:	BL	TL
Male	1.59–1.65	0.49–0.55
Female	2.06–2.28	0.60–0.63

TYPE MATERIAL (from *Noctilio leporinus mexicanus*): Holotype male and allotype female (slides) from host no. 5113, cativo trees, Fort Sherman

(Canal Zone), 2 December 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—1, same data as the holotype; 4, same data but 4 December; 14 (2 lots), Río Tuira (Darién), 5 March 1958, P. Galindo [GML]; 4, from preserved museum specimens collected at Río Santo, near Pacora (Panamá), 9 February 1935, by H. C. Clark [CNHM]. Non-Panamanian paratypes.—7, Fortuna, 2 miles west of Pandora, Estrella Valley (Limon), COSTA RICA, H. W. Setzer [CNHM]. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; the Gorgas Memorial Laboratory, Panamá; Environmental Health Branch at Corozal (Canal Zone); the Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil; and the Bernice P. Bishop Museum, Honolulu.

OTHER MATERIAL EXAMINED.—From *Noctilio leporinus:* 3, Huásimo (Tumbes), PERU, 750 meters elevation, 25 June 1954, C. Kalinowski, CNHM Peru Zoological Expedition (1953–54); 3, Río Guimaral, Valledupar (Magdelena), COLOMBIA, 18 September, no. 682, lot no. 69 [USNM]. We have also seen specimens taken in CUBA from *Noctilio leporinus mastivus* at Los Amacegos, 1 mile west of Santa Fé, Isle of Pines, and from Ariguanabo (Havana), H. Jaume [MCZ]. These differ slightly from our Panamanian specimens and could represent a separate entity.

REMARKS: This species is named for Colonel Robert Traub, USA–MSC (Retired), now at the School of Medicine, University of Maryland, not only in recognition of his outstanding contributions to the systematics of fleas, our knowledge of ectoparasites generally, and many other aspects of medical entomology, but also in appreciation of his invaluable assistance and cooperation through the years.

Group B

Noctiliostrebla aitkeni Wenzel, new species. Figures 107C, 108.

Aspidoptera megastigma (not Speiser, 1900), Jobling, 1949, Proc. Roy. Ent. Soc. Lond., (B), 18: 140–142, fig. 3 (part.: description, figure, and Trinidad record); Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., 122: 220.

This species is closely related to *N. maai* n.sp. and to an undescribed species from Bolivia. It is the only species of Group B which occurs on *Noctilio leporinus* (subsp. *leporinus*). The males are very similar to those of *N. maai* excepting as follows: there is a single rather than a double row of setae along inner margin of tergum I+II, the gonapophyses are slightly more slender and are subacuminate at apex. The females are easily distinguished from *maai* by the very conspicuous cluster of long coarse connexival setae on each side posterior to tergum I+II and by the strong segmental groups of setae usually present posteriorly, medial to the spiracles on each side.

Dr. Harold Oldroyd of the British Museum (Natural History) kindly sent us the female (slide) upon which Jobling based his illustration, from Pointe Gourde Caves, Trinidad. The description and illustrations of *A. megastigma* Jobling (loc. cit.), apply to this species as does his record from Trinidad. In his figure, the coarse setae of the dorsal abdominal connexivum

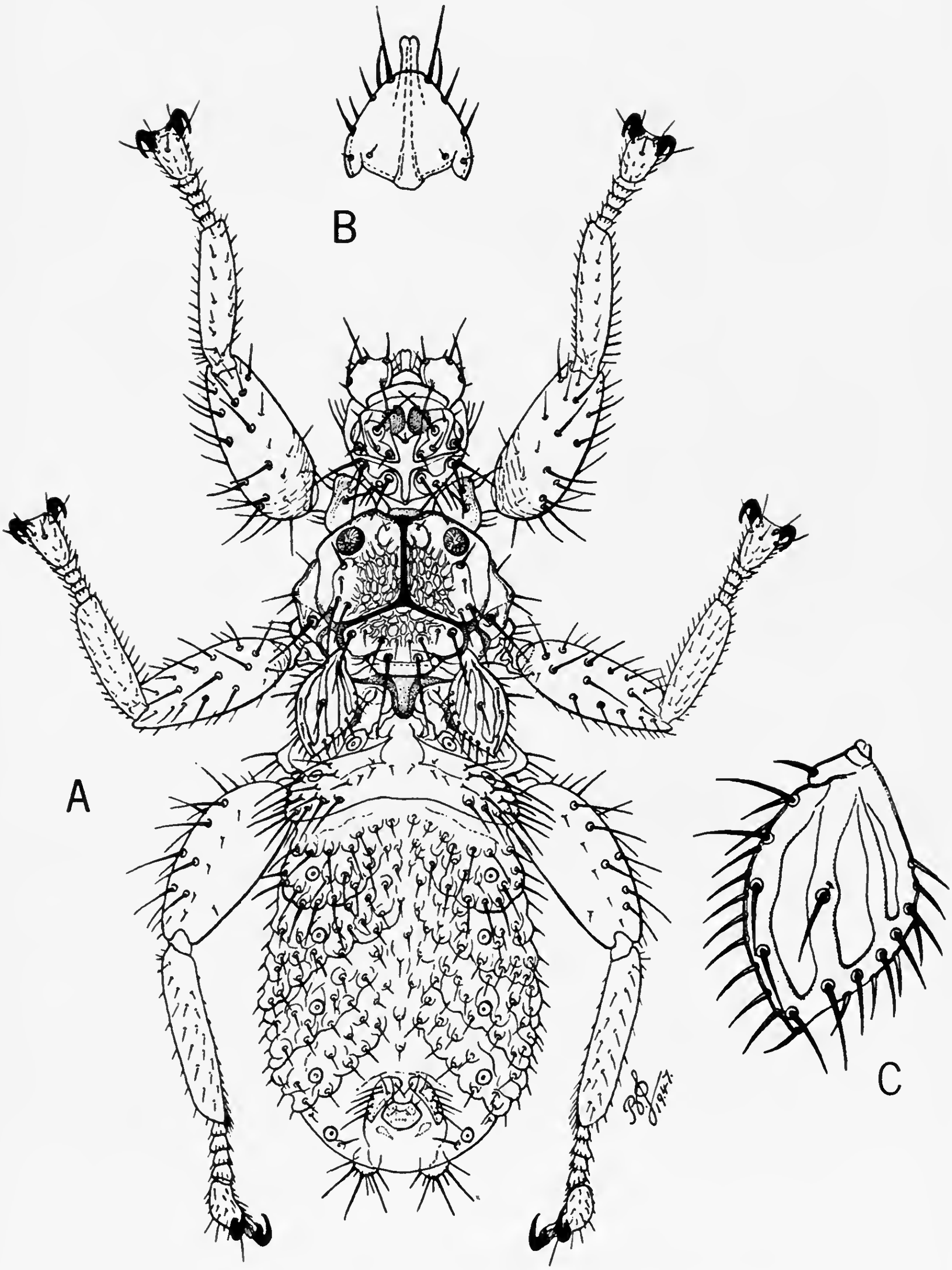

Fig. 108. *Noctiliostrebla aitkeni*, new species, female. A, dorsal view. B, labium. C, wing. From Jobling (1949a, as *Aspidoptera megastigma*). Specimen from *Noctilio l. leporinus*.

do not appear as long as they actually are. To Jobling's description, the following may be added:

Abdomen.—Posterior margin of sternum II nearly straight in both sexes, and nearly identical to that illustrated for *maai* n.sp. (fig. 109). *Female:* Lateral lobes of tergum I+II with about 18 coarse setae; dorsal inner margin with three to five short setae, usually in a single row. Connexivum on each side, posterior to tergum I+II, with a cluster of 12 very long setae, most of them as long as the shorter macrosetae of the lateral lobes of tergum I+II, some of them more than half as long as the longest macrosetae; medial to each of spiracles IV and V on each side of mid-line, are one or more coarser setae. Seventh tergites each with six to eight macrosetae, four of them in a transverse row across middle. *Male:* Inner margins of lateral lobes of tergum I+II with three or four, rarely five setae in a single row on each side. Genital apparatus very similar to that of *maai* n.sp. (fig. 107A).

Measurements:	BL	TL
Male	1.65–1.76	0.55–0.58
Female	1.95–2.20	0.60–0.66

TYPE MATERIAL: Holotype male and allotype female (slides) from *Noctilio l. leporinus*, Manzanilla, TRINIDAD, 13 March 1957, T. H. G. Aitken. In the collection of Chicago Natural History Museum.

Paratypes.—55, same data as the holotype [TVL]; 3 Scotland Bay, TRINIDAD, September 1954, C. C. Sanborn, CNHM Trinidad Zoological Field Trip (1954); 2, Monos Island, B. W. I. [FCUCV]; 16, Kaiserberg Airstrip, east of Zuid River, SURINAM, 12 October 1960, H. A. Beatty, CNHM Guianan Zoological Expedition (1960–62), 2, same expedition, Saramacca River, Loksie Hattie (Brokopondo), SURINAM, 5 January 1962, P. Hershkovitz; 8, Quebrada Esperanza, Río Yauari-Mirim, Maynas (Loreto), PERU, 23 September 1957, C. Kalinowski, CNHM Peru Zoological Expedition (1956–57). Paratypes in the collections of Chicago Natural History Museum; the United States National Museum; the Bernice P. Bishop Museum, Honolulu; Facultad de Ciencias, Universidad Central de Venezuela, Caracas; Departamento de Zoologia, Secretaria da Agricultura São Paulo, Brazil; and the Trinidad Regional Virus Laboratory, Port-of-Spain.

REMARKS: This species is named for Dr. Thomas G. Aitken, of the Trinidad Virus Laboratory (Rockefeller Foundation), in recognition of his valuable contributions to medical entomology.

Noctiliostrebla maai Wenzel, new species. Figures 107A, 109.

Closely related to *N. aitkeni* n.sp., but differing as indicated under that species.

DESCRIPTION: *Abdomen.—Female:* Lateral lobes of tergum I+II with 10–14 coarse setae, and on dorsal inner margin with seven to nine short setae in a double row. Connexivum on each side posterior to tergum I+II with a cluster of 14–16 setae that are coarser than other dorsal and lateral connexival setae, but none more than twice as long as other connexival setae and less than half as long as macrosetae of tergum I+II; a longer seta sometimes present medial to spiracle V; between sixth spiracles is a row of four long setae; seventh tergites with four or five setae, four of them macrosetae. Supra-anal plate as in *N. aitkeni* n.sp. (fig. 107C). *Male:* Inner margin of each lateral lobe of tergum I+II with six to nine, rarely 10 setae in a double row.

Measurements:	BL	TL
Male	1.54–1.63	0.47–0.51
Female	1.87–1.98	0.49–0.55

TYPE MATERIAL: Holotype male and allotype female (slides) from *Noctilio labialis labialis* (host no. 6376), Río Tuira (Darién), 3 March 1958, Pedro Galindo. In the collection of Chicago Natural History Museum.

Paratypes.—From *Noctilio labialis labialis:* 19, same data as holotype; 2, Río Chucanaque (Darién), L. H. Dunn [MCZ]; 10, Juan Mina (Canal Zone), 16 August 1945, H. Trapido [CNHM]; 7, Chilibrillo Caves (Panamá), L. H. Dunn [MCZ]. From *Noctilio labialis:* 7, Playo del Medio (Bolivar), VENEZUELA, 19 April 1961, T. Ojasti [FCUCV]. Paratypes in the collection of Chicago Natural History Museum; the United States National Museum; the Museum of Comparative Zoology at Harvard; the Gorgas Memorial Laboratory; the Environmental Health Branch, USAFSC at Corozal (Canal Zone); Facultad de Ciencias, Universidad Central de Venezuela; Departamento da Zoologia, Secretaria da Agricultura, São Paulo, Brazil; and the Bernice P. Bishop Museum at Honolulu.

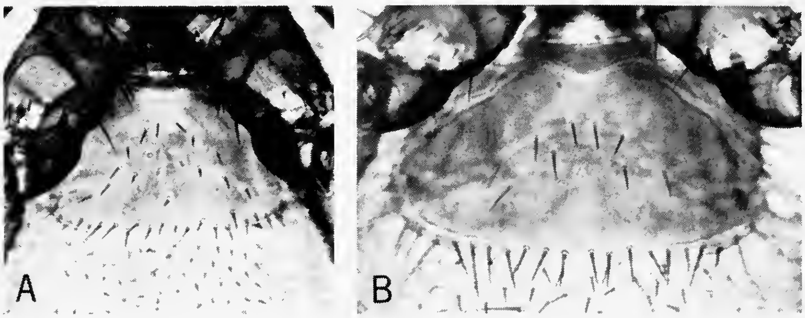

Fig. 109. *Noctiliostrebla maai,* new species, sternum II. A, male holotype. B, female allotype.

REMARKS: This species is named for Dr. Tsing C. Maa, in appreciation of the valuable assistance given by him, and in recognition of his important contributions to our knowledge of the batflies.

KEY TO PANAMANIAN SPECIES OF *NOCTILIOSTREBLA*

Median wing vein usually with one or two (rarely none) setae near middle. Posterior margin of sternum II (fig. 109) straight or nearly so, in both sexes, the marginal setae rather uniformly distributed. *Female:* Supra-anal plate much as in *aitkeni* (fig. 107C) with a pair of short setae on each side, one inserted at middle of lateral margin, the other on dorsal surface of plate at about lateral fourth. *Male:* Gonapophyses (fig. 107A) similar to those of *aitkeni;* aedeagus with a dorsal subapical spine. Host: *Noctilio labialis labialis* .... *maai* n.sp.

Median wing vein without setae near middle. Posterior margin of sternum II broadly emarginate (fig. 106B) in female; outwardly arcuate or angulate (fig. 106A) in the male, the median marginal setae subspiniform and more closely set, so as to form a false ctenidium. *Female:* Supra-anal plate (fig. 107D) typically with a strong seta on each side along lateral margin and a very short one ventral to it. *Male:* Gonapophyses as in fig. 107B; aedeagus without a dorsal subapical spine Host: *Noctilio leporinus mexicanus* .... *traubi* n.sp.

Genus **Paradyschiria** Speiser

Paradyschiria Speiser, 1900, Arch. Naturg., **66A**, Bd. I, pp. 38, 55–56 (diagn.), 62, 65 (keyed). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 25 (keyed), 29 (cit.). Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 13 (keyed), 26–27 (char., key to spp.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, **28**: 357 ff. (morph., syst. pos.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 418 (keyed); 1942, Bol. Ent. Venez., **1**: 86 (keyed). Jobling, 1949, Parasitology, **39**: 321 (keyed); 1951, Trans. Roy. Ent. Soc. Lond., **102**: 216 (morph. abdomen). Grandi, 1952, Introd. Studio Ent., **2**: 478.

Type-species: *Paradyschiria fusca* Speiser, 1900.

The species of this genus are the only apterous Streblidae known and superficially resemble small Nycteribiidae. This resemblance is enhanced by the extensive membranous areas of the mesonotum with accompanying reduction of the sclerites. The females of *P. fusca* Speiser and *lineata* Kessel are unique in possessing a vertical sclerite in the lateral connexivum between the posterior margins of the lateral lobes of tergum I+II and spiracle III. This is feebly sclerotized excepting a narrow strip along anterior margin which is more strongly sclerotized and easily visible in slide preparations as well as on specimens in alcohol. The female cerci are free and not united with the ventral arc.

We tentatively recognize four species of this previously monotypic genus. Two of them, *P. lineata* Kessel and *P. parvuloides* n.sp., occur in Panama.

PROVISIONAL KEY TO SPECIES OF *PARADYSCHIRIA*

1. Mesonotum (fig. 114A) with a short seta (rarely absent) anterior and lateral to the long macroseta of postero-lateral angle. *Female:* Lateral abdominal connexivum without a vertical sclerite between tergum I+II and spiracle III. Terminal cone (fig. 112D) with the usual four apical macrosetae, and with a short seta along each lateral margin and a pair of short discal setae at mid-length. *Male:* Gonapophyses slightly but distinctly hooked at apex..............2

   Mesonotum without a short seta anterior and lateral to the long macroseta of postero-lateral angle. *Female:* Lateral abdominal connexivum with an elongate-oval, vertical sclerite between posterior margin of lateral lobe of tergum I+II and spiracle III. Terminal cone (fig. 112B) with or without short discal setae, and in addition a pair of macrosetae, one on each side near posterior angle. *Male:* Right gonapophysis (fig. 113A) straight at apex, the left very feebly hooked at apex 3

2. *Female:* Seventh sternites (fig. 112C) with from two to four spine-like setae on apical margin. *Male:* Gonapophyses rather abruptly tapered on apical half .... *parvuloides* n.sp.

   Female: Seventh sternites with normal setae along apical margin. *Male:* Gonapophyses rather evenly tapered to apex..............*parvula* Falcoz

3. Posterior margin of tergum I+II usually with one (rarely two) macrosetae that are conspicuously longer than the others (figs. 111A). *Female:* Mid-dorsal setae of abdominal connexivum conspicuously shorter than those lateral to them, those near base and apex shortest, the apical ones less than half as long as the setae lateral to them (figs. 110A, B). Terminal cone (fig. 112B) usually with baso-lateral macrosetae more widely separated than the outer setae of apical margin .... *lineata* Kessel

   Posterior margin of tergum I+II usually with two or three long subequal macrosetae that are conspicuously longer than the others. *Female:* Most of mid-

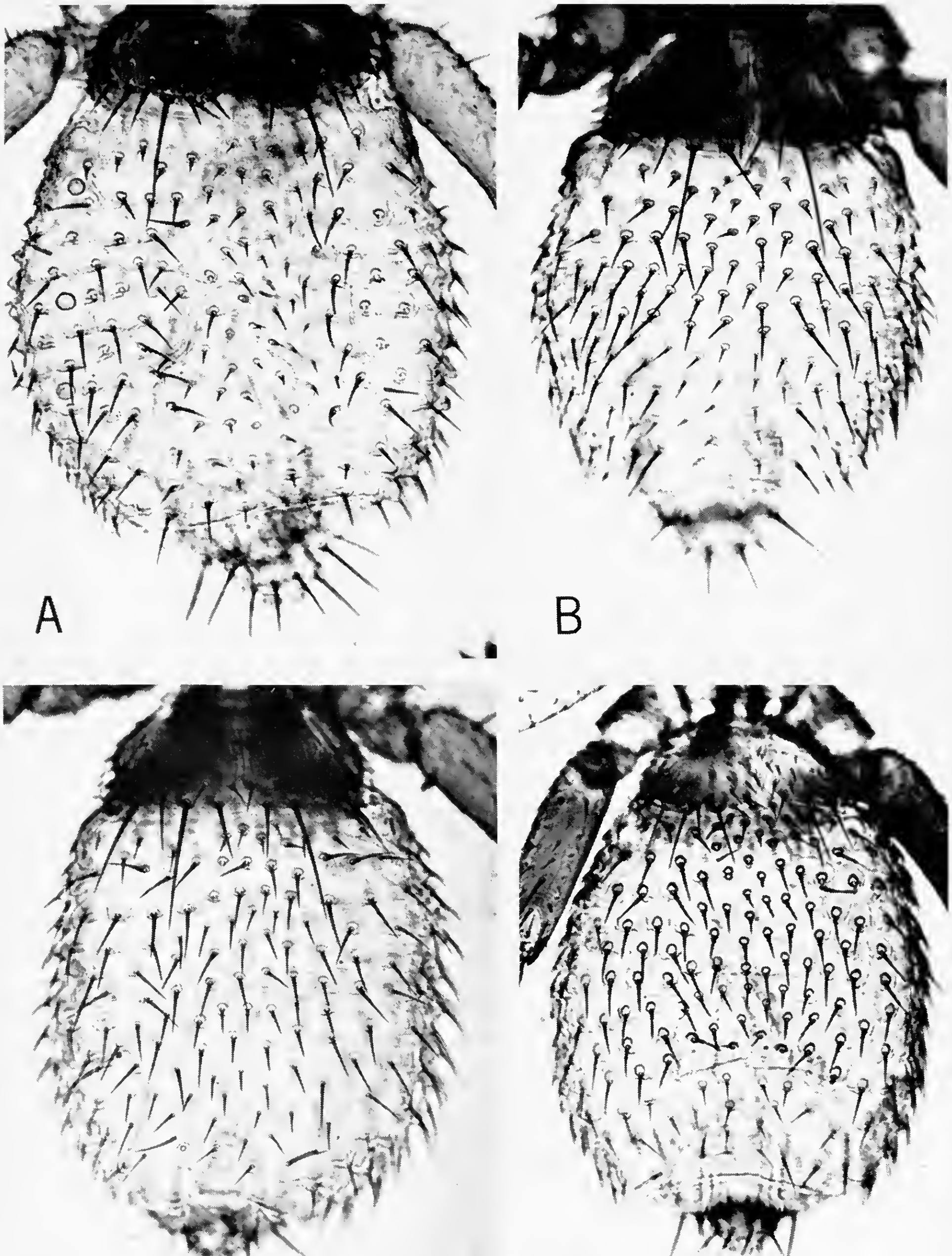

Fig. 110. Female abdomen, dorsal view, of species of *Paradyschiria*. A and B, *P. lineata* Kessel; A, from *Noctilio leporinus mastivus*, Central Mercedes, Mátas, CUBA; B, from *N. l. mexicanus* (no. 5558), Changuinola (Bocas del Toro). C, *P. fusca* Speiser, from *N. l. leporinus*, Manzanilla, TRINIDAD. D, *P. parvuloides*, new species, from *N. l. labialis* (no. 6376), Río Tuira (Darién).

dorsal setae of abdominal connexivum (fig. 110C) shorter than those lateral to them, but not markedly so, many more than half as long as the setae lateral to them. Baso-lateral macrosetae of terminal cone usually no more widely separated than outer macrosetae of apical margin .... *fusca* Speiser

Paradyschiria fusca Speiser. Figures 110C, 111B.

Paradyschiria fusca Speiser, 1900, Arch. Naturg., 66A, Bd. I, pp. 56–57 (descr.), 62 (cat.), 65 (keyed), pl. 3, fig. 1—Orocué, Colombia, from *Noctilio leporinus* (Type repository unknown). [?] Cole, 1927, Proc. Calif. Acad. Sci., **16**: 453 (morph. male genit.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658.

Paradyschiria dubia (not Rudow, 1871), Speiser, 1902, Zeitschr. Syst. Hymenop. Dipt., **2**: 159 (synonymizes *P. fusca* Speiser, in error). Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 27. Stiles and Nolan, 1931, op. cit., p. 658 (part.). Costa Lima, 1921 Arch. Esc. Sup. Agric. Med., Nictheroy, **5**: 29 (part.). Bequaert., 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 418. Guimarães, 1941, Papèis Avulsos, Dept. Zool. Secret. Agric., São Paulo, **1**: 217–222, figs. 1–4 (redescr.); 1944, loc. cit., **6**: 186, figs. 5–9 (larva). Jobling, 1949, Parasitology, **39**: 316 ff., 328, fig. 3A (part.; synonymizes *P. lineata* Kessel, 1925 and *P. parvula* Falcoz, 1931). Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., **122**: 220.

Dr. T. C. Maa has informed us (pers. comm.) that he was unable to locate the type of *P. fusca* and that it is probably lost. Thus, any interpretation must be based upon Speiser's description and figure and the type host and type locality. Unfortunately, these do not permit us to determine which (if any) of the four species that we have segregated is *fusca*. His figure only permits one to determine that it is a *Paradyschiria*. No lateral macrosetae are shown on the supra-anal plate. This suggests that the species is either *parvuloides* n. sp. or one which we tentatively refer to *P. parvula* Falcoz. However, the figure does not show a small seta anterior and lateral to the posterior macroseta of the mesonotum. This is present in both *parvuloides* and *parvula*, neither of which occur on *Noctilio leporinus*. We doubt that there is a species with the combination of characters shown by Speiser and conclude that his illustration is too inaccurate to permit recognition of *P. fusca*. His description is of no help.

The principal clues to its identity, then, are the type locality and type host. According to Bequaert (1940, p. 418), the type locality—Orocué, Colombia—is in the Department of Boyacá. He was unaware, apparently, that there is also a locality of that name in the Department of Vaupés. Both are in Amazonian Colombia, and in all likelihood the same species of *Paradyschiria* occurs on *Noctilio leporinus* in both localities. *P. lineata* occurs in coastal Colombia, but judging from the distribution patterns of other streblids, including those on Noctilionidae, we doubt that it occurs in Amazonian Colombia. We have studied specimens—from Trinidad, Venezuela and Surinam—of a closely related population which we provisionally interpret as *fusca*. It appears to be the species redescribed and figured by Guimarães (1941) as *P. dubia*, from Brazil. The specimens from Trinidad and Surinam are easily distinguishable from our Panamanian specimens of *lineata*, but those from Venezuela are difficult to separate. Perhaps *P. fusca* (*sensu* Guimarães, 1941) and *lineata* Kessel represent clinal extremes.

Designation of a neotype of *fusca* must be deferred until specimens from near the type locality are available.

Paradyschiria lineata Kessel. Figures 110A, B; 111A; 112A, B; 113A.

Paradyschiria lineata Kessel, 1925, Jour. N. Y. Ent. Soc., **33**: 27–28—Cuba (British Museum of Natural History). Jobling 1949, Parasitology, **39**: 328 (as synonym of *P. dubia* Speiser, 1902, not Rudow 1871, in error).

Jobling (loc. cit.) synonymized *P. lineata* Kessel under *P. dubia* Speiser 1902 (= *P. fusca* Speiser), not Rudow, 1871. As indicated above, the specific identity of *P. fusca* Speiser is uncertain, though it seems that it is not

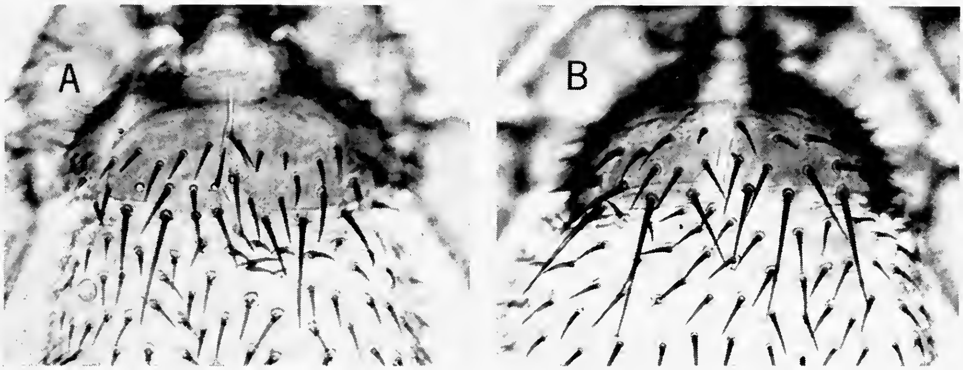

Fig. 111. Abdominal tergum I+II, male. A, *Paradyschiria lineata* Kessel, from *Noctilio leporinus mastivus* (CNHM no. 93668), Los Amacegas, Isle of Pines, CUBA. B, *P. fusca* Kessel, from *N. l. leporinus*, Manzanilla, TRINIDAD.

the same as *lineata* Kessel, described from Cuba. We cannot separate our Panamanian specimens, taken from *Noctilio leporinus mexicanus*, from Cuban specimens taken from *N. l. mastivus*. We therefore apply Kessel's name to the specimens from Panama.

Measurements:	BL	TL
Male	1.37–1.87	0.41–0.47
Female	1.76–1.98	0.47–0.49

PANAMANIAN MATERIAL EXAMINED.—From *Noctilio leporinus mexicanus:* 22 specimens (4 lots) as follows: 12 (1 bat), Changuinola (Bocas del Toro), 29 February 1960; 10 (3 bats), Fort Sherman (Canal Zone), 2 and 4 December 1959; 1, removed from preserved museum specimen collected at Río Santo, near Pacora (Panamá), H. C. Clark, 9 February 1935 [CNHM].

OTHER MATERIAL EXAMINED: CUBA.—From *Noctilio leporinus mastivus:* 1, removed from preserved museum specimen from Los Amacegos, 1 mile west of Santa Fé, Isle of Pines, February 1961, Gilberto Silva [CNHM]; 1, Ariguanabo (Havana), H. Jaume [MCZ].

Paradyschiria parvula Falcoz

Paradyschiria parvula Falcoz, 1931, Parasitology, **23**: 267, figs. 4, 5—Brazil, from *Dirias albiventer* [= *Noctilio labialis*] (Museum National d'Histoire Naturelle,

Paris). Jobling, 1949, Parasitology, **39**: 328 (as syn. of *P. dubia*, in error).
Paradyschiria dubia (not Rudow, 1871), Costa Lima, 1921 (part.), Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 23 (host record from *N. labialis*), 29 (cat.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 658 (part.). Guimarães, 1941, Papèis Avulsos, Secret. Agric., São Paulo, **1**: 221 (part., record from *Noctilio albiventer*).

We have not examined the type of *P. parvula*, but we have a series collected by Dr. Merl Kuns from *Noctilio labialis* at San Joaquin (Beni), BOLIVIA, which we provisionally identify as this species. It is closely related to *parvuloides* n.sp. but is easily separated by the characters of the female seventh sternites (see key). In addition to the characters given in the key, *parvula* and *parvuloides* may be separated from both *fusca* and *lineata* by their smaller size and the relatively uniform, subequal macrosetae of the posterior margin of tergum I+II.

A small series received from Dr. Machado-Allison and collected in Venezuela at Playo del Medio (Bolivar) and Calabozo (Guarico), VENEZUELA, may be this species. However, they represent a puzzling mixture of characters of *parvula, parvuloides,* and *fusca* and more extensive series will be needed to determine their identity. They could represent a mixture of species, or an undescribed species, but it is also possible, as may be the case with some other streblids, that *parvula* and *parvuloides* represent either clinal extremes or subspecies, and that eastern Venezuela is an area of hybridization or an intermediate point on a cline.

Paradyschiria parvuloides Wenzel, new species. Figures 110D; 112C, D; 113B; 114.

Paradyschiria dubia (not Rudow, 1871), Cooper, 1941, Yearb. Amer. Phil. Soc., **1941**: 126 (chromosome no.). Jobling, 1949, Parasitology, **39**: 316 (table 1), 328 (part., records from *Dirias albiventer minor*, Panama).

Differing from *P. lineata* Kessel and *fusca* Speiser in having a short seta (fig. 114A) lateral and slightly anterior to the posterior mesonotal macroseta (absent in *fusca* and *lineata*), and in lacking lateral macrosetae on the supra-anal plate of the female (fig. 112D). In these respects it resembles *P. parvula* Falcoz (of our interpretation) but differs from it and from both *fusca* and *lineata* in having from two to four short stout spine-like setae (fig. 112C) rather than normal setae on apical margins of seventh sternites of female. The male gonapophyses are rather abruptly tapered on apical half, rather than evenly tapered as in *parvula.*

DESCRIPTION: *Head.*—As in *P. lineata* and *P. fusca*. *Thorax.*—As in those species, except that a short seta is present on prescutum on each side, lateral and slightly anterior to the postero-lateral macroseta (fig. 114A). *Abdomen.*—Sternum I+II setose in a median, roughly triangular area, the marginal setae longer toward sides. *Female:* Tergum I+II with (as usual) a pair of isolated setae near base; on each lobe there are well developed setae near mid-line on apical half and laterally on lateral half; usually one or two conspicuously longer and stouter submarginal setae near apical margin and a row of eight or nine setae along apical margin of each lobe, three or four of them much longer than the others. Tergum VII+supra-anal plate (terminal cone) well sclerotized and pigmented, with four apical macrosetae, a pair of short discal setae at mid-length, and a minute seta at each posterior angle, lateral to the outer macroseta. Seventh sternites scarcely longer than broad, with eight to ten short setae basally and two much longer, slender subapical setae, the outer seta nearly twice as long as the inner; with an apical row of three or four short, spine-like setae and lateral to them a stout seta which is nearly as long as the subapical macroseta. Dorsal and lateral connexivum clothed with moderately long setae, these slightly shorter along mid-line, those at extreme base and beyond middle as long as the setae lateral to them; setae of ventral connexivum very short, except for pairs of segmental setae; all setae borne on

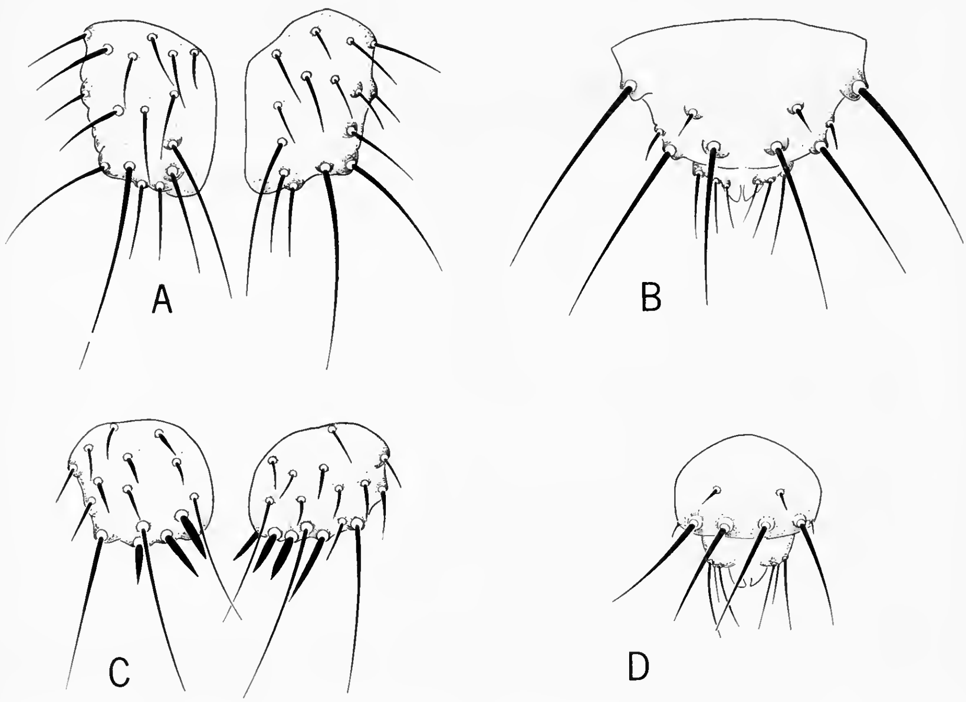

Fig. 112. A, seventh sternites and B, terminal cone, female abdomen of *Paradyschiria lineata* Kessel, from *Noctilio leporinus mexicanus* (no. 5558), Changuinola (Bocas del Toro). C and D, same structures, *P. parvuloides*, new species, paratype from *Noctilio l. labialis* (no. 6376), Río Tuira (Darién).

sclerotized plaques. *Male:* Tergum I+II with setae of posterior margin shorter than in female, three or four usually longer than others but not more than twice as long as discal setae. Connexivum covered with dense, relatively short setae, these shortest along the sides; ventral setae only a little shorter than dorsal setae. Sternum V divided into two short transverse oval sclerites bearing about six bristles each, four along apical margin, two near outer margin. Hypopygium covered with setae similar to those of connexivum, except for two or three longer slender setae apically near inner margin. Gonapophyses and aedeagus as shown in fig. 113B, abruptly tapered apically, in lateral view, and slightly hooked at apex.

Measurements:	BL	TL
Male	1.30–1.48	0.38–0.42
Female	1.37–1.66	0.38–0.41

TYPE MATERIAL (734 specimens, 26 lots, from *Noctilio labialis minor*): Holotype male and allotype female (slides), host no. 6374, Río Tuira

(Darién), 2 March 1958, Pedro Galindo [GML]. In the collection of Chicago Natural History Museum.

Paratypes.—5 (1 bat), Fort Davis (Canal Zone), 26 October 1960; 3, Galeta Island (Canal Zone), 19 November 1959; 1, Gamboa (Canal Zone), 19 September 1960; 1, Juan Mina (Canal Zone), 20 April 1954, P. Galindo [GML]; 10, same locality, 16 August 1945, H. Trapido; 2, from preserved bats collected at Los Cáscadas (Canal Zone), 1933, by L. H. Dunn [CNHM];

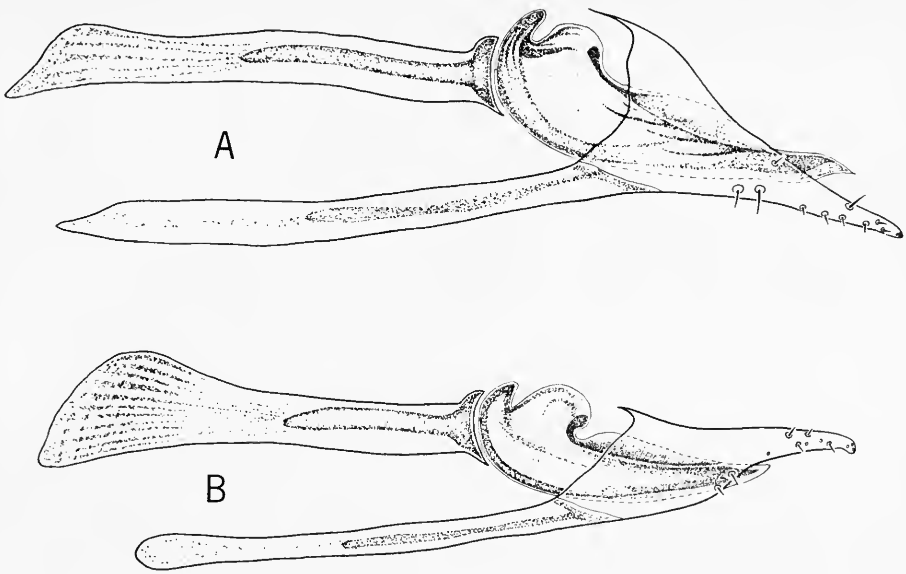

Fig. 113. Male genital apparatus, left lateral view. A, *Paradyschiria lineata* Kessel, same host data as for fig. 112A. B, *P. parvuloides*, new species, paratype from *Noctilio l. labialis* (no. 6374), Río Tuira (Darién).

2, Barro Colorado Island (Canal Zone), 5 December 1956, C. B. Koford [USNM]; 5 (2 lots), Summit (Canal Zone), 30 September 1932, L. H. Dunn [CU]; 4 (slides), same data [BMNH—Jobling Collection]; 121, same locality and collector, 5 August 1930 [AMNH]; 3, same locality, K. W. Cooper [MCZ]; 8, Salamanca, Río Pequeni (Canal Zone), 1 April, Griswold [MCZ]; 1, Pacora (Panamá), 6 June 1961; 1 from preserved bat collected at Panamá (Panamá) [CNHM]; 202 (3 lots), Chilibrillo Caves (Panamá), L. H. Dunn [MCZ]; 15, same locality [USNM]; 17, same locality, L. H. Dunn [CU]; 2, Río Mono Camp (Darién), 25 July 1963, Wilbur Lowe; 137, same locality, 3 March 1958, P. Galindo [GML]; 5, Río Chucanaque (Darién), L. H. Dunn [MCZ]; 39, same data as holotype, and 133, same data but 2 March 1958; 4 (alcohol), "Darien," 4 February 1933, L. H. Dunn [BMNH—Jobling collection, det. as *P. lineata* Kessel, by Jobling]; 1, near Río Guánico, Guánico (Los Santos), 8 February 1962. From *Sturnira lilium parvidens:* 1, same locality, 8 February 1962.

Non-Panamanian paratypes.—75 (6 lots) from *Noctilio labialis* as follows: 26, 6 miles west of Rama, Bluefields, NICARAGUA, elevation 50 feet, 29 April 1963, D. C. Carter; 26, 9 miles NE of Puerto Gulfito (Puntarenas) COSTA RICA, 29 April 1963, D. C. Carter; 18, Unguía, Golfo de Urabá (Choco) COLOMBIA, 8–11 March 1950, P. Hershkovitz, CNHM Colombian Zoological Expedition (1948–52); 7, Río Docompado (Cauca), COLOMBIA, 350 meters elevation, 26 September 1958, Kjell von Sneidern, CNHM Colombian Zoological Expedition (1958–59); 8 (from type specimen of *Noctilio*

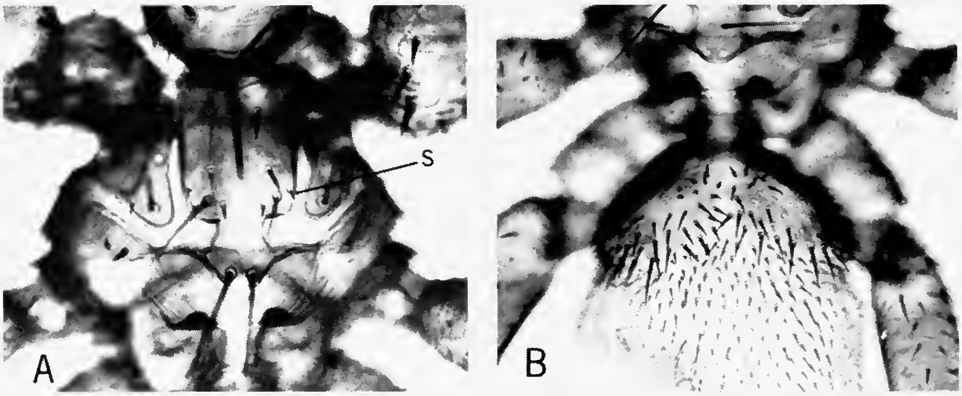

Fig. 114. *Paradyschiria parvuloides*, new species, male. A, thorax, dorsal view (*s* = seta antero-lateral to posterior mesonotal macroseta). B, base of abdomen and thorax, showing posterior chaetotaxy of tergum I+II.

minor Osgood), Encontrados (Zulia), VENEZUELA, 15 February 1908, Ned Dearborn, Field Museum Expedition (1908). Paratypes to be deposited in the collections listed on p. 410.

REMARKS: This species appears to be restricted to *Noctilio labialis* and possibly to the subspecies *minor* Osgood. The single specimen from *Sturnira lilium parvidens* (no. 9351) is probably a contaminant from a specimen of *N. l. minor* (no. 9352) collected at the same time.

Parastrebla Wenzel, new genus

Type-species: *Parastrebla handleyi* Wenzel, new species.

Similar to *Pseudostrebla, Speiseria,* and *Trichobius,* but differing as follows: from *Pseudostrebla* in that the laterovertices lack a pigmented suture, the postvertex is membranous and the head is deep and not flattened; from *Trichobius* and *Speiseria* in having conspicuous tibial macrosetae; from *Speiseria* in not having greatly elongated hind legs; and from all other known New World Streblidae by the presence in the female (male unknown) of a ventral, feebly sclerotized, subapical abdominal plate (fig. 116B) bearing blunt spines, anterior to the seventh sternites.

DIAGNOSIS: *Head.*—Distinctly narrower than thorax; width greater than length from base of occipital lobes to apex of frontoclypeus; about as high as wide. Eyes faceted, not projecting beyond postgenae. Laterovertices and occipital lobes well defined, the latter somewhat inflated; laterovertices lacking a diagonal suture. Palpi oval, approximately as broad as long, with both ventral and marginal setae. *Thorax.*—Widest at level of transverse suture, narrowing apically; median suture present; humeral calli slightly produced but not prominent. *Wings.*—Venation as in *Trichobius;* anal vein with several strong setae near basal angle. *Legs.*—As in *Pseudostrebla,* the middle and hing legs progressively longer than the forelegs, the hindlegs not greatly elongated. All tibiae with conspicuously long macrosetae in addition to short setae. *Abdomen.*—As in *Trichobius,* but female with a very feebly sclerotized plate (sixth sternum?), anterior to seventh sternites, whose apical margin has a row of nine or ten blunt spines. Ventral arc well developed, translucent, with conspicuous flanges. Sternopleura and pleurotrochantines as in *Speiseria, Pseudostrebla* and *Trichobius phyllostomae,* the anterior margin projecting between coxae and angulately emarginate.

REMARKS: The female genital structure of *Parastrebla* is very similar to that of the *Trichobius major* group, especially of *T. truncatus* Kessel. However, we cannot determine with certainty, from the slide preparation, whether or not the cerci are fused or articulated with the ventral arc. The structure of the head and abdomen suggest that the genus is in some ways intermediate between *Trichobius* on the one hand, and *Pseudostrebla* on the other.

Parastrebla handleyi Wenzel, new species. Figure 116.

DESCRIPTION (*Female*): *Head.*—Eyes small, transverse, with seven or eight indistinct facets. Genae and postgenae with numerous, short, discal setae and conspicuously longer marginal setae. Laterovertices subquadrate, declivous anteriorly, with about six conspicuous and one short setae. Occipital lobes each with three very long and about six other strong, shorter setae.

Thorax.—Anterior margin biconcave for reception of occipital lobes of head, bituberculate at middle; calli feebly produced. Median suture extending about two-thirds the distance to transverse suture; disks of prescutum and scutum with numerous, rather uniformly distributed, recumbent, short setae, which become longer (though still short) anteriorly; longer, strong setae present laterally. Scutellum with four macrosetae. Underside rather uniformly, densely setose, the setae short, with longer, strong setae along sides and posterior margin, the latter fully emarginate at middle. *Wings.*—Costa with ten to twelve strong dorsal setae, these gradually shorter apically on basal half, the setae on apical half short; marginal setae very strong on about basal half and much more numerous than dorsal setae, becoming progressively shorter on apical half. R_1 with one very long basal macroseta (as in *Pseudostrebla*) followed by about four shorter but strong setae, followed by short setae; R_s bare; third, fourth and fifth longitudinal veins each with three or four strong, basal setae, the other setae short. *Legs.*—Densely clothed with short setae. Profemora with about nine dorsal macrosetae arranged in two rows each side and two others laterally near apex. Mesofemora with about four macrosetae on apical half of dorsal surface, two ventro-laterally on each side near apex, and a row of about eight shorter erect setae on lateral surface on basal half. Metafemora with about 19 macrosetae on dorsal, lateral, and ventral surfaces. Protibiae with about four erect macrosetae along dorsal edge, mesotibiae with five, metatibiae with six. Tarsomeres 1–4 together a little longer than the last segment (excluding the claws), which is laterally slightly compressed; tarsomere 1 slightly longer than 2–4, its ventral surface with several pairs of short but rather strong setae.

Abdomen.—Lateral lobes of tergum I+II with about 16 discal macrosetae and about a dozen short ones along the lateral margin. Dorsal connexivum bare except for four pairs of conspicuous segmentally arranged setae; lateral and ventral connexivum densely clothed with short setae of about same size; with two transverse rows, each of about four much longer setae anterior and lateral to sternum VI (?); tergum VII narrow, parallel-sided, strap-like, continuous with the supra-anal plate and bearing four minute setae arranged in two pairs, one anterior to the other, evenly spaced. Supra-anal plate very short, with a short seta on each side and four apical macrosetae. Seventh sternites oval, with about 14 setae of which three on apical margin are macrosetae.

Measurements:	BL	TL	WL	WW
Holotype female	2.12	0.80	1.76	0.82

TYPE MATERIAL: A unique holotype female (slide) from *Micronycteris nicefori* (host no. 11565), Armila (San Blas), 13 March 1963, C. O. Hand-

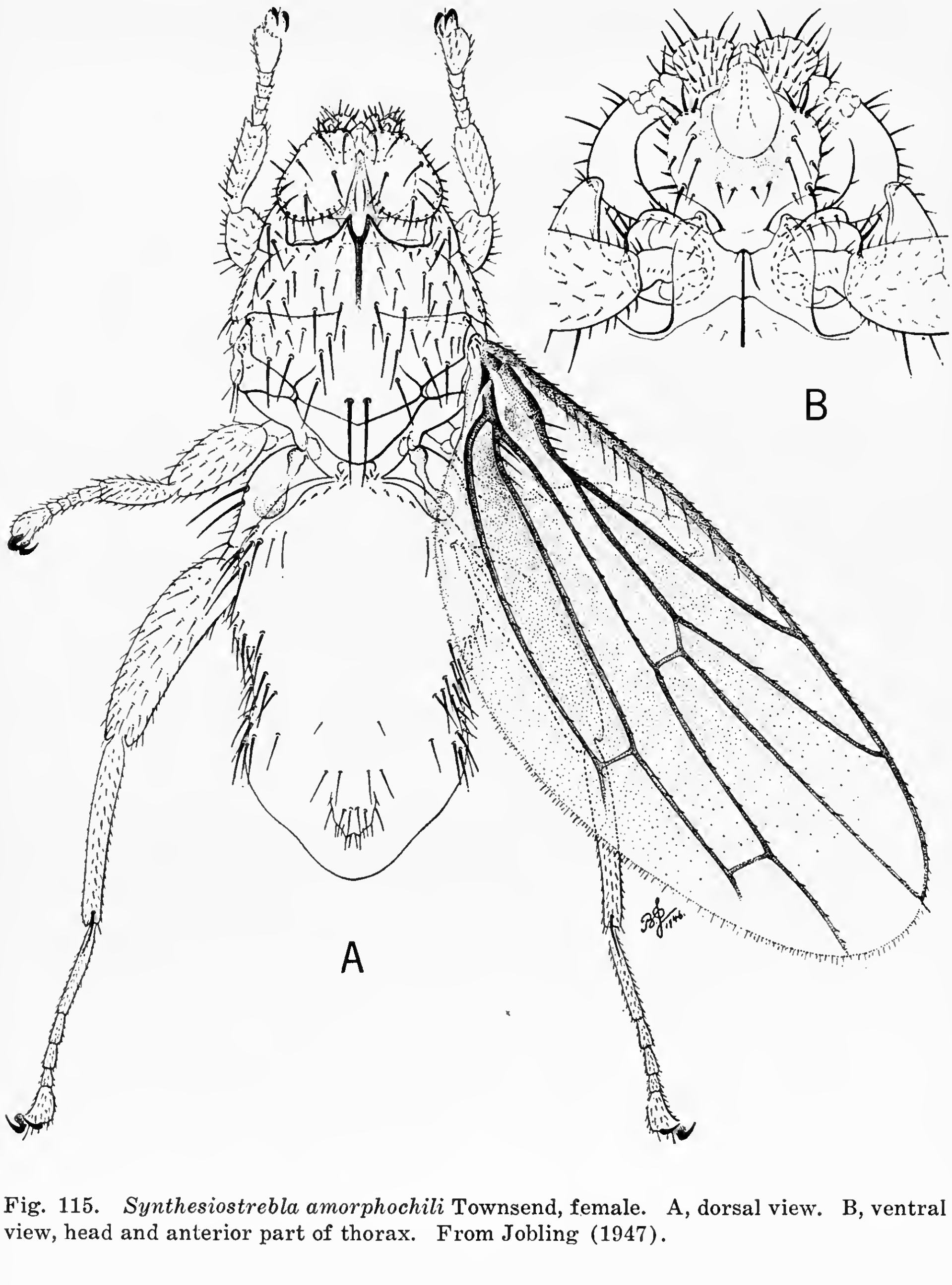

Fig. 115. *Synthesiostrebla amorphochili* Townsend, female. A, dorsal view. B, ventral view, head and anterior part of thorax. From Jobling (1947).

ley, Jr. and F. M. Greenwell. In the collection of Chicago Natural History Museum.

REMARKS: This species is named after Dr. Charles O. Handley, Jr., in recognition of his invaluable contributions to this volume.

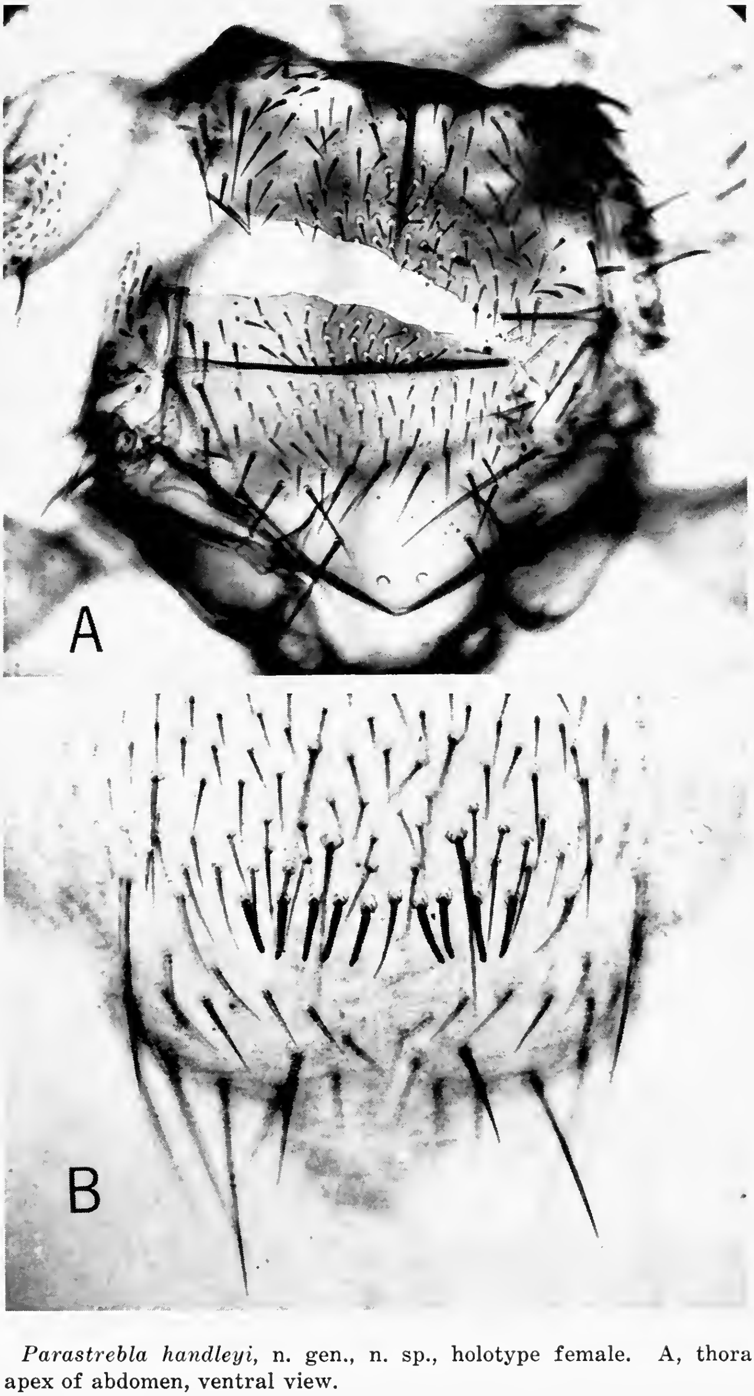

Fig. 116. *Parastrebla handleyi*, n. gen., n. sp., holotype female. A, thorax, dorsal view. B, apex of abdomen, ventral view.

Genus **Pseudostrebla** Costa Lima

Pseudostrebla Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 23 (diagn.), 25 (keyed, as *Psaudostrebla*, sic!), 30 (cat.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 12 (keyed), 19. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654. Curran, 1935, Amer. Mus. Novit., no. 765, p. 6 (keyed). Jobling, 1936, Parasitology, 28: 359, 367 ff., 370 (keyed); 1939, Arb. Morph. Tax. Ent., 6, (3), pp. 269–270 (diagn., keyed). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 417 (keyed); 1942, Bol. Ent. Venez., 1: 86 (keyed). Jobling, 1949, Parasitology, 39: 321 (keyed).

Type-species: *Pseudostrebla ribeiroi* Costa Lima, 1921.

Only one species of *Pseudostrebla* (*ribeiroi* Costa Lima) has been described. In our material from Panama we recognize two, one of them new. In the collections of Chicago Natural History Museum are two additional undescribed species. All are from bats of the genus *Tonatia*. It appears that each species of *Tonatia* is parasitized by a different species of *Pseudostrebla*. The Panamanian species may be separated as follows:

KEY TO PANAMANIAN SPECIES OF *PSEUDOSTREBLA*

Head: Posterior margin of occiput on each side with a feebly developed, unisetose tubercle; oral cavity about as long as or slightly longer than broad. *Legs:* hind tibiae scarcely longer than the tarsi, with five macrosetae, of which the hind two are nearly approximate and on opposite sides of tibia, middle macroseta longest, slightly more than half as long as tibia. Host: *Tonatia minuta* ...... *greenwelli* n.sp.

Head: Posterior margin of occiput on each side with a well-developed bisetose tubercle; oral cavity strongly transverse, more than twice as wide as long. *Legs:* Hind tibiae about a third again as long as the tarsi, with six macrosetae, three on basal third, two very long ones just beyond middle, the sixth near apex. Host: *Tonatia silvicola* .... *ribeiroi* Costa Lima

Pseudostrebla ribeiroi Costa Lima. Figures 117; 118, B, D.

Pseudostrebla ribeiroi Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 23–25, pl. 2, fig. 4—Brazil: Matto Grosso, from "*Tonatia amblyotes*" [sic!] (?Museu Nacional do Rio de Janeiro). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 19. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 656. Jobling, 1939, Arb. Morph. Tax. Ent., 6, (3), pp. 268 (notes), 271–273 (redescr.), fig. 1A–C; 1949, Parasitology, 39: 316 ff., fig. 2F.

A single male specimen that we have identified as this species was collected from *Tonatia silvicola* (=*amblyotis*) at Armila (San Blas), 12 March 1963, by C. O. Handley, Jr. and F. M. Greenwell. We have seen 13 additional specimens (9 lots) from the same host, from COLOMBIA, PERU, and ECUADOR. Measurements are given below to supplement Jobling's excellent figure and description. They are based on the single Panamanian specimen and a series of 11 Colombian specimens.

Measurements:	BL	TL	WL	WW
Male	2.23–2.30	0.85–0.88	1.63–1.65	0.77
Female	2.45–2.90	0.84–0.97	1.63–1.93	0.77–0.95

Pseudostrebla greenwelli Wenzel, new species. Figure 118A, C.

Similar to *P. ribeiroi* Costa Lima, but differing from that species by the characters given in the key and those noted below in the description, as well as by its much smaller size and the different male gonapophyses.

DESCRIPTION: Smaller, and less strongly pigmented and less strongly setose than *ribeiroi*. *Head.*—Transverse, but appearing less oblong than that of *ribeiroi;* laterovertices with about 10 setae, including minute setae along anterior margin (12–13 in *ribeiroi*); occipital lobes with about nine coarse setae (about 12 in *ribeiroi*) in addition to the laterally directed setae along side margins, the posterior margin of each lobe with a feeble, unisetose tubercle (in *ribeiroi* a prominent bisetose tubercle); mediovertex with four setae, two each side of middle; palpi transverse but only about a third again as

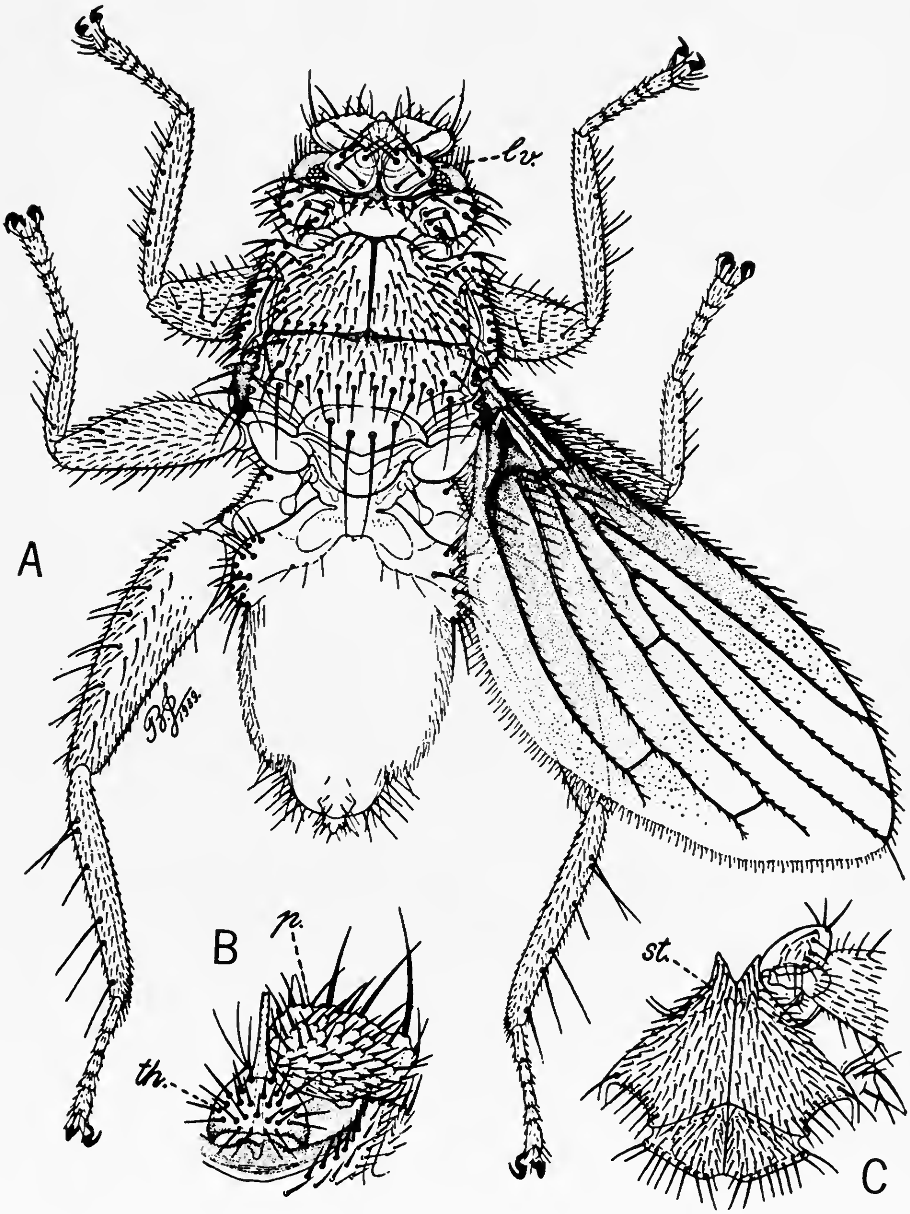

Fig. 117. *Pseudostrebla ribeiroi* Costa Lima. A, female, dorsal view. B, mouthparts. C, venter of thorax. From Jobling (1949b).

wide as long (nearly twice as wide as long in *ribeiroi*); oral cavity about as long as or slightly longer than broad (in *ribeiroi* strongly transverse, more than twice as wide as long, the theca retracted, in repose, into cavity above postgenae).

Thorax.—Mesonotum about as wide as long; prescutum and scutum microsetose throughout (in *ribeiroi*, distinctly longer than broad, scutum and baso-lateral angles of prescutum microsetose). Anterior margin of prescutum only moderately projecting at middle (strongly in *ribeiroi*); median suture extending posteriorly to transverse suture, the latter slightly sinuous and poorly defined at middle; chaetotaxy in general much as

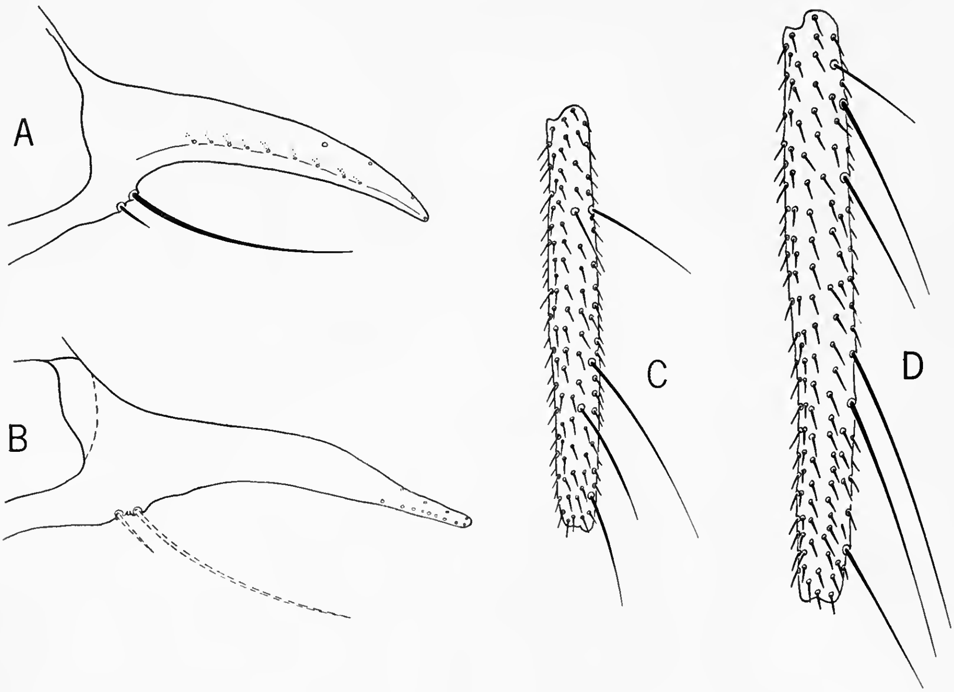

Fig. 118. A, C, *Pseudostrebla greenwelli*, new species; A, left male gonapophysis, holotype; C, hind tibia, paratype male. B, D, same structures, *P. ribeiroi* Costa Lima, from *Tonatia "amblyotis"* (= *silvicola*), Río Guapayá, La Macarena (Meta), COLOMBIA.

ribeiroi, but less dense and setae paler; scutum at middle with two irregular rows of setae between long antescutellar scutal setae and transverse mesonotal sutures (three in *ribeiroi*); mesepisternum (viewed from above) with coarse setae along inner and posterior margins, with very short setae laterally. *Wings*.—Very similar to those of *ribeiroi* but the coarse setae a little shorter. *Legs*.—Fore-, mid-, and hindlegs progressively longer. Inner face of pro- and metafemora covered with short setae, setae of outer face a little longer; profemora with a row of longer setae along ventro-lateral margin, a few long setae dorsally and apico-laterally; mesofemora with about two pairs of conspicuously longer setae dorso-apically, a subapical seta on each side, and five or six along ventro-lateral margin; hind femora with a row of about six longer setae on basal half of dorsal margin and a double row of six macrosetae, and another pair of macrosetae distally on each side on lateral and ventro-lateral margins. Protibiae with about five setae along dorsal margin, that are distinctly longer than the others; mesotibiae with five conspicuously longer setae along dorsal margin. Hind tibiae (fig. 118C)

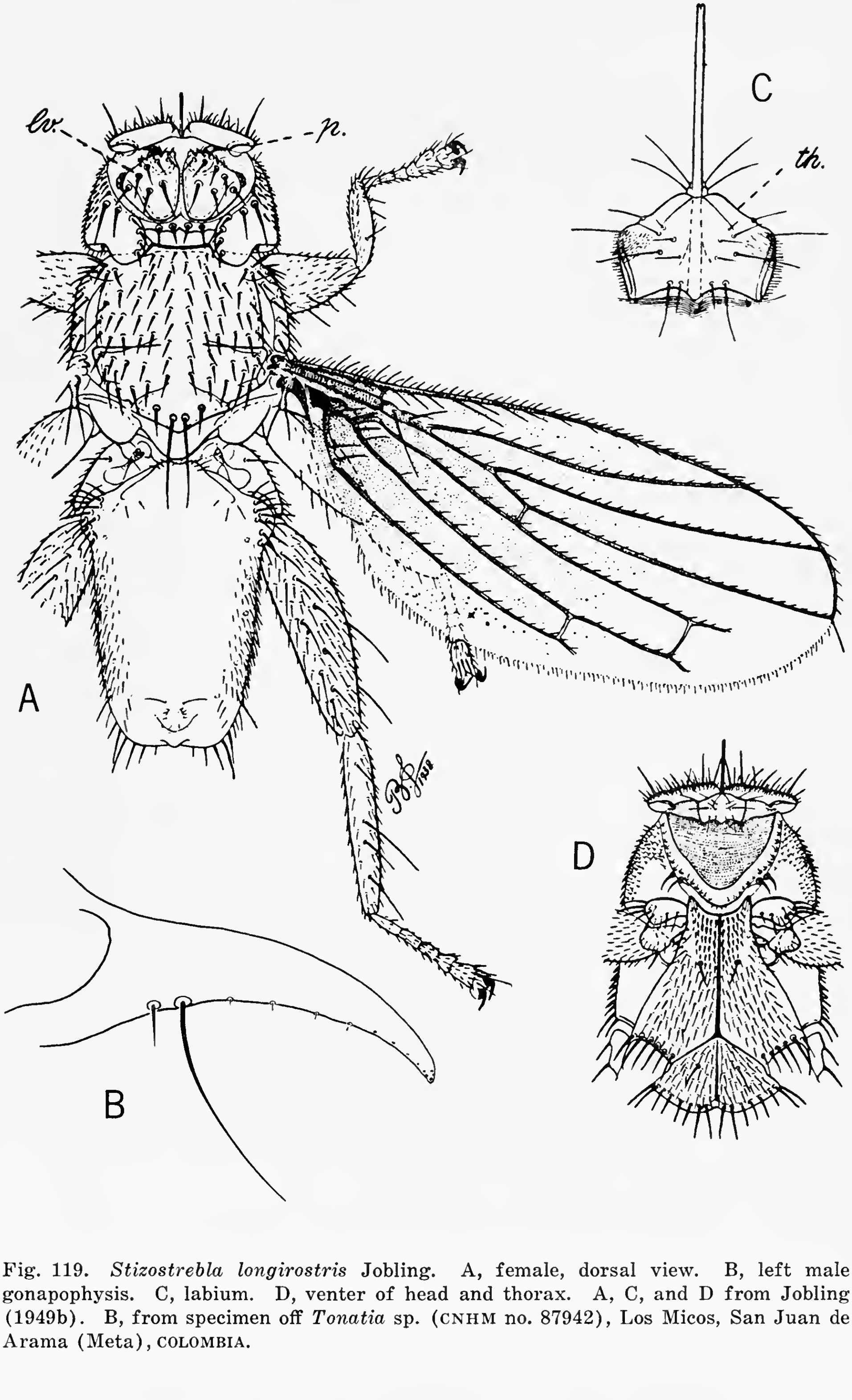

Fig. 119. *Stizostrebla longirostris* Jobling. A, female, dorsal view. B, left male gonapophysis. C, labium. D, venter of head and thorax. A, C, and D from Jobling (1949b). B, from specimen off *Tonatia* sp. (CNHM no. 87942), Los Micos, San Juan de Arama (Meta), COLOMBIA.

a little shorter than hind femora, with five macrosetae. Hind tarsi slender, about three-fourths as long as tibiae; last segment strongly, laterally compressed.

Abdomen.—Very similar to that of *ribeiroi.* Lateral lobes of tergum I+II with eight to ten long setae and eight to ten short ones (about 19 coarse macrosetae and eight to ten shorter setae in *ribeiroi*). Sternum II as in *ribeiroi* but less strongly setose. *Female:* Tergum VII and supra-anal plates apparently fused, but basal portion longer, triangular, with a pair of short setae near apex of triangle, which points anteriorly; triangular portion continuous distally with a very small crescent-like sclerite (? supra-anal plate) which bears a pair of long setae and a pair of short setae. Ventral arc flat, crescentic, non-setose. Seventh sternites triangular, inner edges parallel; with 10–12 short setae anterior to long apical setae, four of which are macrosetae (about 15 discals in *ribeiroi*). *Male:* Gonapophyses (fig. 118A) rather evenly tapered apically, with a row of microsetae on each side (abruptly tapered apically in *ribeiroi,* and without row of microsetae).

Measurements:	BL	TL	WL	WW
Male	1.70–1.76	0.58–0.59	1.24–1.26	0.60–0.63
Female	1.81	0.62	1.29	0.66

TYPE MATERIAL: Holotype male and allotype female (slides) from *Tonatia minuta* (host no. 11764), Armila (San Blas), 20 March 1963, C. O. Handley, Jr. and F. M. Greenwell. In the collection of Chicago Natural History Museum. Paratype, a male, same data but 25 March; in the collection of the United States National Museum.

Genus **Stizostrebla** Jobling

Stizostrebla Jobling, 1939, Arb. Morph. Tax. Ent., **6**: 269 (discussion), 270 (keyed), 273 (diagn.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 417 (keyed); 1942, Bol. Ent. Venez., **1**: 86 (keyed). Jobling, 1949, Parasitology, **39**: 321 (keyed).

Type-species: *Stizostrebla longirostris* Jobling, 1939.

This genus contains the single described species, *S. longirostris* Jobling.

Stizostrebla longirostris Jobling. Figure 119.

Stizostrebla longirostris Jobling, 1939, Arb. Morph. Tax. Ent., **6**: 273, fig. 2—Brazil, "from a bat" (Deutsches Entomologisches Institut).

In the collection of Chicago Natural History Museum is a series of eight specimens of this species, collected from *Tonatia* sp., apparently *T. silvicola,* at San Juan de Arama, Los Micos (Meta), COLOMBIA by Kjell von Sneidern. This host occurs in Panama, and it is possible that the parasite does too.

Genus **Eldunnia** Curran

Eldunnia Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, pp. 5 (keyed), 6 (diagn.). Jobling, 1936, Parasitology, **28**: 357 ff. (morph.), 370 (keyed); 1939, Arb. Morph. Tax. Ent., **6**, (3), pp. 269 (discussion), 270 (keyed); 1949, Parasitology, **39**: 322 (keyed). Bequaert, 1940, Revista Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 417 (keyed); 1942, Bol. Ent. Venez., **1**: 84 (keyed).

This monotypic genus is unique in having a postgenal ctenidium of only about 18 spines, limited to the underside of the head. The male genital apparatus is also distinctive. In addition to characters given by Curran, the following may be added:

Head.—Laterovertices transverse, without dark lines or sutures. Eyes small, with six facets. Occipital lobes and postgenae forming prominent lateral lobes which fit into deep concavities on anterior margin of thorax. Postvertex a sclerotized transverse strip which bears setae. Underside of head on each side of oral cavity with a pale oval area like that of *Pseudostrebla* and *Parastrebla*. *Legs.*—Hind tibiae with a subapical seta that is distinctly stronger than the others. *Abdomen.*—*Female:* Tergum VII feebly sclerotized, transverse. Seventh sternites triangular. Cerci free, ventral arc feebly sclerotized. *Male:* Cerci free, without apodemes that extend to surstyli. Gonapophyses (fig. 121) short, strongly narrowed distally, with several pairs of ventral setae; aedeagus blade-like, but strongly narrowed apically, not coiled at base.

Fig. 120. *Eldunnia breviceps* Curran. Head and thorax, dorsal view, male from *Lonchophylla robusta* (no. 12213), Puerto Obaldía (San Blas).

Its very distinct male genital apparatus notwithstanding, *Eldunnia* appears to share more characters, especially of head structure, with *Pseudostrebla* and especially *Stizostrebla,* than with any other genera. It does not appear to be closely related to the genera which we regard as Streblinae.

Eldunnia breviceps Curran. Figures 39C, 120, 121.

Eldunnia breviceps Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479; 1935, Amer. Mus. Novit., no. 765, p. 6 (descr.), figs. 7, 9—Chilibrillo Caves, Panamá, from *Lonchophylla robusta* (American Museum of Natural History). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418. Jobling, 1949, Parasitology, 39: 316 ff., fig. 2B.

Excepting the scutellum, the mesonotum of this remarkable species is covered with microsetae (fig. 120).

Fig. 121. *Eldunnia breviceps* Curran. Male genital apparatus, left lateral view. Same data as for specimen in fig. 120.

Measurements:	BL	TL	WL	WW
Male	1.32–1.47	0.49–0.51	1.10–1.18	0.49–0.60
Female	1.26–1.70	0.49–0.52	1.25–1.37	0.60–0.66

PANAMANIAN MATERIAL EXAMINED: In addition to the type and paratype, we have examined 18 specimens in 11 lots (12 bats), from *Lonchophylla robusta* as follows: holotype female, Chilibrillo Caves, Chilibre (Panamá), 30 January 1931, L. H. Dunn [AMNH], and the paratype, same data but 9 March 1933 [MCZ]; 1, same locality, 27 March 1958, GML; 5 (3 bats), Almirante (Bocas del Toro), 23 and 31 January 1960; 4 (2 bats), Isla Bastimentos (Bocas del Toro), 30 January and 1 February 1963; 4 (3 bats), Buena Vista caves (Colón), 15 September and 19 November 1959; 2 (2 bats), Armila (San Blas), 14 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 2 (1 bat), Puerto Obaldía (San Blas), 4 April 1963, Handley and Greenwell.

REMARKS: This species is known only from Panama. It appears to be restricted to *Lonchophylla robusta,* though it is possible that it may occur on other species of the genus. None were taken from the few specimens of *Lonchophylla mordax* and *L. thomasi* that were collected in Panama. Of approximately 55 specimens of *L. robusta* that were examined, only 11 (20%) were positive for *E. breviceps*. In only one instance were more than two flies collected from a single host.

Although Curran (1935) refers to page 479 of the Fam. Gen. N. Am. Dipt. as the original citation for *E. breviceps*, there is a question in our minds as to whether or not this (1934) usage was a *nomen nudum*. The genus *Eldunnia* was keyed out, and *E. breviceps* was given in parentheses as the included species. Because the paratype lacks the abdomen, its sex is unknown.

Subfamily **Streblinae**

As defined by Jobling (1936), the subfamily Streblinae would include the following genera: *Anastrebla* (= *Strebla* auct.), *Strebla* (= *Euctenodes* Waterhouse), *Metelasmus, Paraeuctenodes, Pseudostrebla, Parastrebla,* n. gen., *Stizostrebla,* and *Eldunnia.* Jobling characterized the subfamily on the basis of shape and width of the head, shape and position of the palpi, and shape and relative size of the mesonotum.

The palpi of *Pseudostrebla, Parastrebla,* and of *Stizostrebla* and *Eldunnia* exhibit a wide range of shape and width, including that (e.g., *Pseudostrebla greenwelli* n.sp.) typical of Trichobiinae. In none of these are they modified to form a shield-like front as in the other genera assigned to the Streblinae by Jobling. The other characters, too, vary. They seem to represent specializations toward a polyctenoid body form, and probably have evolved independently at least a couple of times.

The ventral accessory setae of the male gonapophyses in *Pseudostrebla* and *Stizostrebla* are inserted posterior to the macrosetae, as in the *uniformis, longipes,* and *dugesii* groups of *Trichobius* and in the genera *Speiseria, Noctiliostrebla, Aspidoptera, Mastoptera, Exastinion* and *Paradyschiria.* The male of *Parastrebla* is unknown, but we predict that it will be of this type. In *Strebla, Anastrebla, Paraeuctenodes,* and *Metelasmus,* the accessory setae are anterior to the macrosetae, as in the *major-sparsus* and *caecus* groups of *Trichobius,* and in the genera *Megistopoda, Paratrichobius, Neotrichobius, Joblingia,* and *Anatrichobius.* These and some other characters, including female genital structure, appear to reflect natural groupings. If this is so, then the Streblinae of Jobling include convergent types. Until the relationships of the genera can be investigated more thoroughly, we restrict the Streblinae to those genera which have a complete postgenal ctenidium, which extends around the side of the head to the dorsal surface. The relationships of *Eldunnia* are puzzling. The male genital apparatus is strikingly different from that of any other New World Streblidae. However, the structure of the head appears to relate it to *Stizostrebla* and *Pseudostrebla.*

In the following section, we have used some special terms which apply only to the Streblinae. The laterovertices are divided into two or more distinct areas by dark, internal lines or ridges. The area behind the eye is often set off separately by such an internal ridge and bears a single seta.

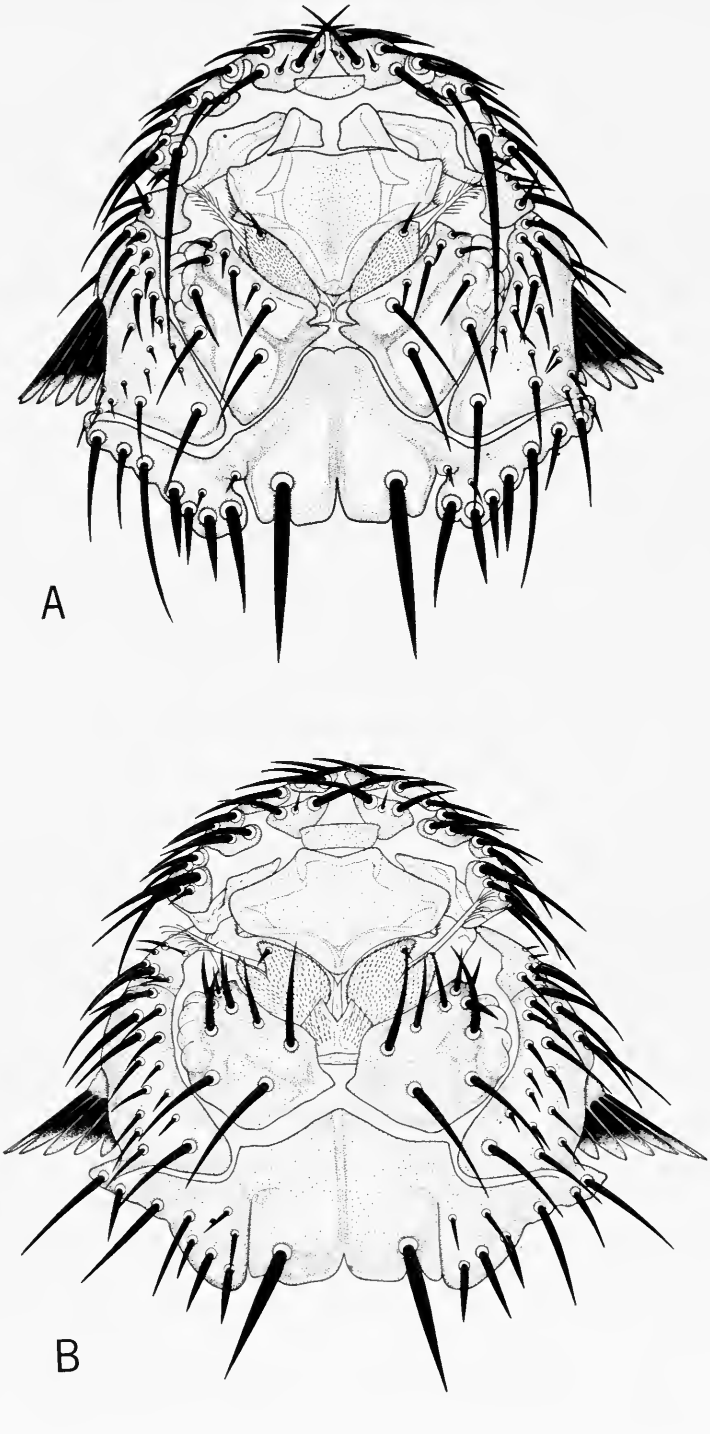

Fig. 122. Dorsum of head. A, *Strebla carolliae*, new species (composite drawing from several specimens off *Carollia p. azteca*, from localities in Panama). B, *Strebla hertigi*, new species, from *Phyllostomus h. panamensis* (no. 4651), Chepo Road (Panamá).

We have called this area the "postocular sclerite." Behind the anterior margin of the prescutum on each side, extending inwardly from the spiracle is a row of stout bristles of variable number, which we call the "epaulets" (fig. 134). Farther behind on each side of the prescutum is an arcuate row of setae, which are usually conspicuously longer than the other discal prescutal setae. We call these the "prescutal arc" of setae (fig. 134).

We have called the underside of the head, anterior to the ctenidium, the "ante-ctenidial area." Its length is measured along the mid-line between the anterior margin of the ctenidium and the anterior margin of the palpi; its width is measured between the lateral margins of the postgenae, in front of the ctenidium. Measurements of body length were made from the anterior margin of the palpi, rather than of the frontoclypeus, as was done for the other Streblidae.

Genus **Strebla** Wiedemann
(=*Euctenodes* Waterhouse), *new synonymy.*

Strebla Wiedemann, 1824, Analecta Ent., p. 19; 1830, Aussereurop. Zweifl. Ins., 2: 612. Macquart, 1835, Hist. Nat. Ins., Dipt., 2: 637. Walker, 1849, List. Dipt. Ins. Brit. Mus., pt. 3, p. 1146 (part.). Kolenati, 1856 (& 1857), Parasiten d. Chiropteren, p. 46. Rondani, 1878, Ann. Mus. Civ. Stor. Nat. Genova, **12**: 167. Bigot, 1885, Ann. Soc. Ent. Fr., (6), **5**: 226, 232 (keyed). Williston, 1896, Man. Fam. Gen. N. Am. Dipt., 2nd ed., p. 152 (keyed). Coquillet, 1910, Proc. U. S. Nat. Mus., **37**: 609.

Euctenodes Waterhouse, 1879, Trans. Roy. Ent. Soc. Lond., **1879**: 310 (with *E. mirabilis* Waterhouse, as type-species). Bigot, 1885, Ann. Soc. Ent. Fr., (6), **5**: 226 (discuss.), 233 (keyed). Speiser, 1900, Arch. Naturg., **66A**, Bd. I, pp. 41, 42, 63, 66 (keyed). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 26 (keyed), 32 (cit.). Kessel, 1924, Parasitology, **16**: 406–409 (char.); 1925, Jour. N. Y. Ent. Soc., **33**: 13 (keyed), 30 (char., key to spp.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1934, Bull. Amer. Mus. Nat. Hist., **66**: 522 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, **28**: 355 ff. (morph., syst. pos.), 370 (keyed). Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, **12**: 255 ff. (comp. notes). Jobling, 1939, Arb. Morph. Tax. Ent., **6**: 269 (discuss.), 270 (keyed). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., **3**: 417 (keyed); 1942, Bol. Ent. Venez., **1**: 86 (keyed). Schuurmans-Stekhoven, Jr., 1951 (& 1941?), Beiträge Fauna Perus, **3**: 96. Jobling, 1949, Parasitology, **39**: 322 (keyed). Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 178 (keyed), 188 (records). Maa, 1965, Jour. Med. Ent., **1**: 386.

Type-species: *Hippobosca vespertilionis* Fabricius, 1805.

Wiedemann (1824, p. 19) based his genus *Strebla* on *Hippobosca vespertilionis* Fabricius. He also gave a short description and figure of the type specimen of *vespertilionis*, and indicated its location as "In Museo Regio Havniensi." His original figure (in color) did not show setae on the hind legs. The dark structures he figured at the basal angles of the head (and later interpreted to be eyes) are the dorsally curved ends of the ctenidium. The presence of the ctenidium and the shape of the thorax clearly show the insect to be a member of the Streblinae. The relatively short hindlegs indicate, however, that the insect is a species of *Euctenodes* Waterhouse, not of *Strebla,* Speiser (1900), Kessel (1924) and later authors.

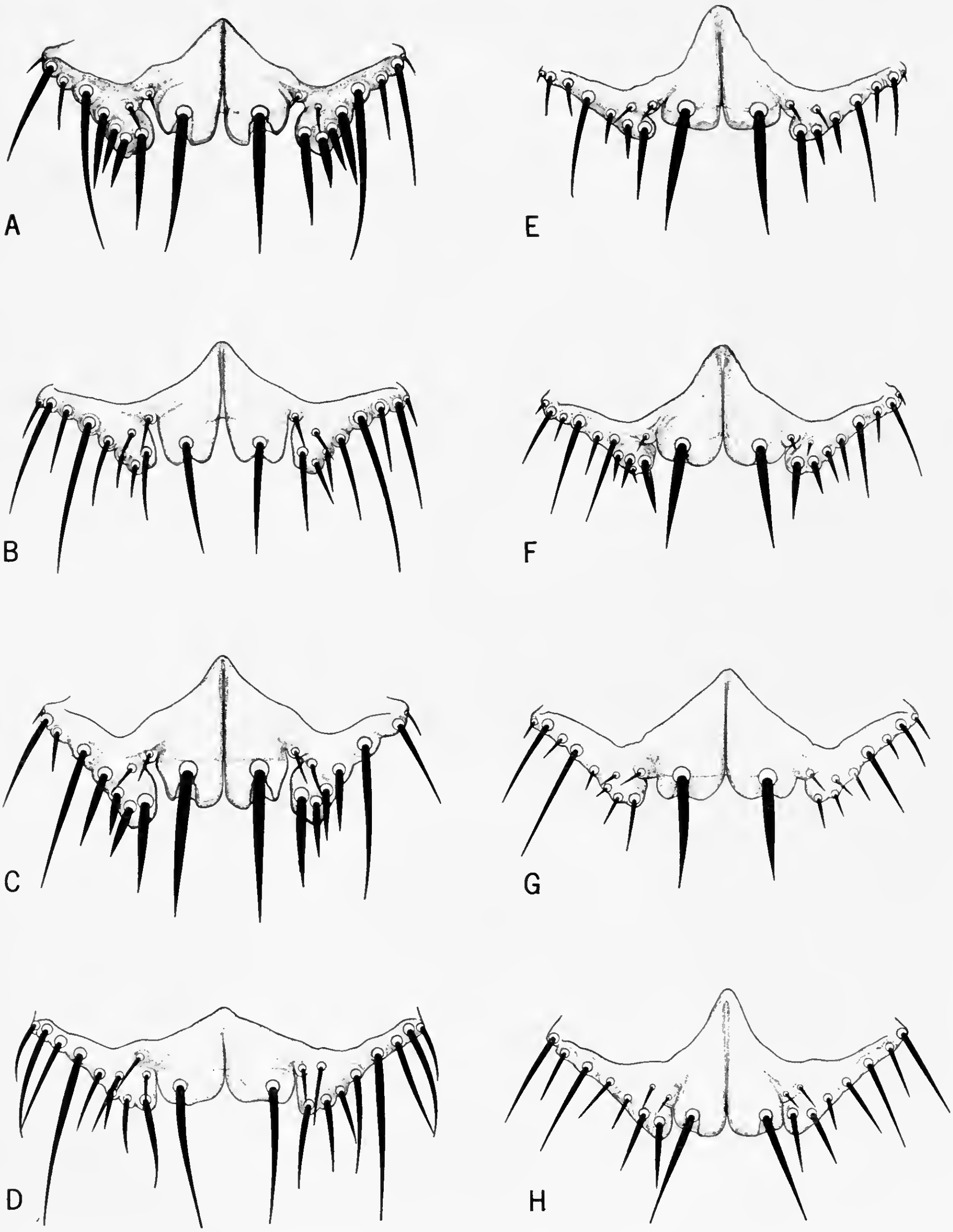

Fig. 123. Postvertex and occipital plates (of head) of species of *Strebla*. A, *S. mirabilis* (Waterhouse) from *Phyllostomus h. panamensis* (no. 4138), Natural Bridge, Madden Dam (Canal Zone). B, *S. vespertilionis* (Fabricius), from *Desmodus r. murinus* (no. 5236), Red Tank (Canal Zone). C, *S. kohlsi*, new species, from *Tonatia s. silvicola* (CNHM nos. 69897–99), Cauca Valley above Cáceres, Puri (Antioquia), COLOMBIA. D, *S. galindoi*, new species, paratype. E, *S. alvarezi*, new species, from *Saccopteryx bilineata* (no. 4659). F, same, from *Saccopteryx bilineata*, Finca Santa Cristina, (Escuintlas), GUATEMALA. G, *S. altmani*, new species, paratype from *Lonchorhina aurita*. H, *S. hoogstraali*, new species, from *Tonatia minuta* (no. 9162).

In 1830, Wiedemann added his interpretation and description of the "eyes" and slightly altered the illustration (now black and white) to change the wing somewhat and to add conspicuous setae on the hind tibiae. Macquart's (1835) figure is copied from this. Wiedemann again referred to the specimen as being in the Copenhagen Museum and it is assumed that the

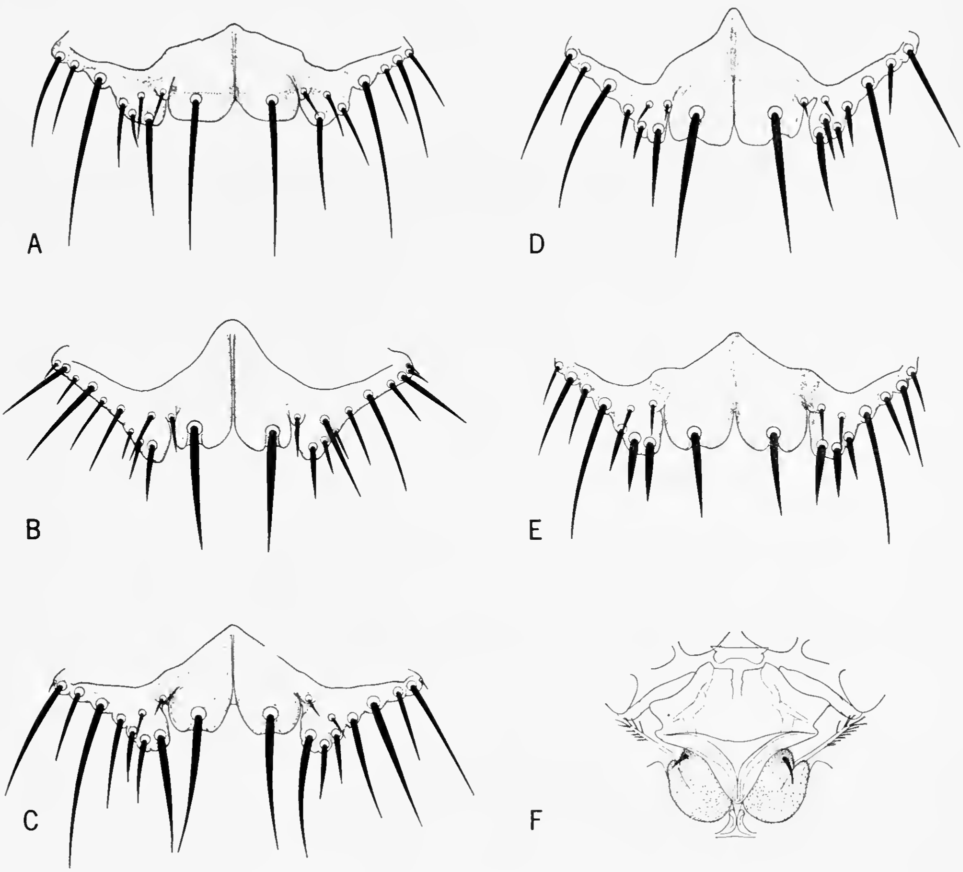

Fig. 124. A–E, postvertex and occipital plates (of head) of species of *Strebla*. A, *S. diaemi*, new species, paratype from *Diaemus youngii*, Río Raposo, COLOMBIA. B, *S. consocius*, new species, paratype from *Phyllostomus h. hastatus* (TVL nos. 1406–21) Guanapo Heights, TRINIDAD. C, *S. diphyllae*, new species, paratype from *Diphylla ecaudata centralis*, San Lorenzo, N.E. of Volcan de Jumay (Jalapa), GUATEMALA. D, *S. machadoi*, new species, holotype. E, *S. christinae*, paratype from *Phylloderma stenops* (no. 11986). F, antennae and frontoclypeus, *S. galindoi*, new species.

revised figure, too, was based on the type. Poor though the figure is, the illustration of the hind tibiae clearly shows the fly to be a species of *Euctenodes*, since the species regarded as *Strebla vespertilionis* by Speiser and Kessel (loc. cit.) has elongated hindlegs and lacks metatibial macrosetae.

Thus, *Euctenodes* should be synonymized under *Strebla*, and a new name is needed for *Strebla* (not Wiedemann, 1824) of Speiser, Kessel *et al.*

The genus *Strebla* is taxonomically very difficult. In the past, a number of closely related species have been confused under *mirabilis* (Waterhouse). Only one other species was described (*tonatiae* Kessel). In our studies, we have segregated 15 species, 12 of them new. We considered it desirable to present a preliminary revision of the genus here, since 12 of the 15 species have been collected in Panama. After this study was completed, three additional new species from Colombia, Venezuela, and Surinam came to our attention, and it is likely that more will be discovered in the future. Further, some of the host data suggest that cryptic species exist which we presently are unable to separate on morphological grounds (see remarks under *S. mirabilis*). Many of the species appear to be restricted to a single host.

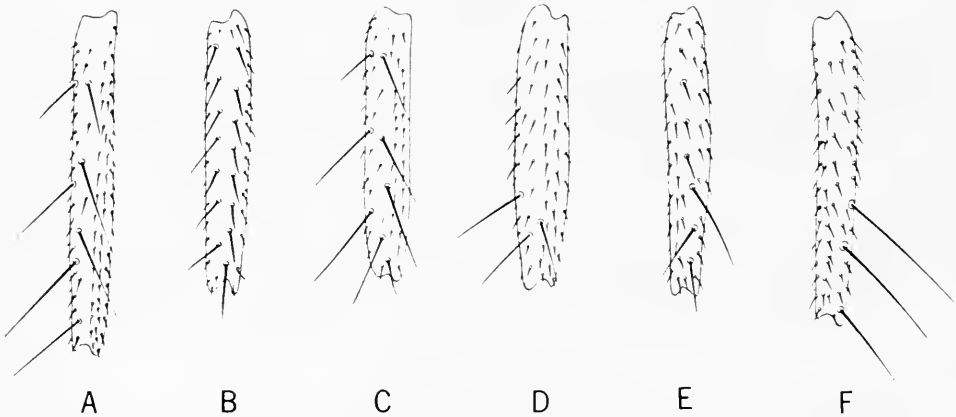

Fig. 125. Metatibiae, dorsal view. A, *Strebla consocius*, new species. B, *S. vespertilionis* (Fabricius). C, *S. diaemi*, new species. D, *S. galindoi*, new species. E, *S. mirabilis* (Waterhouse). F, *S. hertigi*, new species.

KEY TO THE SPECIES OF *STREBLA*

1. Frontoclypeus entire (fig. 122B). The second, anterior pigmented mesonotal suture lacking or indistinct (fig. 127B) 2

   Frontoclypeus with a pair of apical detached plates (fig. 122A) or with an unsclerotized median suture (fig. 124F). Second anterior pigmented mesonotal suture usually distinct, as in fig. 134, though absent in *christinae* n.sp. 6

2. Upper edge of posterior tibiae with two or three macrosetae (fig. 125D–F). Anterior margin of postvertex as in fig. 122B. Eyes consisting of a single row of about four facets. Hosts: *Phyllostomus* spp. .... *hertigi* n.sp.

   Upper edge of posterior tibiae with six to eight macrosetae (fig. 125A–C) 3

3. Anterior margin of postvertex forming an obtuse angle (fig. 124A). Prescutum (fig. 127A), anterior to the transverse mesonotal suture, broader than long; with a row of short bristles extending across entire width behind the anterior margin. Host: *Diaemus youngii* .... *diaemi* n.sp.

   Anterior margin of postvertex forming an angle less than or only slightly greater than 45° (figs. 123H, 124B). Prescutum, anterior to the transverse suture, longer than broad; short, stout bristles near anterior margin limited to a group on each side, near the anterior angles (figs. 128, 129) 4

4. Bristle at apex of third longitudinal vein only slightly larger and stronger than the preceding "erect" setae. Angle formed by the anterior margin of the postvertex about equal to or slightly greater than a right angle (fig. 124B). Eyes small but distinctly faceted. Host: *Phyllostomus hastatus* ...*consocius* n.sp.

   Bristle at apex of third longitudinal vein a strong and conspicuous macroseta (fig. 126) which is at least twice as long as the preceding erect setae. Eyes consisting of a single hyaline lens, facets indistinguishable. Angle formed by the anterior margin of the postvertex conspicuously less than a right angle (fig. 123H). Hosts: *Tonatia* spp. 5

5. Mesonotum (fig. 129B), more sparsely setose, the prescutum with only about 25–28 setae on each side behind the epaulets; scutum laterally with two irregular rows of setae between the antescutellar row and the transverse mesonotal suture; setae of antescutellar row subequal. Host: *Tonatia minuta*........ ....*hoogstraali* n.sp.

   Mesonotum (fig. 129A), more densely setose, the prescutum with about 42–46 setae on each side behind the epaulets; scutum, toward the sides, with three irregular rows of setae between the antescutellar row and the transverse suture; some of the lateral setae of antescutellar row distinctly longer than the median ones. Host: *Tonatia brasiliensis* ....*tonatiae* (Kessel)

6. Frontoclypeus with a median unsclerotized suture (fig. 124F). Anterior margin of postvertex as in fig. 124B; setae of postvertex and occiput long and slender. Host: *Tonatia bidens* ....*galindoi* n.sp.

   Frontoclypeus with a pair of apical detached plates (fig. 122A) 7

7. Upper edge of posterior tibiae with two rows of setae which are conspicuously longer than the others, the apical ones longest 8

   Upper edge of posterior tibiae either with a single row of longer setae of which the apical two or three are macrosetae or with only two or three subapical macrosetae that are distinctly longer than other tibial setae 10

8. Eyes consisting of a single elongate hyaline lens. Anterior margin of postvertex subacuminate (fig. 124D). Mesonotal chaetotaxy as in fig. 131B. Host: *Micronycteris minuta* ....*machadoi* n.sp.

   Eyes multi-faceted. Anterior margin of postvertex not thus 9

9. Second or anterior transverse mesonotal suture absent. Mesonotal chaetotaxy as in fig. 131A. Postvertex as in fig. 124E, the spinelets relatively short and stout, as are the inner three spinelets of occiput on each side. *Female:* Tergum VII with two pairs of setae. Anterior margin of ventral arc of terminal cone produced as a broad rounded lobe (fig. 44A). *Male:* Gonapophyses (in lateral view) strongly curved. Host: *Phylloderma stenops* ....*christinae* n.sp.

   Second or anterior transverse mesonotal suture present; mesonotal chaetotaxy as in fig. 132. Postvertex as in fig. 123B, the spinelets more slender, as are the inner three occipital spinelets on each side. *Female:* Tergum VII typically with three pairs of setae. Anterior margin of ventral arc not produced. *Male:* Gonapophyses (lateral view) only very feebly curved, nearly straight. Host: *Desmodus rotundus* ....*vespertilionis* (Fabricius)

10. Anterior margin of postvertex broadly blunt (fig. 122A). Hosts: *Carollia* spp. ....*carolliae* n.sp.

    Anterior margin of postvertex much more strongly rounded, or angulate 11

11. Inner occipital setae fine, bristle-like, not spinelets (fig. 123G). Hosts: *Lonchorhina aurita, Macrophyllum macrophyllum* ....*altmani* n.sp.

    At least one or two, usually three or four of inner occipital setae on each side are spinelets 12

12. Anterior margin of postvertex as in fig. 123E, F. Prescutum (fig. 137B) with only two irregular transverse rows of setae laterally between the transverse mesonotal suture and the anterior suture ....*alvarezi* n.sp.

    Anterior margin of postvertex otherwise (figs. 123A, C; 124C). Prescutum (figs. 133, 134) with at least three irregular transverse rows of setae laterally between the transverse mesonotal suture and the anterior suture 13

13. Prescutum (fig. 133) densely setose anteriorly; median discal setose area extending anteriorly nearly to margin, the antero-lateral setose areas (anterior to arcs) extending along sides nearly to epaulets. Postvertex and occiput as in fig. 124C, their setae strong, but not stout spines or spinelets. Host: *Diphylla ecaudata* .... *diphyllae* n.sp.
    Prescutum (fig. 134) sparsely setose anteriorly; median discal setose area extending only to about middle, distinctly separated from antero-median paired setae; area behind epaulets along lateral margins bare 14
14. Head elongate, the ventral ante-ctenidial area only slightly wider than long (24:22). Detached frontoclypeal plates distinctly longer than wide. Host: *Tonatia silvicola* .... *kohlsi* n.sp.
    Head short; ventral ante-ctenidial area nearly half again as wide as long (59:41) Hosts: *Phyllostomus hastatus panamensis*, (?) *Trachops cirrhosus* .... *mirabilis* (Waterhouse)

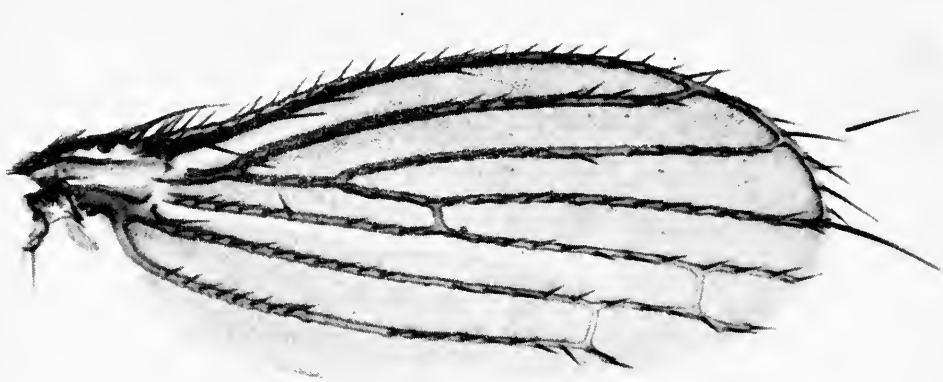

Fig. 126. Wing, *Strebla hoogstraali*, new species, male paratype from *Tonatia silvicola* (no. 9102), Las Palmitas (Los Santos).

Strebla hertigi Wenzel, new species. Figures 122B, 125F, 127B.

A very distinctive species not closely related to any other, that is easily recognized by the following combination of characters: frontoclypeus entire (without apical detached plates), eyes consisting of only four or five ocelli in a row; metatibiae with only two or three macrosetae; setae and macrosetae of occiput and spines of postvertex comparatively short; dorsal plate of postgenae with a postero-lateral emargination; postvertex long, subquadrate.

DESCRIPTION: *Head* (fig. 122B).—Frontoclypeus without detached apical plates. Anterior plate of laterovertices with five to six setae; postocular sclerite distinct. Chaetotaxy of head as illustrated, except that long, outer setae of occiput are a little more slender than shown. Postero-lateral margin of dorsal sclerite of postgenae emarginate for reception of ctenidium. Eyes with four or five facets in a single row. Ventral ante-ctenidial area about as wide as long (24:23). Postvertex long, its anterior margin obtusely angulate.

Thorax (fig. 127B).—Prescutum without a second pigmented suture; epaulets consisting of five or six setae which extend across anterior margin to median pair; prescutal setae extending anteriorly to anterior margin; arcuate row of long setae present but not conspicuously differentiated. Setose area posterior to arc consisting of about four irregular transverse rows at middle, three toward sides. Antescutellar scutal setae mostly subequal, not distinctly longer laterally, except for long macroseta at extreme lateral margin; two rows of scutal setae in addition to antescutellars, anterior half of scutum bare toward sides. *Wings.*—R_s approximately a third again as long as distance from fork to *r-m* (25:17.5). All veins setose to base, excepting the sixth longitudinal. *Legs.*—Protibiae with five exceptionally long macrosetae, mesotibiae with three. Hind tibiae (fig. 125F) apically with three macrosetae, the distal one less than half as long as the basal one. First segment of hind tarsi with a median row of heavy plantar bristles, one or two outwardly near base, one inwardly at apex and several fine ones anterior to this; plantars of following segments minute.

Abdomen.—Anterior face of tergum I+II with three short setae; inner dorsal margin with three to five setae, two very fine. *Female:* Tergum VII with two pairs of macrosetae; the second, posterior pair more than half as long as anterior pair, sometimes with a supernumerary. Supra-anal plate with four long, apical macrosetae and a pair of short but well-developed basal setae. Seventh sternites with 13–16 setae consisting of four macrosetae (two very long), three to five intermediate setae, and four to nine short setae. Ventral arc triangularly produced anteriorly, with a single pair of setae. *Male:* Hypopygium dorso-laterally on mid-third with a macroseta and one or two shorter setae; dorso-apical margin with six to eight macrosetae; a long apical macroseta below these on each side. Gonapophyses nearly straight, slightly sinuate above, the macroseta inserted at about basal fourth. Sternum V at middle with two transverse rows of setae in addition to marginal setae.

Measurements:	BL	TL	WL	WW
Male	2.56–3.13	0.85–0.88	1.87–1.95	0.84–0.93
Female	2.56–3.08	0.88–0.93	1.87–2.14	0.91–0.96

TYPE MATERIAL: Holotype male and allotype female (slides) from *Phyllostomus hastatus panamensis* (host no. 4650), hollow tree, Chepo Road (Panamá), 8 October 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes: PANAMA.—From *P. h. panamensis:* 38 (12 bats), same data as the holotype; 1 (20 bats), Chilibrillo Caves (Panamá), 17 July 1959 and 1, 28 October 1959; 1, Tapia (Panamá), 25 July 1923, J. P. Chapin [MCZ]; 1, Fort Sherman (Canal Zone), 6 April 1960; 3 (2 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 2, Almirante (Bocas del Toro), 29 January 1960. From *Phyllostomus d. discolor:* 1, Río Tuira (Darién), 10 March 1958, P. Galindo [GML]; 3, Río Mandinga (San Blas), 18 and 29 May 1957, P. Galindo [GML]; 1, Armila (San Blas), 1 April 1963, C. O. Handley Jr. and F. M. Greenwell. From *Lasiurus egregius* (mist net): 1, Armila (San Blas), 23 February 1963, Handley and Greenwell. From *Artibeus j. jamaicensis:* 1, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959. From *Desmodus r. murinus:* 1, Guánico (Los Santos), 26 January 1962.

COSTA RICA.—From *Phyllostomus h. panamensis:* 1, Playa del Coco, Guancaste, 20 August 1962, F. Truxal, Los Angeles County Museum. NICARAGUA.—From *Phyllostomus h. panamensis,* 5 km. N and 14 km. E of Condega: 2 (1 bat), 23 June 1964, J. Knox Jones [KU]; 8 (1 bat), 25 June 1964, J. D. Smith [KU]; 19 (1 bat), 24 June, and 10 (1 bat), 25 June 1964, T. E. Lawlor [KU]. EL SALVADOR [H. Felten, SNI].—From *Phyllostomus discolor verrucosus:* 5, Hacienda San Diego (La Libertad), 15 November 1953; 1, same data but 8 February 1953; 5, San Rafael Cedros (Cuscatlan), 7 September 1953; 496 (1 lot), "Hohle *Ceiba pentandra*, an Strasse San Salvador–Sta. Ana bei San Andres" (La Libertad), 482 meters elevation, 27 September 1953; 11, "Hohle bei Suchitoto (Cuscatlan)," 7 June 1953; From *Desmodus rotundus:* 1, "Hohle *Ceiba pentandra*, bei km. 31, Strasse San Salvador, Sta. Ana," 4 August 1953. *Without host:* 2 lots, 27 specimens. GUATEMALA.—*Without host:* 5, Patulul, April 1906. COLOMBIA.—From *Phyllostomus discolor:* 1, Cucuta, May 1940. VENEZUELA.—From *Phyllostomus d. discolor:* 1, Biological Station, Rancho Grande (Aragua),

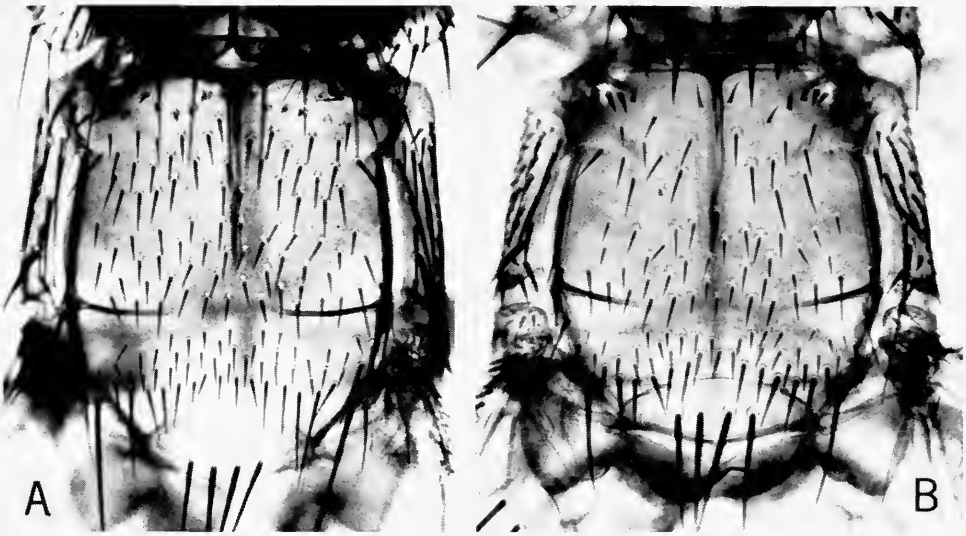

Fig. 127. Thorax, dorsal view. A, *Strebla diaemi*, new species, male paratype from *Diaemus youngi*, Río Raposo, COLOMBIA. B, *S. hertigi*, new species, male paratype from *Phyllostomus discolor*, Port-of-Spain, TRINIDAD.

31 August 1962, C. Machado and R. Antequera [FCUCV]. TRINIDAD (TVL unless otherwise indicated).—From *Phyllostomus discolor* [*discolor*]: 2, Alta Gracia Trace, Siparia, 20 January 1958; 31, Long Circa, Port-of-Spain, 2 August 1954; 6, Masson Hospital, Port-of-Spain, 29 October 1956; 7, Emperor Valley Zoo, Port-of-Spain, 13 and 18 March 1958; 1, Santa Cruz, 28 June 1956; 2, Port-of-Spain, C. C. Sanborn, 8 November 1954, CNHM Trinidad Zoological Field Trip (1954). BRITISH GUIANA.—*Without host:* 2, Kartabo, Bartica District, 1921, A. E. Emerson. SURINAM.—From *Phyllostomus discolor:* 3, Kaiserberg Airstrip, east of Zuid River, 12 October 1960, and 4, same locality, 12 December 1960, H. A. Beatty, CNHM Guianan Zoological Expedition, 1960–62. PERU.—From *Phyllostomus discolor:* 3, Hacienda Bogetes, Salitral (Piura), 23 April 1959, 180 meters elevation, C. Kalinowsky, CNHM Peruvian Zoological Expedition. Paratypes to be deposited in the collections listed on p. 410.

OTHER MATERIAL EXAMINED: We have at hand dozens of additional lots collected in MEXICO, COSTA RICA, and NICARAGUA from *Phyllostomus discolor* *verrucosus* by J. Knox Jones [KU] and collaborators and by Fred Truxal and collaborators [LACM]. We have not yet tabulated these records.

REMARKS: This species is named in honor of Dr. Marshall Hertig, distinguished medical entomologist of the Gorgas Memorial Laboratory.

S. hertigi may occur on *Phyllostomus d. discolor* throughout most, if not all of its range; but we have seen specimens only from the tropical lowlands, from Mexico to Peru and northeastern South America. In Panama, it often occurs together with *S. mirabilis* on *Phyllostomus h. panamensis*, but perhaps only where ecological situations are favorable for its transfer to that host from *P. discolor*. Interestingly, *S. mirabilis* does not seem to occur on *P. h. panamensis* in Costa Rica and Nicaragua, but is entirely replaced by *hertigi*. For further discussion, see p. 645, and following paper, p. 683.

Strebla diaemi Wenzel, new species. Figures 124A, 125C, 127A.

Similar to *S. hertigi* n. sp., *S. consocius* n. sp., and *S. tonatiae* (Kessel) in having the frontoclypeus entire. Among these, it resembles *hertigi* in the shape of the postvertex, but differs conspicuously in having seven metatibial macrosetae (rather than two or three) and in having convex, multifaceted eyes, whereas *hertigi* has a single row of four facets. It resembles *consocius* in the metatibial setae and eyes, but differs markedly from that species in the shape of the postvertex as well as in other characters given in the key.

DESCRIPTION: *Head.*—Frontoclypeus entire, without apical detached plates. Anterior plate of laterovertices with about seven setae; postocular sclerite distinct. Dorsal surface of postgenae not emarginate laterally; posteriorly with about 15 short setae and, near inner posterior margin, a conspicuous macroseta of about same length as the long, outer occipital setae; lateral to the macroseta is a shorter seta of about same length as inner occipitals. Postvertex and occiput as illustrated (fig. 124A), but the setae usually more nearly like those shown on right side. Eyes multi-faceted and projecting, seven or eight facets visible from above. Ventral ante-ctenidial area more than half again as wide as long (29.5:18.5).

Thorax (fig. 127A).—Prescutum with one pigmented suture; epaulets consisting of eight or nine setae on each side and extending inwardly on each side to paired median setae behind anterior margin; arc of longer setae not well-defined, though the lateral setae of arc are conspicuous. About six to eight median antescutellar setae scarcely longer than the scutal setae anterior to them; on each side of these are three or four longer setae, one conspicuously longer; to each side of antescutellars are two prominent setae, one a very long macroseta. *Wings.*—All veins except sixth longitudinal, setose to base. Costa without a macroseta at apex. R_s about two and a half times as long (29:11) as distance from fork to *r-m*. *Legs.*—Pro- and mesotibiae dorsally each with eight or nine conspicuous macrosetae in a double row; metatibiae (fig. 125C) with seven macrosetae, the apical ones about as long as the first three tarsomeres combined. First segment of hind tarsus elongate, slightly longer than next three segments combined; ventrally with a median longitudinal row of five very heavy, long plantar bristles, and lateral to these, two others on basal half of outer edge and three or four slightly weaker ones along inner edge. Plantar bristles of succeeding segments very small, relatively inconspicuous.

Abdomen.—Dorsal inner margin of lateral lobes of tergum I+II with three to four setae. *Female:* Tergum VII with a pair of very long macrosetae and, posterior to these, two pairs of setae in tandem, the anterior of these shorter, the posterior pair about two-thirds to three-fourths as long as the anterior macrosetae. Supra-anal plate with four apical macrosetae and on each side, near base, one or two pairs of shorter, conspicuous setae. Seventh sternites with 12–15 setae, four to seven of these being macrosetae. Ventral arc produced anteriorly as a finger-like process, its posterior edge with eight fine setae, the two median setae much shorter than the others. *Male:* Hypopygium very long and prominent; sternum VII+VIII dorsally with two conspicuous macrosetae a little beyond middle, and medial and slightly posterior to these, two setae that are more than half as long as the macrosetae; tergum IX dorsally with a row of four macrosetae. Gonapophyses gradually tapered and curved from base to knobbed apices; sides with scattered microsetae, chiefly on apical third, a few anterior to macroseta; ventral macroseta inserted at about apical third; accessory seta minute.

Measurements:	BL	TL	WL	WW
Male	2.53–2.80	0.88–0.93	1.76–1.92	0.82
Female	2.89–3.16	0.93–0.99	1.87–1.92	0.82–0.88

TYPE MATERIAL: PANAMA.—Holotype male and allotype female (slides), from *Diaemus youngii cypselinus* (host no. 11422), Armila (San Blas), 4 March 1963, C. O. Handley, Jr. and F. M. Greenwell. In the collection of Chicago Natural History Museum.

Paratypes.—6, same data as the holotype; 4, same host and collectors, Isla Bastimentos (Bocas del Toro). COLOMBIA.—7, same host, Río Raposo (Valle de Cauca), 10 August 1962, C. J. Marinkelle and W. Thornton; 1, same host, Río Mecaya (Caqueta), 1851 meters elevation, 2 March 1952, P. Hershkovitz, CNHM Colombian Zoological Expedition (1948–52). PERU.—14, same host, Río Calleria, Colonia Calleria, "15 km. from [?Río] Ucayali" (Loreto), 8 October 1961, B. Malkin and J. S. Hurley. Paratypes in the collections of Chicago Natural History Museum; the United States National Museum; and C. J. Marinkelle, Universidad de los Andes, Bogota, Colombia.

OTHER MATERIAL EXAMINED: 2, from "bats," Orinoco River, VENEZUELA, collected by Olalla, [MCZ, det. as *mirabilis* by Bequaert].

REMARKS: The only host known for this species is *Diaemus youngii,* a vampire bat which often attacks poultry (Goodwin and Greenhall, 1961).

Strebla consocius Wenzel, new species. Figures 124B, 125A, 128.

Closely related to *S. tonatiae* (Kessel) but differing in the greater angle formed by the anterior margin of the postvertex, the convex, multi-faceted eyes (a single hyaline lens in *tonatiae*), and in not having a conspicuous macroseta at apex of costal wing vein.

DESCRIPTION: *Head.*—Frontoclypeus without apical detached plates. Anterior plate of laterovertices with six setae; postocular sclerite distinct. Dorsal surface of postgenae not emarginate laterally, posteriorly with about 10 short setae, as well as a conspicuous macroseta near inner posterior margin and lateral to it a shorter but conspicuous seta. Postvertex and occiput as illustrated (fig. 124B) but anterior margin generally a little more pointed and the festoon setae usually more like those shown on right side. Eyes relatively small, multi-faceted, about seven facets of varying sizes, visible from above. Ventral ante-ctenidial area wider than long (29:22).

Thorax (fig. 128).—Prescutum without second or anterior transverse suture; epaulets usually with five to six setae; discal setae relatively sparse, setose area not quite reaching epaulets along sides; arc of longer setae not distinguishable, though long outer seta is present. Antescutellar setae conspicuously longer than other scutals. *Wings.*—All veins except sixth setose to base. Costa without a macroseta at apex. R_s only about a fourth longer (23:17) than distance from fork to crossvein *r-m*. *Legs.*—Protibiae with about eight conspicuously long macrosetae, mesotibiae with nine to ten. Metatibiae with six or seven conspicuously long macrosetae along dorsal edge, the apical ones longest. First segment of hind tarsus about as long as next two segments combined, the ventral surface with two irregular rows of conspicuous plantar bristles and an inner row of much shorter ones; plantars of following segments minute, inconspicuous.

Abdomen.—Inner dorsal margins of tergum I+II with five to six setae. *Female:* Tergum VII with two macrosetae and posterior and medial to them a pair of setae nearly half as long. Supra-anal plate with four apical macrosetae only. Seventh sternites

Fig. 128. Thorax, dorsal view, *Strebla consocius*, new species, female paratype from *Phyllostomus hastatus* (CNHM no. 87115), Santa Rita, Iquitos (Loreto), PERU.

with 11–12 setae, about five of these very long and coarse, one much longer than the others. Ventral arc very narrow, with two longer setae and eight minute ones along middle. *Male:* Hypopygium as in *diphyllae*. Gonapophyses heavy anteriorly, ventral margin nearly straight, the dorsal margin gradually curved to near apex where both are markedly curved, apices knobbed. Sides with scattered microsetae from apices nearly to base; ventral macroseta inserted slightly beyond middle, extending nearly to apex; accessory seta minute.

Measurements:	BL	TL	WL	WW
Male	2.86–2.97	0.96–0.99	1.76–1.90	0.82–0.93
Female	3.08–3.11	0.96–1.04	1.98–2.23	0.91–0.99

TYPE MATERIAL: Holotype male and allotype female (slides), from *Phyllostomus h. hastatus* (CNHM host nos. 61915–19), cave, Guanapo Heights, TRINIDAD, Frank Wonder, CNHM Trinidad Zoological Expedition (1947). In the collection of Chicago Natural History Museum.

Paratypes: TRINIDAD.—From *Phyllostomus h. hastatus:* 9, same data as holotype; 4, same locality, 11 July 1954 and 1 same locality, 1 October 1957, T.H.G. Aitken [TVL]; 1, Tamana Cave, Mount Tamana, 20 November 1957, T.H.G. Aitken [TVL]. From *Carollia p. perspicillata:* 1, same data as the preceding. *Without host:* 5, same locality and date as the preceding. VENEZUELA.—From *Phyllostomus hastatus* subsp.: 1, San Sebastian Cave (Aragua), 2 September 1961, Carlos Bordon [FCUCV]. SURINAM (CNHM Guianan Zoological Expedition, 1960–62).—From *Phyllostomus h. hastatus:* 6, Lelydorplan (Surinam), 21 January 1962, Philip Hershkovitz; 12 (3 lots), Kaiserberg Airstrip, east of Zuid River, elevation 900 feet, 15 October to 23 November, H. A. Beatty. From *Phyllostomus* sp. (probably *hastatus*): 2, same locality and collector as the preceding, 12 October 1960. PERU (CNHM Peru Zoological Expeditions, Celestino Kalinowski).—From *Phyllostomus* sp.: 6, Mann, (Madre de Dios), 17 October 1954; 10, Santa Rita, Iquitos (Loreto), 16 October 1956. From *Trachops* sp. (!): 9, Quebrada Esperanza, Río Yauari-Mirim, Maynas (Loreto), 22 September 1957. *Without host* (removed from cloth wrappings containing numerous preserved bats): 1 each, presumably from Huajyumbe (Cuzco), 16 September 1950, and Marcapata (Cuzco), 24 August 1950.

REMARKS.—The specimen with doubtful host from Huajyumbe was resting lightly on the fur of an alcohol-preserved specimen of *Mesophylla macconelli.* The specimen from Marcapata was doubtfully associated with *Molossus rufus.* No species of *Strebla* are known to us from these host genera. The association with *Molossus* seems especially dubious. The only streblids known to us from this genus are species of the genus *Trichobius* (see *Trichobius dunni*).

S. consocius seems to be restricted to *Phyllostomus hastatus* in northeastern South America and Amazonian Peru. It probably occurs on this host elsewhere in the Amazonian region, but we are unable to verify this from the limited material collected in that region.

Strebla tonatiae (Kessel). Figure 129A.

Euctenodes tonatiae Kessel, 1924, Parasitology, **16**: 411–412, figs. 7, 8—Gualaguiza, Ecuador, from *Tonatia brasiliensis* (British Museum of Natural History); 1924, Jour. N. Y. Ent. Soc., **33**: 30, pl. 4, fig. 26. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654. Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, **12**: 255 ff., figs. 10–12. Jobling, 1949, Parasitology, **39**: 316 ff.

We have not seen the type of *S. tonatiae* (Kessel), but our Peruvian specimens agree well with Kessel's figure and with the host of *tonatiae.* The identity of the host of our Peruvian specimens has been verified by Mr. Philip Hershkovitz of Chicago Natural History Museum. The host of the type of *S. tonatiae* has not been checked.

S. tonatiae and *S. hoogstraali* n. sp. differ from all others known to us in possessing a long conspicuous macroseta at the apex of the costal wing vein. The eyes of both species consist of a single hyaline lens as in *S. machadoi* n. sp., but they differ markedly from this species in the shape of the postvertex and in having the frontoclypeus entire (without apical detached plates). They appear to be most closely related to *S. consocius* n. sp., from *Phyllostomus h. hastatus.* Though small and of nearly the same shape as in *tonatiae,* the eyes of *consocius* have distinguishable facets. Further, the postvertex is of a different shape.

Measurements:	BL	TL	WL	WW
Male	1.90	0.66	1.10	0.55
Female	2.67	0.82	1.21	0.55

MATERIAL EXAMINED: From *Tonatia brasiliensis* (host no. 75586): a male and female, Huajyumbe (Cuzco), PERU, elevation 630 meters, 23 May 1953, Celestino Kalinowski, CNHM Peru Zoological Expedition (1953–54).

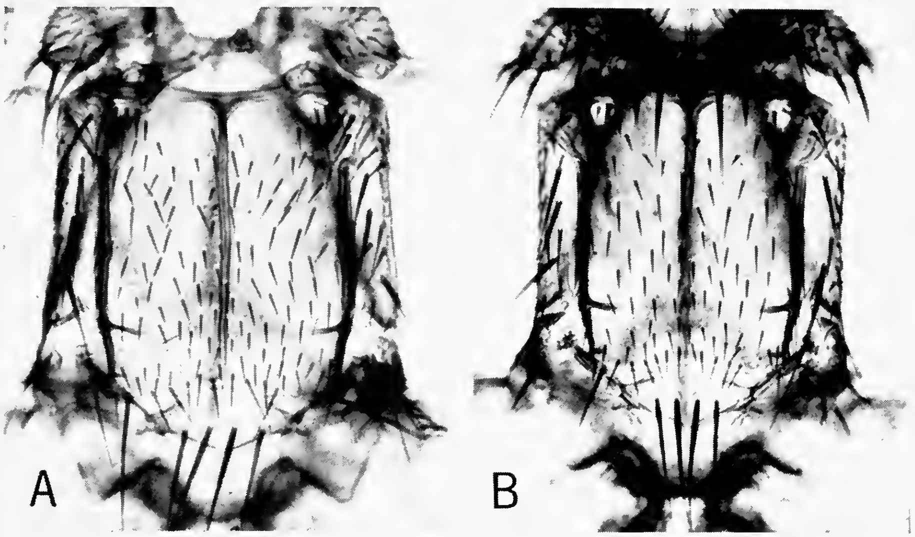

Fig. 129. Thorax, dorsal view. A, *Strebla tonatiae,* from *Tonatia brasiliensis* (CNHM no. 75586), Huajyumbe (Cuzco), PERU. B, *S. hoogstraali,* new species, same data as for fig. 126.

Strebla hoogstraali Wenzel, new species. Figures 123H, 126, 129B.

Very closely related to *S. tonatiae* (Kessel) but easily separated from that species by the distinctive mesonotal chaetotaxy, which is much sparser than it is in *tonatiae* (see fig. 129). In addition to the strikingly different chaetotaxy of the prescutum, the scutal setae of the antescutellar row are subequal in *hoogstraali,* while they are much longer at sides than at middle in *tonatiae.*

DESCRIPTION: *Head.*—Almost identical to that of *S. tonatiae.* Frontoclypeus entire, without apical detached plates. Anterior plate of laterovertices with six setae. Postocular sclerite distinct. Postgenae posteriorly with eight short bristles and, in addition one long and one medium bristle. Postvertex and occiput as illustrated (only the two inner setae are spinelets, the others are thinner than shown). Eyes consisting of a single elongate hyaline lens. Ventral ante-ctenidial area a little wider than long (21.5:18).

Thorax.—Prescutum without second pigmented suture; epaulets with four setae; disk rather sparsely setose, setae gradually sparser and a little longer anteriorly, prescutal arc of longer setae present but not conspicuous. Antescutellar setae subequal, scutum with two irregular transverse rows of setae at sides anterior to antescutellars.

Wings.—Setae of wing veins relatively longer than usual in the genus; a conspicuous macroseta at apex of costa. Length of R_s approximately equal to distance from fork to *r-m* (12:11). Sixth longitudinal bare for only a short distance at base. Third crossvein situated approximately midway between second crossvein and *r-m*. *Legs.*—Pro- and mesotibiae each with seven or eight macrosetae. Metatibiae with six macrosetae on dorsal margin; hind tarsus elongate, more than half as long as tibia, the first tarsomere slightly shorter than 2–4 combined, with a median row of six or seven long heavy plantar bristles and two on each side basally; remaining tarsomeres with very minute plantars.

Abdomen.—Anterior face of tergum I+II with one or two short setae; dorsal inner margin with two or three fine short setae; dorsal connexivum bare, except for four pairs of minute segmental setae; lateral connexival setae nearly twice as long as ventrals. *Female:* Tergum VII united with the supra-anal plate; with two pairs of macrosetae, the anterior pair longer and more widely separated than the posterior pair. Supra-anal plate with four, long, thin apical setae. Seventh sternites with about eight setae, three apical ones conspicuous macrosetae. *Male:* Sternum V with two transverse rows of discal setae at middle and laterally, sometimes with three. Setae of apical margin long, subequal, a little longer toward sides. Sternum VI large. Hypopygium as in *alvarezi.* Gonapophyses very slender, curved apically, apices knobbed; macrosetae rather short, not reaching apices of gonapophyses, inserted distal to mid-length.

Measurements:	BL	TL	WL	WW
Male	1.93–1.99	0.63–0.68	0.99–1.10	0.49–0.57
Female	2.06–2.26	0.66–0.71	1.04–1.18	0.51–0.62

TYPE MATERIAL (19 specimens [6 bats] from *Tonatia minuta*) : Holotype male and allotype female (host no. 12018) from Armila (San Blas), 29 March 1963, C. O. Handley, Jr. and F. M. Greenwell. In the collection of Chicago Natural History Museum.

Paratypes.—2, same data as the holotype; 3, same data but 7 March; 7, Las Palmitas, Guánico (Los Santos), 24 January 1962; 8 (3 bats), Sibube (Bocas del Toro), 17 to 24 January 1963, C. O. Handley, Jr. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; the Gorgas Memorial Laboratory, Panamá; the Environmental Health Branch, USAFSC, at Corozal (Canal Zone); Faculdad de Ciencias, Universidad Central de Venezuela; and the Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil.

REMARKS: This species is named for Dr. Harry Hoogstraal, Chief of Medical Zoology, United States Naval Medical Research Unit No. 3, Cairo, Egypt, in recognition of his many outstanding contributions to our knowledge of ectoparasites and many other aspects of medical entomology, and in appreciation of his cooperation through the years.

Strebla galindoi Wenzel, new species. Figures 123D, 124F, 125D, 130.

Distinct from all other species in that the frontoclypeus is neither entire nor with apical detached plates but is intermediate in structure, having a median unsclerotized suture (fig. 124F). It is apparently related to *S. mirabilis* but is distinct from that species in that it has no detached frontoclypeal plates and the anterior margin of the postvertex is broadly obtuse rather than strongly projecting.

DESCRIPTION: *Head.*—Frontoclypeus without apical detached plates, but with a median unsclerotized suture anteriorly. Anterior plate of laterovertices with seven to eight setae; postocular sclerites distinct. Posterior portion of dorsal sclerite of postgenae with eight short setae, and (near posterior margin) two long conspicuous ones; lateral margin not emarginate. Postvertex and occiput as illustrated in fig. 123D (the outer seta slightly more slender than shown). Eyes multi-faceted and projecting, about eight facets visible from above. Ante-ctenidial area of underside half again as broad as long (30:20).

Thorax.—Prescutum with a second anterior pigmented suture; epaulets with five long setae. Three transverse rows of setae between transverse and second sutures. Scutum at middle with two rows of setae anterior to the antescutellars, the latter unusually long and becoming even longer laterally. *Wings.*—All veins, except sixth longitudinal, with setae basally. Apex of costa without a macroseta. R_s about half again as long as

Fig. 130. Thorax, dorsal view, *Strebla galindoi*, new species, male paratype from *Tonatia bidens* (no. 5489), Almirante (Bocas del Toro).

distance from fork to *r-m* (17:11). *Legs.*—Protibiae with four to five much longer setae (four stout) on outer edge, about three on inner. Mesotibiae with two oblique rows of heavy setae apically on inner face, the basal row with four setae, the apical one with two; another conspicuous macroseta along dorsal edge at middle, preceded by several long, weaker setae. Metatibiae with three macrosetae on apical two fifths, the two on dorsal margin approximately as long as first two tarsomeres combined, the third lateral in position and a little more than half as long as other two. Three rows of heavy plantar bristles on first tarsomere, minute plantars on following segments.

Abdomen.—Inner dorsal margins of lateral lobes of tergum I+II with four fine setae. Connexivum with a group of three to five setae on each side of most anterior pair of segmental setae. *Female:* see *Remarks*. *Male:* Hypopygium with a dorso-lateral macroseta and medial to it a short seta; tergum IX with two pairs of macrosetae in a transverse row. Gonapophyses strongly curved and rather abruptly tapered apically; sides with numerous microsetae on a little more than apical third; ventral macroseta inserted at about basal third, not reaching apex, accessory seta well developed.

Measurements:	BL	TL	WL	WW
Male	2.47	0.82–0.93	1.65–1.76	0.82

TYPE MATERIAL: Holotype male and paratype male (slides) from *Tonatia bidens* (host no. 5489), Almirante (Bocas del Toro), 28 January 1960, C. M. Keenan and V. J. Tipton. Holotype in Chicago Natural History Museum; paratype in the United States National Museum.

OTHER MATERIAL EXAMINED: A female, from *Tonatia* sp., Coora T. P. D. Estate, Quiram Road, St. Patrick Co., TRINIDAD, 13 January 1959 [TVL].

REMARKS: The female from Trinidad is too badly damaged to permit study of the abdominal characters. It has about 12 setae on each of the seventh sternites.

This species is named in honor of Mr. Pedro Galindo of the Gorgas Memorial Laboratory, in recognition of his noteworthy contributions to our knowledge of the ectoparasites of Panama, and for his invaluable assistance in facilitating the field work in Panama.

Strebla christinae Wenzel, new species. Figures 44A, 124E, 131A.

S. christinae n. sp. is the only species of those with detached frontoclypeal plates that lacks a second or anterior pigmented mesonotal suture. From related species that have numerous strong metatibial setae and multifaceted eyes—*diphyllae* n.sp., *vespertilionis* (Fabricius), *mirabilis* (Waterhouse)—it may be recognized by the relatively short spine-like setae and shape of the postvertex (fig. 124E) and, in the female, by the conspicuous anteriorly produced lobe of the ventral arc.

DESCRIPTION: *Head.*—Detached frontoclypeal plates irregular, about as wide as long. Anterior plate of laterovertices with seven setae; postocular sclerite distinct. Dorsal surface of postgenae not emarginate laterally, its posterior portion with 10–11 shorter but conspicuous setae, one very long posterior seta and lateral to it one that is about half as long. Postvertex and occiput as illustrated. Eyes multi-faceted, projecting, about seven facets visible from above. Ventral ante-ctenidial area a little wider than long (21.5:19.5).

Thorax (fig. 131A).—Prescutum lacking a second pigmented suture; setae rather uniformly distributed and extending anteriorly nearly to anterior margin along median suture, and to epaulets along sides, the epaulets consisting of three to five setae which merge into the median prescutal setae; arc of longer setae poorly defined, only the two outer setae distinctive. Scutal setae of antescutellar row longer than discals and becoming longer toward sides; discal setae arranged in three transverse rows. *Wings.*—All veins except sixth longitudinal setose to base. A longer seta at apex of costa but not a macroseta. R_s nearly half again as long as distance from fork to *r-m*. *Legs.*—Dorsal edge of metatibiae with a double row of 10–12 macrosetae, of varying length. First segment of hind tarsi with a transverse row of three coarse plantar bristles a little beyond middle, and five or six shorter, finer ones basally; plantars of segments 2–4 distinctive but not as coarse as those of first segment.

Abdomen.—Inner dorsal margin of lateral lobes of tergum I+II with from three to five setae. *Female:* Tergum VII with a pair of macrosetae and posterior and median to them a pair of setae about one-fourth as long. Supra-anal plate with four apical macrosetae and on each side four conspicuous setae, two dorso-lateral, one lateral, and one ventral. Seventh sternites with about nine setae, three of them macrosetae. Ventral arc produced anteriorly (fig. 44A) as a conspicuous microsetose lobe; with four short setae, inner pair twice as long as outer. *Male:* Sternum V short, with no more than two transverse rows of discal setae throughout width. Sterna VI and VII+VIII forming a wide ring. Hypopygial setae as in *diaemi* n.sp. Gonapophyses curved basally, nearly straight apically, apices mucronate below; ventral macroseta inserted at about basal third, short, extending only a little more than half the distance to apex; accessory seta minute; with scattered microsetae along sides on apical third.

Measurements:	BL	TL	WL	WW
Male	2.75–2.87	0.93	1.65–1.81	0.95–0.99
Female	2.97–3.00	0.93–0.96	1.81–1.92	0.93–1.04

TYPE MATERIAL: Holotype male, allotype female (slides) and 7 paratype females from *Phylloderma stenops* (host no. 11986), Armila (San Blas), 26

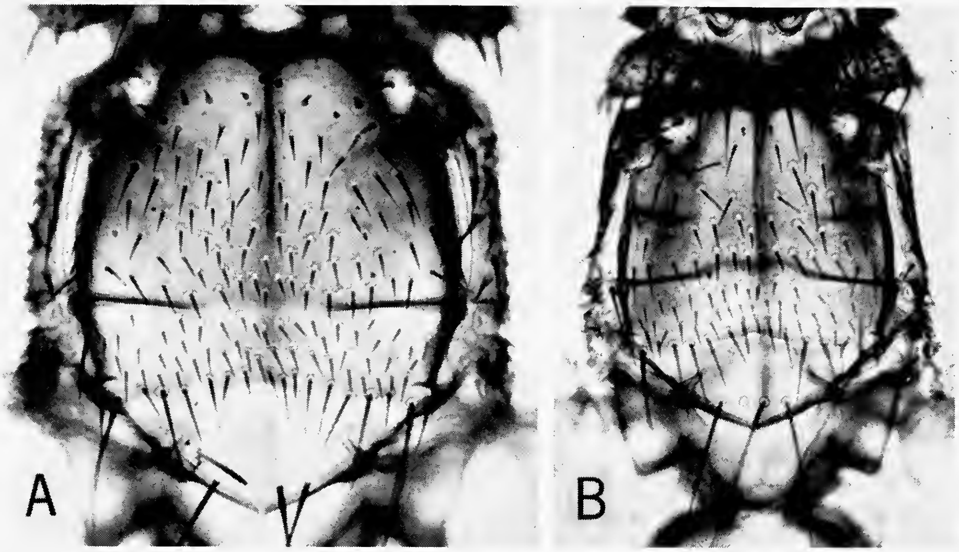

Fig. 131. Thorax, dorsal view. A, *Strebla christinae*, new species, male paratype. B, *S. machadoi*, new species, holotype.

March 1963, C. O. Handley, Jr. and F. M. Greenwell. 1 male paratype, same data, but 27 February 1963. Holotype and allotype in the collection of Chicago Natural History Museum. Paratypes in the collections of Chicago Natural History Museum; the United States National Museum; and the Environmental Health Branch, U. S. Army, at Corozal (Canal Zone).

This species is named for Christina Johnson Fowler in grateful appreciation of her invaluable assistance in producing this volume.

Strebla machadoi Wenzel, new species. Figures 124D, 131B.

S. machadoi n. sp. is easily separated from all other species in that it is the only one with detached frontoclypeal plates that has non-faceted eyes. The subacuminate anterior margin of the frontoclypeus is also distinctive.

DESCRIPTION (*Female*): *Head.*—Detached frontoclypeal plates small, about as wide as long. Anterior plate of laterovertices with six setae; postocular sclerite distinct. Dorsal sclerite of postgenae posteriorly with five or six short bristles, a long, conspicuous one on postero-median angle and lateral to this a seta of intermediate length; lateral margin emarginate for reception of ctenidium. Postvertex and occiput as illustrated (fig. 124D), but with the inner three or four setae on each side more distinct spinelets than shown. Ventral ante-ctenidial area wider than long (21:17). Eyes consisting of a single elongate hyaline lens. *Thorax.*—Prescutum with a pigmented second or anterior transverse suture; prescutum sparsely setose, a bare area along median line on anterior division, except for two long setae and a short seta on each side of line; epaulets consisting of five to six stout setae; arc of longer setae distinct; two transverse rows of setae laterally between transverse and anterior suture; antescutellar bristles very long at sides, becoming gradually and distinctly longer medially, the median bristles distinctly longer than the discal scutal setae arranged in two or three irregular transverse rows.

Fig. 132. Thorax, dorsal view, *Strebla vespertilionis* (Fabricius), from *Desmodus rotundus murinus* (no. 5236), Red Tank (Canal Zone).

Wings.—All veins except sixth longitudinal setose to base. Apex of costa without a macroseta. *Legs.*—Pro- and mesotibiae without distinctive characters. Metatibiae with two conspicuous macrosetae near apex, preceded by a double row of eight to ten setae that are shorter than the macrosetae but at least twice as long as the other tibial setae. First segment of hind tarsus with two rows of heavy and an inner row of weaker but still prominent plantar setae, four across apical margin; segments 3 and 4 with distinct plantar bristles, but none as heavy or as long as those of first segment, those of the fourth segment relatively weak.

Abdomen.—Anterior face of tergum I+II with four short setae; inner dorsal margin with two fine setae. *Female:* Tergum VII with a pair of macrosetae and posterior to them a pair of more closely placed, shorter setae that are less than one-half as long as macrosetae. Supra-anal plate with four long apical setae and a pair of short setae on each side near base. Seventh sternites with eight setae, two of these macrosetae. Ventral arc produced anteriorly as a broad, short, rounded microsetose lobe about twice as wide as long, with two long and two short setae on posterior edge. *Male:* Unknown.

Measurements:	BL	TL	WL	WW
Female	2.39	0.77	1.65	0.85

TYPE MATERIAL: Holotype female from *Micronycteris minuta* (host Machado-Allison no. 495), La Guanote, Caripe (Monagas), VENEZUELA, J. Ojasti. In the collection of the Faculdad de Ciencias, Universidad Central de Venezuela, Caracas. A paratype, sex undetermined (abdomen missing), same data as the holotype, in the collection of Chicago Natural History Museum.

REMARKS: This species is named for Dr. Carlos Machado-Allison, of the Departamento de Parasitología y Microbiología, Faculdad de Ciencias, Universidad Central de Venezuela, in recognition of his valuable contributions to the study of ectoparasites.

Strebla vespertilionis (Fabricius). Figures 123B, 125B, 132.

Hippobosca vespertilionis Fabricius, 1805, Syst. Antliat., p. 339.6—"America meridionalis vespertilione" (Type: See discussion below.)

Strebla vespertilionis Wiedemann, 1824, Analect. Ent., p. 19, fig. 7; 1830, Aussereurop. Zweifl. Ins., **2**: 612, pl. xb, fig. 13a, b. Macquart, 1835, Hist. Nat. Ins. Dipt., **2**: 637, pl. 24, fig. 16. Walker, 1849, List. Dipt. Spec. Brit. Mus., **4**: 1146 (cit., part.). Osten-Sacken, 1878, Cat. N. Am. Dipt., Smiths. Misc. Coll., no. 270, p. 214 (cit., part.)

Strebla wiedemannii (new name for *vespertilionis* Fabricius [not Nitsch, 1803], in error), Kolenati, 1856, Parasiten d. Chiropt., p. 46. Speiser, 1900, Arch. Naturg., **66A**, Bd. I, pp. 32, 43 (status); 1907, Ent. News, **18**: 103. Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, **5**: 31 (cit. only, not fig.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654 (cit.).

Euctenodes mirabilis (not Waterhouse, 1879), Kessel, 1924, Parasitology, **16**: 411 (part., from *Desmodus* sp.), figs. 2, 3; 1925, Jour. N. Y. Ent. Soc., **33**: 30 (part., from *Desmodus* sp.), pl. 3, fig. 21, pl. 4, figs. 22, 23. Stiles and Nolan, 1938, Bull. Nat. Inst. Hlth., Wash., no. 155, pp. 654, 732 (part., from *Desmodus* sp.). Jobling, 1949, Parasitology, **39**: 318–19, 328 (part., from *Desmodus rotundus*), (? figs. 3 D, E.). Hoffmann, 1953, Mem. Congr. Cient. Mex., **7**: 188 (? part., from *Desmodus r. murinus*). Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., no. 122, p. 269.

Kolenati (1856) erroneously regarded *Strebla vespertilionis* as a homonym, changed the name to *Strebla wiedemannii*, and noted:

> "Das Original exemplar sich in konigl. Museum zu Kopenhagen."

In 1863 (p. 18), however, Kolenati stated:

> "Das Original exemplar aus der zu Kopenhagen existierenden alten Toüder Liênd-Schestedt'schen Sammlung, welches Wiedemann zur Beschreibung und Abbildung überlassen wurde, ist entweder bei die Zeichung verloren gegangen, *oder nicht mehr zurückgegeben worden, weil an dem Platze dieses Originalstückes, welcher vorhalten blieb als die Sammlung vor 30 Jahren umgestellt wurde, kein nadelstich ist* [italics ours]. Diese Mitthieilung machte mir Prof. Steenstrup, am 10 Nov. 1857."

Dr. Sven G. Larson (pers. comm.) of the Copenhagen Museum recently confirmed the absence of the type of *vespertilionis* and added:

> "If there is a possibility that Wiedemann, for some reason or another, did not return the animals to the owners (Sehested & Tønder Lund), the type may possibly be in Vienna, where most of Wiedemann's animals are found, as far as I know."

We then asked Prof. Dr. Max Beier of the Vienna Museum to see if there were specimens in Wiedemann's material that could possibly be Fabricius' type. To our surprise, Dr. Beier answered:

"... übersende ich Ihnen mit gleicher Post unser einziger Exemplar von *Strebla vespertilionis* F. Dieses Stück stammt zweifellos aus der Sammlung Wiedemann, da es die grüne Etikett am Klebeblättchen trägt. ... Wahrscheinlich handelt es sich also um die verschollene Type von Fabricius."

The specimen is of a species that parasitizes *Desmodus rotundus.* It carries four labels: one reading "Strebla vespertilionis, Pernambuco, Bgt.;" a second, reading "Schiner 1869;" a third "vespertilionis det. Speiser" (!); and the fourth, reading "Strebla vespertilionis F." The specimen is glued to a celluloid card, which bears a green, quadrangular marker at the base. The "Bgt." on the first label is puzzling. It is possible that it is an abbreviation of Bigot. The word "Strebla" is hand-printed and resembles the sample of Bigot's hand-printing given by Horn and Kahle (Ent. Beihefte, 2, pl. 11, fig. 1). The specimen seems to have come to the Vienna Museum through the Schiner collection in 1869. This, too, is puzzling, since, according to Horn and Kahle (ibidem, 4, p. 302), the Wiedemann Diptera went to Vienna *via* W. von Winthem, and the same authorities (p. 305) state that the von Winthem Diptera went to that museum in 1852. We are not convinced that this specimen is the type of *vespertilionis,* but in view of Dr. Beier's experience, we accept it as an authentic Wiedemann specimen. If it is not the type, however, it is quite possible that it is the specimen upon which Wiedemann based his 1830 description and illustration (see p. 591). It is certainly congeneric with the specimen figured, and it matches in the setation of the hind tibiae, taking into account the poor quality of the figure. Since we cannot demonstrate that this specimen is Fabricius' type, we designate it as a neotype, so as to fix the identity of the type-species of the type-genus of the family.

As pointed out by Speiser, *Strebla wiedemannii* Kolenati, 1863, is not the same as *wiedemannii* Kolenati, 1856 (& 1857). Speiser considered it to be identical with *Trichobius parasiticus* and *T. dugesii* Townsend. Actually, it probably was a mixture of species and the specimen illustrated (Kolenati, 1863, pl. 16, fig. 36) may be an undescribed species of *Trichobius* that occurs in the West Indies, Mexico, and Guatemala.

Strebla vespertilionis of von Röder (1896, p. 26) from *Vampyrops lineatus* was probably a species of *Paratrichobius. Strebla avium* Macquart (1854, p. 308) could have been a hippoboscid. We have not seen the original description. To our knowledge, no one has re-examined the type. It was supposed to be in Macquart's collection at Marseilles. We do not know if it exists or not.

Dr. T. C. Maa has examined the type of *Strebla mexicana* Rondani (1878, p. 168). According to him (pers. comm.), it is heavily coated with dirt, but on the basis of a superficial examination, he believes it to be "a *Euctenodes*" [= *Strebla*]. Only a few species of *Strebla* are known to us from Mexico. They include *S. vespertilionis, carolliae* n. sp., *diphyllae* n.sp. and *hertigi* n. sp. We hope that in the future there will be an opportunity to clean and make a slide preparation of the type of *mexicana* so as to establish its identity. It is in the museum at the University of Florence (Italy).

S. vespertilionis is similar to *machadoi* n. sp. and *christinae* n. sp. in possessing two rows of six or seven conspicuously longer setae each, on the upper edge of the metatibiae (fig. 125B). It differs conspicuously from both in mesonotal chaetotaxy (fig. 132) and from *machadoi* in having multi-faceted eyes rather than a single hyaline lens, and from *christinae* in having a second or anterior pigmented transverse suture, as well as the other characters given in the key. Actually, *vespertilionis* appears to be more closely related to *diphyllae*, but this species has only a single dorsal row of longer metatibial setae and it has distinctly curved gonapophyses. The only other species known to us that have nearly straight gonapophyses are *S. hertigi* n. sp., *consocius* n. sp., and *diaemi* n. sp. In the two last-named species, the ventral macroseta is inserted distal to middle on the gonapophysis, while in *hertigi* and *vespertilionis*, it is inserted basally. *S. hertigi*, however, belongs to the group of species with entire frontoclypeus; its eyes consist of a row of four facets; and its gonapophyses, apically, are upwardly sinuate rather than downwardly curved.

DESCRIPTION: *Head.*—Frontoclypeus with apical detached plates that are distinctly longer than broad. Anterior plate of laterovertices with eight setae; postocular sclerite distinct. Dorsal sclerite of postgenae not emarginate laterally; posterior portion with 11–13 short setae and near posterior margin, two long setae. Postvertex and occiput as figured (fig. 132B), but with most of the long occipital setae and spinelets of postvertex more slender than shown. Eyes multi-faceted. Ventral ante-ctenidial area distinctly wider than long (30:22).

Thorax (fig. 132).—Prescutum with a pigmented second or anterior transverse suture; epaulets consisting of five or six spinelets; arc of longer setae distinct; discal setae not reaching epaulets; three irregular transverse rows of setae between transverse mesonotal suture and anterior suture. Antescutellar setae much longer than other scutal setae, those near sides longer than those at middle. *Wings.*—All veins except sixth setose to base. Seta at apex of costa not a macroseta. R_s nearly twice as long (22.5:13) as distance from fork to crossvein *r-m*. *Legs.*—Protibiae dorsally with three heavy setae along inner edge, near apex, preceded by four slender, shorter setae; outer edge with one or two strong setae near apex. Mesotibiae apically with about five strong dorsal setae on outer edge; inner edge with two strong setae preceded by a row of weaker ones. Metatibiae (fig. 125B) with about 14 conspicuous setae in a double row, the apical two nearly twice as long as the others. Ventral surface of hind tarsus with a median, longitudinal row of five very heavy plantar bristles and lateral to these, basally, a row of five very short plantars along inner edge; plantar bristles of succeeding segments minute.

Abdomen.—Inner dorsal margins of lateral lobes of tergum I+II with three to four setae. *Female:* Tergum VII with variable chaetotaxy, usually with three pairs of setae, an anterior pair of macrosetae and posterior to these two pairs of shorter strong setae. Supra-anal plate with four apical macrosetae and on each side near base a pair of setae that are about one-third as long. Seventh sternites with about 17 setae, seven or eight of them very long, about five much longer than the others. Ventral arc with both anterior and posterior margins slightly indented, not produced; with four setae, two longer, two minute. *Male:* Hypopygium as in *S. diphyllae* n.sp. Gonapophyses gradually tapered, with both dorsal and ventral margins curved to the knobbed apices; sides, especially on apical third, with numerous microsetae; ventral macroseta inserted at about basal third, extending about three-fourths the distance to apex; accessory seta minute.

Measurements:	BL	TL	WL	WW
Male	2.97–3.03	0.93–1.00	1.70–1.91	0.82–0.89
Female	2.94–3.41	1.00–1.04	2.03–2.17	0.89–0.96

PANAMANIAN MATERIAL EXAMINED: 50 lots, 288 specimens, from more than 92 bats. From *Desmodus r. murinus:* 1, Paraíso (Canal Zone), 17 November 1960; 9, Red Tank (Canal Zone), 27 January 1960; 45 (7 bats), Almirante (Bocas del Toro), 23 to 31 January 1960; 1, Changuinola (Bocas del Toro), 27 February 1960; 72 (40 bats), Casa Tilley near Cerro Punta (Chiriquí), 23 January and 6 February 1960; 1, same locality, 11 March 1962; 5, Chilibrillo Caves (Panamá), 2 May 1957 [USNM]; 2, same locality, L. H. Dunn no. 878 [MCZ]; 4, San Pedro Cave, Taboga Island (Panamá), L. H. Dunn [MCZ]; 12, near La Chorrera (Panamá), 18 April 1959, H. Trapido; 112 (10 lots, 12 bats), Guánico (Los Santos), 26 January to 25

Fig. 133. Thorax, dorsal view, *Strebla diphyllae*, new species, male paratype, same data as holotype.

February 1962; 22 (3 bats), Río Tuira (Darién), 24 to 27 February 1958, P. Galindo [GML]; 3, Río Mono Camp (Darién), 24 July 1963, W. Lowe [GML]. From *Artibeus jamaicensis:* 3 (9 bats), Almirante (Bocas del Toro), 26 and 28 January 1960. From *Vampyrodes major:* 2, Almirante (Bocas del Toro), 22 January 1960. From *Lasiurus egregius:* 1, Armila (San Blas), 23 February 1963.

OTHER MATERIAL EXAMINED: 1162 flies in 113 lots, from more than 150 bats, mostly from *Desmodus rotundus,* from 69 localities in MEXICO, GUATEMALA, HONDURAS, EL SALVADOR, COLOMBIA, ECUADOR, PERU, VENEZUELA, TRINIDAD, and SURINAM.

REMARKS: 96% of all the lots and 97% of all the specimens of *S. vespertilionis* examined were from *Desmodus rotundus.* Excluding one collection from mixed hosts that included *Desmodus,* only 7 lots (including those from Panama) are from bats other than *Desmodus.* These bats include *Lasiurus egregius* (a genus not known to harbor Streblidae), *Artibeus jamaicensis, Vampyrodes major, Saccopteryx bilineata, Centurio senex, Carollia perspicillata* and *Phyllostomus discolor.* From the history and nature of the collections, we are convinced that some of these represent contaminations or errors of association. However, several obviously represent temporary or transitory associations.

Kessel (1924, p. 411) stated that her redescription of *E. "mirabilis"* was based on a specimen from *Hemiderma* [= *Carollia*] *perspicillatum,* but her figures are obviously of *Strebla vespertilionis,* which occurs on *Desmodus rotundus.* Jobling has informed us (pers. comm.) that his figures (1949, figs. 3D, E) of *"mirabilis"* were based on a specimen from *Desmodus r. rotundus* from Diego Martin Cave, Trinidad. One would assume, then, that this specimen was *vespertilionis.* However, the short, detached frontoclypeal plates are much more like those of *mirabilis* than those of *vespertilionis,* and it will be necessary to examine his slide to determine the identity of his specimen.

Strebla diphyllae Wenzel, new species. Figures 124C, 133.

Euctenodes mirabilis (not Waterhouse, 1879), Bequaert, 1933, Publ. Carnegie Inst. Wash., no. 431, p. 571. ?Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 184, 188 (part., from *Diphylla*).

Very closely related to *S. vespertilionis* (Fab.), but differing from it in having shorter frontoclypeal plates; more densely setose prescutum; tergum VII of female with four rather than six setae; and male gonapophyses distinctly bent rather than nearly straight.

DESCRIPTION: *Head.*—Short. Frontoclypeus with apical detached plates, these slightly wider than long. Anterior plate of laterovertices with eight setae; postocular sclerite distinct. Postgenae with lateral margins not marginate, posteriorly with eight or nine short bristles and near margin two long conspicuous bristles, the inner one nearly as long as the setae of postvertex, the outer one a little shorter; lateral to them a shorter bristle. Postvertex and occiput as illustrated (fig. 124C). Eyes multi-faceted with seven or eight facets visible from above. Ventral ante-ctenidial area wider than long (32.5:21).

Thorax.—Prescutum with anterior transverse suture; epaulets consisting of five to six stout spinelets; setose area of disk extending anteriorly along mid-line to the double pair of short setae behind the anterior margin, and along sides nearly to epaulets; arc of seven longer setae distinct; three rows of setae laterally between transverse and anterior sutures. Scutum with about three transverse irregular rows of setae; antescutellar setae long. *Wings.*—All veins except sixth with setae to base; costa without an apical macroseta. R_s about half again as long (30:21) as distance from fork to *r-m*. *Legs.*—Protibiae with about three heavy conspicuous setae, preceded by several long fine setae on inner margin; outer margin with two or three heavier setae. Mesotibiae with eight or nine conspicuously coarser setae. Metatibiae with a dorsal row of nine or ten long setae, the apical one about as long as first segment of hind tarsus, the others progressively shorter anteriorly, the basal ones about twice as long as short setae on lateral face. Ventral surface of first segment of hind tarsus with three longitudinal rows of heavily pigmented conspicuous plantar bristles, those along inner edge smaller; plantar bristles of following segments very small but stout.

Abdomen.—Inner dorsal margins of tergum I+II with about four setae. *Female:* Tergum VII with two long macrosetae and a pair of shorter setae, posterior and medial to them, only a little more than half as long. Supra-anal plate with a median pair of strong setae along basal margin in addition to the four apical macrosetae. Seventh sternites with 20–21 setae. Ventral arc slightly thickened at middle, with two longer and two minute setae. *Male:* Hypopygium dorsally with a lateral macroseta and medial to it a very short seta on sternum VII+VIII, and on tergum IX a transverse row of six macrosetae, the medial pair longest. Gonapophyses strongly bent a little beyond

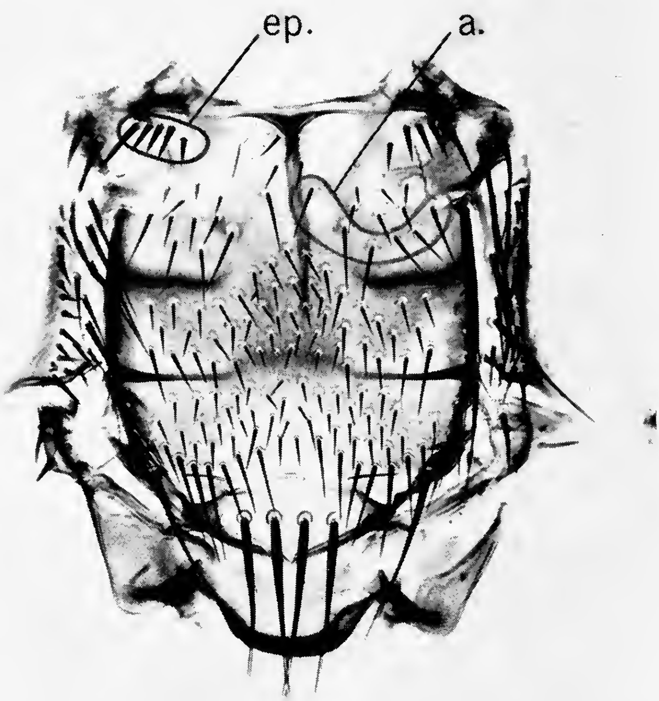

Fig. 134. Thorax, dorsal view, *Strebla mirabilis* (Waterhouse), male from *Phyllostomus h. panamensis* (no. 4138), Natural Bridge, Madden Dam (Canal Zone). *ep* = epaulet; *a* = prescutal arc of setae.

middle; macrosetae inserted near middle, not reaching knobbed apices; sides with scattered microsetae on a little more than apical third.

Measurements:	BL	TL	WL	WW
Male	2.11–3.20	1.02–1.04	1.81–1.92	0.91–0.93
Female	3.20–3.53	1.00–1.07	1.84–2.47	1.10–1.21

TYPE MATERIAL: GUATEMALA (CNHM Guatemala Zoological Expeditions, 1936, 1948, 1951–52).—Holotype male and allotype female (slides) from *Diphylla ecaudata centralis* (CNHM cat. nos. 73191–94, 73345–46), San Lorenzo, 4 miles northeast of Volcan de Jumay (Jalapa), 5700–5750 feet elevation, 15 February 1952, R. D. Mitchell and Luis de la Torre. In the collection of Chicago Natural History Museum.

Paratypes.—From *Diphylla e. centralis:* 13 (7 bats), same data as the holotype; 3 (5 bats), Finca El Progresso (Santa Rosa), 4500 feet elevation, 3 August 1951, Luis de la Torre; 4, Finca Recreo, Municipio Yepocapa (Chimaltenango), elevation 4400 feet, 11 May 1948, R. L. Wenzel, L. de la Torre, and R. D. Mitchell; 15 (5 bats), same locality, 25 October 1948, R. D. Mitchell and L. de la Torre. From *Trachops cirrhosus coffini:* 1, Finca Recreo (Chimaltenango), 2 May 1948, Wenzel, Mitchell and de la Torre. From *Desmodus rotundus murinus:* 5 (5 bats), Finca El Progreso (Santa Rosa), 3 August 1951, L. de la Torre; 2, Finca Olas de Moca (Sololá), 2700 feet elevation, 3 March 1934, F. J. W. Schmidt.

Non-Guatemalan Paratypes. MEXICO.—From *Diphylla e. centralis:* 2, Yocat (Yucatan), R. T. Hatt [MCZ, det. Bequaert, 1933, as *E. mirabilis*]; 18, Xilitla (San Luis Potosi), C. R. Shaw [MCZ]; 4, 2 km. north of Felipe Carillo Puerto (Quintana Roo), 16 August 1962, J. Knox Jones [KU]. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; Snow Entomological Museum, the University of Kansas; the Museum of Comparative Zoology at Harvard University; and the Environmental Health Branch, USAFSC at Corozal (Canal Zone).

REMARKS: The Guatemalan records from *Trachops* (Finca Recreo) and *Desmodus* (Finca El Progresso) almost certainly represent strays from other bats collected at the same time and placed in the same bags as specimens of *Diphylla e. centralis.* This does not seem to be true for the specimens from *Desmodus* collected at Finca Olas de Moca. Six specimens of *S. vespertilionis* n. sp. were collected together with three *S. diphyllae,* from the same host specimen. As nearly as can be determined from the field records, no specimens of *Diphylla ecaudata* were collected at that locality.

Although *Diphylla ecaudata* was collected in Panama, no specimens of *Strebla diphyllae* were obtained. In Venezuela, a new species (not described here) related to *mirabilis,* was collected from this host by C. O. Handley, Jr. In view of the fact that monotypic New World hosts do not, in any instance known to us, have different streblids in different parts of their range, the suggestion of Burt and Stirton (1961, p. 37) that *Diphylla ecaudata* is monotypic should be questioned.

Strebla mirabilis (Waterhouse), *new combination.* Figures 123A, 125E, 134, 135A.

Euctenodes mirabilis Waterhouse, 1879, Trans. Roy. Ent. Soc. Lond., 1879: 310, pl. 10, figs. 1, 2. Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Veter., Nictheroy, 5: 32 (cit.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Ex., Fis. y Nat., 3: 418 (part., from *Phyllostomus h. panamensis*). Cooper, 1941 (part.), Yearb. Amer. Phil. Soc., 1941: 126 (chromosome no.).

Closely related to *S. kohlsi* but distinct in having a shorter head and shorter frontoclypeal plates (see key). It is primarily a parasite of *Phyllostomus hastatus,* though it may also occur on *Trachops* (see below). *S. kohlsi* is known to us from *Tonatia silvicola. Phyllostomus, Trachops,* and *Tonatia* are related genera of the subfamily Phyllostominae.

DESCRIPTION: *Head.*—Frontoclypeus with apical detached plates, these approximately as long as wide, though inner margin is appreciably longer than apical. Anterior division of laterovertices with eight setae; postocular sclerite distinct. Dorsal sclerite of postgenae not emarginate laterally, its posterior portion with ten fine and mostly very short setae and, along posterior margin, two conspicuous long setae. Postvertex and occiput as illustrated (fig. 123A). Eyes convex, multi-faceted, about eight facets visible from above. Ventral ante-ctenidial area wider than long (59:41).

Thorax (fig. 134).—Prescutum with second anterior pigmented suture; epaulets with four to five setae; discal setose area not extending to epaulets; arc of long setae very distinct. Scutal setae of antescutellar row longer toward sides; three transverse rows of setae present between them and the transverse mesonotal suture. *Wings.*—R_s less than twice as long (22:13) as distance from fork to crossvein *r-m*. Seta at apex of costa longer than others preceding it but not a conspicuous macroseta. Fifth longitudinal vein bare for a short distance before base. *Legs.*—Protibiae with a double row of longer setae along dorsal edge, the basal ones small, the apical three on inner edge and two on outer edge very stout; apices with two strong curved ventral setae. Setae of mesotibiae very similar to those of protibiae. Metatibiae with two conspicuous macrosetae on apical third, these preceded by a distinctly shorter and finer seta and then a row of five or six shorter setae, all of them longer than the other tibial setae. Ventral surface of first segment of hind tarsi with two rows of heavy, short plantar bristles along outer half and an irregular row or two of shorter bristles along inner edge; following segments with minute, very fine plantar bristles that can hardly be detected except in slide preparations.

Abdomen.—Inner dorsal margins of lateral lobes of tergum I+II with four to six setae on each side. Sternum II with setose median triangular area, the apical marginal setae conspicuously longer than the discals, a conspicuously long macroseta on each side of middle, separated by about four shorter setae. Dorsal connexival setae along sides longer than ventral setae, those along lateral margins shortest. *Female:* Tergum VII roughly tear-drop shaped; distally with a pair of very long macrosetae and medial and posterior to these, a pair of setae that are only half as long. Supra-anal plate with four apical macrosetae and a pair of shorter discal setae. Seventh sternites with 11–12 setae, two to four of them very long macrosetae. Ventral arc with two long and two minute setae; produced anteriorly as a small poorly sclerotized lobe. *Male:* Sternum V well developed; apical margin with about eight conspicuous macrosetae alternating with shorter setae, all longer than discals, of which there are two transverse rows at middle and three toward sides. Hypopygium with a very long macrosetae on each side and medial to this a short bristle on sternum VII+VIII; dorsum of tergum IX with three pairs of macrosetae. Gonapophyses bent apically, with scattered microsetae along middle on apical half; apices knobbed; ventral macroseta not reaching apex.

Measurements:	BL	TL	WL	WW
Male	2.32–2.72	0.86–0.93	1.54–1.65	0.81–0.84
Female	2.58–3.08	0.92–0.97	1.73–1.94	0.91–0.95

PANAMANIAN MATERIAL EXAMINED.—From *Phyllostomus hastatus panamensis:* 140 (17 bats), hollow tree, Chepo Road (Panamá), 8 October 1959; 112 (20 bats), Chilibrillo Caves, 17 July 1959; 4 (2 bats), same locality, 18 August 1959; 322 (13 bats), 28 October 1959; 3, same locality, 2 May 1957 [USNM]; 11, same locality, K. W. Cooper [MCZ]; 2, same locality from preserved museum specimens collected 4 September 1934 by L. D. Lamm; 147, same locality, L. H. Dunn, no. 436 [MCZ]; 1, Tapia (Panamá), 25 July 1923, J. P. Chapin [MCZ]; 1, "Panama" [MCZ]; 12, Farfan (Canal Zone), 19 December, T. Hallinan [AMNH]; 168 (20 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August, 28 September 1959; 77 (5 bats), hollow *Ficus* tree, Fort Kobbe (Canal Zone), 9 October 1959; 4 (3 bats), Fort Sherman (Canal Zone), 30 July 1959; 149 (19 bats), 4 and 6 April 1960; 14, France

Air Force Base (Canal Zone), 8 October 1959; 7, hollow tree, 1 mile from Gatuncillo (Canal Zone), 28 July 1960; 3, Almirante (Bocas del Toro), 29 January 1960. From *Phyllostomus* sp.: 11, Camp Piña (Canal Zone), 26 October 1960. From *Carollia p. azteca:* 25 (3 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August 1959. *Without host:* 1, Chilibrillo Caves (Panamá), 27 August 1959; 30, same locality [MCZ]; 2, same locality, 1 January 1916, T. Hallinan [AMNH]; 31, Barro Colorado Island (Canal Zone), 2 December 1956, K-18 [USNM].

OTHER MATERIAL EXAMINED: MEXICO.—*Without host:* 1, "either from Campeche, Mexico or Yucatan. Original vial had label no. 15 plus included." COLOMBIA.—From *Phyllostomus hastatus:* 6 (3 bats), "Las Campañas," Coloso (Bolivar), 23 May 1949, P. Hershkovitz, CNHM Colombian Zoological Expedition (1949–51); 1, Pitalito (Huila), 1350 meters elevation, 29 November 1951. From *Tonatia* sp.: 1, Río Guayapa, La Macarena (Meta), 10 April 1957, Kjell von Sneidern, CNHM Colombian Zoological Expedition, 1957. PERU.—From *Phyllostomus hastatus:* 2, Vitoc Valley, Province Parma (Junín), 18 September 1940, F. Woytkowski. From *Phyllostomus* sp.: 1, Santa Rita, Iquitos (Loreto), 4 September 1956, C. Kalinowski, CNHM Peru Zoological Expedition, 1956. BOLIVIA.—From "Fledermaus," 2, Mina Cristalmaya (Cochabamba), October 1949, Luis Peña.

REMARKS: Both Mr. B. Jobling and Prof. Oskar Theodor have kindly examined the type of *mirabilis* and compared it with specimens of several related species which we sent them. In addition, Prof. Theodor referred to our manuscript keys and figures. He supplied us with notes and sketches which leave no doubt as to the identity of *mirabilis.* Probably most records that have been published for *mirabilis* from *Phyllostomus hastatus* are of this species. However, one cannot be certain without examining the specimens, since at least two other species also occur on this host. In addition to the verified records given above, *mirabilis* has been reported from *P. hastatus* by Kessel (1924, 1925), Stiles and Nolan (1931), Pessôa and Guimarães (1940), Schuurmans-Stekhoven Jr. (1941), Jobling (1949b), and Goodwin and Greenhall (1961).

We have additional specimens from hosts such as *Tonatia bidens* in Brazil (Urucum de Curumba) and *Vampyrops vittatus* (same locality and expedition), but we are not certain of their identity. We have recently segregated specimens of a very closely related species, taken from *Diphylla ecaudata* in Venezuela, which we were unable to describe and illustrate in time to include in this paper.

Strebla (?) mirabilis from *Trachops cirrhosus.* Figure 135B.

We have specimens that appear to be *mirabilis,* taken from *Trachops c. cirrhosus* in Panama and from *T. c. coffini* in Guatemala. The gonapophyses of these appear to be slightly more angulately bent (fig. 135B) than in *mirabilis* (fig. 135A) from *Phyllostomus.* The number of setae on the seventh sternites (each) ranged from 13–16 in specimens from *P. h. panamensis* and 11–13 in specimens from *T. c. coffini.*

It should be noted that to the north in Costa Rica and Nicaragua, *Phyllostomus h. panamensis* does not appear to carry *Strebla mirabilis,* but only *S. hertigi* (see "Host-parasite Relationships"). One explanation for the absence of *mirabilis* there, is that its range, like that of many ectoparasites, may not be as great as that of the host. However, it does appear to occur on *Trachops* much farther north, in Guatemala. Further, all of the Panamanian specimens of *mirabilis* from *Phyllostomus* were taken below ±500 feet elevation, though *P. h. panamensis* was taken at elevations of up to 2000 feet. The specimens from *Trachops c. cirrhosus* in Panama were taken from between sea level and 1700–3200 feet, while those from *T. c. coffini* in Guatemala were taken at 4400 feet. Its altitudinal distribution plus the fact that *mirabilis* is absent from the usual host in Costa Rica and Nicaragua, and yet is present on *Trachops* to the north in Guatemala suggest that the population on *Trachops* is a separate, cryptic species.

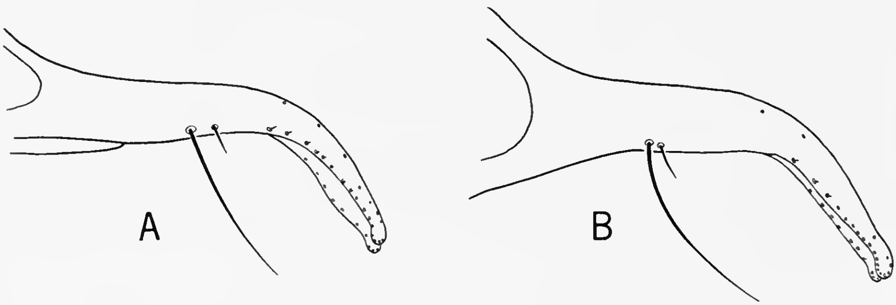

Fig. 135. *Strebla mirabilis* (Waterhouse), left male gonapophysis. A, of specimen from *Phyllostomus h. panamensis* (no. 4138), Natural Bridge, Madden Dam (Canal Zone). B, of specimen from *Trachops cirrhosus coffini* (CNHM nos. 65181–90), Finca Recreo, Municipio Yepocapa (Chimaltenango), GUATEMALA.

MATERIAL EXAMINED: PANAMA.—From *Trachops c. cirrhosus:* 2 (2 bats), Fort Sherman, 22 October and 23 November 1959; 9 (5 bats), culvert, Chepo Road (Panamá), 12 October 1959 and 24 May 1960; 29 (24 bats), Cerro Hoya (Los Santos), 1700–3200 feet elevation, 10 to 25 February 1962; 1, Armila (San Blas), 16 March 1963, C. O. Handley, Jr. and F. M. Greenwell. GUATEMALA.—From *Trachops cirrhosus coffini:* 30 (5 bats), Finca Recreo, Municipio Yepocapa (Chimaltenango), 4400 feet elevation, 11 May 1948, R. L. Wenzel, R. D. Mitchell, and L. de la Torre, CNHM Zoological Expedition (1948).

Strebla kohlsi Wenzel, new species. Figure 123C.

Related to *mirabilis* (Waterhouse) and distinguished from it by the elongated head, with ventral ante-ctenidial area hardly wider than long (24:22 as opposed to 59:41 in *mirabilis*), its slightly smaller size, and more elongated frontoclypeal plates.

DESCRIPTION: *Head.*—Elongated. Detached frontoclypeal plates present, their inner edge longer than apical margin, though basal margin is almost as wide as inner edge is long. Anterior plate of laterovertices with six setae; postocular sclerite distinct. Dorsal surface of postgenae not emarginate laterally; posteriorly with about six short setae and a long conspicuous seta and a shorter one near posterior margin. Postvertex and occiput as illustrated, but outer two setae somewhat finer than shown. Eyes multifaceted and projecting, about seven or eight facets visible from above. Ante-ctenidial area of underside only slightly wider than long (24:22).

Thorax.—Second pigmented suture of prescutum present but not very distinct; epaulets consisting of four setae; discal setose area not extending anteriorly beyond anterior end of longitudinal membranous fissures; arcuate row of long setae well defined; three transverse rows of setae laterally between sutures. Antescutellar setae more or less uniform in length. *Wings.*—Seta at apex of costa distinctly longer than those preceding it, but not a conspicuous macroseta. R_s half again as long (23:15) as distance between fork and crossvein *r-m*. Fifth longitudinal vein with a short, bare area at base, this less than half as long as bare area on sixth vein. *Legs.*—Protibiae dorsally with four heavy macrosetae on inner edge, and two or three on outer; mesotibiae with one or two on inner edge and four or five on outer, preceded by more slender long bristles. Metatibiae with two conspicuous macrosetae on apical third. Ventral surface of first segment of hind tarsi with two longitudinal rows of shorter plantar bristles near inner edge and outwardly at base a longer more conspicuous one, and across apex three additional coarser ones; succeeding segments with distinct plantar bristles but without very coarse longer ones.

Abdomen.—Anterior face of tergum I+II with two short setae; inner dorsal margin with about four fine setae on each side. *Female:* Tergum VII with a pair of macrosetae and posterior to these a pair of shorter ones that are less than half as long as anterior pair. Supra-anal plate with four apical macrosetae and, basally, a pair of shorter setae that are slightly shorter than the posterior pair on tergum VII. Seventh sternites each with about 14 setae, one a macroseta. Ventral arc slightly longer at middle, not produced as a lobe, with four setae. *Male:* Hypopygium with a dorso-lateral macroseta on each side; tergum IX with two pairs of macrosetae dorsally and another macroseta on each side.

Measurements:	BL	TL	WL	WW
Male	2.20–2.47	0.88–0.93	1.59–1.81	0.77–0.82
Female	2.28–2.58	0.80	1.59–1.76	0.74–0.77

TYPE MATERIAL: PANAMA.—Holotype male and allotype female (slides), from *Tonatia silvicola* (hosts no. 11352, 11547, resp.), Armila (San Blas), 1 and 12 March 1963, C. O. Handley, Jr. and F. M. Greenwell. In the collection of Chicago Natural History Museum.

Paratypes.—1, same data as holotype and 4, same data but 28 March 1963; 5, same host, Cerro Malí (Darién), 8 February 1964, C. O. Handley, Jr. COLOMBIA, from *Tonatia silvicola* (=*amblyotis*): 1, Puri, Cauca Valley above Caceres, 23 August 1952, P. Hershkovitz, CNHM Zoological Expedition.

REMARKS: This species is named in honor of Glen M. Kohls of the Rocky Mountain Laboratory in recognition of his outstanding contributions to our knowledge of ectoparasites, especially the systematics and biology of ticks.

Strebla carolliae Wenzel, new species. Figures 122A, 136.

Euctenodes mirabilis (not Waterhouse, 1879), Kessel, 1924, Parasitology, **16:** 409 (descr.), 411 (part., from *Hemiderma* [=*Carollia*] *perspicillatum;* 1925, Jour. N. Y. Ent. Soc., **33:** 30 (part., from *Hemiderma perspicillatum* and *Carollia p. azteca*). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, pp. 654, 738 (part.). Pessôa and Guimarães, 1940, Arq. Inst. Biol. São Paulo, **11:** 426 (part., gives records of Kessel, 1925). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Ex., Fis. y Nat., **3:** 418 (part., from *Carollia p. azteca*). Cooper, 1941 (part.), Yearb. Amer. Phil. Soc., **1941:** 126 (chromosome no.). Jobling, 1949, Parasitology, **39:** 318–19, 328 (part., from *Carollia perspicillata*). Goodwin and Greenhall, 1961, Bull. Amer. Mus. Nat. Hist., no. 122, p. 250.

S. carolliae may be separated from all other species of the genus by the broadly blunt anterior margin of the postvertex. It is most closely related to *alvarezi,* a smaller species with a more narrowly rounded projection of the postvertex.

DESCRIPTION: *Head.*—As illustrated (fig. 122A). Detached frontoclypeal plates wider than long. Postocular sclerite distinct. Anterior margin of postvertex very bluntly rounded. Lateral margins of postgena (above) not emarginate. Ante-ctenidial area of underside wider than long (25:17).

Thorax (fig. 136).—Second or anterior pigmented suture of prescutum present, not well defined; epaulets with five setae; lateral discal setae extending to epaulets; arc of longer setae very distinct; three rows of setae at sides, between sutures. Antescutellar scutal setae subequal, except for long, outer macroseta on each side. *Wings.*—Fifth longitudinal vein basally with conspicuous bare area near base, this less than half as long as that of sixth vein. Costa without apical macroseta. R_s nearly twice as long (19.5:10) as distance from fork to crossvein *r-m*. *Legs.*—Fore- and midlegs very similar to those of *altmani,* metatibiae with two macrosetae, one subapical, the other at about apical fourth, preceded by a row of five or six setae that are about half as long as the macrosetae and twice as long as the other tibial setae. Ventral surface of first segment of hind tarsus with long heavy plantar bristles along outer edge, and shorter weaker ones along inner edge, these of about the same size as those on following segments.

Abdomen.—Anterior face of tergum I+II with one short seta; inner dorsal margins of lateral lobes with four to five fine setae. Dorso-lateral setae of connexivum conspicuously larger than ventrals. *Female:* Tergum VII with a pair of macrosetae and posterior to them, two or three setae that are less than half as long. Supra-anal plate with four apical setae only. Seventh sternites with 12–15 setae each. Ventral arc produced anteriorly at middle as a narrowly triangular or spiniform process. *Male:* Sternum V with two transverse rows of discal setae at middle and three at sides in addition to apical marginal setae. Sternum VII+VIII (of hypopygium) on each side with a dorso-lateral macroseta and medial to it a short seta; tergum IX with a lateral macroseta on each side. Gonapophyses slender, angulately bent, apically knobbed, sides with scattered lateral microsetae apically; ventral macroseta inserted slightly posterior to basal third, extending almost to apex.

Measurements:	BL	TL	WL	WW
Male	1.99–2.31	0.74–0.81	1.42–1.46	0.71–0.75
Female	2.40–2.58	0.82–0.85	1.54–1.65	0.75–0.84

TYPE MATERIAL: Holotype male (host no. 4616) and allotype female (host no. 4618), on slides, from *Carollia perspicillata azteca,* air-raid shelter, Fort Davis (Canal Zone), 6 October 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum. Paratypes include only those specimens, listed below, that were collected from species of *Carollia* in Panama and in the countries to the north.

Paratypes. PANAMA.—From *Carollia p. azteca,* 296 flies, from more than 287 bats, as follows: 15 (12 bats), same data as the holotype and 6 (7 bats), same locality, 17 November 1960, and 18 and 19 November 1959; 2, Camp Piña (Canal Zone), 26 October 1960; 8 (4 bats), Coco Solo (Canal Zone), 13 January 1960; 1, Fort Clayton (Canal Zone), 9 January 1953, F. Blanton; 2, same locality, 8 December 1960; 5 (21 bats), Fort Gulick (Canal Zone), 15 September and 29 October 1959; 1, Old Battery, Fort Randolph (Canal Zone), 1 October 1959; 10 (32 bats), Fort Sherman (Canal Zone), 23 November and 4 December 1959; 3 (2 bats), same locality, 16 March and 18 October 1960; 32 (66 bats), France Air Force Base (Canal Zone), 8 October to 30 November 1959; 11 (1 bat), Juan Mina (Canal Zone), 28 July 1960; 16 (23 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September and 25 November 1959; 3 (3 bats), Brazoa Brook, Navy Tank Farm, 6 October 1959; 2 (2 bats), Rousseau Road, culvert, 13 October 1959; 18 (21 bats), railroad culvert, east of Summit Gold Club (Canal Zone), 26 October 1959; 9, "second culvert W. of bridge 5742 on the old RR" (Canal Zone), L. H. Dunn [MCZ]; 4, "RR tower culvert at tower 34–12, Summit" (Canal Zone), L. H. Dunn [MCZ]; 1, culvert, Gatun Tank Farm (Canal Zone), 19 November 1959; 9, Gatun Dam (Canal Zone), L. H. Dunn 185 [MCZ]; 3, Camp

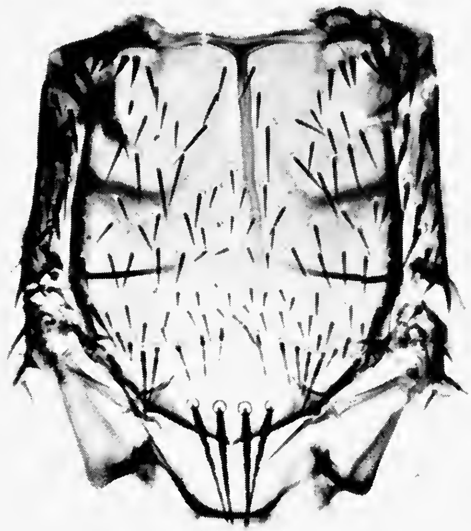

Fig. 136. Thorax, dorsal view, *Strebla carolliae*, new species, male paratype from *Carollia p. azteca* (no. 3984), Río Chilibrillo (Panamá).

Chágres, Madden Dam (Canal Zone), 21 and 25 June 1963, GML; 2, Summit (Canal Zone) [USNM]; 7, same locality [CU]; 2, same locality, K. W. Cooper [MCZ]; 8, RR culvert, same locality, L. H. Dunn [MCZ]; 5 (2 lots), same locality, 17 April 1957, C. B. Koford [USNM]; 3, Gamboa (Canal Zone), 1 May 1957; 11, hollow tree, one mile from Gatuncillo (Canal Zone), 28 July 1960; 1, Taboga Island (Panamá), L. H. Dunn 449-A [MCZ]; 13 (10 bats), La Chorrera (Panamá), 18 September 1959; 1, culvert, Chepo Road, 12 October 1959; 3, Chilibrillo Caves (Panamá), 28 October 1959; 7 (29 bats), 18 August 1959; 37 (32 bats), Buena Vista Cave (Colón), 3 and 15 September 1959, and 24 November 1959; 4, Porto Bello (Colón), 7 August 1923 [USNM det. as *E. mirabilis* by Kessel; see Kessel, 1924]; 4, Penonomé (Coclé), L. H. Dunn 704-A [MCZ]; 1, Tacarcuna (Darién), 2 September 1958, P. Galindo [GML]; 4 (2 bats), Río Tuira (Darién), 26 February and 5 March 1958, P. Galindo [GML]; 1, Río Chucanaque, 19 February 1958, P.

Galindo [GML]; 3 (3 bats), Punta Piña (Darién), 23 and 24 March 1960; 2 (2 bats), Guánico (Los Santos), 27 January 1962; 3 (3 bats), Cerro Hoya (Los Santos), 18, 23, and 25 February 1962; 13 (11 bats), Almirante (Bocas del Toro), 26 January to 4 February 1960. From *Carollia castanea:* 2 (2 bats), Sibube (Bocas del Toro), 19 and 23 January 1963, C. O. Handley, Jr.; 2 (2 bats), Armila (San Blas), 17 February and 17 March 1963, C. O. Handley, Jr. and F. M. Greenwell; 1, La Laguna (Darién), 2900 feet elevation, 9 June 1963, GML; 1, Tacarcuna (Darién), 2000 feet elevation, 19 July 1963, GML. From *Carollia subrufa:* 1 (2 bats), Isla Bastimentos (Bocas del Toro), 3 February 1963, C. O. Handley, Jr. and F. M. Greenwell. From *Carollia* sp.: 1, Cerro Tigre (Canal Zone), 15 January 1953. From *Glossophaga soricina leachii:* 1, Bella Vista, L. H. Dunn, 397-B [MCZ]. From *Desmodus r. murinus:* 1, Chilibrillo Caves (Panamá), L. H. Dunn [MCZ]; 2, Almirante (Bocas del Toro), 29 January 1960; 1, Fort Clayton, 13 October 1959. From *Lonchorhina aurita:* 1, two miles north of Summit, 17 April 1957 [USNM]; 1, culvert E of Summit Golf Club (Canal Zone), 26 October 1959; 1, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November 1959. From *Trachops cirrhosus:* 1, Río Mandinga (San Blas), 30 May 1957. From *Macrophyllum macrophyllum:* 4 (3 bats), Fort Gulick (Canal Zone), 15 September 1959. From *Phyllostomus h. panamensis:* 1, Guánico (Los Santos), 26 January 1962; 1, hollow tree, Chepo Road (Panamá), 8 October 1959. From *Pteronotus parnellii fuscus:* 3 (3 bats), culvert east of Summit Golf Club (Canal Zone), 26 October 1959. From *Natalus mexicanus:* 1, Penonomé (Coclé), L. H. Dunn [MCZ]; From *Artibeus j. jamaicensis:* 1, Almirante (Bocas del Toro), 23 January 1960. From *Lonchophylla robusta:* 1 (16 bats), Buena Vista Cave (Colón), 16 June 1960; 1, Chilibrillo Caves (Panamá), 2 August 1960. From *"Leaf nosed bat":* 8, Chilibrillo Caves, 10 July 1945, [USNM]. *Without host:* 1, Barro Colorado Island (Canal Zone), 2 December 1956, K-19 [USNM]; 1, Farfan Cave (Canal Zone), L. H. Dunn 329-A [MCZ].

Non-Panamanian paratypes. GUATEMALA.—From *Carollia p. azteca:* 3 (3 bats), small cave, 0.2 mile northeast of Cueva de Lanquin, Lanquin (Alta Vera Paz), 10 June 1948, R. D. Mitchell and Luis de la Torre, CNHM Guatemala Zoological Expedition, 1948. From *Glossophaga s. leachii:* 1, Sonarate (Progresso), 15 October 1948, Luis de la Torre. EL SALVADOR.—From "*Glossophaga soricina* or *Carollia* sp.": 1, near Santa Tecla (Libertad), Felten [SNI]. From *Glossophaga soricina:* 1, Mineral Encuentro, 19 June 1953, H. Felten [SNI]. BRITISH HONDURAS.—From *Carollia p. azteca:* 1, Belize, 7 October 1939, Ivan T. Sanderson. HONDURAS—*Without host:* 1, Coxen Hole, Ruatan Island, 9 January 1940, D. D. Davis, Field Museum-Leon Mandel Caribbean Expedition.

OTHER MATERIAL EXAMINED: COLOMBIA.—From *Carollia perspicillata:* 1, Río Raposo, 10 July 1962, C. J. Marinkelle. VENEZUELA.—From *Carollia subrufa:* 1, Rancho Grande, El Limon (Aragua), 21 March 1960, 3576 feet elevation, C. O. Handley, Jr. From *Carollia p. azteca:* 1, same locality and collector, 30 March 1960; 4, Guacharo Cave ("Cerro de la Cueva"), C. Monagas, 16 August 1962 [FCUCV]. From *Artibeus lituratus:* 1, 38 km.

south of El Dorado (Bolivar), 2 August 1962, Ojasti [FCUCV]. TRINIDAD [TVL, T.H.G. Aitken, unless otherwise indicated].—From *Carollia p. perspicillata:* 1, Moko Estate, Maraval, 27 November 1956; 1, Masson Hospital, Port-of-Spain, 5 December 1956; 1, Arena Forest, Brazil, 8 January 1957; 4, Arena Trace (Los Lomas), east of Cunupia, 5 September 1957; 1, Marocas Valley, 7 November 1954; 1, Belmont Valley Road, Port-of-Spain, 26 February 1958; 4, Coroney Cave no. 1, Blue Range, Diego Martin, 5 May 1958; 1, Las Lomas, 27 June 1958; 6, La Fontaine Cave, Petit Valley, Diego Martin, 13 and 20 March 1959; 1, Waller Field, 5 July 1956; 1, near San Rafael, 17 February 1947, F. Wonder, CNHM Trinidad Zoological Expedition (1947). *Without host:* 3, Melapo Forest, 9 March 1956, W. G. Downs. TOBAGO.—From *Carollia p. perspicillata:* 2, Fort George, Scarborough, 2 September 1956. BRITISH GUIANA.—*Without host:* 7, Georgetown, 18 August 1924, A. E. Emerson. SURINAM.—From *Carollia* sp.: 1, Krakka-Pdehra Road (Surinam), 25 October 1962, B. Malkin. BRAZIL.—From *Carollia perspicillata:* 1, Rocha (São Paulo), 9 September 1961, A. M. Olalla.

REMARKS: As may be judged from the above records, the normal hosts of this fly are species of *Carollia.* The fairly numerous but scattered records from other hosts reflect the ubiquity of the principal host, *C. perspicillata* (see "Host-parasite Relationships," below).

Strebla altmani Wenzel, new species. Figure 123G, 137A.

Distinct from all other species that have short inner occipital setae in that these are all fine setae, none are spinelets; the male gonapophyses, too, are distinct in that they are rather abruptly narrowed and tapered from mid-length to apex.

DESCRIPTION: *Head.*—Detached frontoclypeal plates very small and weakly sclerotized, difficult to see even in alcohol specimens. Anterior plates of laterovertices with about six setae; postocular sclerite distinct. Dorsal surface of postgenae not emarginate laterally; with about ten short bristles, a long, conspicuous bristle near inner posterior margin and lateral to this a medium bristle. Postvertex and occiput as illustrated (fig. 123G) except that all of occipital setae are fine (not spinelets as shown). Eyes multifaceted and projecting, about six large facets visible from above. Ventral antectenidial area approximately as wide as long (17:17 or 17.5).

Thorax (fig. 137A).—Second pigmented suture of prescutum present; epaulets with four or five setae; prescutal setae relatively sparse and more or less uniformly distributed, setose area extending to epaulets along sides; arc of long setae present but not conspicuous; two or three irregular transverse rows of setae between transverse sutures. Scutum with two transverse rows of discal setae anterior to the row of subequal antescutellar setae. *Wings.*—Fifth longitudinal vein bare for a short distance before base, the bare area less than half as long as that of sixth vein. Costa without apical macroseta. R_s more than twice as long (17.5:7.5) as distance from fork to crossvein *r-m.* *Legs.*—Pro- and mesotibiae dorsally with a double row of longer setae, only one or two of these on each side stronger than the others (three on inner edge of mesotibiae). Metatibiae with two subapical macrosetae preceded by a double row of setae that are much shorter and finer than the macrosetae but much longer than other tibial setae. Ventral surface of first segment of hind tarsi with two or three irregular rows of plantar setae, these not heavily pigmented and scarcely heavier than those of following segments.

Abdomen.—Anterior face of tergum I+II with one short seta; inner dorsal margin of lateral lobes with three or four fine setae. *Female:* Tergum VII with two macrosetae and posterior to these a pair of setae that are half as long. Supra-anal plate small, with four long apical setae only. Seventh sternites with nine or ten setae including three or four macrosetae. A small crescent-shaped postgenital sclerite present anterior to ventral arc; arc with two short and two minute setae. *Male:* Sternum VI very short, with only one transverse row of discal setae at middle, two laterally in addition to apical marginal setae. Hypopygium as in *carolliae* n. sp. Gonapophyses very slender, curved, apices not knobbed, with microsetae scattered along sides; macrosetae extending nearly to apex.

Measurements:	BL	TL	WL	WW
Male	1.40–1.49	0.49–0.52	1.10–1.13	0.51–0.55
Female	1.59–1.95	0.56–0.59	1.24–1.31	0.63–0.65

TYPE MATERIAL: Holotype male (slide) and allotype female (slide) (host no. 4191) from *Lonchorhina aurita aurita,* mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *Lonchorhina a. aurita,* 208 flies (37 lots, 47 bats) as follows: 163 (29 lots, 31 bats), same data as the holotype; 26 (10 bats), same data but 25 November 1959; 13 (5 bats), railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959; 6 (1 lot), two miles north of Summit, 17 April 1957 [USNM]. From plastic bag containing *Carollia p. azteca* and *Lonchorhina a. aurita:* 25, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November 1959. From *Macrophyllum macrophyllum,* 108 flies (19 lots, 46 bats) as follows: 83 (18 lots, 21 bats), Fort Davis (Canal Zone), 13 October 1959; 25 (25 bats), same locality, 29 July 1960; 21 (9 bats), Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 2, Río Tuira (Darién), 10 March 1958, P. Galindo [GML]; 2 (2 bats), culvert, Chepo Road (Panamá), 12 October 1959. From *Carollia p. azteca:* 1, air raid shelter, Fort Davis (Canal Zone), 6 October 1959; 20 (13 bats), mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 9 September 1959; 8 (18 bats), same locality, 25 November 1959; 1, railroad culvert east of Summit Golf Club (Canal Zone), 26 October 1959; 2 (2 bats), Buena Vista Cave (Colón), 3 September 1959. From *Trachops c. cirrhosus:* 1 (15 bats), culvert, Chepo Road (Panamá), 24 May 1960. From *Pteronotus parnellii fuscus:* 1, mine shaft, Coco Plantation, Gamboa Road (Canal Zone), 25 November 1959. From unidentified host (probably *Macrophyllum macrophyllum*): 1, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959.

Non-Panamanian paratypes.—From *Lonchorhina aurita:* 12 (4 lots), Rancho Grande (Aragua), VENEZUELA, 18 July, 7 and 12 August 1949, Dr. J. Racenis [FCUCV]. Paratypes to be deposited in the collections listed on p. 410.

REMARKS: *S. altmani* appears to be a normal parasite of both *Lonchorhina aurita* and *Macrophyllum macrophyllum,* closely related genera of phyllostomine bats. We are unable to distinguish between specimens from these two hosts. However, it appears to occur in larger numbers per individual host bat on *Lonchorhina* than on *Macrophyllum* (See "Host-parasite Relationships"). It also occurred consistently on *Carollia p. azteca,* in larger numbers than one would expect if these were merely strays or transitory transfers, but only where *Carollia* was roosting with one of the normal hosts. It was never taken on *Carollia* in the absence of one of these hosts.

This species is named in honor of Lt. Col. Robert M. Altman, in recognition of his important contributions to our knowledge of the ectoparasites of Panama, especially his initiation of a systematic survey.

Strebla alvarezi Wenzel, new species. Figures 123E, F; 137B.

Closely related to *carolliae* n.sp., but easily distinguished from that species by its smaller size, the shape of the anterior margin of the postvertex (fig. 123E, F) which is not broadly blunt as in *carolliae* (fig. 122A), the much smaller detached frontoclypeal plates, and the less strongly curved male gonapophyses.

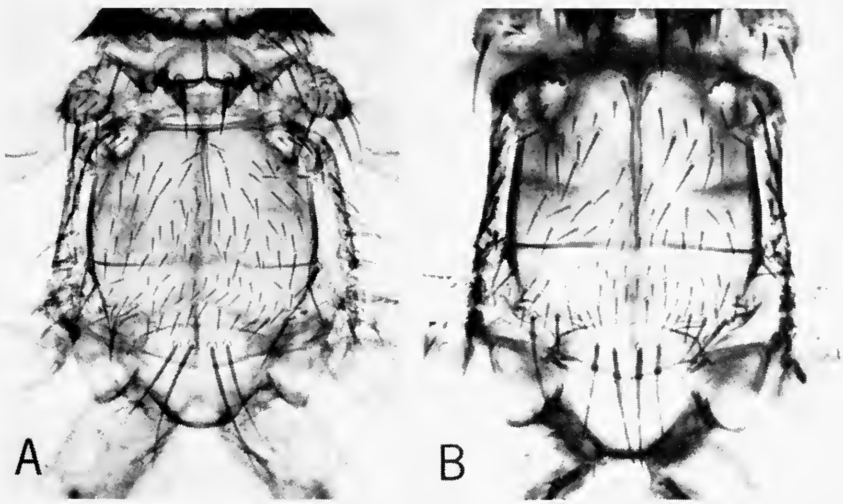

Fig. 137. Thorax, dorsal view. A, *Strebla altmani*, new species, male paratype from *Lonchorhina aurita* (no. 4220), mine shaft, Coco Plantation, Gamboa Road (Canal Zone). B, *Strebla alvarezi*, new species, paratype male from *Micronycteris megalotis* (no. 7955), near Huile (Canal Zone).

DESCRIPTION: *Head.*—Frontoclypeus with apical detached plates small, wider than long. Anterior plate of laterovertices with six setae. Postocular sclerite not differentiated. Postgenae not emarginate laterally, posteriorly with eight or nine short setae, a conspicuously longer seta near inner posterior margin, and lateral to this, a seta of intermediate length. Eyes multi-faceted and projecting, about seven facets visible from above, the upper ones not very distinct. Ventral ante-ctenidial area a little wider than long (17.5:14.5). Postvertex and occipital lobes as in fig. 123E, F.

Thorax (fig. 137B).—Prescutum with well-defined second pigmented suture; epaulets consisting of four setae; prescutal setae sparse, setose area not reaching epaulets; arc of longer setae present; two transverse rows of setae laterally between transverse mesonotal and second pigmented suture. Scutum with about eight subequal antescutellar setae and two short median ones, in addition to a long macroseta each side, in addition to the discal setae. *Wings.*—Seta at apex of costa not conspicuously long. R_s about three times as long (22:7) as distance from fork to crossvein *r-m;* R_s and fifth longitudinal vein bare basally but not as extensively as sixth. *Legs.*—Protibiae dorsally with three macrosetae on inner edge and two on outer; mesotibiae similar. Metatibiae with two macrosetae on apical third, preceded by a row of gradually smaller setae, the basal one scarcely longer than the numerous short tibial setae. Ventral surface of first segment of hind tarsus with three irregular, longitudinal rows of plantar bristles, these not heavily sclerotized, distinctly longer and heavier than those of following segments, though these are not minute.

Abdomen.—Dorsal inner margin of lateral lobes of tergum I+II with three to five setae. Dorso-lateral connexival setae scarcely longer than those of venter. *Female:* Tergum VII with a pair of macrosetae and, posterior to these, a pair of shorter setae. Supra-anal plate with four apical macrosetae only. Seventh sternites with seven to nine setae, three of them much longer than the others. Ventral arc triangularly but not strongly produced anteriorly, with four setae, two larger, two minute. *Male:* Sternum V with two transverse rows of discal setae in addition to long marginals. Sternum VII+VIII dorsally with a macroseta on each side; tergum IX dorsally with a single macroseta on each side. Gonapophyses long, slender, straight on basal two-thirds, curved on apical third; sides apically with scattered microsetae, apices rounded; ventral macroseta inserted at about basal third, extending about two-thirds the distance to apex; accessory seta minute.

Measurements:	BL	TL	WL	WW
Male	1.59–1.76	0.58–0.59	1.10–1.21	0.55–0.60
Female	1.92–2.14	0.63–0.67	1.35–1.37	0.63–0.66

TYPE MATERIAL: From *Micronycteris megalotis:* Holotype male and allotype female (slides) from host no. 7961, taken from culvert under Borinquen Highway near Empire Range, 24 October 1961, C. M. Keenan and R. L. Wenzel. In the collection of Chicago Natural History Museum. Paratypes.—4 males, 1 female, in road culvert one-half mile SE of Empire Range (Canal Zone), 23 October 1961, R. L. Wenzel and C. M. Keenan; 2 males (2 bats), "French Vault," west bank of Canal, 300 yards east of Empire Range, 23 October 1961, same collectors; 2 males, 2 females (5 bats), same data as holotype; 1 male, 1, sex unknown (2 bats), hollow espavé tree, Huile (Canal Zone), 19–20 October 1961, same collectors; 1 male, Loma Boracho (Canal Zone), 20 September 1959; 1 male, Casa Tilley, Cerro Punta (Chiriquí), 23 January 1960; 1 male, Isla Taboga (Panamá), 21 October 1959; 1 female, Guánico (Los Santos), 27 January 1962. From *Micronycteris nicefori:* 3 males, Almirante (Bocas del Toro), 12 February 1960. From *Micronycteris sylvestris:* 2 males, Armila (San Blas), 12 March 1963, C. O. Handley, Jr. and F. M. Greenwell. From *Saccopteryx bilineata:* 4 males (2 bats), hollow tree, Chepo Road (Panamá), 8 October 1959. EL SALVADOR.—From *Saccopteryx bilineata:* 1, 5 km. E of La Libertad (La Libertad), 24 October 1953, H. Felten [SNI]. From a mixed collection of *Saccopteryx bilineata* and *Glossophaga s. leachii:* 10, coastal forest, Hacienda Nancuchiname, San Marcos Lempe (Usulutan), 25 March 1954, H. Felten [SNI]. GUATEMALA.—From *Saccopteryx bilineata:* 7, Finca Santa Cristina, 6 mi. S of Democracia (Escuintla), 20 September 1948, L. de la Torre, CNHM Guatemala Zoological Expedition (1948). Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; the Gorgas Memorial Laboratory, Panamá; the Environmental Health Branch, U. S. Army, at Corozal (Canal Zone); and the Senckenberg Naturforschende Institut, Frankfurt a/Main.

OTHER MATERIAL EXAMINED: A badly damaged specimen, without host, "Río Waupes, BRAZIL," collected by the Olalla brothers [LI-13, MCZ]; an additional male lacking head but probably this species, from *Micronycteris* *megalotis,* Casa Tilley, Cerro Punta (Chiriquí), PANAMA, 6 March 1962.

REMARKS: The specimens from Guatemala have the anterior margin of the postvertex somewhat more pointed (fig. 123F) than those from Panama, (fig. 123E) and they are on the average somewhat smaller. However, we consider them to be the same. The length and disposition of the occipital setae vary, within both populations.

S. alvarezi seems to normally occur on species of *Micronycteris* and on *Saccopteryx bilineata,* bats which belong to different families. This is probably accounted for by the fact that they often roost in close proximity. *S. bilineata* roosts on the shaded outside of logs, tree trunks, and branches, and in houses, caves, etc., while *M. megalotis* (and perhaps other species of *Micronycteris*) roosts inside logs, stumps and tree holes, and in houses, culverts, etc.

S. alvarezi is named for Mr. Vicente Alvarez, of the Environmental Health Branch, USAFSC, at Corozal (Canal Zone), in grateful appreciation of his valued assistance on this project.

Genus **Paraeuctenodes** Pessôa and Guimarães

Paraeuctenodes Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, 12, (2), pp. 257–258. Jobling, 1939, Arb. Morph. Tax. Ent., 6, (3), pp. 269 (discuss.), 270 (keyed). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 417 (keyed); 1942, Bol. Ent. Venez., 1: 85 (keyed). Jobling, 1947, Parasitology, 39: 322 (keyed). Hoffman, 1953, Mem. Congr. Cient. Mex., 7: 179 (keyed), 189.

Type-species: *Paraeuctenodes longipes* Pessôa and Guimarães, 1937.

This genus contains a single described species, *P. longipes* Pessôa and Guimarães (op. cit., p. 258). The holotype female was taken from *Lonchoglossa ecaudata* at Ipiranga, São Paulo (São Paulo), Brazil, and the allotype male from *Phyllostomus hastatus* at São Paulo. *Paraeuctenodes* resembles *Strebla* in having well-developed dorsal postgenal sclerites and in lacking a remiform postgenal seta. However, it resembles *Anastrebla* in lacking metatibial macrosetae and in having elongated hindlegs. The frontoclypeus is entire as in *Anastrebla* and in some species of *Strebla.*

There are two specimens of this genus in the collection of Chicago Natural History Museum. They appear to represent two new species. One was taken from *Carollia p. perspicillata,* near San Rafael, TRINIDAD, and the other (doubtfully associated with *Carollia p. azteca*) was collected in a small cave northeast of Cueva de Lanquin (Alta Vera Paz), GUATEMALA. Thus, it seems highly probable that a species of this genus will be found in Panama.

Anastrebla Wenzel, new genus

Type-species: *Anastrebla modestini,* new species.

Strebla (not Wiedemann, 1824), Speiser, 1900, Arch. Naturg., 66A, Bd. I, pp. 38–43, 63 (cit.), 65 (keyed). Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 26 (keyed), 31 (cit.). Kessel, 1924, Parasitology, 16: 406–409 (char.); 1925, Jour. N. Y. Ent. Soc., 33: 13 (keyed), 29 (char.). Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 653 (part.). Curran, 1934, Man. Fam. Gen. N. Am. Dipt., p. 479 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28: 355 ff. (morph., syst. pos.), 370 (keyed). Pessôa and Guimarães, 1937, Ann. Fac. Med. São Paulo, 12: 235 ff. (comp. notes). Jobling, 1939, Arb. Morph. Tax. Ent., 6: 269 (discuss.). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 417 (keyed); 1942, Bol. Ent. Venez., 1: 85 (keyed). Jobling, 1949, Parasitology, 39: 322 (keyed). Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 178 (keyed), 188 (cit.). Maa, 1963, Jour. Med. Ent., 1: 385.

The name *Strebla* (q.v.) must be used for the species assigned to the genus *Euctenodes* Waterhouse by Waterhouse, Kessel, and subsequent authors. The genus *Anastrebla* is proposed for *Strebla* of Speiser (loc. cit.) and subsequent authors, not Wiedemann, 1824.

DIAGNOSIS: With the characters attributed to *Strebla* (not Wiedemann, 1824) by Kessel (1924) and by Jobling (1939 and 1949). In general, with the characters of *Strebla* Wiedemann, but differing from that genus chiefly in that the hind legs are noticeably more elongated; the metatibiae are slender and lack macrosetae. Postgenae (fig. 39D) poorly developed dorsally (well developed in *Strebla*, fig. 122) and posteriorly bearing a remiform scale (lacking in *Strebla*).

REMARKS: The species of *Anastrebla* superficially resemble those of *Paraeuctenodes* and have similar hindlegs, but the postgenae of *Paraeuctenodes* are similar to those of *Strebla*, and, similarly, lack a remiform scale.

The species of this genus appear to be restricted to bats of the subfamily Glossophaginae. The three species known to us are from *Anoura cultrata*, *A. geoffroyi*, *A. aculeata*, and *Lonchophylla robusta*. The species treated as *Strebla vespertilionis* by Speiser (1900, pp. 38–41; pl. 4, figs. 1, 2) and Kessel (1924, p. 413, figs. 1, 5, 6; 1925, p. 24 [part.], pl. 3, fig. 20, pl. 4, fig. 24) was collected from *Lonchoglossa ecaudata*. We have not seen specimens from this host, but it is clear that the species is closely related to, if not identical with *Anastrebla modestini* n. sp. The streblid figured by Jobling (1929, fig. 4; 1949, fig. 3F) as *Strebla vespertilionis* is also a species of *Anastrebla* and is distinct from any known to us. It is characterized by exceptionally short festoon spinelets on the postvertex and occipital plates. Mr. Jobling (pers. comm.) has informed us that his illustration is based on a specimen, without host or locality data, that was given to him by Hugh Scott.

KEY TO THE SPECIES OF *ANASTREBLA*

1. Eyes with a single hyaline cornea, without *externally* distinct facets. Postvertex and occiput with relatively short, heavy spine-like setae that are not noticeably tapered. Host: *Lonchophylla robusta* .... *nycteridis* n.sp.
   Eyes with seven or eight externally distinct facets, their corneae separate and distinct. Setae of postvertex and occiput longer, distinctly tapered apically, with long points. Hosts: *Anoura* spp. 2
2. Prescutum (fig. 138A) sparsely setose, the median setose area usually not extending beyond the anterior suture. Wing vein R_1 without setae on basal half or more, sixth vein with a few setae apically near the third crossvein, and usually with one to three proximal to mid-length and one or more beyond middle. Median setose area of sternum I narrow, apical margin with about 15 setae .... *modestini* n.sp.
   Prescutum (fig. 138B) more densely setose, the median setose area extending beyond the anterior pigmented suture. R_1 and sixth longitudinal wing veins bare at base only. Setose area of sternum II broader, apical margin with 20–22 setae .... *mattadeni* n. sp.

Anastrebla nycteridis Wenzel, new species. Figure 139A, B.

Closely related to *A. mattadeni* n.sp., but differing as follows: the eyes are not distinctly faceted and projecting but have only a few vague facets that are not distinct in alcohol-preserved specimens, but can be detected in slide preparation (fig. 139A); the laterovertices are much more elongated; the spinelets of the postvertex and occiput are relatively short and stout; the male gonapophyses are heavier and much straighter, only feebly curved nearly to apex (fig. 139B). The female of *nycteridis* is unknown.

DESCRIPTION (*Male*): *Head.*—Anterior division of laterovertices with seven setae, the postero-median seta a very conspicuous macroseta but shorter than in *mattadeni* and *modestini* n. spp., not reaching posterior margin of occiput; posterior division with two setae. Dorsal sclerite of postgena with a long stout seta, no longer than and inserted anterior to the remiform seta. Postvertex and occiput with ten stout spinelets (fig. 139A), the inner four pairs subequal, the outer one distinctly shorter. Eyes a single elongate hyaline lens, facets not externally distinct, though they may be discerned in slide preparations at high magnifications (fig. 139A). Ventral ante-ctenidial area about as wide as long (24:23).

Thorax.—Prescutum with anterior transverse suture. Chaetotaxy much as in *mattadeni;* with three irregular transverse rows of setae along side, the setose area extending further anteriorly along mid-line. Twelve antescutellar setae, the middle four only slightly longer than longest discal scutal setae, the outer longer antescutellars stouter, subspiniform; discal setae forming a single transverse row at mid-line and three at the sides. *Wings.*—Setae lacking along base of R_s (basal half or less) a short basal area on fourth longitudinal vein as well as the usual basal area on the sixth longitudinal vein. R_s distinctly longer (20:15) than distance from fork to crossvein *r-m*. *Legs.*—Hind femora longer than thorax, very similar in chaetotaxy to those of *mattadeni.*

Abdomen.—Inner dorsal margins of tergum I+II with three very fine setae. Sternum II much as in *mattadeni,* but median setose area extending only a little more than halfway to base; with about 18 marginal setae. Hypopygium essentially as in *mattadeni.* Gonapophyses (fig. 139B) similar to those of *mattadeni* and *modestini* (fig. 139D, F), but straighter and heavier.

Measurements:	BL	TL	WL	WW
Male	2.40–2.42	0.80–0.82	1.70–1.95	0.74–0.93

TYPE MATERIAL: Holotype male (slide) from *Lonchophylla robusta* (host no. 5434), Almirante (Bocas del Toro), 28 January 1960, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum. Paratype male, same host, La Laguna (Darién), elevation 2900 feet, GML; in the collection of the United States National Museum.

Anastrebla modestini Wenzel, new species. Figures 138A; 139C, D.

Distinguished from *mattadeni* by the different shape of the laterovertices and the shorter setae of the postvertex and occiput (fig. 139C), and especially by the much sparser mesonotal chaetotaxy (fig. 138A).

DESCRIPTION: *Head.*—Anterior division of laterovertex with ten setae, the postero-median one a very conspicuous macroseta; posterior division with two long bristles. Dorsal sclerite of postgena with a long macroseta, inserted anterior to remiform scale, and extending posteriorly beyond margin of head. Postvertex and occiput, together, with five pairs of heavy sub-equal but narrowly pointed spine-like setae, the pair on postvertex slightly longer than the occipitals, the outer pair only slightly shorter than the others. Eyes with about seven or eight distinct facets visible from above. Ventral ante-ctenidial area wider than long (26:20).

Thorax.—Prescutum with a second transverse suture; a pair of widely separated short setae on anterior margin; epaulets consisting of four setae; setal arc consisting of four or five strong setae that are appreciably longer than the discals; three irregular transverse rows of discal setae between the transverse and anterior sutures, the setose area not extending beyond the anterior suture. Antescutellar row consisting of 10–12 setae, the middle five shorter than the others which are stouter. Discal setae half as long to slightly longer than antescutellars, limited to a single transverse row at middle and two rows laterally. *Wings.*—Very long; R_1 lacking setae on basal half or more in

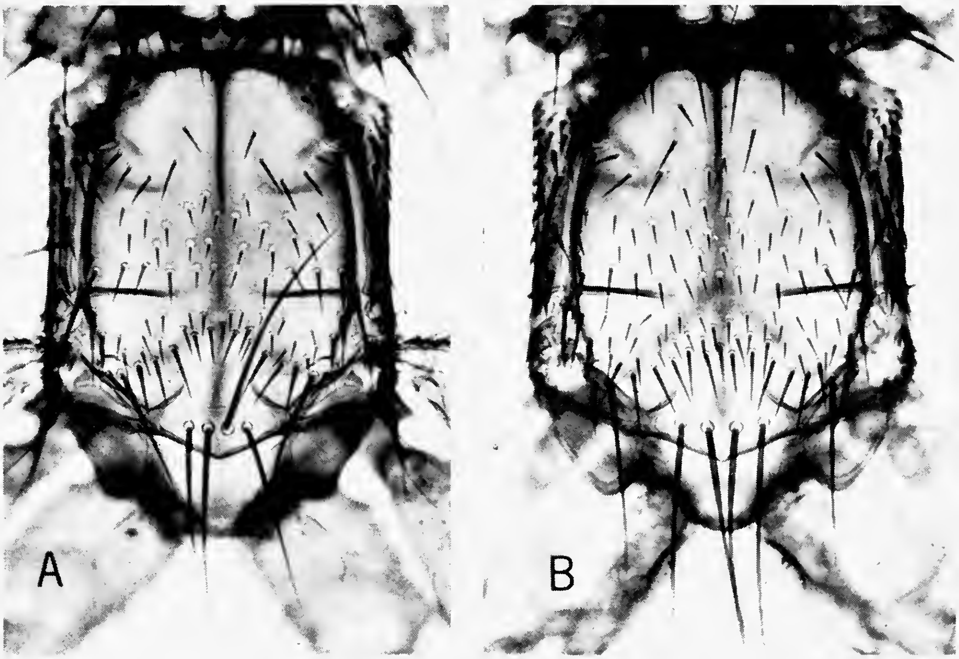

Fig. 138. Thorax, dorsal view. A, *Anastrebla modestini*, new species, male paratype from *Anoura geoffroyi lasiopyga* (no. 6218), Casa Lewis (Chiriquí). B, *A. mattadeni*, new species, paratype from *A. g. lasiopyga* (no. 5343), Rancho Grande (Aragua), VENEZUELA.

mattadeni; R_s bare on basal third to half; sixth longitudinal vein with a few setae apically near third crossvein, and usually with one to three proximal to mid-length and one or more beyond middle, occasionally with more setae but these always much more widely separated than setae of other veins; R_s about three times as long (26:8.5) as distance from fork to crossvein *r-m*. *Legs.*—Markedly elongated, chaetotaxy very much as in *mattadeni.*

Abdomen.—Very much as in *mattadeni.* The median setose area of sternum I narrow and extending anteriorly only a little beyond middle. Apical margin with only about 15 setae, including two macrosetae; four setae between the macrosetae. *Female:* Only one or two longer setae along inner edges of dorsal setose area of dorsal connexivum, the apical one a macroseta. Chaetotaxy of tergum VII and supra-anal plate as in *mattadeni.* Ventral arc with a pair of longer setae on posterior margin, and a pair of minute ones on anterior margin; not produced, but with a microsetose nonsclerotized extension as in *mattadeni. Male:* Hypopygium as in *mattadeni.* The gonapophyses strongly tapered, and rather strongly curved apically; scattered microsetae along sides on about apical fourth; macroseta inserted at about basal fourth, very long, extending to apex; accessory seta well developed.

Measurements:	BL	TL	WL	WW
Male	1.98–2.17	0.77–0.82	1.92–2.06	0.77
Female	2.36	0.85	2.14	0.71

TYPE MATERIAL: PANAMA.—Holotype male from *Anoura geoffroyi lasiopyga* (host no. 6218), Casa Lewis, Cerro Punta (Chiriquí), elevation above 5000 feet, 4 May 1960, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *A. g. lasiopyga:* a male, Cerro Hoya (Los Santos), elevation 1500–3200 feet, 11 February 1962. GUATEMALA.—From *A. g. lasiopyga:* a male, Santa Elena (Chimaltenango), 10,000 feet elevation, 26 January 1934, F. J. W. Schmidt, Field Museum-Leon Mandel Guatemala Zoological Expedition. From *Anoura* sp. (CNHM cat. no. 73362): a male and female, San Lorenzo, 4 mi. NE of Volcan de Jumay (Jalapa), elevation 3750 feet, 15 February 1952, L. de la Torre, CNHM Guatemala Zoological Expedition (1951–52). MEXICO.—From *A. g. lasiopyga:* 1, Santa Lucia (Sinaloa), elevation 3200 feet, 28 July 1963, J. Knox Jones. TRINIDAD.—From *Anoura geoffroyi* [*geoffroyi*]: a male, Aripo Cave, 19 March 1955, W. G. Davis [RML no. 33590]; a male, Tamana Caves, 11 December 1954, C. C. Sanborn, CNHM Trinidad Zoological Field Trip. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; and the Environmental Health Branch, USAFSC, at Corozal (Canal Zone).

OTHER MATERIAL EXAMINED: 3, without host identification, from Cueva Nanarita, Hacienda El Marne (Santa Ana), EL SALVADOR, 960 meters elevation, H. Felten [SNI].

REMARKS: *A. modestini* appears to be restricted to *Anoura geoffroyi*. It is named for Mr. Sulpice Modestin of the Environmental Health Branch, at Corozal (Canal Zone), in appreciation of his assistance in the field.

Anastrebla mattadeni Wenzel, new species. Figures 138B; 139E, F.

Easily distinguished from *A. nycteridis* n.sp. and *modestini* n.sp. by the long slender setae of postvertex and occiput (fig. 139E); from *modestini* which has similar eyes and laterovertex, it may further be separated by its very different mesonotal chaetotaxy (fig. 138B).

DESCRIPTION: *Head.*—Anterior division of laterovertex with nine or ten setae. Dorsal sclerite of postgena with a conspicuous heavy posterior macroseta which is much longer than the remiform seta and extends beyond occiput. Postvertex and occiput with five pairs of long, tapering macrosetae which are gradually shorter toward sides, the inner pair conspicuously longer than the outer. Eyes strongly projecting, multi-faceted, seven or eight facets visible from above. Ventral ante-ctenidial area much wider than long (29:21.5).

Thorax (fig. 138B).—Prescutum with pigmented suture; epaulets diagonal, with four strong short setae; arc consisting of four to five strong conspicuous setae, no discal setae anterior to them; setae of arc nearly twice as long as discals, interval between transverse mesonotal suture and second pigmented suture with four transverse rows of setae toward side, but five or six along middle, where setose area extends anteriorly to a point just beyond level of second suture. Antescutellar row of setae consisting of about 12–14 long very strong setae shorter at middle, longer laterally, the shortest one not quite twice as long as the longest discal scutal setae, of which there are a single irregular transverse row at middle and two to three laterally. *Wings.*—R_1 and R_s without setae

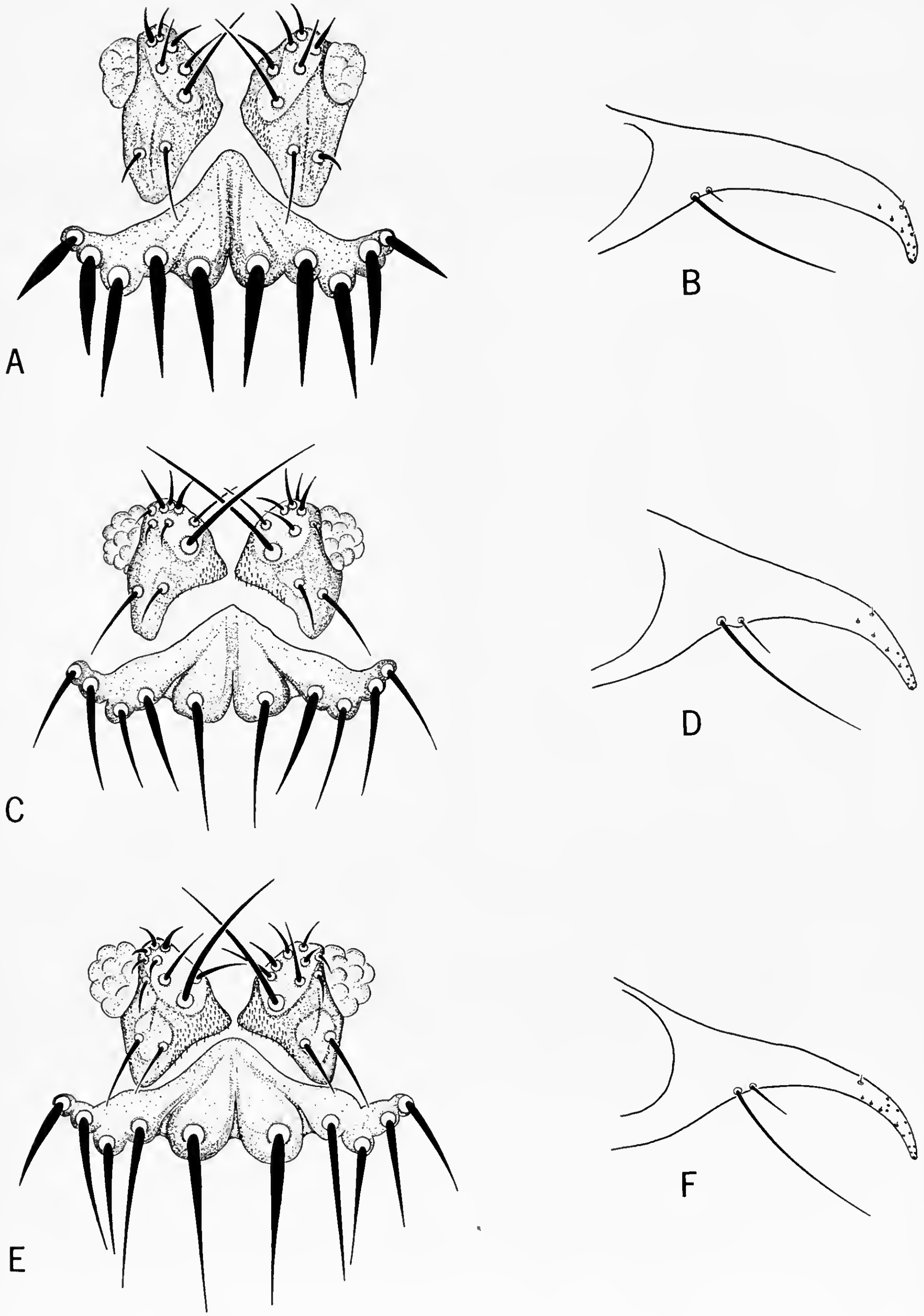

Fig. 139. A and B, *Anastrebla nycteridis*, holotype; A, laterovertices, postvertex, and occipital plates (of head); B, left male gonapophysis. C and D, *Anastrebla modestini*, new species, same structures; C, male paratype from *Anoura g. geoffroyi* (C. C. Sanborn no. 552), Tamana Caves, TRINIDAD; D, holotype male. E and F, *Anastrebla mattadeni*, new species; E, female paratype from *Anoura aculeata* (no. 5344), Rancho Grande (Aragua), VENEZUELA; F, paratype from *Anoura geoffroyi* (no. 5343), same locality.

basally, (R_s sometimes without any setae), fourth sometimes bare at base; sixth without setae basally, as usual. R_s nearly twice as long (20.5:11–12) as distance from fork to crossvein *r-m*. Third crossvein strongly bent and recurrent. Protibiae with a double row of 10–12 longer strong setae, the apical ones macrosetae; mesotibiae with 14–16 strong setae; metatibiae with short setae only. Pro- and mesofemora with a few macrosetae dorsally and laterally on apical half, metafemora with a conspicuous dorsal row of six to eight macrosetae. First segment of all tarsi as long as the next three; underside of hind tarsi with a double row of stronger plantar bristles that are longer than the others, the outer row of about four much stronger; lateral to these are minute plantars; succeeding segments with minute plantars.

Abdomen.—Dorsal inner margins of lateral lobes of tergum I+II with five to six very long, thin setae; anterior face with about five short setae. Sternum II strongly, densely setose in a median triangular area which extends to about basal fourth; apical margin with 20–22 longer setae along apical margin, two of them macrosetae, one each side of middle, with seven or eight setae between them. *Female:* Dorsal connexivum with a few longer setae at base and a few in a single row along inner margin of each lateral setose area, the others very short, about half as long as ventral connexival setae; four pairs of widely separated short segmental setae. Tergum VII with a pair of exceptionally long macrosetae; medial and posterior to these a pair of very short setae. Supra-anal plate with four apical macrosetae and just anterior to them a pair of very short widely separated setae. Seventh sternites with 11–12 long setae, five to seven of them long macrosetae, several of these exceptionally long. Ventral arc not produced, though there is a lobe-like, apparently non-sclerotized, microsetose area extending anteriorly from its dorsal edge; arc with a single pair of short setae. *Male:* Sternum V not differentiated. Hypopygium well developed, with a short seta and two or three macrosetae on each side of sternum VII+VIII, and a row of about eight macrosetae along dorsum and sides of tergum IX.

Measurements:	BL	TL	WL	WW
Male	2.05–2.14	0.77–0.82	1.84–1.92	0.77–0.82
Female	2.17–2.31	0.82	1.98–2.17	0.81–0.89

TYPE MATERIAL: PANAMA.—Holotype male (slide) and allotype female (alcohol) from *Anoura cultrata* (host no. 8593), upper Río Changena Camp (Bocas del Toro), elevation 2500 feet, 27 September 1961, C. M. Keenan and V. J. Tipton. In the collection of Chicago Natural History Museum.

Paratypes.—From *Anoura cultrata:* 15 (2 bats), Cerro Malí (Darién), elevation 4100–4800 feet, 2 and 13 February 1964, C. O. Handley, Jr.; 2 (2 bats), Cerro Tacarcuna (Darién), elevation 4100–4800 feet, 20 February and 9 March, Handley. From *Anoura geoffroyi lasiopyga:* 1, Rancho Mojica (Bocas del Toro), elevation 4800 feet, 12 September 1961. VENEZUELA (Rancho Grande [Aragua], 30 March 1961, C. O. Handley, Jr.).—From *Anoura g. lasiopyga:* 3 (2 bats). From *Anoura aculeata:* 5 (2 bats). From *Enchisthenes hartii:* 1. Paratypes to be deposited in the collections of Chicago Natural History Museum; the United States National Museum; the Environmental Health Branch, USAFSC, at Corozal (Canal Zone); the Departmento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil; and the Faculdad de Ciencias, Universidad de Venezuela.

REMARKS: This species is named for Mr. Edmond Mattaden of the Environmental Health Branch, at Corozal (Canal Zone) in appreciation of his assistance in the field and in the laboratory.

A. mattadeni is recorded from three species of *Anoura*. However, we suspect that it is primarily a parasite of *A. cultrata* and *A. aculeata* and that the records from *A. g. lasiopyga* may be in error, either because of misidentification of the host or contamination in the field. The record from *Enchisthenes hartii* is obviously doubtful and probably represents a contamination.

Genus **Metelasmus** Coquillet

Metelasmus Coquillet, 1907, Ent. News, 18: 292. Costa Lima, 1921, Arch. Esc. Sup. Agric. Med. Vet., Nictheroy, 5: 26 (keyed), 32 (cit.). Kessel, 1925, Jour. N. Y. Ent. Soc., 33: 13 (keyed), 31. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654. Curran, 1934, Fam. Gen. N. Am. Dipt., p. 477 (keyed); 1935, Amer. Mus. Novit., no. 765, p. 5 (keyed). Jobling, 1936, Parasitology, 28, (3), p. 356 ff. (morph.), 370 (keyed); 1939, Parasitology, 31: 494 (synonymizes *Lemosia* Pessôa and Galvão, 1936); 1939, Arb. Morph. Tax. Ent., 6, (3), p. 269 (discuss.), 270 (keyed). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 417 (keyed); 1942, Bol. Ent. Venez., 1: 85 (keyed). Jobling, 1949, Parasitology, 39: 322 (keyed). Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 178 (keyed), 189 (cit.).

Lemosia Pessôa and Galvão, 1936, Revista Ent., 6: 243 (type-species: *Lemosia setosa* Pessôa and Galvão, 1936).

Type-species: *Metelasmus pseudopterus* Coquillet, 1907.

This genus contains a single species, *M. pseudopterus* Coquillet, the only brachypterous species of the subfamily Streblinae. *Metelasmus* resembles *Anastrebla* in possessing a remiform scale at the posterior margin of the dorsal sclerite of the postgena, and in lacking macrosetae on the metatibiae. However, the frontoclypeus has apical detached plates as in many species of *Strebla*.

Metelasmus pseudopterus Coquillet. Figures 39A, B; 140.

Metelasmus pseudopterus Coquillet, 1907, Ent. News., 18: 292, fig.—Sapucay, Paraguay, from *Artibeus lituratus*. (type 10293, United States National Museum). Séguy, 1926, Ency. Ent., (B), 11, Dipt., 3: 192–194, fig. 1. Stiles and Nolan, 1931, Bull. Nat. Inst. Hlth., Wash., no. 155, p. 654. Jobling, 1936, Parasitology, 28, (3), pp. 370–374 (redescr.), figs. 2, 3A–E. Jobling, 1939, ibidem, 31: 494 (synonymizes *Lemosia setosa* Pessôa and Galvão, 1936); 1939, Arb. Morph. Tax. Ent., 6 (3), p. 269 (discuss.), 270 (keyed). Bequaert, 1940, Rev. Acad. Colomb. Cienc. Exact., Fis. y Nat., 3: 418; 1942, Bol. Ent. Venez., 1: 87 (records). Jobling, 1949, Parasitology, 39: 316 ff., fig. 3C. Grandi, 1952, Introduz. Stud. Ent., 2: 478. Hoffmann, 1953, Mem. Congr. Cient. Mex., 7: 189 (records).

Lemosia setosa Pessôa and Galvão, 1936, Revista Ent., 6: 244–248, figs. 1–4.

PANAMANIAN MATERIAL EXAMINED: 49 flies, 38 lots, from more than 48 bats. From *Artibeus j. jamaicensis,* 30 lots, 41 flies (40 bats), as follows: 6 (3 bats), Almirante (Bocas del Toro), 27 January to 1 February 1960; 1, Natural Bridge, Madden Dam (Canal Zone), 31 August 1959; 2, Barro Colorado Island (Canal Zone), 10 December 1956 [USNM]; 2, Punta Piña (Darién), 24 March 1960; 7 (4 bats), Río Setegantí (Darién), 31 January to 5 February 1961; 2 (2 bats), Río Tuira, 25 and 26 February 1958, P. Galindo [GML]; 6 (4 bats), La Laguna (Darién), 2 to 15 June 1963, GML; 5 (5 bats), Tacarcuna (Darién), 20 June to 12 July 1963, GML; 8 (7 bats), Cerro Hoya (Los Santos), 8 to 24 February 1962. From *Artibeus lituratus palmarum:* 2 (2 lots), Barro Colorado Island (Canal Zone), 2 and 3 January 1957. From *Carollia perspicillata azteca:* 2 (2 bats), Almirante (Bocas del Toro), 24 and 30 January 1960; 1, Tacarcuna (Darién), 2 September 1958, GML. From *Vampyressa nymphaea:* 1, Río Mono Camp (Darién), 25 July

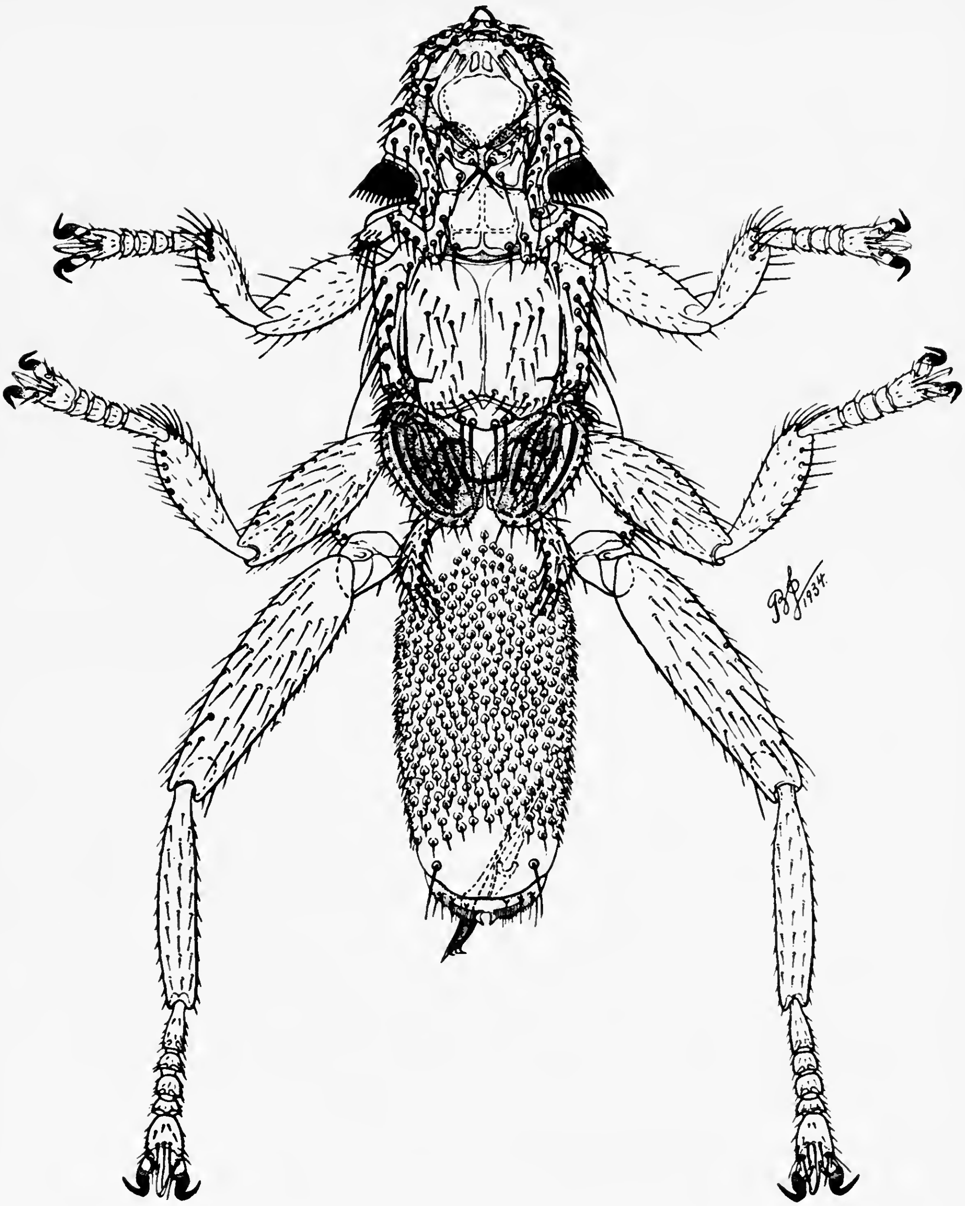

Fig. 140. *Metelasmus pseudopterus* Coquillet, male, dorsal view. From Jobling (1936).

1963, GML. *Without host:* 2 (2 lots), Tacarcuna (Darién), 20 June 1963, GML.

NON-PANAMANIAN MATERIAL EXAMINED: BRAZIL.—From *"Artibeus jamaicensis literatus":* 3, Joinville (Santa Catharina), 8 May 1929. GUATEMALA (CNHM Guatemala Zoological Expedition, 1948).—From *Artibeus j. jamaicensis:* 1, Cueva de Los Ladrones, Finca Los Arcos (Escuintla), 27

September 1948, L. de la Torre. From *Sturnira lilium parvidens:* 1, Finca El Zapote, Zapote (Escuintla), 2400 feet elevation, 14 July 1948, R. D. Mitchell and L. de la Torre. MEXICO.—From *Artibeus jamaicensis:* 1, Cueva de Zapaluta (Chiapas), 5000 feet elevation, 26 June 1960, D. C. Carter. From *Enchisthenes hartii:* 1, La Catarina, 2 miles north of Ciudad Guzman (Jalisco), 11 December 1954, L. de la Torre, CNHM Mexican Zoological Field Trip (1954).

REMARKS: *M. pseudopterus* appears to be a parasite of stenodermine bats, especially of the genus *Artibeus.* The records from *Carollia* may represent contaminations. The specimen taken from *Enchisthenes hartii* in Guatemala may represent a second, very closely related new species.

HOST PARASITE RELATIONSHIPS

Definitions

The semantic difficulties in discussing host-parasite relationships are considerable. Terms such as *principal, primary, true, secondary, original, exceptional,* and *normal,* as applied to hosts reflect the attempts to categorize relationships that in a sense cannot be categorized. Yet these terms may be valuable, if their use is clearly understood.

We have used the terms host specificity and host-parasite specificity "in relation to the [taxonomic] range of hosts" (Rogers, 1962, p. 219). However, as Caullery (1952, p. 182) has emphasized, one must recognize the distinction "between specificity in fact and in principle." [12] It is also necessary to distinguish between apparent specificity, based on limited observations, and specificity based on extensive observations throughout the geographic range of the parasite.

Several terms have been used to describe the range of hosts of a parasite: *monoxenous* for species which are restricted to a single host; *oligoxenous* for species which have moderate specificity (Rogers, loc. cit.); and *polyxenous* for species with low specificity. The term oligoxenous has been applied both to species that normally occur on two or more unrelated hosts and to those which occur on closely related ones. Perhaps the term *stenoxenous* should be used for the latter. Thus, *Trichobius joblingi, Speiseria ambigua,* and *Strebla carolliae,* which are characteristic parasites of species of *Carollia,* would be stenoxenous, while *Trichobius dugesioides,* which is a characteristic (see below) parasite of *Trachops cirrhosus* but also occurs on *Carollia p. azteca* and possibly *C. subrufa,* would be oligoxenous (see "Host specificity," below).

Oligoxenous and polyxenous and perhaps even stenoxenous species would in most instances probably have *preferred* hosts, but a preferred host may not be the most *suitable* host, i.e., the host on which the parasite has

[12] "The first is specificity shown by the direct observation of natural phenomena; the second that which results from experiment." (Caullery, loc. cit.)

the greatest reproductive success (see Haas, 1965). Given sufficient time and opportunity for adaptation by the parasite, the most suitable host or hosts would in most instances become the preferred host or hosts in a given geographic area. Except in rare instances, use of the term "preferred" for a host has been inferential and not based on extensive observation or experimental evidence. We have used the terms *principal* or *primary* to indicate the host to which the largest number of records apply. It may or may not be the most suitable host or the preferred host but may simply reflect the known records. Needless to say, these reflect the history and accidents of collecting, and relative abundance of hosts.

When Jobling (1949) summarized what was known about the host-parasite relationships of New World Streblidae, he referred to Streblidae that normally occur on more than one host as being *heteroxenous*. We do not use this term because it is generally applied to parasites which complete their cycle of development only by passing through (or on) two or more (intermediate and definitive) successive hosts (see Caullery, op. cit., p. 127). This term would properly apply to most ticks.

We found it convenient to use Caullery's (op. cit.) distinction between *normal* and *exceptional* hosts. The latter would run the gamut from transitory or temporary hosts to hosts of very low preference. We would not include disturbance transfers and contaminations under this category. Similarly, we referred to parasites which regularly and consistently occur on a host (though not necessarily with a high degree of preference for it) as its *characteristic* or *normal* parasites, the others as *exceptional* parasites.

Species of the same genus, which occur together on the same host species, we refer to as *synoxenous,* and those which occur on different hosts in the same or different geographic areas as *alloxenous.* Alloxenous species may be either sympatric or allopatric.

We suggest that the terms *host limitation* and *host-limited* be used to refer to the extent to which the parasite, throughout its life cycle, is directly dependent upon and associated with the host. Thus, holometabolous insects with free-living young, like fleas, exhibit a low degree of host limitation. Batflies, which are pupiparous and generally leave the host only long enough to pupiposit or mate, exhibit a high degree of host limitation. Anoplura and Mallophaga are host-limited, since all stages of the life cycle are directly dependent upon the host.

Host Specificity

Perhaps the greatest single need in determining the degree of host specificity in fact, is for sufficiently large and carefully made, geographically representative collections that enable one to statistically evaluate the frequency with which a parasite is found on a given host or hosts. The literature is replete with host-parasite lists which are not and cannot be evaluated. For groups like the Anoplura and the Mallophaga which are host-limited and exhibit an extraordinarily high degree of host specificity, the problem is of an entirely different order than for Siphonaptera which are much less host-limited, or for the Streblidae. The Streblidae are for the most part winged and thus quite mobile. Further, their hosts tend to roost in association with other species. The number of exceptional associations and of contaminations due to pooled collecting are relatively high, even for species which prove to be monoxenous.

Thus, in the absence of quantitative data, it is difficult to determine the degree of host specificity, even if the parasite is monoxenous or oligoxenous, especially if their hosts are ubiquitous. For such hosts may not only acquire the parasites of other hosts, but their parasites in turn may transfer, with varying degrees of ease, to other hosts with which the normal host roosts (hosts whose ecological adjustments most nearly approach those of the normal host) or to hosts which are taxonomically related.

The Streblidae of bats of the genus *Carollia* illustrate these points. In Panama, three species of *Carollia* were collected. *Carollia perspicillata* is one of the commonest and most widespread bats in the lowland tropics of Central and South America. It is tolerant of a wide variety of lowland ecological conditions. Because it is catholic in its selection of roosting sites, it comes to roost in association with a wide variety of bats. In Trinidad alone, where the bat fauna (62 species) is somewhat limited by comparison with the mainland, Goodwin and Greenhall (1961) recorded roosting associations of *C. p. perspicillata* with 23 other species of bats. The same ecological amplitude is shown by *C. p. azteca* in Panama.

Carollia castanea, on the other hand, though a common lowland species, is more limited ecologically, and thus in its roosting sites, than *C. p. azteca. Carollia subrufa* is also an abundant bat in certain lowland localities, but again is more restricted ecologically than *C. p. azteca.* It also occurs at higher elevations than either *azteca* or *castanea,* especially above 3000 feet, where the number of species, of both bats and streblids, are sharply reduced. Thus, by comparison with *azteca,* the opportunities for parasite exchange between *C. subrufa* or *C. castanea* and other bats are greatly reduced.

The records of Panamanian Streblidae reflect the differences in ecological amplitude of these hosts. Fifteen species were collected from *C. p. azteca,* four from *C. subrufa,* and three from *C. castanea.* Three—*Speiseria ambigua, Strebla carolliae,* and *Trichobius joblingi*—occurred on all three hosts. As can be seen from table 6 and fig. 141, they were the predominant flies on *Carollia p. azteca.* They were the only species on *C. castanea.* These data suggest that they are characteristic or normal parasites of bats of the genus *Carollia,* possibly of all Carolliinae, and that other species (all of which show high numerical values for other hosts) are either exceptional parasites, or represent contaminations or errors. If this is true, then these three species should occur only infrequently, as exceptional parasites or contaminations, on hosts other than *Carollia.* This is indeed the case. Conversely, this apparently is also true for the 12 other species reported from *Carollia.* Nearly all of them are from hosts with which *Carollia* may roost, and they show the same high incidence of parasitization for their normal hosts, as do the species characteristic for *Carollia* on *Carollia.* The bar graphs in fig. 141 show the incidence of parasitization by streblid species, of *Carollia p. azteca* and seven hosts (among many) with which it

TABLE 6. STREBLIDAE FROM BATS OF THE GENUS *CAROLLIA*, ACCORDING TO SPECIES

	A Number of bats parasitized	B Percent of bats parasitized	C Percent of streblid-infested bats	D Number of Streblidae taken	E Percent of all Streblidae on host
Carollia p. azteca 339 considered; 284 (83.8%) parasitized by Streblidae					
Trichobius joblingi	282	83.18	99.29	1104	74.44
Speiseria ambigua	99	29.20	34.85	160	10.78
Strebla carolliae	100	29.49	35.21	121	8.15
Trichobius dugesioides	38	11.20	13.38	53	3.57
Strebla altmani	19	5.60	6.69	29	1.95
Trichobius yunkeri	3	0.88	1.05	3	0.20
Metelasmus pseudopterus	3	"	"	"	"
Aspidoptera busckii	2	0.58	0.70	2	0.13
Trichobius macrophylli	"	"	"	"	"
Aspidoptera delatorrei	1	0.29	0.35	1	0.06
Mastoptera guimaraesi	"	"	"	"	"
Nycterophilia parnelli	"	"	"	"	"
Trichobius dugesii	"	"	"	"	"
" *johnsonae*	"	"	"	"	"
" *sparsus*	"	"	"	"	"
Carollia castanea 36 considered; 34 (99.4%) parasitized by Streblidae					
Trichobius joblingi	34	94.44	100.00	78	86.66
Strebla carolliae	6	16.66	17.64	6	6.66
Speiseria ambigua	4	11.11	11.76	6	6.66
Carollia subrufa 30 considered; 19 (63.3%) parasitized by Streblidae					
Trichobius joblingi	18	60.00	94.73	66	91.66
Speiseria ambigua	4	13.33	21.05	4	5.55
Strebla carolliae	1	3.33	5.26	1	1.38
Trichobius dugesioides	1	3.33	5.26	1	1.38

commonly roosts, in Panama. The eight species of bats belong to the family Desmodidae and four subfamilies of Phyllostomidae. The implications need no further explanation. The very low incidences mostly represent transitory transfers, or other nonspecific associations, but some undoubtedly represent errors or contaminations due to collecting techniques. It is to be expected that a large percentage of exceptional species will be reported

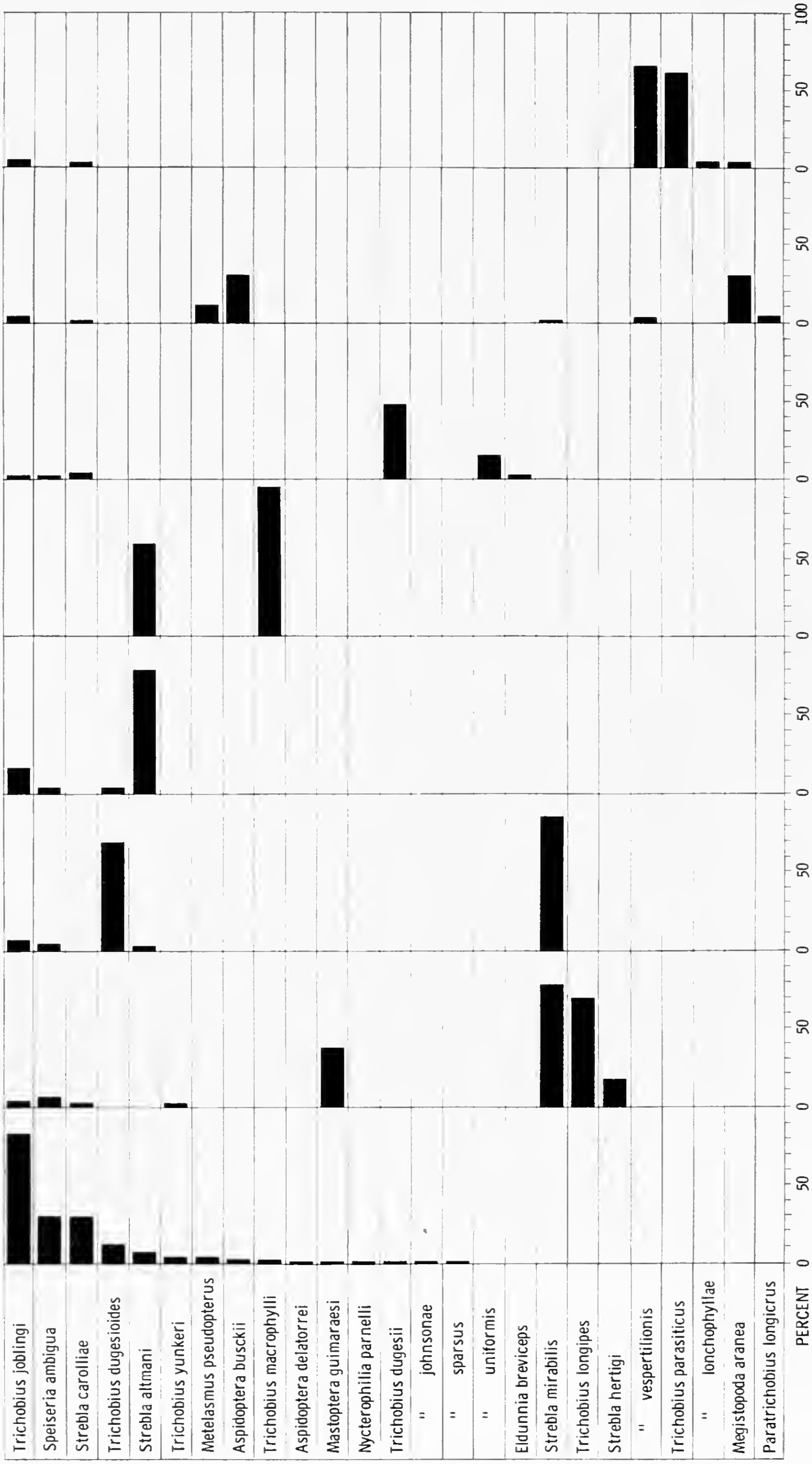

Fig. 141. Incidence of Streblidae on eight species of bats in Panama (in percent of specimens of each host species parasitized).

from ubiquitous hosts, because of the more numerous opportunities for transfer of parasites from other bats. There will also be a larger number of contaminations and errors recorded for them, simply because more are collected. It will be noted that some of the parasites listed in fig. 141 (like *Trichobius yunkeri*, *T. johnsonae*, and *Nycterophilia parnelli*) are characteristic parasites of other hosts, like *Pteronotus* spp., which are not included in the figure.

Two species of Streblidae, *Strebla altmani* and *Trichobius dugesioides*, which appear to be characteristic parasites of other hosts, occurred in sig-

TABLE 7. INCIDENCE OF *TRICHOBIUS JOBLINGI* (*j.*) AND *T. DUGESIOIDES* (d.) ON *CAROLLIA PERSPICILLATA AZTECA* AND *TRACHOPS CIRRHOSUS CIRRHOSUS* IN PANAMA.

	A Percent of hosts parasitized		B Number of flies collected		C Percent (of all Streblidae on host)		D* Mean no. of flies per host	
	j.	d.	*j.*	d.	*j.*	d.	*j.*	d.
Trachops cirrhosus 55 bats considered; 54 (98.2%) parasitized by Streblidae	5.45	**67.27**	5	**263**	1.59	**84.02**	0.09	**4.69**
Carollia p. azteca 339 bats considered; 284 (83.77%) parasitized by Streblidae	83.18	**11.20**	1104	**121**	74.44	**3.57**	3.87	**0.18**

*Mean no. per host = mean no. of each species per host bat parasitized by that species.

nificant numbers on *C. p. azteca*. *S. altmani* appears to be characteristic of both *Lonchorhina aurita* and *Macrophyllum macrophyllum*, related genera of Phyllostominae. Although it was taken on 5.6% of the *Carollia p. azteca* considered, it apparently did not occur on *Carollia* in the absence of one of the normal hosts. *T. dugesioides* appears to represent a more complicated situation. It parasitized 67% of the specimens of *Trachops cirrhosus* examined (table 7) and constituted 84% of the Streblidae on that host, but it parasitized only 11.2% of *Carollia p. azteca* and constituted only 3.57% of the Streblidae on that host. Records indicate that it is an exceptional parasite of other hosts. *Trachops cirrhosus* and *Carollia p. azteca* often roost in the same sites.

There appears to be very little transfer of *T. joblingi* from its normal host, *C. p. azteca*, to *Trachops*, while the reverse appears to be true for *dugesioides* from *Trachops* to *Carollia p. azteca*. One might assume from the data that the incidence of *T. dugesioides* on *C. p. azteca* is to be explained by a simple transfer from *Trachops*, when the two hosts roost together. This does not appear to be the case. Most of the specimens of *dugesioides* that occurred on *Carollia p. azteca* were from bats that roosted in caves and a mine shaft, typical sites for *Trachops cirrhosus*. Interestingly, no *Trachops* were recorded from these collecting sites. On the other hand, quite a different situation prevailed among hosts collected from a culvert along Chepo Road. Here, a series of seven *Trachops cirrhosus* were infested with an average of 17 *dugesioides* per bat parasitized by that species, as opposed to an average of 4.69 for all localities. Seventeen *Carollia p. azteca* were collected in this same culvert. Not a single specimen of *T. dugesioides* was taken from them! The reasons are not apparent, but several possibilities are suggested. Fifteen of the 17 *Carollia* were females; it may be that *dugesioides* is not attracted to females. However, in other localities where *Carollia* was parasitized by *dugesioides*, there was no observable difference in parasitization according to sex of the host. One may suggest, too, that transfer does not easily take place in an "unnatural" roosting site such as a culvert. Still another possibility is that this streblid has such a strong preference for *Trachops* that it will parasitize another host only if it emerges from the puparium in the absence of the normal host, for example, if the *Trachops* colony has moved to another roosting site. If this is the case, it would be most interesting to determine whether or not host-conditioning of these parasites takes place.

Analyses of host associations, similar to those shown in table 6 were used to evaluate the relationships of most of the common hosts and their Streblidae. These were the bases for determining which flies are normal or characteristic for a host in the host-parasite list (p. 663).

This is a simple approach. Much more sophisticated statistical techniques will be needed for investigating many of these problems. For example, we have not taken into consideration the size of the sample. Data have been lumped to a considerable extent. We have eliminated from consideration mixed collections or pooled collections, or collections which we definitely know to have been contaminated. The columns indicate different indices that can be used as a guide in evaluating the degree of host specificity. In general, it was our experience that if the values in Columns B, C, and E were below 1%, the records represented contaminations and errors in labeling, or disturbance transfers. Slightly higher values appeared to represent disturbance transfers or transitory associations of a non-specific nature. In most instances normal associations, including those of low host preference, gave higher values.

In general, each of the figures appears to be a valid index as to the degree of specificity. In some instances, the percentage for each species of the total number of Streblidae collected from the host, gave a better appreciation of the relationship to the host. In others, especially when populations of Streblidae on the host were small, the figures in Columns B and C gave a clearer picture. In instances where the host is parasitized only under special circumstances, the figure in Column C was more instructive. For example, *Strebla alvarezi* was taken on species of *Micronycteris* and on *Saccopteryx bilineata*, two genera of bats which often roost in close proximity (see p. 627).

The incidence of parasitization of these hosts by *S. alvarezi* (table 9) was very low. It was only 12.09% for the 124 specimens of *Micronycteris megalotis* collected, and even lower for *Saccopteryx bilineata.* The figure for *Trichobius keenani,* a species known to us only from species of *Micronycteris,* is even lower. Thus, the figures given in Column B for the over-all incidence of *S. alvarezi* could be interpreted to mean that *megalotis* is an exceptional host of this fly. However, *Micronycteris* species roost in small groups, usually in relatively exposed situations (see pp. 627 and 647), conditions probably not suitable for the maintenance of large populations of Streblidae.

If this is true, then bats from many roosting sites would be negative for Streblidae, even though the host might elsewhere be parasitized by species that are restricted to it, or to it and to closely related species. It would seem, then, that a more significant indicator of the host relationship would be a figure which at least to some degree takes this into account, e.g., one which shows the incidence of each species on those bats that were parasitized by Streblidae. Further, this eliminates from consideration host specimens which for one reason or another were not examined, or were not etherized and examined promptly enough to recover the Streblidae. The figures in Column C, then, more nearly approximate those in E and probably give a truer picture of the specificity, though not of the incidence of parasitization within the total population of the host (see p. 647).

We are in need of acceptable indices of host specificity that take into account the variables mentioned. Their development and use would be facilitated by the use of modern data processing techniques.

Analysis of the field data for all of the Streblidae indicates that *in Panama* about 55% of the species are known only from a single host; another 15% appear to be monoxenous, but occasionally occurred as exceptional parasites on other hosts; about 13.5% were stenoxenous, i.e., they occurred on bats of a single genus; and 15% were oligoxenous and normally occurred on bats of two or more genera. A few are unassignable. None were polyxenous.

This is in closer agreement with the conclusions of Ross (1961) than of Jobling (1946), though Ross dealt with only a few species, from a relatively limited area. Jobling concluded that only nine of the 36 species of New World Streblidae recognized by him were monoxenous, and that the rest were "heteroxenous," i.e., they normally occurred on more than one species of bat. His conclusions were the natural consequence of having to deal with unreliable host data and the limited collections available at the time. This made it nearly impossible to discriminate closely related species. His interesting ideas on the relationships between the roosting habits of the hosts and the Streblidae they harbored are generally valid, but his statement that a very large number of the rare forest bats are free of Streblidae is not entirely true. Also contrary to his belief, some species of Streblidae, e.g., *Trichobius macrophylli* and members of the *Trichobius caecus* group, may regularly occur in large numbers on the host, while others may do so in exceptional cases.

Although most of the Panamanian Streblidae appear to be monoxenous or stenoxenous, a preliminary study of extensive collections from Mexico indicates that toward the edge of the distribution of the family, the species tend to be less host specific, at least those that occur on cave bats. Seasonal movements, including migration, appear to be more common among bats of the temperate zone. It seems probable that cave Streblidae would have a better chance of maintaining themselves throughout the year, if they could live on whatever host was predominant at a given time. In other instances, essentially tropical hosts living near the periphery of their range in ecologically "marginal" situations, would probably be less uniformly distributed and less abundant. Other things being equal, ecological polyvalence (including host preference) would presumably be advantageous to parasites of such hosts. This would agree with findings in some other groups of ectoparasites, as well.

Parasite Faunules

Because of the high degree of host specificity, it is possible, in most cases, to identify a host by its Streblidae. This is true even when the parasites are not strictly monoxenous, because the composition of the streblid faunule of a host is distinctive. For example, *Strebla carolliae, Trichobius joblingi,* and *Speiseria ambigua* constitute a faunule that is characteristic of bats of the genus *Carollia.* If *Trichobius dugesioides* is also present, the faunule is characteristic of *Carollia perspicillata azteca* and possibly of *C. subrufa.* Similarly, *Trichobius costalimai, Trichobioides perspicillatus* and *Strebla hertigi* form a characteristic faunule of *Phyllostomus discolor,* both *P. d. discolor* and *P. d. verrucosus.*

The streblid faunule may differ between "subspecies" of the host. For example, *Trichobius longipes, Mastoptera minuta,* and *Strebla consocius* constitute the faunule on *Phyllostomus hastatus hastatus,* at least in northern South America, while *T. longipes, Mastoptera guimaraesi* and *Strebla mirabilis* constitute the faunule on *P. h. panamensis* in northwestern South America and Panama. In the lowlands of Panama (and possibly Colombia), this faunule may include *Strebla hertigi,* as well. The faunule may also vary geographically in the same subspecies. For example, in Costa Rica and Nicaragua, *Strebla mirabilis* apparently disappears from *P. h. hastatus* and is entirely replaced by *S. hertigi.*

In Panama, the number of characteristic species per host varied from one to five. Not all of them necessarily occur on each host bat or in all roosting sites or localities. Below, we have listed the number of host species collected in Panama that fell into each category.

No. of characteristic streblid species per host:	0	1	2	3	4	5
No. of host species:	51	14	21	7	6	1

These figures will change with further collecting. For example, it will probably be found that fewer than 14 hosts harbor only a single species, and that some of the hosts which were negative do have Streblidae.

Undoubtedly, many factors determine the nature of the streblid faunule on any one bat, including evolutionary history of host and parasite, physical and biotic factors of the environment (including the host), biology of host and parasite, and size of host and parasite, to list a few. In general, the largest number of species of Streblidae are recorded from hosts that are ecologically labile, especially ubiquitous hosts and/or hosts that tend to roost in sizable (sometimes very large) colonies. Among such hosts in Panama are *Phyllostomus h. panamensis, Carollia perspicillata azteca, Artibeus jamaicensis,* and *Pteronotus parnellii fuscus.* On the other hand, species of the genus *Tonatia,* which may harbor four or more species of Streblidae each, live in separate family groups! *Carollia p. azteca* had the largest number of characteristic species of any host bat in Panama.

Synoxenous Parasites

Although a little more than 70% of the host species collected harbored two or more species of Streblidae, and 35% harbored three or more, it is only rarely that an individual host bat normally harbors two species of the same genus simultaneously. When this is so, the flies are usually morphologically different types, presumably specialized for living on different body regions of the host. In those rare instances in which this does not appear to be the case, one of the two species appears to be secondarily acquired from an ecologically and/or taxonomically related host, and most if not all of these exchanges appear to be unilateral or non-reciprocal.

We have already noted that *Trichobius joblingi,* a normal parasite of *Carollia,* and *T. dugesioides,* a characteristic parasite of *Trachops* (and possibly of *Chrotopterus*), occur together on *Carollia p. azteca* and, sometimes on *C. subrufa.* On the other hand (see above), *joblingi* rarely transfers from *Carollia* to *Trachops.* Likewise, *Strebla altmani* may occur together with *S. carolliae* on *Carollia p. azteca* but only when the latter is associated with *Lonchorhina aurita,* one of the normal hosts of *altmani;* but *S. carolliae,* the characteristic *Strebla* of *Carollia,* rarely transfers to *Lonchorhina* under the same circumstances.

Trichobius johnsonae is a characteristic parasite of *Pteronotus parnellii fuscus,* and *T. yunkeri* of *Pteronotus suapurensis* and *P. psilotis.* In one instance, 27 specimens of *johnsonae* and 26 of *yunkeri* were recorded on a single specimen of *P. suapurensis.* It cannot be determined from the field data whether or not *P. p. fuscus* was also present. It may be that the collection was not taken from a single host species or individual, as represented.

Trichobius sparsus normally occurs in small numbers together with *T. johnsonae* on *Pteronotus parnellii fuscus.* However, these two species of *Trichobius* belong to different groups and probably are specialized in their feeding habits.

The only other synoxenous species of New World Streblidae that we know are the two species of *Strebla, mirabilis* and *hertigi,* that occur together on *P. hastatus panamensis* in Panama, and possibly Colombia. *S. mirabilis* typically occurs in larger numbers (see following paper, table 11 and fig. 147) as the "dominant" species, and *hertigi* in smaller numbers as the "subordinate" species. However, in Costa Rica and Nicaragua, *mira-*

TABLE 8. INCIDENCE* OF FOUR SPECIES OF STREBLIDAE ON *PHYLLOSTOMUS HASTATUS PANAMENSIS* COLLECTED AT FIVE LOCALITIES IN PANAMA.

Localities	*Strebla mirabilis*	*Strebla hertigi*	*Trichobius longipes*	*Mastoptera guimaraesi*
Chepo Road (Panamá) (hollow tree in forest) 8 Oct. (16 bats)	100.00 (200)	87.50 (40)	100.00 (86)	93.75 (113)
Chilibrillo Caves (Panamá) July & Oct. (17 bats)	76.57 (206)	5.38 (1)	70.58 (45)	5.88 (1)
Madden Dam (Canal Zone) (natural bridge and small cave. 28–29 Sept. (14 bats)	92.85 (170)	14.28 (1)	28.57 (47)	7.13 (1)
Fort Kobbe (Canal Zone) (hollow *Ficus* tree) 9 Oct. (5 bats)	100.00 (77)	0.00	100.00 (35)	0.00
Fort Sherman (Canal Zone) (buildings & bunkers) 4 & 6 April (19 bats)	100.00 (146)	5.26 (1)	47.36 (43)	42.10 (77)

*Shown as percent of hosts parasitized by each species. Figures in parentheses = number of specimens of each species of streblid.

bilis does not seem to occur on *P. h. panamensis* but is entirely replaced on that host by *S. hertigi.* The limited data suggest that competitive displacement is involved. The problem is discussed in the following paper.

Ecology of Parasitization

Little is known about the population ecology and dynamics of Streblidae, or their relation to parasitization of the bat hosts. However, as was pointed out (p. 426), population densities may be high for Streblidae of bats like *Pteronotus*, which roost in relatively large colonies, usually in long established sites, and low (or the parasites absent) in new or temporary sites. In general, too, as Jobling (1949b) indicated, Streblidae tend to be absent from those forest bats which roost in small numbers in exposed situations. Thus, species of Emballonuridae, in general, have few or no Streblidae, or possibly acquire them (see p. 627) from other ecologically associated bats whose roosting sites may be slightly more favorable for Streblidae. Bats like *Thyroptera*, which roost singly or in very small numbers in rolled leaves of *Heliconia* and bananas, lack these flies. Their roosting habits probably render them unsuitable as hosts for Streblidae. However, they may have Nycteribiidae of the genus *Hershkovitzia.*[13] This

[13] The Nycteribiidae appear better able to maintain themselves on hosts that roost apart from others, in relatively restricted sites and in small numbers. As a family, they also have a broader climatic tolerance and distribution than do Streblidae.

may be the situation, too, in *Anthorhina* and *Mimon,* the only Phyllostomidae known to us that normally harbor Nycteribiidae. Closely related phyllostomine genera are parasitized by Streblidae and have distinctive faunules. Even bats of the genus *Tonatia,* which roost in family groups, have well-developed streblid faunules. However, these bats usually roost in the interior of *Nasutitermes* nests which had been hollowed out and used as nests by parrots, and then abandoned. In such an enclosed "home," it is likely that the microclimate and other conditions are suitable for Streblidae. Further, the Streblidae would be relatively restricted, to both bat and roosting site, and the hazards of being separated from the host would be correspondingly reduced.

In bats whose roosting sites and habits fall between the extremes represented by *Pteronotus* and *Thyroptera,* one would expect to find considerable variance in both the incidence and density of Streblidae, especially if the host roosts in a wide variety of situations. *Phyllostomus hastatus panamensis* appears to be such a host. Table 8 shows the incidence of the four characteristic species of Streblidae of that host, based on collections made at five Panamanian localities. Forest situations appear to be most suitable for parasitization of this host by *S. hertigi* and it is probable that this fly transfers to it from *Phyllostomus d. discolor* in these habitats (see following paper, by Wenzel and Tipton). Caves appeared to be less favorable sites than the others, for all of the Streblidae of *P. hastatus panamensis.* This is interesting, because the genera and species groups of Streblidae represented on this host are characteristic of Phyllostominae, bats which as a group tend to be forest dwellers.

One can only guess at the factors that completely exclude *Mastoptera guimaraesi* from *P. h. panamensis* in a *Ficus* tree, when this fly was present in large numbers on the same host roosting in a building, and also parasitized 100% of the bats in a hollow espavé tree in a forest along Chepo Road. Further, at Fort Sherman, only four *guimaraesi* were recovered from 13 bats collected in one building, whereas 73 were taken from six bats collected in two others!

Similarly, only 14.5% of 124 specimens of *Micronycteris megalotis* collected at 27 sites throughout Panama, were parasitized by Streblidae (table 9). Yet, in an area of a few square miles near the Empire Range (Canal Zone), the senior author and Charles M. Keenan found that 64.7% of them were infested. A thousand yards (or less) away, along the road to Cocolí, the bats were equally as numerous but all were negative for these flies. More bats were collected at these sites than for which data are given, but the differences are nonetheless evident. The area in which the parasitized bats occurred included a considerable amount of forest in which there were logs and large espavé and other trees with basal tree holes, both suitable roosting sites for this bat. In the area along the road to Cocolí, where no parasitized bats could be found, the forest was mostly young "second growth." No tree holes were seen there, and all of the bats taken were roosting in culverts and similar man-made sites.

As pointed out (p. 627), *Micronycteris megalotis* roosts in small num-

Table 9. Incidence of Streblidae on *MICRONYCTERIS MEGALOTIS MICROTIS* in Panama

	A Number of *megalotis* parasitized	B Percent of *megalotis* parasitized	C* Percent of parasitized *megalotis*	D Number of Streblidae taken	E Percent of all Streblidae on host
Empire Range Area					
6 sites: 17 bats	11	64.70			
Strebla alvarezi	10	58.82	90.90	15	65.21
Trichobius keenani	3	17.64	27.27	8	34.78
Total, excluding Empire Range Area					
21 sites: 107 bats	7	6.54			
Strebla alvarezi	5	4.67	71.42	5	50.00
Trichobius keenani	2	1.86	28.57	5	50.00
Total localities					
27 sites: 124 bats	18	14.51			
Strebla alvarezi	15	12.09	83.33	20	60.60
Trichobius keenani	5	4.03	27.77	13	39.39

*Percent of those *megalotis* parasitized by Streblidae that were parasitized by *S. alvarezi* or *T. keenani*, respectively.

bers, in *relatively* exposed situations. In natural habitats, it roosts just inside tree holes and hollow logs, but in habitats disturbed by man, it also roosts in culverts, buildings, and similar sites. In the Empire Range area, parasitized individuals were taken in all of these roosts. We think it probable that the parasites of this bat can establish and maintain themselves only in relatively undisturbed areas, where the host populations are able to roost in natural and relatively stable sites such as tree holes, and where populations of the host have maintained themselves over a considerable period of time. This would explain the absence of the parasites in such heavily disturbed areas as the one outside the Empire Range area near Cocolí.

Extensive and intensive collecting, with appropriate ecological observations, population estimates of the hosts, and other data, will provide valuable insights, but autecological studies of hosts and parasites are essential to an understanding of the problems of parasitization.

Taxonomic Concordance

It is premature to attempt a detailed study of the concordance between the classification of the Streblidae and that of their hosts. The taxonomy and morphology of the Streblidae are too imperfectly known to permit one to delineate probable phyletic relationships within the family. Still to be investigated are puparial characters, internal morphology, morphology of the reproductive apparatus, and chromosome karyotypes, among others.

Nonetheless, a tentative grouping (table 10) of the genera and species groups of the New World Streblidae, based largely on structure of the abdomen and head, reveals a number of interesting correlations with the classification of the hosts.

In the *Trichobius pallidus, caecus,* and *major* groups, the laterovertices and occipital lobes or plates of the head are poorly differentiated. They are better differentiated, but still poorly sclerotized, in *Joblingia* and *Anatrichobius.* They are well sclerotized in other genera. In Series 3, they are well differentiated, and in Series 4 (Streblinae), they reach their maximum development and differentiation.

One may question the validity of these groupings, since any of the characters on which they are based could evolve independently. We tentatively regard the insertion of the accessory setae posterior to the macrosetae on the male gonapophyses as a generalized condition, and the free cerci of the female as a derived condition. In some instances, the gonapophyseal setae are poorly differentiated; and it cannot be determined which, if any, are accessory and which are macrosetae. Likewise, it is sometimes very difficult to determine whether the female cerci are free or not. It will be necessary to further investigate these and many other characters. However, with the exception of Series 3, the series seem to be internally consistent, even though the *inter* and *intra* series relationships are not clear.

If the groupings have validity, then it appears that *Trichobius* is not a homogeneous genus. This is certainly true. The genus is sufficiently polymorphic that one can justify creating a series of separate genera or subgenera for most of the *Trichobius* groups and perhaps even further subdivide the *major* group. Some of these appear to be ancestral to distinctive evolutionary lines. For example, it is clear that *Joblingia* and *Anatrichobius* are brachypterous derivatives of the *major-corynorhini* subgroup of the *major* group of *Trichobius.* It is also reasonably clear that *Megistopoda, Paratrichobius* and *Neotrichobius* evolved from species of, or closely related to, the *Trichobius phyllostomae* group; that the *dugesii* group is closely related to and probably derived from the *longipes* group; that the genus *Trichobioides* evolved from a species of, or related to the *dugesii* group; and further that the brachypterous *Mastoptera* probably evolved from a species related to *Trichobioides perspicillatus.*

In their male and in some female characters, the Streblinae appear similar to the *caecus* group of *Trichobius.* However, they are so highly specialized in their head characters, and differ sufficiently in most female characters that, at present, we cannot demonstrate a relationship. Within the Trichobiinae, the least specialized streblids appear to be the *pallidus, caecus* and *major* groups of *Trichobius.* The male of *Synthesiostrebla* has not been examined. The general morphology and female genital structure suggest that the genus may be related to the *pallidus* group.

The female of *Stizostrebla longirostris* has not been studied, either, but its morphology suggests that it is closely related to *Pseudostrebla.* Superficially, *Parastrebla handleyi* appears very similar to *Pseudostrebla,* but in its female genital structure is very similar to members of the *Trichobius*

TABLE 10. TENTATIVE GROUPING OF NEW WORLD STREBLIDAE.
(* = recorded from Panama. ? = assignment dubious.)

DIVISION I

Subfamily NYCTEROPHILIINAE. Form flea-like. Abdominal terga I and II distinctly separated lateroventrally, fused dorsally; sterna I–VI of male represented by normally developed, similar sclerites. Male genital apparatus external.

Nycterophilia Ferris, p. 432
coxata Ferris, p. 434
**fairchildi* n.sp., p. 436
**natali* n.sp., p. 438
**parnelli* n.sp., p. 434

DIVISION II

Subfamilies TRICHOBIINAE, STREBLINAE. Form not flea-like. Abdominal terga I and II completely fused; male sterna dissimilar, III and IV absent, V and VI often absent. Male genital apparatus internal.

SERIES 1 (TRICHOBIINAE). *Male.*—Accessory gonapophyseal setae inserted posterior to the macrosetae. Female.—Abdominal cerci articulated or fused with ventral arc; postgenital sclerite usually present.

Trichobius Gervais, p. 442
pallidus group, p. 447
pallidus (Curran), p. 447
caecus group, p. 448
caecus Edwards, p. 450
**galei* n.sp., p. 449
**johnsonae* n.sp., p. 455
**yunkeri* n.sp., p. 453

?**Synthesiostrebla** Townsend, p. 429
amorphochili Townsend, p. 429

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Trichobius Gervais
major group, p. 456
?*adamsi* Augustson, 1943
corynorhini Cockerell, 1910
hirsutulus Bequaert, 1933
major Coquillet, 1899
pseudotruncatus Jobling, 1939a
(= *kesselae* Jobling, 1938)
**sparsus* Kessel, p. 457
sphaeronotus Jobling, 1939a
truncatus Kessel, 1925

Joblingia Dybas & Wenzel, p. 507
**schmidti* Dybas & Wenzel, p. 507

Anatrichobius n.g., p. 502
**scorzai* n.sp., p. 503

?**Parastrebla** n.g., p. 578
**handleyi* n.sp., p. 579

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Trichobius Gervais
phyllostomae group, p. 496
**brennani* n.sp., p. 497
phyllostomae Kessel, p. 498
**vampyropis* n.sp., p. 500

Megistopoda Macquart, p. 540
(= *Pterellipsis* Coquillet, 1899)
**aranea* (Coquillet), p. 542
pilatei Macquart, p. 541
**proxima* (Séguy), p. 543
**theodori* n.sp., p. 545

Paratrichobius Costa Lima, p. 518
**dunni* (Curran), p. 527
**longicrus* (M. Ribeiro), p. 521
**lowei* n.sp., p. 528
**sanchezi* n.sp., p. 530
**salvini* n.sp., p. 532

Neotrichobius n.g., p. 536
**stenopterus* n.sp., p. 539

SERIES 2 (TRICHOBIINAE). *Male.*—Accessory gonapophyseal setae inserted anterior to macrosetae. *Female.*—Cerci united with ventral arc; postgenital sclerite absent except in *Speiseria*.

Trichobius Gervais
uniformis group, p. 459
**keenani* n.sp., p. 462
**lionycteridis* n.sp., p. 464
**lonchophyllae* n.sp., p. 461
**uniformis* Curran, p. 459

Speiseria Kessel, p. 549
**ambigua* Kessel, p. 549

TABLE 10 (continued)

SERIES 3 (TRICHOBIINAE). Head without a complete ventral ctenidium. *Male.*—Accessory gonapophyseal setae inserted anterior to the macrosetae. *Female.*—Cerci free; postgenital sclerite absent.

Noctiliostrebla n.g., p. 560
- *aitkeni* n.sp., p. 567
- **maai* n.sp., p. 569
- *dubia* (Rudow), p. 563
- *megastigma* (Speiser), p. 564
- **traubi* n.sp., p. 565

Paradyschiria Speiser, p. 571
- *fusca* Speiser, p. 573
- **lineata* Kessel, p. 574
- *parvula* Falcoz, p. 574
- **parvuloides* n.sp., p. 575

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Trichobius Gervais

longipes group, p. 465
- **bequaerti* n.sp., p. 471
- **costalimai* Guimarães, p. 471
- **dunni* n.sp., p. 474
- **dybasi* n.sp., p. 469
- **longipes* (Rudow), p. 465 (= *mixtus* Curran)
- **mendezi* n.sp., p. 469

dugesii group, p. 476
- *diphyllae* n.sp., p. 492
- **dugesii* Townsend, p. 478
- **dugesioides* n.sp., p. 488
- *furmani* n.sp., p. 490
- **joblingi* n.sp., p. 481
- **macrophylli* n.sp., p. 486
- **parasiticus* Gervais, p. 494
- **urodermae* n.sp., p. 476

Trichobiodes n.g., p. 510
- **perspicillatus* (Pessôa & Galvão), p. 511

Mastoptera n.g., p. 512
- **guimaraesi* n.sp., p. 514
- **minuta* (Costa Lima), p. 515

Exastinion (Pessôa & Guimarães), p. 558
- **clovisi* (Pessôa & Guimarães), p. 558

Aspidoptera Coquillet, p. 551
- **busckii* Coquillet, p. 555
- **delatorrei* n.sp., p. 557
- *phyllostomatis* (Perty), p. 553

Pseudostrebla Costa Lima, p. 582
- **greenwelli* n.sp., p. 582
- **ribeiroi* Costa Lima, p. 582

?**Stizostrebla** Jobling, p. 586
- *longirostris* Jobling, p. 586

Eldunnia Curran, p. 586
- **breviceps* Curran, p. 588

SERIES 4 (STREBLINAE). Head with a complete ventral ctenidium. *Male.*—Accessory gonapophyseal setae inserted posterior to the macrosetae. *Female.*—Cerci free; postgenital sclerite usually absent.

Strebla Wiedemann, p. 591
- **altmani* n.sp., p. 623
- **alvarezi* n.sp., p. 625
- **carolliae* n.sp., p. 619
- **christinae* n.sp., p. 606
- *consocius* n.sp., p. 600
- **diaemi* n.sp., p. 599
- *diphyllae* n.sp., p. 613
- **galindoi* n.sp., p. 604
- **hertigi* n.sp., p. 596
- **hoogstraali* n.sp., p. 603
- **kohlsi* n.sp., p. 618
- *machadoi* n.sp., p. 607
- *mexicana* Rondani, p. 610
- **mirabilis* (Waterhouse), p. 615
- *tonatiae* (Kessel), p. 602
- **vespertilionis* (Fabricius), p. 609

Paraeuctenodes Pessôa & Guimarães, p. 627
- *longipes* Pessôa & Guimarães, p. 627

Anastrebla n.g., p. 627
(= *Strebla* of authors, not Wiedemann, 1824)
- **mattadeni* n.sp., p. 631
- **modestini* n.sp., p. 629
- **nycteridis* n.sp., p. 629

Metelasmus Coquillet, p. 634
- **pseudopterus* Coquillet, p. 634

The species arrangement is alphabetical. The page on which treated or cited is given for each genus and species. The year of publication is added for species not cited in the text.

major group, especially *T. truncatus.* The male of *Parastrebla* is unknown.

The genital apparatus of *Paradyschiria* and *Noctiliostrebla* appears to be less specialized than in the other Trichobiinae, though it may have undergone simplification. Until they can be studied in greater detail, these two genera are placed in Series 3 with some reservations.

In female genital structure (see pp. 519, 549), *Speiseria* is clearly related to the *Trichobius phyllostomae* group and related genera (Series 1). However, it differs from them in the arrangement of the paired (male) gonapophyseal setae. It can hardly be regarded as related to the *Trichobius uniformis* group, with which it is placed here. The disposition of its gonapophyseal setae may have evolved independently of other groups that have the same arrangement.

Because the Streblidae exhibit a high degree of host-limitation and specificity, the groups of Streblidae proposed above, should, if they have any validity, show some concordance with the host taxa. A number of them do, as will be shown below. In figures 142–146, characteristic host associations were used.

Division I. NYCTEROPHILIINAE

Of seven species (four described) of *Nycterophilia,* five occur on Chilonycterinae and Natalidae (fig. 142).[14] An undescribed species, closely related to one that occurs on *Mormoops* (Chilonycterinae) has been taken from *Platalina* (Glossophaginae). *N. coxata* occurs on *Macrotus* (Phyllostominae), as does a related undescribed species from the West Indies. All the hosts of *Nycterophilia* are primarily cave inhabitants. This would facilitate transfer of these flies, both on a temporary and an evolutionary basis, from Chilonycterinae and Natalidae to other cave-inhabiting bats, such as *Leptonycteris* and *Macrotus.*

Division II. TRICHOBIINAE and STREBLINAE

Series 1. Two species (one undescribed) of the *Trichobius pallidus* group (fig. 142) occur on bats of the family Furipteridae. The species of the *caecus* group are closely related to them but differ in being somewhat more specialized. Their eyes are reduced to a single facet, the median thoracic suture is reduced to a short fork, and the first tarsomere possesses a specialized comb scale. There are several undescribed species from *Natalus* and *Pteronotus* but these have not been studied in enough detail to include in the figure.

The host distributions of these groups of *Trichobius* and of *Nycterophilia* support the view of Dalquest and Werner (1954) and de la Torre (1962) that the Chilonycterinae should be regarded as a separate family of

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[14] The dendrogram of presumed relationships of the families and subfamilies of New World Chiroptera in figures 142, 143, and 145, is based in part upon a sketch provided by Dr. Karl Koopman. We have inserted the Emballonuridae and Vespertilionidae, not included by Dr. Koopman and have changed the position of the Desmodidae.

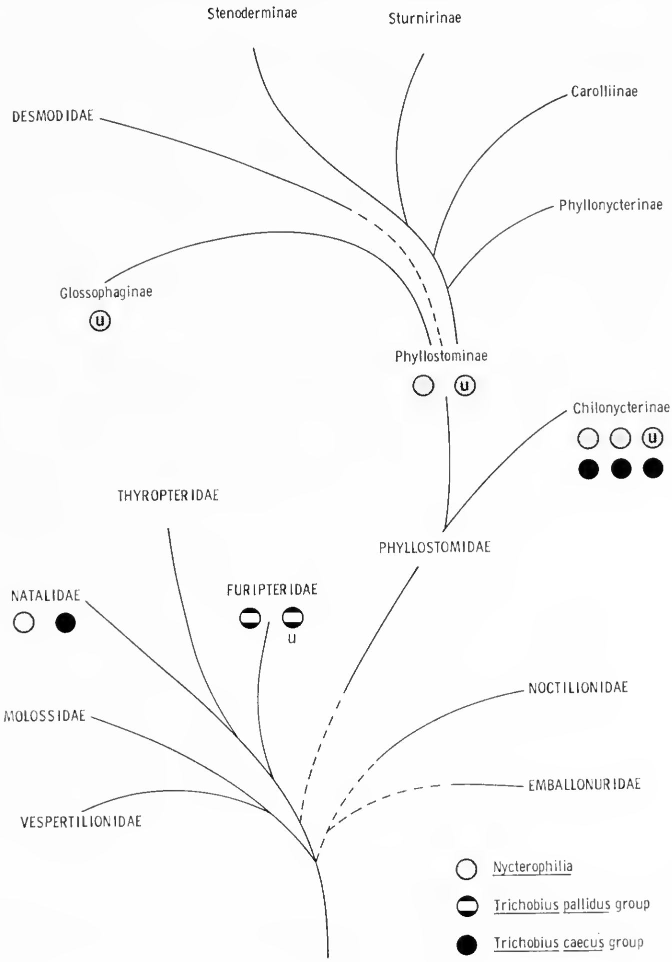

Fig. 142. Dendrogram of families and subfamilies of New World bats, showing host distribution of the species of *Nycterophilia* and of the *Trichobius pallidus* and *caecus* groups. Unless otherwise indicated each symbol represents a separate species. (u = undescribed species.

Vespertilionoidea rather than as a subfamily of Phyllostomidae. On the basis of facial histology (the presence of certain glands), Dalquest and Werner (op. cit.) placed them nearer the Vespertilionidae than to the Furipteridae and Natalidae. De la Torre (unpub. thesis) states that "In skull structure and general morphology the chilonycterid group appears to be much closer to the family Natalidae and to other related genera (*Furipterus, Amorphochilus*, and *Thyroptera*) than to the phyllostomid group." This view is more consonant with the streblid distribution than is that of Dalquest and Werner.

The *Trichobius major* group, and the related brachypterous genera

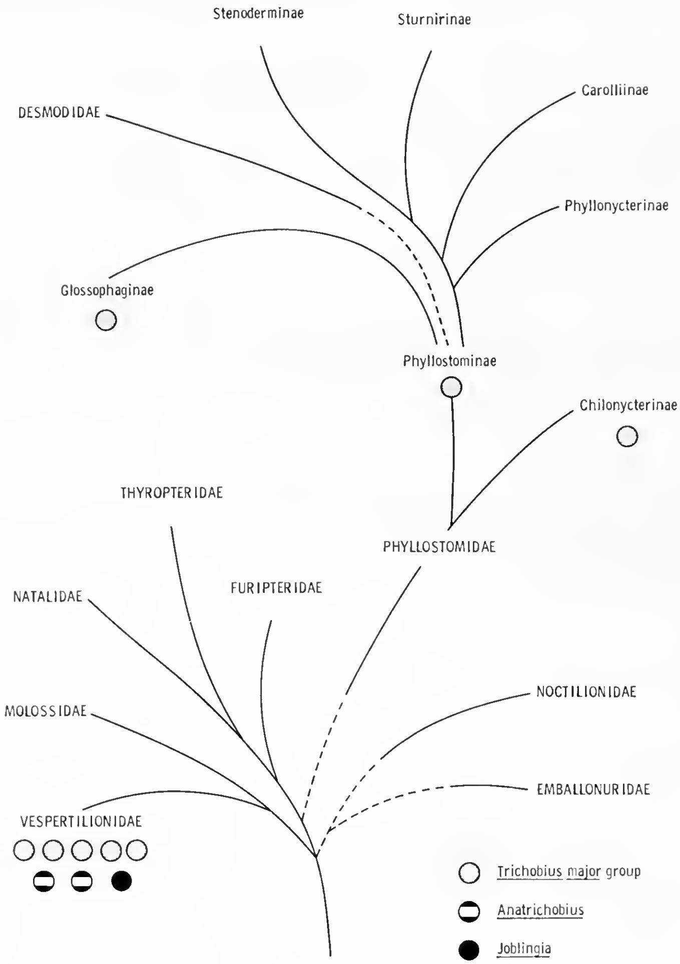

Fig. 143. Dendrogram of families and subfamilies of New World bats, showing host distribution of the species of the *Trichobius major* group and of the derived genera, *Joblingia* and *Anatrichobius* (Series 1). Each symbol represents a separate species.

Joblingia and *Anatrichobius* (fig. 143), occur primarily on cave-dwelling Vespertilionidae, with the exception of a few more specialized forms which occur on other cave bats. These include *T. sparsus* on *Pteronotus parnellii* (Chilonycterinae) and *T. sphaeronotus* on *Leptonycteris nivalis* (Glossophaginae). *Trichobius adamsi* on *Macrotus* (Phyllostominae), is doubtfully included in this group. The species with the most generalized female genital structure are primarily warm temperate North American and subtropical in distribution, either latitudinally or altitudinally. *Joblingia* has been taken only at altitudes above 5500 feet in Panama, Costa Rica, and Guatemala. *Anatrichobius* has been taken at similar elevations in tropical South America and at lower elevations in the southern latitudes.

The Streblidae treated thus far appear to be the most generalized in genital and abdominal structure of all the New World Streblidae. It is interesting to note that they occur chiefly on Vespertilionoidea, which, like the Emballonuroidea, are generally regarded as among the most generalized Microchiroptera. Further, these flies occur chiefly on cave bats. It has been suggested (Jobling, 1949b; Theodor, 1957) in regard to the origin of batflies, that they evolved from guano-inhabiting flies of caves. Few New World Streblidae occur on Emballonuroidea, with the exception of *Paradyschiria* and *Noctiliostrebla* on the Noctilionidae, and several species on Emballonuridae. This is probably because most New World Emballonuridae roost in very small numbers, in exposed situations. Those on the Emballonuridae are related to forms that occur on Phyllostomidae, and at least one host (see p. 627), shares a species with ecologically associated phyllostomine bats.

The *Trichobius phyllostomae* group and the presumably derived genera, are also placed in Series 1, but do not appear to be closely related to the other streblids of that series. All of the described species [15] occur on genera that de la Torre (op. cit.) places as two compact and related groups of Stenoderminae (fig. 144).[16] Their host distribution not only indicates that these Streblidae are closely related and have primarily radiated on the Stenoderminae, but also supports de la Torre's grouping of these hosts.

Of special interest is the distribution of the four species of the *Trichobius phyllostomae* group on *Sturnira, Vampyrops,* and *Artibeus,* and similarly, of the *Megistopoda* species on *Sturnira* and *Artibeus. Aspidoptera,* which belongs to Series 3, is similarly restricted to *Sturnira, Artibeus* (*lituratus* and *jamaicensis*) and possibly *Chiroderma.* Since *Sturnira* apparently does not roost with these bats, though they have been observed feeding with them (de la Torre, pers. comm.), the parallel occurrence of closely related species of three genera of Streblidae on bats of the genera *Sturnira* and *Artibeus,* and of a species of one of these genera on *Vampyrops,* gives credence to de la Torre's contention (op. cit.) that the Sturnirinae should be placed with the Stenoderminae and not retained as a separate subfamily.

Series 2. The species of the *uniformis* group are very closely related. Three of the four occur on three genera of Glossophaginae (fig. 144), respectively, and the fourth (*keenani*) on species of *Micronycteris.* In Panama, *Micronycteris megalotis,* one of the hosts of *keenani,* was frequently found roosting with *Glossophaga soricina,* and it is possible that such an ecological association may, historically, explain this distribution of the flies.

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[15] An undescribed species of *Paratrichobius* has been taken from *Choeronycteris mexicana* in Arizona.

[16] Dr. de la Torre has added several genera which he inadvertently omitted from his dendrogram, which appeared as fig. 4 in his unpublished thesis (1961), and has kindly given us permission to reproduce it. We have used the same dendrogram, with modifications, in fig. 146.

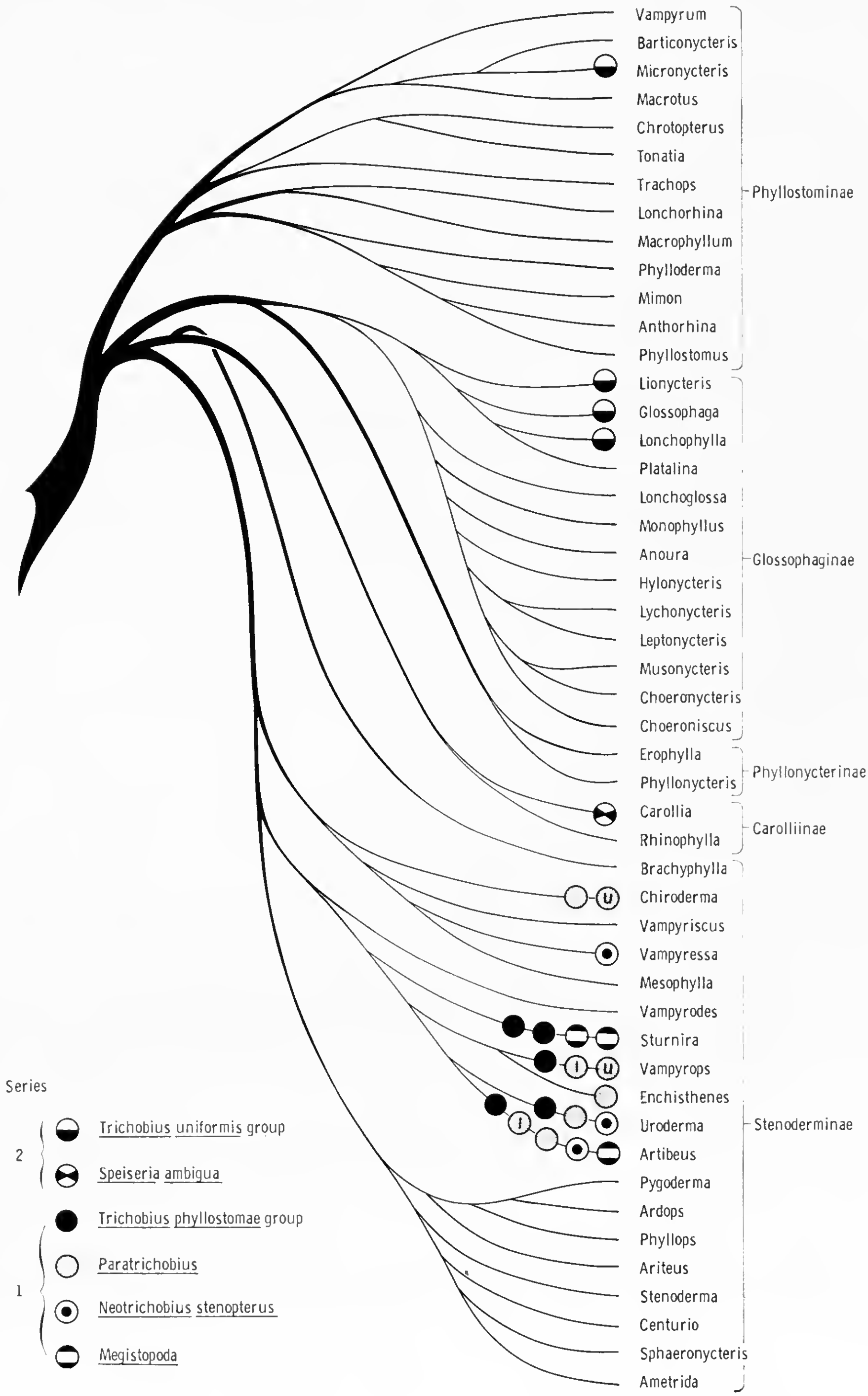

Fig. 144. Dendrogram of relationships of genera of phyllostomid bats, showing host associations of Streblidae of the *Trichobius phyllostomae* group and related genera, and of the *T. uniformis* group. (l = *longicrus* group. u = undescribed species.)

It should be noted that the three host genera of Glossophaginae belong to a cluster of genera that de la Torre considers to be closely related. The Streblidae on other genera of Glossophaginae are not at all closely related to the *uniformis* group.

The genus *Speiseria* cannot be placed satisfactorily with either the *uniformis* group or the *phyllostomae* group and related genera, though it seems to be more closely related to the last-named. It is placed in Series 2, with the *uniformis* group, because of the arrangement of its accessory gonapophyseal setae. In all of its other characters, including the presence of a female postgenital sclerite, it is closer to the *phyllostomae* group and related genera. Although it appears to be primarily a parasite of species of *Carollia*, we have seen several collections taken from *Vampyrops vittatus*, one from Panama, the others from Guatemala. Interestingly, the problem of the relationships of *Speiseria* is much the same as that of the relationship of its principal hosts, the Carolliinae.

Series 3. It should be noted again that the Streblidae of Series 1 and 2—in which the female cerci are articulated or fused with the ventral arc—are largely restricted to or are characteristic parasites of non-phyllostomine bats. On the other hand, most of the genera of Series 3 are characteristic parasites of Phyllostominae, with the exception of *Aspidoptera* on Stenoderminae, *Noctiliostrebla* and *Paradyschiria* on Noctilionidae, and some species of the *Trichobius longipes* and *dugesii* groups. The two latter groups have scattered representatives on a miscellaneous assortment of hosts, probably derived through ecological association. These hosts include Molossidae, Stenoderminae, Glossophaginae, Carolliinae, and Desmodidae, but apparently no Vespertilionoidea or Emballonuroidea.

The distribution of the *longipes* and *dugesii* groups is shown in fig. 145. Several undescribed species are included. With the exception of *T. dunni* and two other closely related (undescribed) species from Molossidae, the members of the *Trichobius longipes* group (p. 465) are restricted to *Phyllostomus* and *Tonatia*, as are the species of *Mastoptera*. These are generally regarded as closely related genera of bats, along with *Mimon*. No Streblidae, only Nycteribiidae, are known from *Mimon*. None are known from the genus *Vampyrum*, either.

In the *dugesii* group, the species of the *dugesii* complex (p. 476) are found on *Macrophyllum* (Phyllostominae), *Glossophaga* (Glossophaginae) *Carollia* (Carolliinae), and *Uroderma* (Stenoderminae). Three undescribed species are known to us from *Anoura* and *Choeronycteris* (Glossophaginae) and *Artibeus* (Stenoderminae). Their close relationship with species of the *Trichobius longipes* group suggests that they are derived from them and have secondarily radiated onto both phylogenetically and ecologically related bats. Of the species in the *parasiticus* complex (p. 487), *T. dugesioides* occurs on Phyllostominae (*Trachops*) and Carolliinae (probably secondarily, on *Carollia*), while three others, including an undescribed species from *Diaemus*, are parasites of Desmodidae. A fifth species, *furmani*, has also been taken on Desmodidae and on *Glossophaga* (Glossopha-

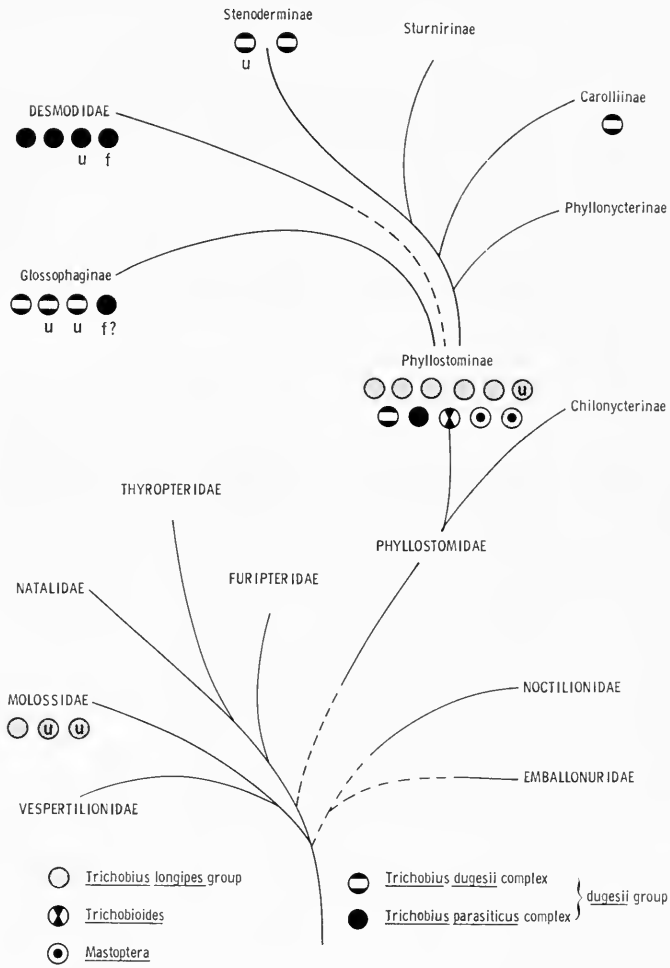

Fig. 145. Dendrogram of families and subfamilies of New World bats, showing host distribution of the species of the *Trichobius longipes* and *dugesii* groups. Unless otherwise indicated, each symbol represents a separate species. (u = undescribed species. f = *T. furmani* new species. ? = host association not confirmed.)

ginae), but its characteristic host has not been ascertained. It is apparent that members of this complex have evolved from parasites of Phyllostominae and some have radiated on the Desmodidae, along with the hosts. The three characteristic species of *Desmodus, Diphylla,* and *Diaemus* are more closely related to each other than to other members of the complex. The most specialized of these three, *T. parasiticus,* parasitizes *Desmodus.*

Series 4. The distribution of genera and species of Streblinae is shown in figure 146. In tibial chaetotaxy and structure of the head, the genus *Strebla* appears to be the most generalized. Most of the species of *Strebla* may be assigned to one of two groups. In the species of one, the frontoclypeus is complete; in the others, it has detached apical plates. Which of these is the generalized condition is not known, though it would seem reasonable to assume that the detached plates are a derived condition. All other Streblidae, including the generalized forms, have a complete frontoclypeus. One species, *S. galindoi*, is intermediate in structure. It is possible that detached plates may have appeared independently more than once, and that their presence may depend to some extent upon the relative length of the head and the mobility of the anterior area. Four of the five species that have a complete frontoclypeus occur on *Phyllostomus* and *Tonatia*, the fifth on *Diaemus*. *S. galindoi*, the species with the intermediate condition, occurs on *Tonatia*. Of the species with detached frontoclypeal plates, five occur on *Phyllostomus*, *Trachops*, and *Tonatia;* one on both *Micronycteris* and *Saccopteryx;* two on Desmodidae; and one on Carolliinae. Three additional undescribed species are known to us, two of them from Emballonuridae (*Saccopteryx* and *Cormura*). These emballonurids appear to be ecologically closely associated with *Micronycteris* (see p. 627), and it seems likely that these species of *Strebla* have moved onto Emballonuridae secondarily. The principal evolution of the genus seems to have been on Phyllostominae, with secondary radiation on the Carolliinae, Desmodidae and possibly Emballonuridae. *Strebla altmani* (on *Lonchorhina* and *Macrophyllum*), *alvarezi* (on *Micronycteris* and *Saccopteryx*), *kohlsi* (on *Tonatia*), *mirabilis* (on *Phyllostomus* and *Trachops*), and *carolliae* (on *Carollia*) appear to be closely related.

The genus *Paraeuctenodes* is known from too few specimens for one to assess host relationships. The only described species, *P. longipes*, was taken from *Lonchoglossa caudifera* (Glossophaginae). We have seen a few specimens of two undescribed species (see p. 627) taken from *Carollia perspicillata*, but this may not be a normal host. In their tibial characters, the species of *Paraeuctenodes* resemble *Strebla* and *Metelasmus*, but unlike them, they lack a remiform postgenal seta.

The three known species of *Anastrebla* occur on *Anoura* (Glossophaginae). An unidentified species has been taken from *Lonchoglossa caudifera* (Speiser, 1900; Kessel, 1924, 1925). The genus *Metelasmus*, which like *Anastrebla* and *Paraeuctenodes* appears to be derived from forms related to *Strebla*, occurs primarily on *Artibeus* but has also been taken from *Enchisthenes* and *Sturnira*.

The Streblidae of the Desmodidae are interesting. The species of *Trichobius* that occur on them—*parasiticus* (on *Desmodus*), *diphyllae* (on *Diphylla*), and an undescribed species (from *Diaemus*)—are very closely related. *T. furmani*, which occurs on *Desmodus* (and apparently other hosts as well), and *T. dugesioides*, a parasite of *Trachops* (and probably secondarily of *Carollia*) belong to this species complex also. Two of the *Strebla* species, *diphyllae* (on *Diphylla*) and *vespertilionis* (on *Desmodus*) are very closely related to species from Phyllostominae. While the third species, *diaemi*, belongs to a different group, it, too, is related to forms (*consocius* and *hertigi*) that occur on the genus *Phyllostomus*. If the streblid fauna of these bats is of any significance in indicating the relationships of the Desmodidae, it would appear that the Desmodidae are derived from

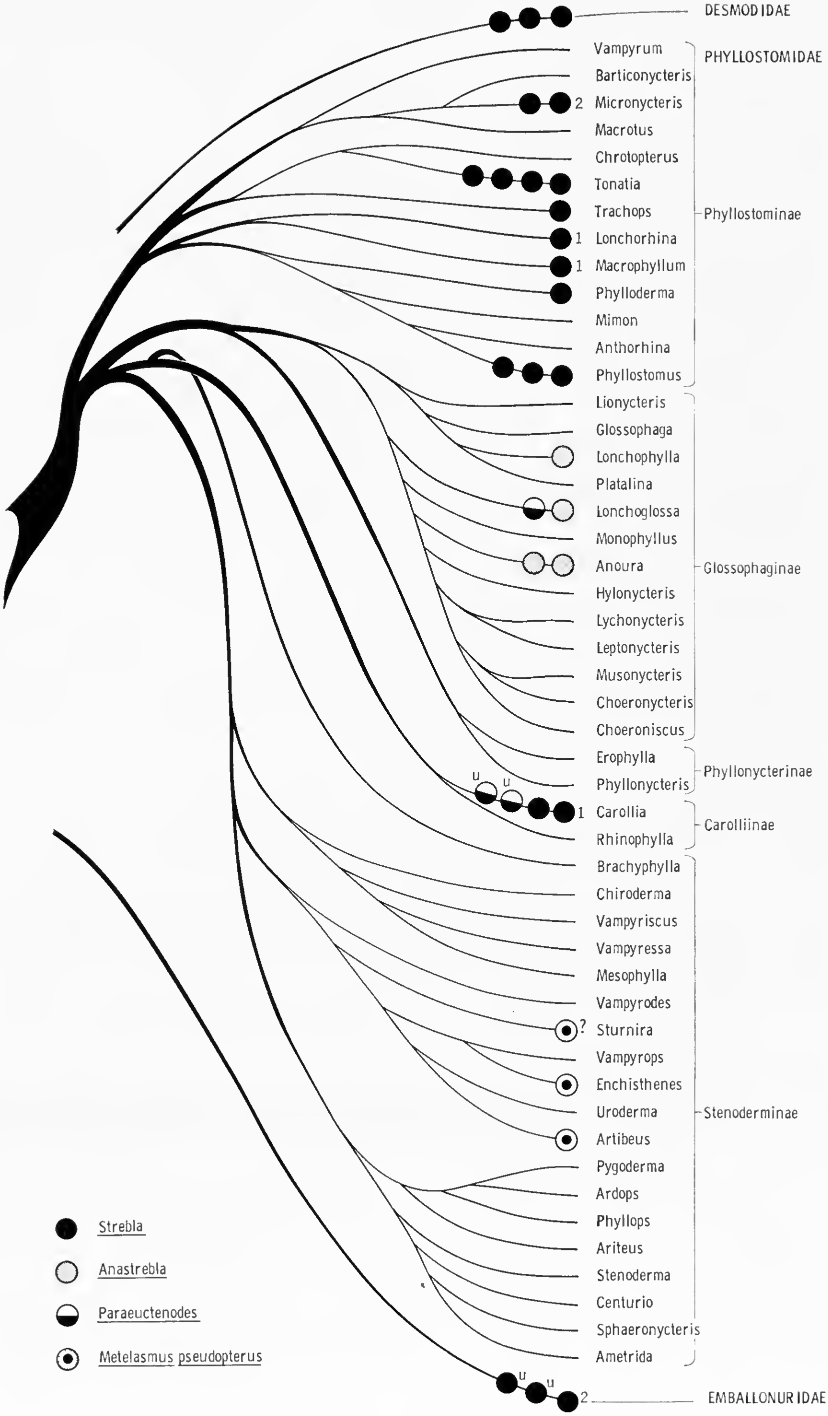

Fig. 146. Hosts of genera and species of Streblinae. *Strebla mirabilis* is shown on both *Trachops* and *Phyllostomus*. u = undescribed. 1 = *S. altmani*. 2 = *S. alvarezi*. Other symbols represent separate species.

Phyllostominae. One might even venture the guess that the ancestral forms were carnivorous or omnivorous species related to *Trachops, Chrotopterus* or *Phyllostomus*.

In our treatment of the Streblidae of Panama we have in several instances discussed data that bear on the taxonomy of the hosts. These are summarized below, and a few other comments are added.

1. The host distribution (fig. 142) of the Nycterophiliinae and of the *Trichobius caecus* (p. 448) and *pallidus* (p. 447) groups support the contention (see p. 652) that the Chilonycterinae do not belong in the Phyllostomidae, but are a separate family of Vespertilionoidea, related to the Natalidae (especially) and the Furipteridae.

2. The host distribution of the *uniformis* group (pp. 459, 655, fig. 144) suggests that the glossophagine genera on which they occur form a natural group. The Streblidae found on the other genera of Glossophaginae exhibit little concordance with the host classification.

3. The Streblidae of Carolliinae are of little help in resolving the relationships of these hosts. *Speiseria ambigua* appears to be more closely related to the parasites of Stenoderminae than to any others, but *Strebla carolliae* and *Trichobius joblingi* are most closely related to parasites of Phyllostominae.

4. The relationships of the Streblidae that occur on Desmodidae suggest that the vampire bats evolved from Phyllostomine bats related to *Trachops, Chrotopterus* or *Phyllostomus* (see p. 659).

5. The streblid faunules of *Phyllostomus hastatus panamensis* and *P. h. hastatus* have only one species of streblid, *Trichobius longipes,* in common. It is suggested that these bats may be distinct species.

6. Similarly, speciation in the streblid genera *Noctiliostrebla* (see p. 562) and *Paradyschiria* suggests that at least some of the subspecies of the host bat, *Noctilio leporinus,* and possibly *N. labialis,* may be distinct species. The parasites should prove valuable in segregating and defining some of the "subspecies" of these hosts.

7. The different Streblidae on *Diphylla ecaudata* in parts of the range of that host, suggest that this bat may not be monotypic (see p. 615).

8. The taxonomic relationships and host associations of their Streblidae, support de la Torre's contention (unpub. thesis, 1961; 1962) that the Sturnirinae should not be treated as a separate subfamily but should be placed with the Stenoderminae. They also support de la Torre's (1961) groupings of genera (fig. 144) within the Stenoderminae.

Abstract

Although primarily concerned with Panama, this study is a preliminary review of the genera and species of New World batflies of the family Streblidae (excluding eight described Nearctic and West Indian and two South American species). Morphology, classification, collecting and study techniques are treated. Twenty-three genera (seven new) and 87 species (50 new) are treated and/or keyed and figured, bringing the total number of described species to 94. Of these, 20 genera and 66 species (44 new) are recorded from Panama. Two genera (one new) and 22 species (20 new) are known only from Panama.

Host and distribution records and biological notes are given. Host-parasite relation-

ships are discussed. Study of more than 12,000 Panamanian Streblidae from more than 50 host species indicates that, contrary to previously held opinion, the New World species are highly host-specific in the lowland tropics, the center of their distribution. In Panama, about 55 percent of the species are known from a single host; another 15 percent are clearly monoxenous, though they may occasionally occur as strays on ecologically associated hosts; and about 13.5 percent of the remaining species are restricted to bats of a single genus. Only about 15 percent of the total normally occur on bats of more than one genus. These are usually bats of the same family or of closely related genera of the same sub-family, though in some instances they are ecologically rather than phylogenetically related genera. It is suggested that more detailed investigations, such as cyto-taxonomic and behavioral studies, may show that some of the species which normally appear to occur on more than one host may prove to be complexes of cryptic species.

Most of the Streblidae on fruit bats (Phyllostomidae: Sturnirinae and Stenoderminae) are closely related and appear to have radiated on these bats. The Streblidae of *Sturnira* are very closely related to those of the Stenoderminae, especially *Artibeus*, and support the view that the Sturnirinae should be included in the Stenoderminae. The Streblidae of the Chilonycterinae (Phyllostomidae), Furipteridae, and Natalidae are closely related and support the view that the Chilonycterinae should be regarded as a distinct family related to the Furipteridae and Natalidae. The streblid faunules of *Phyllostomus hastatus* and of the Noctilionidae suggest that some of the subspecies of these bats may actually be distinct species. Monotypic hosts appear to rarely, if ever, have different Streblidae in different parts of their geographic ranges. Where such appears to be the case, it is suggested that cryptic host taxa may be involved. However, the ranges of host and parasite need not be coterminous.

In only a few instances do Streblidae of the same genus occur together on the same host. In one such case, there is a suggestion of competition between species of *Strebla* on the bat *Phyllostomus hastatus*. In most other instances of synoxenous Streblidae, the flies appear to be morphologically adapted to different micro-habitats on the hosts.

NEW TAXA.—*Anastrebla* n. gen., *modestini* (type-species), *mattadeni*, *nycteridis*, n. spp.; *Anatrichobius* n. gen., *scorzai* n. sp. (type-species); *Aspidoptera delatorrei* n. sp.; *Exastinion* n. gen. (type-species: *Aspidoptera clovisi* Pessôa & Guimarães, 1936); *Mastoptera* n. gen. (type-species: *Aspidoptera minuta* Costa Lima, 1921), *guimaraesi* n. sp.; *Megistopoda theodori* n. sp.; *Noctiliostrebla* n. gen. (type-species: *Lipoptena dubia* Rudow, 1870), *aitkeni*, *maai*, *traubi*, n. spp.; Nycterophiliinae, new subfam. for *Nycterophilia* Ferris; *Nycterophilia fairchildi*, *parnelli*, *natali*, n. spp.; *Paradyschiria parvuloides* n. sp.; *Parastrebla* n. gen., *handleyi* n. sp. (type-species); *Paratrichobius lowei*, *sanchezi*, *salvini*, n. spp.; *Pseudostrebla greenwelli* n. sp.; *Strebla altmani*, *alvarezi*, *carolliae*, *christinae*, *consocius*, *diaemi*, *diphyllae*, *galindoi*, *hertigi*, *hoogstraali*, *kohlsi*, *machadoi*, n. spp.; *Trichobioides* n. gen. (type-species: *Trichobius perspicillatus* Pessôa & Galvão, 1937); *Trichobius bequaerti*, *brennani*, *diphyllae*, *dugesioides*, *dunni*, *dybasi*, *furmani*, *galei*, *joblingi*, *johnsonae*, *keenani*, *lionycteridis*, *lonchophyllae*, *macrophylli*, *mendezi*, *urodermae*, *vampyropis*, *yunkeri*, n. spp.; *Neotrichobius* n. gen., *stenopterus* n. sp. (type-species).

NEW SYNONYMY.—*Strebla longipes* Rudow, 1870 (=*Trichobius mixtus* Curran, 1935). *Strebla* Wiedemann, 1824 (=*Euctenodes* Waterhouse, 1879). SPECIES REMOVED FROM SYNONYMY.—*Paradyschiria fusca* Speiser (1900), *lineata* Kessel (1925), and *parvula* Falcoz (1931) not synonyms of, nor congeneric with *Lipoptena dubia* Rudow (1870). *Aspidoptera busckii* Coquillet, 1899, not a synonym of *Li. phyllostomatis* Perty, 1833.

CHANGES IN ASSIGNMENT.—*Lipoptena dubia* Rudow, 1870, made type-species of *Noctiliostrebla* n. gen. *Aspidoptera clovisi* Pessôa & Guimarães, 1936, made type-species of *Exastinion* n. gen. *Aspidoptera minuta* Costa Lima, 1921, made type-species of *Mastoptera* n. gen. *Lepopteryx megastigma* Speiser, 1900, transferred to *Noctiliostrebla* n. gen. *Trichobius perspicillatus* Pessôa & Galvão, 1937, made type-species of *Trichobioides* n. gen. *Pseudostrebla* Costa Lima, 1921, *Stizostrebla* Jobling, 1939, and *Eldunnia* Curran, 1934, removed from the subfamily Streblinae and assigned to the Trichobiinae.

HOST-PARASITE LIST

The following list includes all host-parasite records of Streblidae that are included in this paper. All names preceded by a dagger (†) are of records from outside Panama. When a host name is preceded by a dagger, this applies to all of the streblids listed as well. Streblid names preceded by an asterisk (*) indicate that the host bat is probably not a normal host for the fly and that the record probably represents a transitory or accidental association (contamination) or may be in error.

For the sake of uniformity, we have followed Handley's treatment (see Checklist of Mammals) of the Chilonycterinae and Sturnirinae.

Class MAMMALIA
Order CHIROPTERA
Superfamily Emballonuroidea
Family Emballonuridae

Saccopteryx bilineata
Strebla alvarezi n.sp.
* " *vespertilionis* (Fabricius)

Family Noctilionidae

†Noctilio labialis subsp.
Paradyschiria parvula Falcoz
" *parvuloides* n.sp.

†Noctilio labialis albiventer
(=*Dirias albiventer*)
Paradyschiria parvula Falcoz

Noctilio labialis labialis
†*Noctiliostrebla aitkeni* n.sp.
" *maai* n.sp.
Paradyschiria parvuloides n.sp.

"Dirias" sp.
(=*N. labialis*)
**Trichobius joblingi* n.sp.

†Noctilio dorsatus
(=*Noctilio leporinus*)
Noctiliostrebla dubia (Rudow)
" *megastigma* (Speiser)

Noctilio leporinus
Noctiliostrebla traubi n.sp.
Paradyschiria fusca Speiser

†Noctilio leporinus leporinus
Noctiliostrebla aitkeni n.sp.
Paradyschiria fusca Speiser

†Noctilio leporinus mastivus
Noctiliostrebla traubi n.sp.
Paradyschiria lineata Kessel

Noctilio leporinus mexicanus
**Neotrichobius stenopterus* n.g., n.sp.
Noctiliostrebla traubi n.sp.
Paradyschiria lineata Kessel

Superfamily Phyllostomoidea
Family Phyllostomidae
Subfamily Chilonycterinae

Pteronotus parnellii fuscus
(=*Chilonycteris rubiginosa fusca*)
Nycterophilia parnelli n.sp.
**Speiseria ambigua* Kessel
**Strebla altmani* n.sp.
* " *carolliae* n.sp.
Trichobius sparsus Kessel
" *yunkeri* n.sp.
* " *joblingi* n.sp.
* " *costalimai* Guimarães

Pteronotus psilotis
Nycterophilia fairchildi n.sp.
Trichobius johnsonae n.sp.

Pteronotus suapurensis
Nycterophilia fairchildi n.sp.
Trichobius johnsonae n.sp.
" *yunkeri* n.sp.

Subfamily Phyllostominae

Micronycteris megalotis microtis
Strebla alvarezi n.sp.
**Trichobius joblingi* n.sp.
" *keenani* n.sp.

Micronycteris minuta
†*Strebla machadoi* n.sp.
**Trichobius dugesioides* n.sp.

Micronycteris nicefori
Parastrebla handleyi n.g., n.sp.
Strebla alvarezi n.sp.
**Trichobius joblingi* n.sp.
" *keenani* n.sp.

†Micronycteris brachyotis
(=*M.* [*Lampronycteris*] *platyceps*)
**Trichobius joblingi* n.sp.

Micronycteris sylvestris
Strebla alvarezi n.sp.

Lonchorhina a. aurita
Speiseria ambigua Kessel
Strebla altmani n.sp.
* " *carolliae* n.sp.
**Trichobius dugesioides* n.sp.
" *joblingi* n.sp.
* " *macrophylli* n.sp.
* " *yunkeri* n.sp.

Macrophyllum macrophyllum
Strebla altmani n.sp.
* " *carolliae* n.sp.
**Trichobius joblingi* n.sp.
" *macrophylli* n.sp.

Tonatia bidens
Strebla galindoi n.sp.
† " sp. (? *mirabilis*)
Trichobius bequaerti n.sp.

†**Tonatia brasiliensis**
Strebla tonatiae (Kessel)

Tonatia minuta
Mastoptera minuta (Costa Lima)
Pseudostrebla greenwelli n.sp.
Strebla hoogstraali n.sp.
Trichobius mendezi n.sp.

Tonatia s. silvicola
(=*T. amblyotis*)
Mastoptera minuta (Costa Lima)
Pseudostrebla ribeiroi (Costa Lima)
Strebla kohlsi n.sp.
Trichobius dybasi n.sp.

Tonatia sp. (? silvicola)
†*Stizostrebla longirostris* Jobling

Tonatia sp. (?)
Strebla galindoi n.sp.
**Trichobius dugesioides* n.sp.

Phyllostomus d. discolor
**Aspidoptera busckii* Coquillet
**Megistopoda aranea* (Coquillet)
Strebla hertigi n.sp.
* " *mirabilis* (Waterhouse)
Trichobioides perspicillatus (Pessôa & Galvão)
Trichobius costalimai Guimarães
† " *longipes* (Rudow)

†**Phyllostomus d. verrucosus**
Strebla hertigi n.sp.
Trichobioides perspicillatus (Pessôa & Galvão)
Trichobius costalimai Guimarães

†**Phyllostomus discolor** subsp.
**Strebla vespertilionis* (Fabricius)

†**Phyllostomus elongatus**
Trichobioides perspicillatus (Pessôa & Galvão)
Trichobius costalimai Guimarães

†**Phyllostomus h. hastatus**
**Neotrichobius stenopterus* n.g., n.sp.
Strebla consocius n.sp.
**Trichobius joblingi* n.sp.
" *longipes* (Rudow)

Phyllostomus h. panamensis
Mastoptera guimaraesi n.sp.
* " *minuta* (Costa Lima)
**Speiseria ambigua* Kessel
**Strebla carolliae* n.sp.
" *hertigi* n.sp.
" *mirabilis* (Waterhouse)
**Trichobius joblingi* n.sp.
" *longipes* (Rudow)
* " *parasiticus* Gervais
* " *yunkeri* n.sp.

Phyllostomus hastatus subsp.
Strebla consocius n.sp.

Phyllostomus sp.
**Aspidoptera phyllostomatis* (Perty)
Mastoptera guimaraesi n.sp.
†**Megistopoda* sp.
Trichobius longipes (Rudow)
†* " *phyllostomae* Kessel

From a mixed collection of **Phyllostomus and Pteronotus** spp.
Trichobius longipes (Rudow)

Phylloderma s. stenops
Strebla christinae n.sp.

Trachops c. cirrhosus
**Speiseria ambigua* Kessel
**Strebla altmani* n.sp.
* " *carolliae* n.sp.
" (?) *mirabilis* (Waterhouse)
**Trichobius dugesii Townsend*
" *dugesioides* n.sp.
" *joblingi* n.sp.

†**Trachops cirrhosus coffini**
**Strebla diphyllae* n.sp.
" (?) *mirabilis* (Waterhouse)

†**Trachops** sp.
**Strebla consocius* n.sp.

Chrotopterus auritus
Trichobius dugesioides n.sp.

Subfamily Glossophaginae

Glossophaga s. leachii
**Eldunnia breviceps* Curran
**Speiseria ambigua* Kessel
**Strebla carolliae* n.sp.
Trichobius dugesii Townsend
* " *joblingi* n.sp.
" *uniformis* Curran

†**Glossophaga s. soricina**
Trichobius furmani n.sp.

†**Glossophaga s. valens**
Trichobius dugesii Townsend

From a mixed collection of Glossophaga s. leachii and Carollia p. azteca
Speiseria ambigua Kessel
Trichobius dugesii Townsend
" *dugesioides* n.sp.
" *joblingi* n.sp.

Lonchophylla robusta
Anastrebla nycteridis n.sp.
†*Anatrichobius scorzai* n.g., n.sp.
Eldunnia breviceps Curran
**Speiseria ambigua* Kessel
**Strebla carolliae* n.sp.
**Trichobius joblingi* n.sp.
* " *johnsonae* n.sp.
" *lonchophyllae* n.sp.

Lionycteris spurrelli
Trichobius lionycteridis n.sp.

†**Anoura aculeata**
Anastrebla mattadeni n.sp.
Exastinion clovisi (Pessôa & Guimarães)

Anoura cultrata
Anastrebla mattadeni n.sp.
Exastinion clovisi (Pessôa & Guimarães)

†**Anoura g. geoffroyi**
Anastrebla modestini n.sp.
Exastinion clovisi (Pessôa & Guimarães)

Anoura g. lasiopyga
**Anastrebla mattadeni* n.sp.
" *modestini* n.sp.
Exastinion clovisi (Pessôa & Guimarães)

Subfamily Carolliinae

Carollia castanea
Speiseria ambigua Kessel
Strebla carolliae n.sp.
Trichobius joblingi n.sp.

Carollia p. azteca
**Aspidoptera busckii* Coquillet
* " *delatorrei* n.sp.
**Mastoptera guimaraesi* n.sp.
**Megistopoda aranea* (Coquillet)
**Metelasmus pseudopterus* Coquillet
**Nycterophilia parnelli* n.sp.
†?*Paraeuctenodes* sp.
**Paratrichobius dunni* (Curran)
Speiseria ambigua Kessel
Strebla altmani n.sp.
" *carolliae* n.sp.
* " *mirabilis* (Waterhouse)
**Strebla vespertilionis* (Fabricius)
**Trichobius costalimai* Guimarães
* " *dugesii* Townsend
" *dugesioides* n.sp.
" *joblingi* n.sp.
* " *johnsonae* n.sp.
* " *longipes* (Rudow)
* " *macrophylli* n.sp.
* " *sparsus* Kessel
* " *urodermae* n.sp.
* " *yunkeri* n.sp.

†**Carollia p. perspicillata**
Paraeuctenodes sp.
Strebla carolliae n.sp.
* " *consocius* n.sp.
* " *vespertilionis* (Fabricius)
Trichobius joblingi n.sp.

Carollia subrufa
Speiseria ambigua Kessel
Strebla carolliae n.sp.
Trichobius dugesioides n.sp.
" *joblingi* n.sp.

From a mixed collection of **Carollia** sp. and **Natalus s. mexicanus**
Trichobius dugesioides n.sp.

Subfamily Stenoderminae

Sturnira lilium parvidens
Aspidoptera delatorrei n.sp.
Megistopoda proxima (Séguy)
**Paradyschiria parvuloides* n.sp.
**Trichobioides perspicillatus* (Pessôa & Galvão)

Sturnira ludovici
Megistopoda theodori n.sp.
Trichobius brennani n.sp.
* " *yunkeri* n.sp.

Sturnira sp.
**Trichobius costalimai* Guimarães
† " n.sp.

Uroderma bilobatum
?*Neotrichobius stenopterus* n.g., n.sp.
Paratrichobius dunni (Curran)
**Trichobius costalimai* Guimarães
* " *joblingi* n.sp.
* " *keenani* n.sp.
" *urodermae* n.sp.

Vampyrops helleri
Paratrichobius sp. B

Vampyrops vittatus
Paratrichobius sp.
Speiseria ambigua Kessel
**Strebla mirabilis* (Waterhouse)
Trichobius vampyropis n.sp.

Vampyrodes caraccioli major
Strebla vespertilionis (Fabricius)

Vampyressa nymphaea
Aspidoptera busckii Coquillet
Metelasmus pseudopterus Coquillet

Vampyressa pusilla
Neotrichobius stenopterus n.g., n.sp.

Vampyressa sp.
Paratrichobius dunni (Curran)

Chiroderma salvini
Paratrichobius salvini n.sp.

Chiroderma villosum jesupi
Aspidoptera busckii Coquillet
Paratrichobius sp. A
**Trichobius joblingi* n.sp.

Ectophylla macconelli
†*Strebla consocius* n.sp.

Artibeus aztecus
Paratrichobius sp.

Artibeus cinereus
Neotrichobius stenopterus n.g., n.sp.
Paratrichobius lowei n.sp.

†Artibeus j. parvipes
Aspidoptera busckii Coquillet

Artibeus j. jamaicensis
Aspidoptera busckii Coquillet
Megistopoda aranea (Coquillet)
Metelasmus pseudopterus Coquillet
?*Neotrichobius stenopterus* n.g., n.sp.
Paratrichobius sp. (?*longicrus* M. Ribeiro)
**Strebla carolliae* n.sp.
* " *hertigi* n.sp.
* " *vespertilionis* (Fabricius)
**Trichobius joblingi* n.sp.
* " *longipes* (Rudow)
* " *uniformis* Curran

†Artibeus "j. lituratus"
Paratrichobius longicrus (M. Ribeiro)
**Strebla carolliae* n.sp.
Trichobius phyllostomae Kessel

Artibeus lituratus palmarum
Aspidoptera busckii Coquillet
Megistopoda aranea (Coquillet)
Metelasmus pseudopterus Coquillet
Paratrichobius longicrus (M. Ribeiro)
**Speiseria ambigua* Kessel
**Trichobius costalimai* Guimarães
* " *joblingi* n.sp.
* " *lonchophyllae* n.sp.
* " *vampyropis* n.sp.
* " *yunkeri* n.sp.

Artibeus toltecus
Paratrichobius sp.

Enchisthenes hartii
†**Anastrebla mattadeni* n.sp.
Paratrichobius sanchezi n.sp.

Centurio senex
†**Strebla vespertilionis* (Fabricius)

Family Desmodidae

†Desmodus r. rotundus
Strebla vespertilionis (Fabricius)
Trichobius furmani n.sp.
* " *joblingi* n.sp.
" *parasiticus* Gervais

Desmodus r. murinus
**Megistopoda aranea* (Coquillet)
**Speiseria ambigua* Kessel
†*Strebla diphyllae* n.sp.
* " *hertigi* n.sp.
" *vespertilionis* (Fabricius)
**Trichobius costalimai* Guimarães
* " *dugesioides* n.sp.
* " *joblingi* n.sp.
" *parasiticus* Gervais
* " *uniformis* Curran
**Trichobioides perspicillatus* (Pessôa & Galvão)

†Diaemus youngii
Trichobius n.sp.

Diaemus y. cypselinus
Strebla diaemi n.sp.
Trichobius parasiticus Gervais

Diphylla ecaudata
†*Trichobius furmani* n.sp.

†Diphylla e. centralis
Strebla diphyllae n.sp.
Trichobius diphyllae n.sp.
" *parasiticus* Gervais

"Vampire Bats"
Trichobius parasiticus Gervais

Superfamily Vespertilionoidea
Family Furipteridae

Furipterus horrens
†*Trichobius pallidus* (Curran)

Family Natalidae

Natalus stramineus mexicanus
Nycterophilia natali n.sp.
**Speiseria ambigua* Kessel
**Strebla carolliae* n.sp.
**Trichobius dugesioides* n.sp.
" *galei* n.sp.
* " *joblingi* n.sp.

Natalus sp.
Trichobius galei n.sp.

Family Vespertilionidae

Myotis chiloensis
Anatrichobius scorzai n.g., n.sp.
?*Joblingia schmidti* Dybas & Wenzel

†**Myotis c. oxyotis**
Anatrichobius scorzai n.g., n.sp.

Myotis n. nigricans
**Anatrichobius scorzai* n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Mixed collection of
Myotis n. nigricans and
M. chiloensis
Anatrichobius scorzai n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Myotis sp.
Anatrichobius scorzai n.g., n.sp.
Joblingia schmidti Dybas & Wenzel
†**Trichobius joblingi* n.sp.

Lasiurus egregius
**Strebla carolliae* n.sp.
* " *vespertilionis* (Fabricius)

†**Rhogeessa parvula minutilla**
(=*Rhogeessa io* Greenhall)
**Trichobius joblingi* n.sp.

Family Molossidae

Molossus bondae
Trichobius dunni n.sp.

†**Molossus major**
Trichobius sp.
* " *joblingi* n.sp.

†**Molossus "nigricans"**
Trichobius sp.

†**Molossus "rufus"**
**Strebla consocius* n.sp.
Trichobius sp.

†**Molossus** sp.
Trichobius sp.

Miscellaneous

From mixed collection of
D. rotundus, P. hastatus,
C. perspicillata, G. soricina,
T. amblyotis & V. vittatus
†*Trichobius furmani* n.sp.

Bat guano
Joblingia schmidti Dybas & Wenzel

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Some Relationships between Mammal Hosts and their Ectoparasites

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The principal objective of the Panama survey was to collect, record, and/or describe the blood-sucking ectoparasites of mammals and, to a much lesser extent, of birds and reptiles. Similarly, it was intended originally that this volume would serve primarily to delineate this fauna so that investigators of systematics, as well as of zoonoses and epidemiology, would have a firm taxonomic basis for future studies.

However, after reviewing all the papers, we felt it desirable to briefly consider some implications of the data concerning relationships of the hosts and their parasites. These relate chiefly to host-specificity, some epidemiological aspects of host specificity and ecology, altitudinal distribution, and faunal relationships and their zoogeographic implications. Because the objectives of the survey were limited, most of the data were not gathered or recorded with these problems in mind. Nevertheless, the data did provide some insight, and in a few cases suggested possible answers. The data available for bird and reptile hosts and their parasites in Panama are so limited that we have given them little consideration in the following discussion.

I. Host Specificity

Mayr (1957) has raised a number of interesting questions about the problems and implications of host-parasite specificity, for instance (op. cit., p. 8):

> "*Where does host specificity occur?—How strict is it?—What groups of parasites are most host specific?—Why are some parasites highly specific, others of rather wide distribution?* . . . The answers to these questions in the literature appear

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to be largely of the 'example' type. We learn that cestodes and mallophaga tend to be highly host specific, acanthocephalans and some fleas less so. It seems to me that enough information is now available to permit a more statistical approach. Statistics of reliability in the host specificity of the parasites are highly important in order to judge the value of parasites as indicators of relationship in all those special cases where the student of vertebrates is still undecided on the classification of his material."

Mayr was primarily concerned with problems such as the parallel evolution of host and parasite, and of zoogeography. These are intimately related to the ecology of both hosts and their parasites. Consequently, the questions he asked are fundamental to the whole gamut of parasite population problems, including the ecology of parasitization, and thus to the practical problems of epidemiology as well.

Mayr's statement concerning the need for statistics of reliability in host specificity is well founded, but in the case of ectoparasites, we do not agree with him that "enough information is now available to permit a more statistical approach." Excluding a few groups and certain limited geographic areas, the published host records of ectoparasites are quantitatively scanty and unevaluated. The associations themselves are often dubious, chiefly because of inadequate sampling techniques or unreliable identifications. Most of the older collections were made by vertebrate zoologists. Because they were overburdened with collecting and with preparing skins, they could rarely live-trap the hosts, keep them separate, or anesthetize them before searching for parasites. Nor could they examine more than a small number of those collected. Many of the ectoparasites were taken from the skinning table as they were noticed, or when it was convenient.

Nevertheless, these collections were of great importance. Often, they were from hosts and areas not previously represented in collections. They form the core of what is known about tropical ectoparasites. Such collections will continue to be important in filling the great faunistic gaps that still exist. But the quantitative and qualitative data that are needed to establish host relationships on a statistical basis have rarely been gathered, except in autecological studies. These studies are of great importance, but are usually scattered and do not relate the parasite populations to those of other hosts, or of other geographic areas.

The experience gained in studying and evaluating the results of the Panama survey, indicates that in order to meaningfully explore the kinds of problems discussed below, far more refined field sampling techniques, new kinds of field data, and new methods of recording and analyzing them are needed. Sampling must be carefully controlled, intensive, and representative (geographically, seasonally, and in terms of hosts). The data must be recorded in such a way that they can be machine or computer-processed. The volume of data obtained in an extensive survey, as in Panama, cannot possibly be satisfactorily analyzed by exclusively empirical methods. Further, field data from various surveys should be centralized so that new information can be added and corrections made, establishing an integrated and broad basis for future analyses. Urgently needed is the devising of relatively simple statistical techniques which give reliable indices of host-parasite association and which take into account the size of the samples, so that they can be compared with other samples (see Wenzel, Tipton, and Kiewlicz, this volume, pp. 638–643).

However, the available data do reveal certain patterns in regard to host specificity of ectoparasites of warm-blooded terrestrial vertebrates. As with parasites in general, there appears to be an evolutionary trend toward greater host specificity, with a correspondingly closer ontogenetic, morphological, and physiological adjustment to the host by the parasite. Ultimately, the host becomes the "habitat", as the parasites adapt to restricted niches on the host. Presumably, the more specialized (adapted) the parasite becomes in relation to a host, the less competition is encountered by it for that habitat or niche.

The warm-blooded vertebrates whose ectoparasites exhibit the highest degree of niche specialization and of host specificity appear to be the birds and bats. This specificity may be characteristic of any taxonomic level from family to subspecies of parasite. This is probably correlated in part with the relative ecological isolation of birds and bats and their parasites, as compared with non-flying mammals, as well their great age. Among the insect ectoparasites of bats, specificity at the family level (of the parasites) is well marked. Families that are restricted to bats include the Streblidae and Nycteribiidae (Diptera), Polyctenidae (Hemiptera), Ischnopsyllidae (fleas) and Arixeniidae (Dermaptera). Of the mites that parasitize bats, the families Spelaeorhynchidae and Spinturnicidae, among others, are also restricted to them. Even in such widespread trombiculid genera as *Euschoengastia* and *Trombicula,* whose larvae are temporary parasites, the species that occur on bats appear to be restricted to them.

On these hosts, ectoparasites have not only achieved a high degree of host specificity, but, in adjusting to niches on the host's body, they have undergone secondary adaptive radiation and then have speciated again along host lines. Thus the faunule of a given family of ectoparasites on a host may include a series of genera (reflecting niche adaptations), each represented on related hosts by alloxenous species which are ecological homologues (see below). This is especially marked in the biting lice (Mallophaga) of birds. In birds, the body cover is more differentiated than it is in mammals, and provides numerous niches to which parasites can adapt (Clay, 1949, 1957; Ward, 1957). To a lesser extent, this kind of niche specialization is also found in the parasites of bats (see Wenzel, Tipton, and Kiewlicz, this volume, p. 405).

This type of evolution, as Mayr (op. cit., p. 7) pointed out, implies great antiquity of association between the hosts and their parasites. But this is more than a question of time. It seems to us that such a high degree of specialization and host specificity would usually require that throughout its life cycle (or nearly so) the ectoparasite be closely associated with the host. The hazards of host finding are thus greatly reduced. It hardly seems accidental that the groups which exhibit the highest degree of host specificity are those which are host-limited[3] or nearly so, that is, those whose

[3] See Wenzel, Tipton, and Kiewlicz, this volume, p. 637.

life cycle is spent on the host, or whose free-living, immature stages are shortened or eliminated through ovoviviparity. This latter condition exists in nearly all ectoparasites of bats. In the pupiparous Streblidae and Nycteribiidae, ovoviviparity not only keeps the flies closely associated with a relatively mobile host, but also eliminates the dependence of the larvae on a separate source of food. Thus, the vulnerable early stages are less subject to the selective rigors of the host and non-host environments than they would otherwise be. On the other hand, little host specificity is found among those ticks whose eggs are dropped more or less at random and whose young begin their existence as "free-living" forms, dependent upon polyxeny to reduce the hazards of host-finding.

Homozygosity for many characters, including host specificity, would probably be achieved more quickly in host-limited parasites. To a greater extent, dispersal and mating of the parasites would be "vertical". That is, much of the dispersal to new host animals would be to offspring and siblings of the host; consequently, there would be more inbreeding demes among these parasites than among those, like many ticks and fleas,[4] which exhibit little host limitation. In these there would be more horizontal dispersal, i.e., between extra-family hosts and there would be more outbreeding among the parasites. Under such circumstances, homozygosity for host specificity might be achieved more slowly, if at all. Indeed, if flexibility for host specificity proved to be necessary or advantageous (see below) there would probably be selection for either broad adaptive variability or balanced polymorphism (see below). Strict host specificity, in such groups, would be uncommon, as it appears to be in fleas. Carson's (1957) concept of homo- versus heteroselection seems to apply to populations of host-limited and non-host-limited parasites, respectively.

Fleas are the only large group of holometabolous ectoparasites whose pre-adult stages are free-living. These live in the nest, or on the ground around the home of the host. Most fleas are parasites of small mammals, especially rodents. Many of these exhibit strong territoriality and nest in small colonies. Some do not form nests, or nest singly except at breeding time, which usually fluctuates seasonally, especially in the temperate zone. Because most fleas are temperate[5] in distribution, either latitudinally or altitudinally, the seasonal fluctuations in breeding cycles of the hosts undoubtedly play an important role in the evolution of the flea.

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[4] However, some fleas may be essentially host-limited through other mechanisms as, e.g., the ecology of the host. Fleas like *Meringis*, whose early stages take place in the deep underground nests of kangaroo rats (*Dipodomys*) in xeric areas are not only kept in close association with their host, but are correspondingly isolated from other potential hosts. The species exhibit a high degree of host specificity.

[5] Relatively few species of mammals in the tropical lowlands have surface nests or "homes" that are suitable breeding places for fleas, perhaps because of heavy rains and flooding. Further, the majority of fleas parasitize rodents, and there are fewer species of rodents in the lowland tropics than in temperate altitudes and latitudes. Of 35 species of native fleas collected in Panama, only 12 were taken below 2000 feet, six of them from rodents, while 24 were taken above 5000 feet, 18 of them from rodents.

Hopkins (1957a) has given an interesting discussion of host specificity in fleas, and the probable role of polyhaematophagy in their dispersal and host-finding. However, as he pointed out, adequate data on host specificity are available for only a few species. In general, it seems that the probabilities of finding a suitable host or a specific host would be greatly increased if: 1), the blood of more than one host could be utilized by a flea species, at least for nourishment, if not for maturation of eggs; or 2), if several other hosts could provide the nutritional requirements for maturation of the flea ova, even though not as effectively as the "most suitable" host. The latter[6] would in many instances probably be the one usually considered to be the "normal", "true", or "primary" host. In some instances, it would be an essential host. Such polyhaematophagy would greatly increase the chances for survival and maintenance of the species. Thus, it appears to us that some animals may be utilized primarily as "dispersal", "carrier", or "sustaining" hosts.

While some fleas appear to be promiscuous as regards hosts (Hopkins, op. cit.), it would be a mistake to assume that this is generally true and that host specificity is relatively unimportant. As noted above, a general evolutionary trend appears to be toward narrower host restriction with the host ultimately becoming the "habitat" or nearly so. We believe this to be generally true for fleas, and with the same evolutionary advantages. Adaptations to unique characteristics of a host or hosts would lessen competition from other parasites not so adapted. We agree with Hopkins (op. cit.) that most fleas have "true" or optimal hosts. These are not necessarily "original" hosts (*sensu* Holland, 1964) and may differ within the geographic range of the parasite.

In Panama, flea species of the genera *Rhopalopsyllus* and *Adoratopsylla* were taken on a number of hosts but most individuals were recorded from relatively few (table 13), and most showed a high incidence of parasitization on only one host. Cases like that of *Spilopsylla cuniculi* (Mead-Briggs and Rudge, 1960), in which maturation of ova appears to depend upon a specific blood factor of the pregnant female host (rabbit) may prove to be unusual. However, it would be surprising if blood factors of different hosts did not vary greatly in relation to the fecundity of given species of fleas and if there were not, in turn, adjustments of the fleas to these differences.

As inferred by Hopkins, polyhaematophagy would seem to be an adaptive device which permits a non-host-limited blood-sucking ectoparasite to exploit the competitive advantage of at least some degree of host specificity without overly suffering the evolutionary consequences of having free-living young. We further suggest that "horizontal" dispersal is essential to the maintenance of the heterozygosity necessary for polyhaematophagy.[7]

[6] Caullery (1952, p. 175) has cautioned that, "The normal host in nature is not, however, necessarily that on which the parasite develops most actively. . . . animals on which pathogenic species cause acute infections are exceptional hosts . . ."

[7] Lewontin (1959, p. 398), states, "While stable polymorphic systems arise only through the operation of interpopulational selection, the selective forces within a population tend always to a destruction of the system with a consequent return to the homozygous state."

It seems very probable that the kind of flexible host specificity or polyhaematophagy that exists in many fleas depends on balanced polymorphism. There is probably feed-back, with polyhaematophagy dependent upon horizontal dispersal, and its concomitantly greater outbreeding and heterozygosity, and heterozygosity in turn dependent upon polyhaematophagy and horizontal dispersal. Further, heterozygosity for many other characters is probably essential to a parasite species whose young and adults are exposed to a wide gamut of extra-host environmental factors. Thus, the kind of "host transfers" which occur among fleas that otherwise are relatively host-group specific may be understood (see Johnson and Layne, 1961, and "Faunal Relationships", below). This is unlike the usual situation in Anoplura and Mallophaga. These host-limited parasites have achieved a much more narrowly limited steady state (homeostasis) as regards adjustments to both hosts and extra-host environment.

II. Coexistence and Competitive Displacement [8]

The preceding discussion is based on the premise that adjustment to specific hosts and, further, to niches on these hosts, is selected for in the evolutionary process of achieving "optimal conditions of existence and survival (homeostasis)" (Emerson, 1960, pp. 342–343; see also Emerson, 1954), through lessening of competition. DeBach (1966, p. 204) has summarized this view in somewhat different terms, "Niche differentiation and habitat differentiation may be closely related aspects of the same tendency to evolve away from direct competition, and evolution of both niche and habitat differentiation permits many species to live together in communities." [9]

DeBach (op. cit.) has given an excellent review of the problems of coexistence and competitive displacement and of the pertinent literature. We agree with him (op. cit., pp. 186–190) that competition must be viewed in a broad sense, and it does not necessarily involve limited resources such as food. We agree with him further (op. cit., p. 200), that "the processes involved in competition between ecological homologues [10] may be many and varied, or may not be more different from those involved in intra-specific competition with either species alone."

Whatever the processes, if the premise stated is sound, we should find

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[8] Competitive displacement is defined by DeBach (1966, p. 187) as "elimination, in a given habitat, of one species by another species where one possesses the identical ecological niche of the other."

[9] Ward (1957, p. 458), in studying Mallophaga of birds of the genus *Tinamus* (Tinamiformes) has attributed a positive statistical association between pairs of species on these hosts to a "possible cooperative interaction between species and a diversity of the habitat which permits several species to coexist in a limited microgeographic area." We believe that his analysis of the interspecific associations of pairs of species of Mallophaga can be interpreted in terms of selective advantage without implying a cooperative interaction.

[10] DeBach (op. cit., p. 186) defines "ecological homologues" as "two or more different species having the same ecological niche." They need not be taxonomically related.

evidence of coexistence and competitive displacement among ectoparasites. Such evidence could be of several types, including: observed evolutionary end results; analyses of population interactions through field sampling and/or observation; and experimental manipulation. The first type of evidence has been discussed for several groups of ectoparasites, notably the bird lice (Clay, 1957; Ward, 1957), and fleas and sucking lice (Hopkins, 1957, a,b). Analyses like these are immensely valuable in recognizing, understanding, and defining the problems, and lead to evidence of the other two types mentioned above. Unfortunately, there are few studies or papers that deal with evidence of the second type for ectoparasites. The host, habitat, and geographic distributions of two synoxenous species of the genus *Strebla* (batflies) which parasitize bats of the genus *Phyllostomus* appear to provide some evidence of these population interactions.

Throughout its range in South America and Panama, *Phyllostomus hastatus* harbors a streblid faunule consisting of a minute brachypterous, mite-like species of the genus *Mastoptera;* a fully winged, rather generalized streblid of the genus *Trichobius* (*longipes*); and one or two species of *Strebla.*

The species of *Strebla* are highly modified, polyctenoid forms, with short legs, a well-developed head ctenidium, highly modified palpi, and mouthparts with short labella. Their depressed form and short legs fit them admirably for rapid movement on the wing membranes, as well as through the pelage. They are all quite similar, though some have shorter and broader heads, or differ in other relatively minor details. The uniformity of their structure suggests that the species are ecological homologues, or nearly so. With few exceptions, they are monoxenous and alloxenous.[11] Two species, *S. hertigi* and *S. mirabilis,* may be synoxenous on *Phyllostomus h. panamensis.* The host relationships are shown diagrammatically in fig. 147, which should be referred to in the following discussion.

Phyllostomus h. panamensis is parasitized by *Strebla mirabilis* in Panama, Colombia, and possibly farther south, along the west coast of South America. It is also parasitized by *S. hertigi* in Panama, and possibly in Colombia, although our samples from Colombia are not extensive enough to demonstrate this. We have no collections from the west coast of South America. *Phyllostomus h. hastatus,* on the other hand—as represented in our material from eastern Venezuela, Trinidad, Surinam and Amazonian Peru—is parasitized only by *S. consocius,* a fly which appears to be monoxenous. Since *P. discolor* and its parasite *S. hertigi* are distributed throughout the range of *Phyllostomus hastatus* and beyond, it is interesting that *hertigi* coexists with another species of *Strebla* on *P. hastatus* only in part of the range of one subspecies (*panamensis*) of that host.

As noted, *hertigi* appears to be the only species of *Strebla* that parasitizes *Phyllostomus discolor.* This bat is ecologically much more restricted

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[11] "Alloxenous" is defined in the preceding paper (p. 637) as referring to species of the same genus which occur on different hosts, as opposed to "synoxenous" (together, on the same host).

than *P. hastatus*. It is essentially a fruit-eating species that lives in groves and forests. The omnivorous and ecologically more tolerant *P. hastatus* occurs in these habitats too, but also roosts in sites like caves, tree holes, and houses. Interestingly, if one examines some of the data (table 11) for Panamanian collections, it appears that while 76 to 100% of the individuals of *P. h. panamensis* are parasitized by *Strebla mirabilis*, only 4.26 to 14.38% are parasitized by *Strebla hertigi*. If one takes into account the numbers

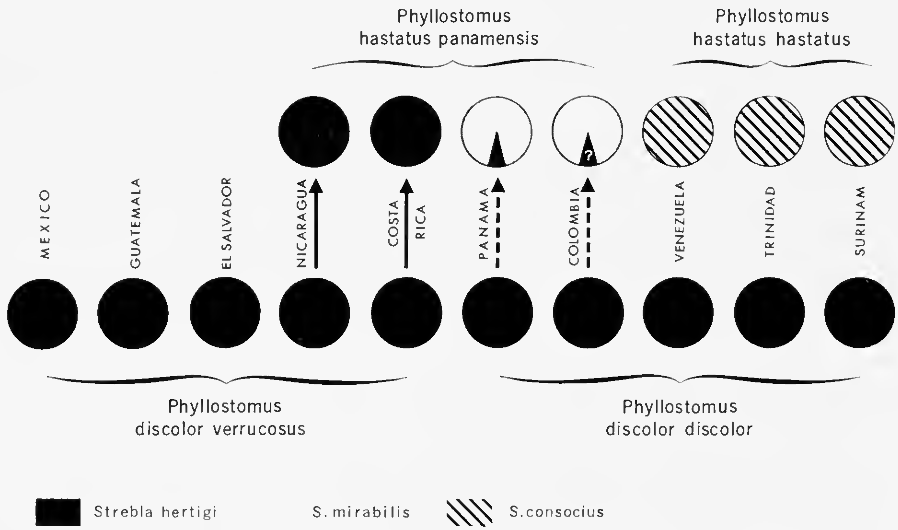

Fig. 147. Occurrence of species of *Strebla* on *Phyllostomus hastatus* and *Phyllostomus discolor* in Central America and northern South America, based on collections studied.

of individuals of the two flies, the difference is even more striking. It will also be noted (table 11) that *hertigi* was absent or nearly so, from those colonies of *P. h. panamensis* that roosted in non-forest sites like caves and buildings. This suggests that this bat is a suitable host for *hertigi* only where ecological conditions of its roosting sites are similar to those of *P. discolor*. It further suggests that *P. h. panamensis* acquires *hertigi* in those situations where it can come into contact with *discolor* and/or its parasites, probably through roosting sites. From table 11 it will be seen that in the cases cited for Panama, the mean number of *Strebla* per host bat examined (column D) ranged from 7.7 to 15.4 for *mirabilis* and 0 to 2.5 for *hertigi*. If the mean number per bat is calculated for only those bats parasitized by each species (column E) the highest for *hertigi* is 2.85. It will be noted that the highest (mean) number of *mirabilis* per bat were taken from hosts on which no *hertigi* were found.

In Costa Rica and Nicaragua, where *P. h. panamensis* reaches the northern limit of its distribution, the picture appears to be very different. Here,

TABLE 11. NUMBERS OF *STREBLA MIRABILIS* AND *S. HERTIGI* FROM *PHYLLOSTOMUS H. PANAMENSIS*. (Central America)

Localities	A Hosts parasitized by Streblidae/ number examined.	B Percentage of host bats parasitized:		C No. of *Strebla* collected:		D Mean no. per bat from *panamensis* examined:		E Mean no. of *mirabilis* or *hertigi* per bat parasitized by each:	
		mirabilis	*hertigi*	*mirabilis*	*hertigi*	*mirabilis*	*hertigi*	*mirabilis*	*hertigi*
PANAMA									
Chepo Road (Panamá) (Hollow tree in forest)	16/16	100.00	87.50	200	40	12.50	2.50	12.50	2.85
Chilibrillo Caves (Panamá)	16/17	76.57	5.38	206	1	12.11	0.06	12.87	1.00
Madden Dam (Canal Zone) (Natural bridge and small cave)	13/14	92.85	14.28	170	2	12.13	0.14	13.07	1.00
Fort Kobbe (Canal Zone) (Hollow *Ficus* tree)	5/5	100.00	0.00	77	0	15.40	0.00	15.40	0.00
Fort Sherman (Canal Zone) (Buildings & bunkers)	19/19	100.00	5.26	146	1	7.68	0.53	7.68	1.00
COSTA RICA									
All localities (3)	10/11	0.00	91.00	0	38	0.00	3.45	0.00	3.80
NICARAGUA									
NE of Condega (Estelí)	6/6	0.00	66.66	0	39	0.00	6.50	0.00	9.74

none of the specimens collected were parasitized by *S. mirabilis*! The only species of *Strebla* present on that host was *hertigi*. All of the six host bats included in the sample from Nicaragua were parasitized by Streblidae, but only four (66%) by *Strebla hertigi*. On these four bats (column E), the number of *hertigi* per bat was 9.74! Thus, when *mirabilis* was absent, the numbers of *hertigi* per bat increased to a level nearly comparable to those of *mirabilis* on *P. h. panamensis* in Panama.

We are not certain that *Strebla mirabilis* is absent from *P. h. panamensis* throughout Costa Rica and Nicaragua. Interestingly, a single collection from Sibube (Bocas del Toro), Panamá (near Costa Rica) had three specimens of *hertigi* and two of *mirabilis*. One individual of *P. h. panamensis* from Armila (San Blas), had five *hertigi* and no other Streblidae.

Why is *S. mirabilis* replaced by *hertigi* on *Phyllostomus h. panamensis* in Costa Rica and Nicaragua? Several answers may be suggested. The simplest is that toward the northern limit of its range, the roosting sites and/or population structure of the host are not as suitable for *Strebla mirabilis* as they are further south, nearer the epicenter of the host's range,[12] and thus *mirabilis* cannot maintain itself on this bat at these latitudes. Another possibility, which assumes that *Phyllostomus discolor* is the "reservoir" of the *hertigi* that parasitize *P. h. panamensis*, is that the *hertigi* on *P. discolor discolor* differ from those on *P. discolor verrucosus*.[13] If this is so, it may be that the population on *P. discolor discolor* is better adapted to *P. h. panamensis* than is *S. mirabilis*, and thus competitively displaces *mirabilis* on that host in Costa Rica and Nicaragua. The differences in the *Strebla* populations on *P. h. panamensis* do appear to coincide with the geographic separation of the two races of *P. discolor* (fig. 147). However, if the single small collection from *P. h. panamensis* taken at Sibube is indicative, then there may be a geographic gradient in the ratio of *mirabilis* to *hertigi* on that host. This would lend support to the first explanation. Unfortunately, nearly all of the Panamanian collections are from the Canal Zone and the Province of Panamá. Extensive intermediate collections are necessary for an understanding of this problem.

Whatever the explanation, the salient fact is that in Panama—where the two species of *Strebla* coexist on the same host—the mean number of *hertigi* per host is very small compared with that on its normal host, and with that on *P. h. panamensis* in Costa Rica and Nicaragua where it does not coexist with *mirabilis*. These data strongly suggest that in Panama some kind of competitive interaction between *hertigi* and *mirabilis* keeps the population of *hertigi* on *P. h. panamensis* at a lower level than when *mirabilis* is absent. They further suggest that *mirabilis* is absent from this host in Costa Rica and Nicaragua because of competitive displacement.

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[12] One could similarly argue that at these latitudes climatic or other ecological conditions are not suitable for *mirabilis*, though the occurrence of this species even farther north at higher elevations, on *Trachops cirrhosus* is then difficult to explain (see p. 617).

[13] We are unable to detect morphological differences between specimens of *hertigi* from these two subspecies.

If this is so, it may also explain the failure of either *hertigi* or *mirabilis* to parasitize *P. h. hastatus* in the presence of *S. consocius* (fig. 147). However, one can also argue that this host is physiologically or ecologically (specifically?) so distinct as to be unsuitable for either *hertigi* or *mirabilis*, even though *mirabilis* is present on *Trachops*,[14] and *hertigi* on *Phyllostomus d. discolor* in areas occupied by *P. h. hastatus*.

"Delousing" the hosts and infesting them with known numbers of parasites may provide evidence of the third type, i.e., the evidence derived through experimental manipulation. The host bats are easily kept alive in the laboratory (See Wenzel, Tipton, and Kiewlicz, p. 425, this volume).

Barnes (1965, pp. 274–276) has suggested that two California fleas of the genus *Anomiopsyllus* which live in the nests of the wood rat, *Neotoma fuscipes* are mutually exclusive (competitive displacement, *sensu* DeBach, op. cit.). A rather similar host distribution was noted by Tipton and Méndez (pp. 317–318, this volume) for *Kohlsia mojica* and *traubi* (and perhaps *keenani*) on *Peromyscus n. nudipes* in Panama. While some differences in geographic and ecological distribution appear to be involved, these may be factors in the process of competitive displacement (see DeBach, op. cit. p. 204).

Complementary distributions on quite a different taxonomic level, may also bear analysis in this connection, for example: the world-wide host and geographic distributions of Streblidae and Nycteribiidae; the relative absence of Streblidae and Nycteribiidae on Molossidae, which are parasitized by Polyctenidae; or the absence of dermanyssid mites on oryzomyine rodent hosts, which are normally heavily parasitized by laelaptid mites of the genus *Gigantolaelaps* (see Yunker and Strandtmann, this volume, p. 83).

III. Epidemiological Considerations

Of approximately 212 terrestrial mammals reported for Panama (including man and 10 introduced species), ectoparasites are recorded for 155. Undoubtedly many more species occur than are indicated in the comprehensive host-parasite list (p. 797). The collections here reported were not made with statistical analysis in mind, and thus were not uniform in sampling, recording techniques, or in coverage. For example, relatively few collections of ectoparasites were made in the subtropical zone (approx. 2500–5000 feet). Because of this, we have had to carefully select our data in treating various aspects of host-parasite relationships. Nonetheless, with these and other factors taken into account, it is evident that certain hosts acquire a disproportionately large number of parasites in comparison with others.

Large numbers of species of ectoparasites were recorded for certain *euxenous* (= hospitable) hosts, as opposed to *apoxenous* (= inhospitable) hosts, which had few or none (fig. 148). For example, 15 or more species of ectoparasites were reported from 18 host species: 41 from the opossum,

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[14] See Wenzel, Tipton, and Kiewlicz (p. 617, this volume) for a discussion of the taxonomic status of "*mirabilis*" on *Trachops*.

Didelphis marsupialis; 37 from the spiny rat, *Proechimys semispinosus;* 31 from the short-tailed bat, *Carollia perspicillata azteca;* 29 each from the spiny pocket mouse, *Heteromys desmarestianus* and the deer mouse, *Peromyscus n. nudipes;* 25 from the cotton rat, *Sigmodon hispidus;* 24 each from the tree squirrel, *Sciurus granatensis,* and the coati, *Nasua nasua;* 23 each from the rice rat, *Oryzomys capito* and the cane rat, *Zygodontomys microtinus;* 21 from *Homo sapiens;* 19 each from the porcupine rat, *Hop-*

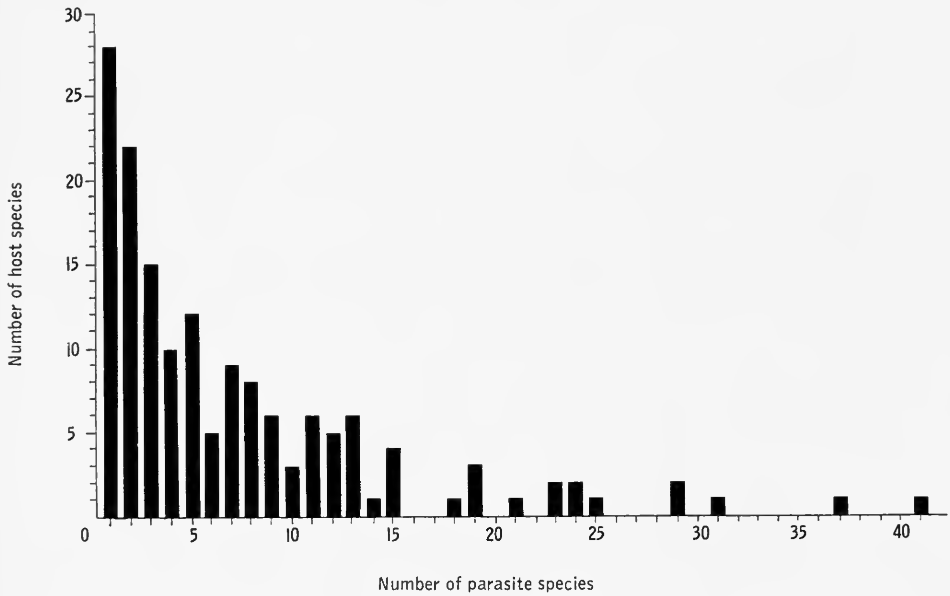

Fig. 148. Numbers of species of mammal hosts, according to numbers of species of ectoparasites taken from each in Panama. Negative hosts are not included.

lomys gymnurus, the spiny pocket mouse, *Liomys adspersus,* and the rice rat, *Oryzomys caliginosus;* 18 from the four-eyed opossum, *Philander opossum,* and 15 each from the brown mouse, *Scotinomys xerampelinus,* the nine-banded armadillo, *Dasypus novemcinctus,* and the fruit bat, *Artibeus j. jamaicensis.* In general, analysis of the other hosts indicates that the number of nonspecific (exceptional) parasites decreases with increasing ecological specialization and/or geographical restriction of the host.

The species with the largest number of parasites reported for it is the common opossum, *Didelphis marsupialis.* Of 41 species reported for this host from Panama, probably no more than four or five are characteristic parasites and none appear to be monoxenous! Four are characteristic parasites of marsupials, but not of *Didelphis* alone. These are a dermanyssid mite, *Ornithonyssus wernecki;* a tick, *Ixodes luciae;* and a flea, *Adoratopsylla i. copha;* the fourth is a flea, *Juxtapulex echidnophagoides,* which occurs on both marsupials and the armadillo, *Dasypus novemcinctus,* in Panama. It appears then, that *Didelphis* must acquire most of its parasites from other hosts. It is a truly ubiquitous, ecologically broadly tolerant animal, which ranges from sea level to above 5000 feet elevation, in Panama.

It moves through and between a number of ecological formations, both horizontally and altitudinally, and thus comes into contact with many other components of the communities of which it is a part, including other hosts and their parasites. Some of these parasites move onto *Didelphis*, in varying degrees of association, mostly in small numbers, as opportunity permits or circumstances require. An individual opossum carries a much smaller number of species than is apparent from the comprehensive host-parasite list, the faunule varying from habitat to habitat, and especially at different elevations.

The fleas reported from *Didelphis* illustrate this point (see Tipton and Méndez, this volume, p. 326). Below 2500 feet, they were: an agouti flea, *Rhopalopsyllus a. tupinus;* a paca flea, *R. l. lugubris;* an armadillo flea, *R. cacicus saevus* (probably through use of armadillo burrows); and *Polygenis klagesi,* from the ubiquitous spiny rat, *Proechimys semispinosus.* Between 2500 and 5000 feet elevation, they were *Polygenis r. beebei* (from species of *Oryzomys,* especially *O. caliginosus* and *O. capito*); and the marsupial flea *Adoratopsylla i. copha.* At elevations above 5000 feet, they were: the rabbit flea, *Hoplopsyllus glacialis exoticus; Juxtapulex echidnophagoides,* shared by *Didelphis* and the nine-banded armadillo; a squirrel flea, *Pleochaetis d. dolens;* and more abundantly than at lower elevations, a marsupial flea, *Adoratopsylla i. copha.* Throughout its range, *Didelphis* was occasionally parasitized by the cat flea, *Ctenocephalides f. felis.* This kind of pattern is reflected in the other groups of ectoparasites collected from the opossum, too.

While its ecological tolerance and vagility obviously influence the number of parasites it acquires, *Didelphis* may tolerate a greater variety of parasites than do many other hosts. It is a primitive animal that is only superficially specialized. Many parasites adjust to specialized differences of the hosts. It is significant that so many parasites of New World marsupials show little specificity to host species, but rather to marsupials as a group. The large number of ectoparasites it acquires may partly reflect an easier "penetration" of *Didelphis* by non-specific parasites, due to the relative absence of competition from forms which are more narrowly adjusted to it or from forms which may be adjusted to it only in certain environments.

The interrelationships between *Didelphis* and other hosts are far more numerous and complex than indicated by the above discussion. In Panama more than 70 hosts were recorded for the 37 non-marsupial parasites that were reported from *Didelphis.* These included 11 species of birds and reptiles and three of bats. Thus, the number of possible interrelationships through exchange of ectoparasites and/or micro-organisms, directly, or indirectly through "intermediary" hosts, is enormous.

Didelphis could well play an important role in the dissemination of ecto- and endoparasites between animals that are ecologically more restricted. This might also be true of some of the other euxenous hosts.

While there appears to be little taxonomic relationship between these "carrier" hosts, all have one feature in common with *Didelphis*, namely that they contact many components of a community, but in different ways. Among the bats, *Carollia perspicillata azteca* (see Wenzel, Tipton, and Kiewlicz, this volume, p. 638) roosts in a wide variety of sites and with a variety of hosts. Tree squirrels, on the other hand, contact a wide range of components through their foraging and nesting activities, both on the forest floor and in the tree strata.

Many of the euxenous hosts are ubiquitous in yet another sense. Some, like *Proechimys semispinosus, Peromyscus nudipes, Oryzomys capito* and *O. albigularis* may be abundant more or less uniformly distributed (pervasive) forest animals, and the grassland *Sigmodon hispidus* and *Zygodontomys* may be similarly distributed. Some of these hosts exhibit considerable sociability and even commensalism. Further, populations of such common and widespread species may be restricted to "pockets" in areas where their habitats are discontinuous. In the presence of an extraordinary abundance of food, such a population may increase far beyond the ordinary carrying capacity of the pocket. With the exhaustion of this extraordinary increment of food, the excess numbers of rodents may spill over into neighboring areas in outbreaks that are referred to as *ratadas* or "rat plagues" in rural South America.[15]

From the lists of ectoparasites given for them (p. 797), it is obvious that hosts like these must have contacts with many other host species or their runways, nests, etc., and/or their parasites. Further, rat plagues or *ratadas* must provide unusually favorable circumstances for exchange of both ecto- and endoparasites and other micro-organisms. It is quite likely that they may acquire pathogens from ecologically more restricted hosts and ectoparasites, and thus become "carriers" or even reservoirs, in the epidemiological sense.

Although no arthropod vectors have been demonstrated, the ecology of the Beni (Bolivia) epidemic of haemorrhagic fever emphasizes the importance of this type of host. *Proechimys guyannensis,* and *Calomys callosus,* two rodents that have been incriminated in the epidemiology of this disease (Kuns, 1964), are typical *ratadas* forms (Hershkovitz, pers. comm.). *Proechimys semispinosus* (see above) is one of the notable euxenous hosts in Panama.

For ectoparasites one could assemble a graph very similar to that (fig. 148) shown for the hosts. The largest number of host species were recorded for Acarina, especially chiggers and ticks, and a few fleas like *Ctenocephalides felis.* Brennan and Yunker (this volume, p. 235) recorded 35 hosts each for the chiggers *Eutrombicula goeldii* and *E. alfreddugesi,* in Panama. The epidemiological importance of such non-specific (promiscuous) or of

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[15] Hershkovitz (1962) has given an extended discussion of pocket populations and *ratadas.* He cites instances in which *ratadas* of South American cricetines are correlated with cyclic fruiting and seed production of bamboos. As many as 17-20 years may elapse between fruiting.

polyxenous ectoparasites, especially the immature stages of heteroxenous ticks, is well documented in the literature on arthropod-borne diseases.

If survey and sampling techniques are sufficiently refined, it should be possible, through modern data processing, to analyze many of the complex interrelationships between hosts, parasites, and the extra-host environment. This should not only lead to a better understanding of the population dynamics, but may make it possible to evaluate hosts and ectoparasites of a given area in terms of their potential epidemiological importance.

IV. Altitudinal distribution

In the following discussion we refer to tropical, subtropical, and montane zones in the sense of Holdridge and Budowski (see fig. 149 and Fairchild, "Introduction," p. 5, this volume). This differs from the classification of Goldman and Zetek (1926) and that of Fairchild (loc. cit.). The tropical zone of Fairchild correlates more closely with many parasite distributions than does that of Holdridge and Budowski. When we describe groups as being temperate in distribution, we are referring to their climatic adjustment without restricting them geographically.

A. Mites and Ticks

Family **Laelaptidae**

Subfamily LAELAPTINAE. Most of the laelaptine mites occurred in the tropical and subtropical zones. Some, like *Laelaps nuttalli* and *Echinolaelaps echidninus* (both introduced), were taken only near sea level. Others, like *Haemolaelaps glasgowi,* were taken from sea level to 7500 feet. Tipton, Altman, and Keenan (this volume, p. 34) suggest that this species is composite. Most species of *Gigantolaelaps* were tropical and subtropical, like their oryzomyine hosts. However, *G. inca* (described from Peru) was taken only above 5000 feet, as was *Eubrachylaelaps jamesoni* (described from Mexico). The native species of *Laelaps* showed considerable differences in their altitudinal ranges. Some, like *pilifer* and *dearmasi,* occurred only in the tropical and subtropical zones, while others, like *thori,* were taken between 2000 and 7800 feet.

Families **Dermanyssidae, Trombiculidae**

We cannot assess the altitudinal distributions of these two families. In general, the Dermanyssidae appeared to be tropical and subtropical in distribution, though *Ornithonyssus bacoti,* the Tropical Rat Mite, was taken from sea level to 5000 feet. The Tropical Fowl Mite, *O. bursa,* occurred at low elevations, while *O. sylviarum,* the Northern Fowl Mite, was taken at 5700 feet on Volcan Chiriquí, the southernmost record of this species.

Family **Spinturnicidae**

The altitudinal distribution of these mites was very similar to that of the Streblidae (see below). As in the case of the streblid *Joblingia,* the spinturnicid genus *Paraspinturnix* on *Myotis n. nigricans* was taken only in the lower montane zone.

Superfamily **Ixodoidea**

The altitudinal distribution of the ticks is discussed by Fairchild, Kohls, and Tipton on pp. 168–170, this volume. Most species of *Amblyomma* occurred in the lowlands and those of *Ixodes* in the highlands.

B. Rove Beetles

Family **Staphylinidae**

The parasitic amblyopinine staphylinid beetles are primarily temperate in their distribution, both altitudinally and latitudinally in South America. The Middle American species, including those taken in Panama, are from the montane zones. The distribution shown for *Amblyopinus tiptoni* (fig. 150) is typical.

C. Batflies (Diptera)

Family **Streblidae**

The Streblidae are primarily tropical and subtropical in distribution, with very few species in the warm temperate and none in the cool temperate regions. This is strikingly illustrated by their altitudinal distribution in Panama. Of the 66 species recorded from Panama, 49 (ca. 75.4%) were restricted to the tropical zone, or nearly so. The ranges of a few of these extend into the lower elevations of the subtropical zone.

About nine species (12.3%) were either restricted to the subtropical zone or ranged from the tropical or subtropical zones to the lower altitudes of the lower montane. Three of these—*Anastrebla mattadeni*, *A. modestini*, and *Exastinion clovisi*—occurred only on bats of the genus *Anoura*, which are primarily subtropical. The other six species were parasites of fruit-eating bats (Phyllostomidae: subfamilies Stenoderminae and Sturnirinae).

Four species (6.2%) were taken only in the lower montane zone. These were *Joblingia schmidti* from *Myotis n. nigricans*, *Anatrichobius scorzai* from *M. chiloensis*, *Trichobius keenani* from *Sturnira ludovici*, and *T. vampyropis* from *Vampyrops vittatus*. No species were taken in the upper montane zone.

A few species had a considerable altitudinal range. Three (4.6%) occurred with their hosts, *Desmodus r. rotundus* and *Trachops c. cirrhosus* from sea level to nearly 5600 feet. *Paratrichobius "longicrus"* showed a similar altitudinal range, but occurred on different stenodermine hosts at different elevations. It may be a composite species (see Wenzel, Tipton, and Kiewlicz, this volume, p. 519).

For the most part, the altitudinal range of a host and its Streblidae coincided closely. An outstanding exception to this is the very restricted distribution of *Joblingia schmidti*, as compared with its host *Myotis n. nigricans*. As Handley points out (p. 770) this bat is probably a composite species. According to him (pers. comm.) the montane population is probably a separate species, while the lowland population in Panama may consist of several cryptic species. This probably explains the puzzling distribution of species of *Basilia* (Nycteribiidae) on this host in Panama and elsewhere in Latin America.

Family **Nycteribiidae**

Although the Nycteribiidae appear to tolerate cooler climates and penetrate further into the temperate regions than do the Streblidae, this was not reflected in the altitudinal distributions of the seven species that have been collected in Panama. All are from the tropical zone.

D. Fleas

The altitudinal distribution of the fleas is shown in figure 149. It should be emphasized that the ranges of a number of the species would be extended by further collecting and also that the chart does not reflect relative abundance at different altitudes. Although some species were taken throughout a considerable altitudinal range, they were obviously most abundant in a much narrower one. This is reflected in the data given by Tipton and Méndez (beginning on p. 325, this volume).

Family **Pulicidae**

Tunga penetrans is the only New World species of the genus that is not restricted to Southern Brazil (São Paulo, Bahia, Goyaz). It occurs from South America to Mexico and has a correspondingly broad altitudinal range as well (fig. 149). The known species of *Rhynchopsyllus* have the same altitudinal distribution as their host bats (genus *Molossus*). *Juxtapulex echidnophagoides*, known from Costa Rica (+4300 feet elev.), and Panama, has an altitudinal range similar to that of the batfly, *Joblingia*, as does *Hoplopsyllus glacialis exoticus*, from Panama. All of the 859 specimens of *Juxtapulex* collected in Panama were from above 5000 feet elevation. The altitudinal ranges of *Pulex irritans* and *P. simulans* are interesting. They are discussed by Tipton and Méndez (this volume, p. 293), who feel that *simulans* may be lowland and *irritans* highland in Middle America.

Family **Rhopalopsyllidae**

These fleas are principally South American. Most of the South American genera are decidedly temperate in distribution, but the two large genera, *Rhopalopsyllus* and *Polygenis*, are represented in the subtropical and tropical zones. Nine species of these two genera were taken in Panama. Seven were primarily tropical and subtropical in distribution and two were taken only in the lower montane.

Family **Ceratophyllidae**

Species of five genera were collected in Panama. *Ceratophyllus altus*, the only species of the genus known from Panama, occurs in the lower montane zone. *Dasypsyllus gallinulae perpinnatus*, another bird flea, is altitudinally and latitudinally temperate, and occurs from Western North America to Panama and probably South America (Johnson, 1957). It was taken in the lower montane zone of Panama. *Dasypsyllus l. venezuelensis* occurs in the same zone, but at slightly lower elevations. The other three genera of Ceratophyllidae that were taken in Panama are *Jellisonia, Pleochaetis,* and *Kohlsia*. These three genera of rodent fleas are centered in the

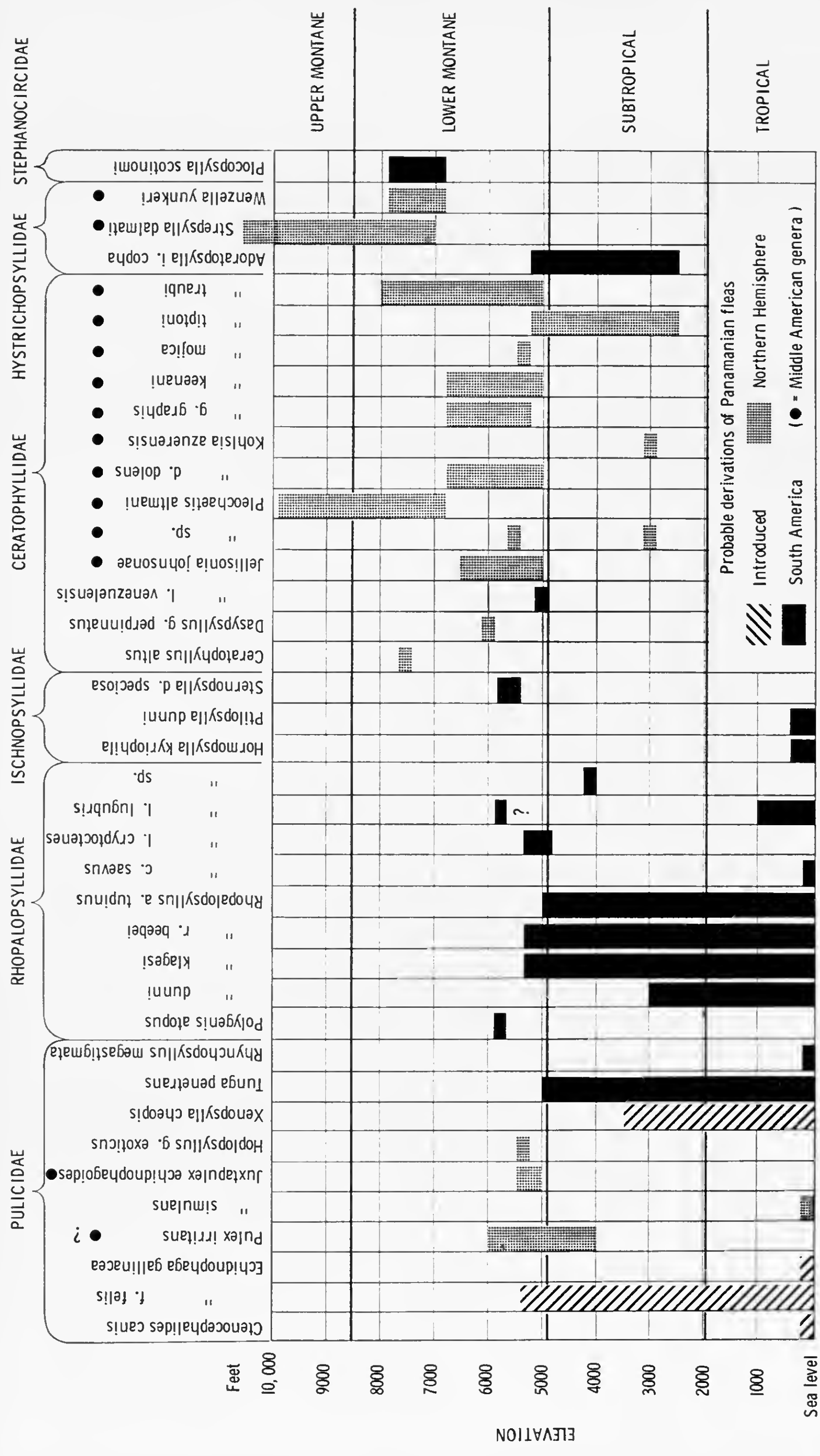

Fig. 149. Altitudinal distribution of fleas collected in Panama.

warm temperate and temperate zones of Middle America and Mexico, and this is reflected in their altitudinal distribution. A few species were taken in the subtropical, but none in the tropical zone.

Family **Ischnopsyllidae**

The bat fleas were represented by two lowland South American genera, *Hormopsylla* and *Ptilopsylla*, both of which occurred at or near sea level, and by *Sternopsylla distincta speciosa*, which occurred in the lower montane zone. *Sternopsylla* is closely related to the other two genera and occurs as *S. distincta distincta* in central and southern United States.

Family **Hystrichopsyllidae**

Adoratopsylla i. copha, taken in subtropical and lower montane zones, is a South American race of a species belonging to a South American genus. It occurs in Mexico as *A. i. intermedia*. *Strepsylla dalmati* and *Wenzella yunkeri*, both known only from the upper montane zone, belong to genera that are endemic to the highlands of Middle America.

Family **Stephanocircidae**

Plocopsylla scotinomi, the only known Middle American species of the temperate South American subfamily Craneopsyllinae, was taken only in the upper montane zone.

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In general, ectoparasite taxa of South American relationships occurred below and those of holarctic affinities above 5000 feet elevation.

V. Altitudinal Concordance Between Hosts and Parasites

The altitudinal distributions of host-limited parasites like the Spinturnicidae and of nearly host-limited ones like the Streblidae and Nycteribiidae paralleled those of their hosts quite closely. The collections of biting and sucking lice were not adequate to determine to what extent this was true for them. It is not true of groups like the fleas, ticks, and the laelaptine mites, which in general are not host-limited. The data for the Laelaptinae must be treated with considerable caution, because some of the species may be composite (see Tipton, Altman, and Keenan, this volume, p. 31).

In figure 150, we have shown the altitudinal distribution of a series of representative mammal hosts and some of their characteristic non-host-limited parasites. The altitudinal ranges must not be taken too literally, for several reasons. First, they do not reflect the relative abundance of the hosts and parasites at different elevations. The data on altitudinal distribution of the fleas given by Tipton and Méndez (beginning on p. 325, this volume) give an indication of this, but the nature of the field data does not permit detailed analyses of this type. Second, the data are lumped for all of Panama. Regional and edaphic climatic differences greatly modify the fauna and flora and thus affect the altitudinal range of both host and parasite in a given locality, as do other environmental factors. Environments on the drier Pacific slopes of the mountains are quite different from

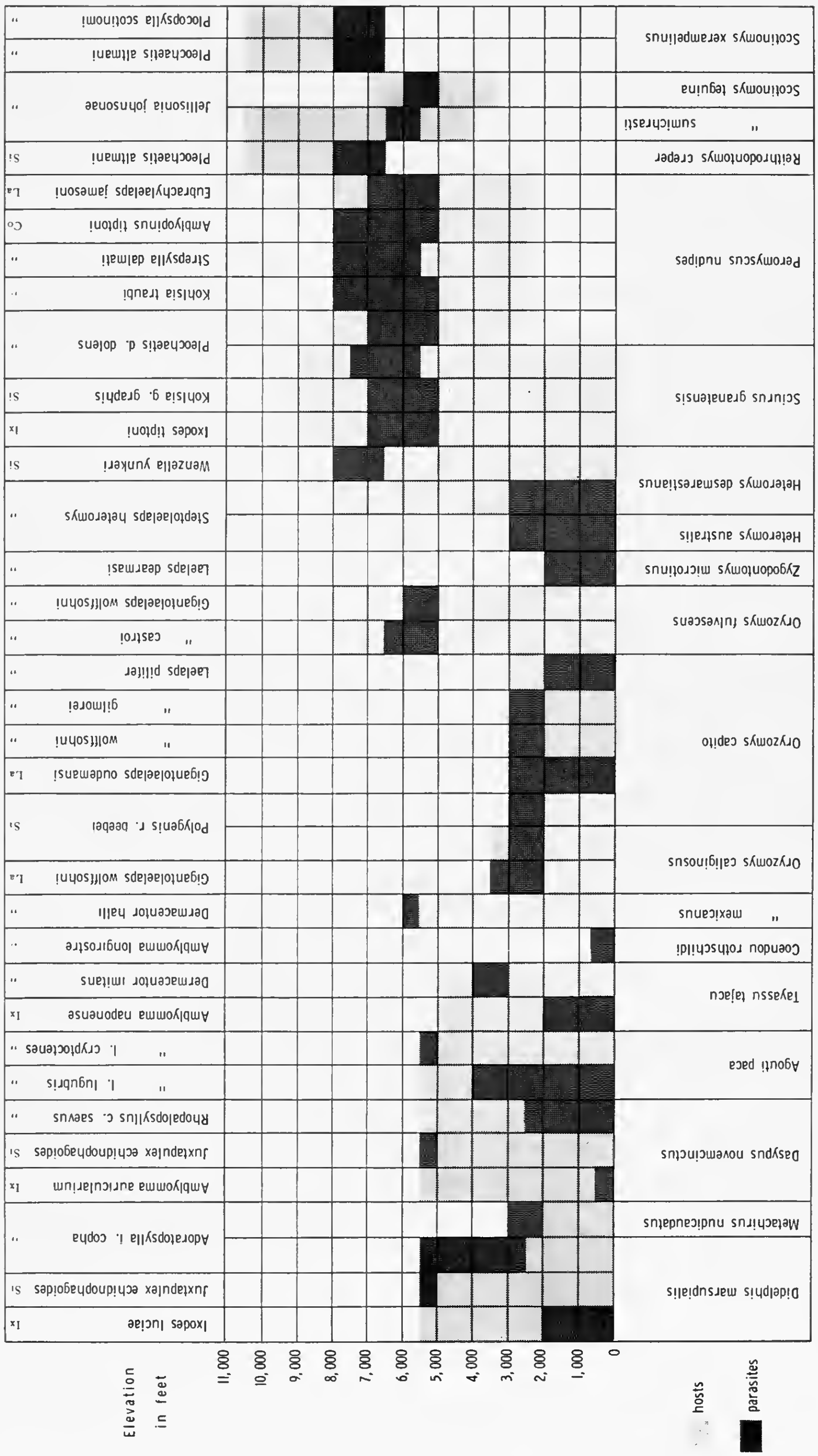

Fig. 150. Altitudinal ranges of selected mammal hosts and of some characteristic ectoparasites *on those hosts* in Panama.

those on the more humid Atlantic slopes. Similarly, the habitat at the summit of a mountain 4000 feet high differs from that at the same altitude on a mountain that is 10,000 feet high. Carefully documented field collections and ecological observations should provide an appreciation of these factors.

In spite of the limitations of the data, it is clear that the altitudinal ranges shown for many parasites do not coincide with those of the hosts. Nor does the altitudinal range of a parasite on a given host necessarily coincide with the entire altitudinal range of the parasite. In some instances, as in the case of the flea *Jellisonia johnsonae* (fig. 150) these differences could reflect sampling techniques or local edaphic differences. On the other hand, the flea *Strepsylla dalmati* was taken on *Peromyscus n. nudipes* from about 5500 feet to the altitudinal limit of this host at 8000 feet; but it was taken above this altitude on other hosts, like *Reithrodontomys* and *Scotinomys*. Similarly, *Pleochaetis altmani* was taken on *Scotinomys xerampelinus* and *Reithrodontomys creper*, between 5600 and 8000 feet (fig. 150), but a few specimens were taken on *Reithrodontomys sumichrasti* at 10,300 feet.

Other authors have also indicated that parasites may not have as broad distributions as the hosts. This may be an attribute of non-host-limited forms. The population density of most hosts must decrease as one moves away from optimum habitat conditions, and the opportunities for their non-host-limited parasites to encounter a suitable host probably decrease correspondingly, or even disproportionately because of their lesser vagility. Under these circumstances, one might expect selection to narrow the ecological range of a parasite so that it corresponds more nearly to the optimal environmental conditions of the most suitable host(s). In this respect, it should be remembered that homoiothermal hosts would have relatively greater ability to move into climatically less suitable habitats than would poikilothermal non-host-limited parasites.

It must also be noted that distribution may be correlated with subspecies of the host. For example, no fleas were taken on *Sciurus granatensis* below 5000 feet. All, including those apparently specific to this host, were from the subspecies *S. granatensis chiriquensis*, above 5000 feet. Similarly, *Wenzella yunkeri* was taken only from *Heteromys desmarestianus chiriquensis*, but not from the other subspecies that occurred at lower elevations. It is clear that in the future, host identifications to subspecies must be given whenever possible. Correlation between host subspecies and parasites and altitudinal data may in some cases indicate that the taxonomic status of the host merits further investigation.

VI. Faunal Relationships

Few groups of ectoparasites are well enough known for the Neotropical Region as a whole to permit an evaluation of the faunal relationships of their Panamanian representatives. Though it is not well known for either Middle or South America, we believe that the flea fauna of Panama and certain other critical areas has been sampled well enough to give a general picture of the distribution of the families and genera. Very large and representative collections of batflies (chiefly Streblidae) are at hand from Middle

America, and representative samples have been secured from northern South America and to some extent Peru, though the fauna of the Amazon basin is still largely unknown. The distribution of the amblyopinine beetles (Staphylinidae) and the laelaptine mites also contribute some interesting points that bear on faunistics and zoogeography.

In the following discussion we refer to all of the North American continent between the northern boundary of Mexico and the southern boundary of Panama as Middle America, and to the area north of Mexico as North America. We have arbitrarily used the term in this geographic sense as did Baker (1963), rather than in a zoogeographic sense (see Hershkovitz, 1958). However, we have followed Hershkovitz (op. cit.) in his use and definition of the Patagonian Subregion.

In the following discussion, it should be remembered that of 50 genera and ± 300 species of cricetine rodents recorded from South America, all but two recent invaders (see Hershkovitz, this volume, p. 738) are complex penis types and no parasites have been reported for these two. Thus, when we refer to South American complex-penis-type Cricetinae, we do not infer that there are South American simple-penis-type hosts for which ectoparasites have been reported. Both groups are well represented in Middle America.

A. Mites

Family **Laelaptidae**

Subfamily LAELAPTINAE. The geographic and host distribution of the laelaptine mites are instructive. Eight genera were taken from rodents in Panama. Four of them belong to a complex of six closely related genera (Tipton, 1960, p. 258). These are *Laelaps, Tur, Mysolaelaps,* and *Echinolaelaps. Laelaps* and *Echinolaelaps* are cosmopolitan and occur mostly on Murinae, Microtinae and complex-penis-type Cricetinae. They do not occur on peromyscines. Except for the introduced *L. nuttalli,* the species were taken almost exclusively on *Oryzomys* and related complex-penis-type Cricetinae. The species of *Tur* occur almost entirely on caviomorph rodents of the family Echimyidae, of South American origin. *Mysolaelaps* also is neotropical and occurs on South American complex-penis-type cricetines and on caviomorphs. Two related genera, *Longolaelaps* and *Tricholaelaps* occur on Murinae (*Rattus*) in Sumatra.

Haemolaelaps is a cosmopolitan genus with more than 60 species which are associated with a wide range of hosts, but chiefly sciuromorph rodents (Tipton, op. cit., p. 242). *H. glasgowi,* the only species taken in Panama, occurred on a wide variety of small mammals, including rodents of the three suborders and marsupials (table 12).

The 14 described species of *Gigantolaelaps,* chiefly South American, are almost exclusively parasites of oryzomyine Cricetinae. The five species taken in Panama were originally described from South America; all have been taken in Venezuela, four of them also in Brazil, the fifth in Peru. All except one occurred below 5000 feet in Panama. *Gigantolaelaps inca,* described from Peru, was taken only above 5000 feet, chiefly on *Oryzomys* *albigularis* and *O. alfaroi* (fig. 150) sparingly on *Peromyscus* and *Didelphis*.

The genus *Eubrachylaelaps* is closely related to *Haemolaelaps, Cavilaelaps* (on South American caviomorphs) and *Gigantolaelaps* (Furman, 1955; Tipton, op. cit.). The eight described species occur mostly on the simple-penis-type cricetines, *Peromyscus and Neotomodon,* in the subtropical and temperate altitudes and latitudes from Panama to California. *Eubrachylaelaps rotundus* Fonseca has been reported only from South America (Brazil and Venezuela) from a variety of sciuromorph and complex-penis-type myomorph (cricetine) rodents and marsupials. About half of the specimens taken in Venezuela (Furman and Tipton, 1961) were from *Zygodontomys.* This appears to represent a host transfer for *Eubrachylaelaps.*

The total numbers of Laelaptinae collected are tabulated for each genus of mites and of hosts, in table 12. We are aware that this method of presentation has many weaknesses, e.g., it does not show the host associations by species. Nonetheless it does show the preponderant associations of *Eubrachylaelaps* with *Peromyscus,* of *Gigantolaelaps* with complex-penis-type Cricetinae, especially *Oryzomys;* of *Laelaps* with caviomorph rodents and complex-penis-type Cricetinae; the promiscuity of *Haemolaelaps glasgowi;* the restriction of *Steptolaelaps* to the sciuromorph Heteromyidae, and of *Tur* to the caviomorph Echimyidae.

To summarize—of the eight genera that occur in Panama, three (*Laelaps, Haemolaelaps, Echinolaelaps*) are cosmopolitan; three (*Mysolaelaps, Gigantolaelaps, Tur*) are primarily South American, and are associated in Middle and North America with rodents of South American derivation or affinities; while *Eubrachylaelaps* and *Steptolaelaps* appear to be Middle and North American in origin.

The principal hosts of one South American genus (*Tur*) are caviomorph rodents. The principal hosts of the other two, as well as of two of the cosmopolitan genera, are primarily Murinae, and Microtinae, and complex-penis-type Cricetinae. Most Murinae and the Microtinae have complex penes, too. The occurrence of the preponderance of the Laelaptinae on rodents of this type suggests that Hershkovitz's treatment (1962) of the Cricetinae as a subfamily of the Muridae is sound. It is of special significance that many of the host associations of the genera of Laelaptinae are at a suprageneric level, as evidenced strikingly by the species of *Tur* on Echimyidae (Caviomorpha) and of the genus *Steptolaelaps* on Heteromyidae (Sciuromorpha). Thus, the differences in host associations between the related genera *Eubrachylaelaps* and *Gigantolaelaps,* with *Eubrachylaelaps* on simple-penis-type Cricetinae (Peromyscini, see Hooper and Musser, 1964, p. 54) and *Gigantolaelaps* only on complex-penis-type Cricetinae (chiefly oryzomyine genera) suggest a long period of geographic isolation and of differentiation of the two groups of hosts and parasites.

If we have belabored this point, it is because we believe it is important to establish the point—as evidenced by their mites and other ectoparasites, as well as by their distribution—that the simple-penis-type Cricetinae do appear to constitute a group, phyletically distinct from the other New World

TABLE 12. NUMBERS OF LAELAPTINE MITES COLLECTED IN PANAMA, ACCORDING TO GENERA OF HOSTS AND MITES.
(introduced species not included)

Hosts	*Tur* (2 spp.)	*Mysolaelaps* (*parvispinosus*)	*Echinolaelaps* (*lowei*)	*Laelaps* (3 spp.)	*Eubrachylaelaps* (*jamesoni*)	*Gigantolaelaps* (5 spp.)	*Steptolaelaps* (*heteromys*)	*Haemolaelaps* (*glasgowi*)	No. of host animals examined
Order MARSUPIALIA									
Family Didelphidae									
Philander (opossum)	..	..	..	..	..	..	..	8	109
Metachirus (nudicaudatus)	..	..	..	..	..	..	..	47	41
Didelphis (marsupialis)	..	..	..	..	..	10	..	3	207
Order RODENTIA									
Suborder Sciuromorpha									
Family Sciuridae									
Sciurus (granatensis)	..	..	..	..	..	..	..	26	129
Family Heteromyidae									
Liomys (adspersus)	..	..	..	..	..	..	4	3	62
Heteromys (2 spp.)	1	..	..	..	1	..	146	5	80
Suborder Myomorpha									
Family Cricetidae									
Subfamily Cricetinae									
***Oryzomys (10 spp.)**	..	..	..	309	2	1928	..	89	296
***Nectomys (alfari)**	..	..	2	..	..	28	..	11	3
***Zygodontomys (microtinus)**	..	..	..	144	..	26	..	2	74
***Sigmodon (hispidus)**	..	..	..	20	..	20	..	49	153
Tylomys (panamensis)	..	..	..	..	..	..	..	1	9
Peromyscus (2 spp.)	..	..	..	3	236	16	..	102	329
Reithrodontomys (3 spp.)	..	..	..	5	1	1	..	44	174
Scotinomys (2 spp.)	..	..	..	..	..	..	..	20	121
Suborder Caviomorpha									
Family Echimyidae									
Proechimys (semispinosus)	1610	..	..	35	..	1	..	9	616
Hoplomys (gymnurus)	18	..	..	..	..	..	..	5	9

* = Complex-penis-type Cricetinae.

Cricetinae, as postulated by Hooper (1960, p. 19).[16] We believe that failure to recognize this distinction, has caused considerable confusion in thinking about the history and relationships of the Cricetinae and their parasites, and that it has led to erroneous conclusions regarding the immigration and evolution of the Cricetinae in South America.

B. Rove Beetles

Family **Staphylinidae**

Subfamily STAPHYLININAE. The distribution of the staphylinid beetles of the tribe Amblyopinini roughly parallels that of the stephanocircid fleas. These interesting beetles, which parasitize small mammals, are at present centered in South America. Seevers (1952) recognized five genera (table 13), one of them monotypic and known only from Tasmania where it occurs on a native murid. Three genera, with 19 species, are restricted to the South American continent; but *Amblyopinus,* with ±30 species, is represented by five species in Panama, Guatemala, and Mexico. Amblyopinini are chiefly temperate in distribution, those of the middle latitudes being mostly montane. In South America they are largely restricted to the Patagonian Subregion, though a number of species occur in the southern part of the Brazilian Subregion, in the Andes of Colombia, and in the highlands of Venezuela and the Guianas. In Panama, they were taken at altitudes above 5000 feet; in Guatemala, above 6000 feet.

Seevers (op. cit.) regarded *Myotyphlus* from Tasmania as the most generalized genus and *Edrabius* of the Patagonian Subregion as most closely related and derived from the same stock. He considered the other three genera to have evolved from a common stock, with *Megamblyopinus, Amblyopinus,* and *Amblyopinodes* to be more specialized, in that order. *Edrabius* and *Megamblyopinus,* the most generalized South American genera are known only from *Ctenomys* (Caviomorpha) in the Patagonian Subregion. While most of the species of *Amblyopinus* appear to be host-species specific, the taxonomic range of hosts for the genus is considerable, and includes marsupials and various sciuromorph, caviomorph, and myomorph rodents.

Amblyopinodes, the most specialized genus, is confined mostly to South American complex-penis-type Cricetinae. Machado-Allison (1963) has shown that ten of the known species occur on *Akodon, Holochilus, Nectomys, Oryzomys* (2 species), *Oxymycterus* and *Scapteromys;* the eleventh species is from *Cavia.* He stated (op. cit., p. 414) that "parasitism [by *Amblyopinodes*] on *Oryzomys,* a genus of Holarctic [!] origin, and upon *Cavia* is secondary or accidental in the second case." There is no reason to believe that the association with *Oryzomys* is secondary. *Oryzomys* is related to *Nectomys.* Indeed, all of the hosts listed except *Cavia,* are South American complex-penis-type Cricetinae. Further, there is no reason to assume

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[16] Hooper stated that this group of genera "has the aspect of a distinct natural unit, of subfamily or family rank, which like the Heteromyidae and Geomyidae is endemic to the New World. The possibility that it is a natural group now requires intensive investigation, using all pertinent information." But, see also Hershkovitz (1966b).

Table 13. Numbers of Species of Amblyopinine Staphylinid Beetles by Geographic Area.

Genus	Total Species	S.A.	PAN.	GUAT.	MEX.	TAS.	Hosts
Myotyphlus	1	..	..	..	..	1	Myomorpha (Muridae)
Edrabius	6	6	..	..	..	..	Caviomorpha (*Ctenomys*)
Megamblyopinus	2	2	..	..	..	..	Caviomorpha (*Ctenomys*)
Amblyopinus	±30	26	2	1	2	..	Marsupialia Rodentia: Caviomorpha, Sciuromorpha, Myomorpha
Amblyopinodes	11	11	..	..	..	..	Myomorpha (S.Am. Cricetinae) Caviomorpha (*Cavia*)

(S.A. = South America; PAN. = Panama; GUAT. = Guatemala; MEX. = Mexico; TAS. = Tasmania).

that *Oryzomys* is of holarctic origin in any different sense than might be postulated for all the other South American Cricetinae.

It is noteworthy that *Amblyopinus*, the only genus with Middle American representatives, is also the only one which exhibits marked ecological polyvalence, as indicated by both its host and geographic distribution in South America. The Middle American species appear to have transferred to peromyscine Cricetinae and to parasitize them almost exclusively. This may reflect the relative lack of complex-penis-type hosts in the montane zones. It is most interesting that *Amblyopinodes*, whose species are restricted to *Oryzomys* and other complex-penis-type Cricetinae, has not been found in Middle America.

C. Batflies

Family **Streblidae**

Of the 23 described genera of New World Streblidae, 20 are known from Panama, and two others almost certainly occur there. Two monotypic genera *Eldunnia* (*breviceps*) and *Parastrebla* (*handleyi*), are known only from Panama. Since their hosts are primarily South American in distribution, these flies probably occur there too. One genus, *Joblingia*, is known only from the montane zones of Panama (Chiriquí), Costa Rica, and Guatemala, and is probably endemic to the warm temperate areas of Middle America.

All of the other genera that occur in Middle America and the Antilles also occur in South America, as do most of the species. In northern Mexico and southwestern United States, there are a few species that do not occur in either Panama or South America, and also one group—the *Trichobius major* group—from which *Joblingia* and *Anatrichobius* were almost certainly derived. The most generalized representatives of this group, *T. major*, *corynorhini*, and *hirsutulus*, occur on Vespertilionidae in southern United States, Mexico, the highlands of Guatemala, and in the Greater Antilles. Somewhat more specialized species occur in the Greater Antilles (on Vespertilionidae); the most specialized ones occur on other hosts, including Chilonycterinae, both in the Greater Antilles and in Middle America. One, *T. sparsus*, occurs in the lowlands of Panama, on *Pteronotus parnellii fuscus* (Phyllostomidae: Chilonycterinae).

Two described genera are known only from South America, but probably only one (*Synthesiostrebla*) is restricted to that continent. An undescribed genus has been taken from *Noctilio l. leporinus*[17] in Surinam, northern Brazil (near Surinam) and Venezuela. The *Trichobius pallidus* group (which is closely related to the *caecus* group), is known to us only from the two genera of Furipteridae. The *caecus* group occurs on the related family Natalidae and the apparently related Chilonycterinae (see Wenzel, Tipton, and Kiewlicz, this volume, pp. 443–4, 447–8, 652–3).

Two genera that appear to be centered in South America, extend into Panama. They are *Pseudostrebla*, on species of *Tonatia* in the lowlands, and *Anatrichobius*, on *Myotis* in the lower montane zone.

The only endemic genera and species groups in Middle America, then, are primarily temperate or subtropical in distribution, with a few derived species in the tropical lowlands. One other genus and one species group could be regarded as centered in, though not restricted to the West Indies, southwestern United States, and Middle America. These are *Nycterophilia* and the *Trichobius caecus* group, whose principal and probably original hosts appear to be Natalidae and Chilonycterinae. The Chilonycterinae and Natalidae occur in the Antilles and in Middle and South America. We are not in a position to judge at this time whether this distribution represents a recent dispersal or is a fairly old one. It is old enough for speciation to have occurred in both of the major geographic areas concerned. If the dispersal is a recent one from Middle America and the Greater Antilles to South America, these hosts and their streblids might be part of an earlier endemic tropical lowland fauna that was isolated until the emergence of the Panama land bridge. However, judging from their distribution in the Greater Antilles, dispersal of these hosts was probably not unduly hampered by relatively narrow water gaps. The only Streblidae for which the Panamanian isthmus seems to have been a barrier, either with or without water gaps, are temperate forms like *Joblingia*.

The lowland tropical Streblidae of Middle America and the coastal lowlands of Colombia, Peru, and Western Venezuela, form a faunal unit. It is replaced by an "allopatric" unit in eastern Venezuela, the Guianas, and

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[17] It has not been taken from the races of *Noctilio leporinus* that occur in the Amazon basin, northwest South America and Middle America, or the Greater Antilles.

parts of the Amazon Basin; this in turn is replaced by other faunal assemblages in various parts of the Amazon Basin and southern South America.

To summarize, the tropical lowland streblid fauna of Panama is exceptionally rich and representative and is entirely a continuation of the South America fauna. Because few Streblidae are temperate, the montane fauna is very limited. The few clearly endemic Middle American elements occur entirely in the montane zones. These are chiefly species and species groups, although there is one endemic genus, *Joblingia.* Panama appears to be the southern limit of this genus, and is the most northern limit known of the related genus, *Anatrichobius,* whose principal distribution is in the highlands and southern latitudes of South America. There are no taxa of Streblidae common to the New and Old Worlds. Dispersal between the two was probably very early.

Family **Nycteribiidae**

Of 13 genera of Nycteribiidae, only two are known from the New World. *Hershkovitzia,* the most generalized genus of the family, is known from two species that parasitize the highly specialized, ecologically isolated, relict family Thyropteridae in South America. Since *Thyroptera* occurs in Panama, *Hershkovitzia* may ultimately be found there, too. The other nycteribiid genus, *Basilia,* occurs in both the Old and the New World, chiefly on Vespertilionidae. Since the principal host genus, *Myotis,* occurs in both hemispheres, one is tempted to conclude that the entire dispersal is recent. However, as pointed out by Guimarães and D'Andretta (1956), there are distinctive endemic elements of the genus in Middle and South America whose distributions suggests that there was an earlier dispersal, too. This is also suggested by the occurrence on *Myotis* of Streblidae of the *Trichobius major* group and of the genera *Joblingia* and *Anatrichobius.* These appear to have evolved on *Myotis,* yet have no Old World relatives.

All of the Nycteribiidae that are known from Panama occur in the lowland tropics. As pointed out by Guimarães (p. 402, this volume), "Panamanian Nycteribiids seem to belong to the South American assemblage of *Basilia* species."

E. Fleas

The two preceding groups are primarily tropical and subtropical in distribution. Their distributions exhibit many features in common with those of the fleas, though the latter are primarily temperate in distribution and show numerous relationships with Old World forms. In the following discussion we have treated those forms whose host and geographic distributions have a bearing on the faunal relationships of the native fleas of Middle and South America. Table 17 should be consulted for a summary of the numbers of genera and species of native New World fleas according to families and geographic subregions. Figure 149 shows the altitudinal distribution of the Panamanian fleas. We have drawn heavily upon Johnson (1957) for information regarding South American fleas, and upon Hopkins and Rothschild (1953, 1956, 1962) for information regarding certain families of Middle and North American fleas. For a comprehensive review of host associations of fleas, for the world, refer to Hopkins (1957a).

Family **Pulicidae**

Subfamily TUNGINAE (including Hectopsyllinae). These are largely confined to South America. *Tunga penetrans* has been carried by man to other tropical parts of the world, and two species have been described from China.[18] Of the five South American species of *Tunga,* four are restricted to Southern Brazil, while the fifth, *T. penetrans,* occurs throughout the tropical lowlands of South and Middle America. Its dispersal within the hemisphere may have been facilitated by man.

The genus *Hectopsylla* is centered in the Patagonian Subregion, with eight species described from South America, chiefly from birds and caviomorph rodents. None have been taken in Panama, but *H. knighti* Traub is known from Mexico. This is one of the few genera of primarily temperate South American distribution that is found in the montane zones of Middle America. The fact that the species of this genus infest birds probably explains its dispersal across the isthmus.

The two species of the genus *Rhynchopsyllus* parasitize bats of the genus *Molossus* (Molossidae). One species is known from Peru and Panama, the other from numerous localities throughout South America, chiefly in the southern latitudes and interior Peru, Ecuador, Colombia, and (?) Venezuela.

Subfamily PULICINAE. Tribe Pulicini. Of the genus *Pulex,* only the human flea, *P. irritans,* has been recorded from South America. The four other known species occur in Middle America and the United States. *Juxtapulex echidnophagoides,* is known from Panama and Costa Rica. In Panama, its principal hosts appear to be the armadillo, *Dasypus novemcinctus fenestratus* and the opossum, *Didelphis marsupialis caucae.*

Tribe Spilopsyllini. *Actenopsylla* with a single species (*suavis*) of bird flea is known only from Mexico. All of the other native species of Pulicidae that have been taken in Middle and South America, are rabbit fleas of the genera *Hoplopsyllus* (subg. *Euhoplopsyllus*) and *Cediopsylla.* These are two of the only flea genera of recent holarctic or nearctic derivation that occur in South America. The genus *Cediopsylla* has not been taken in Panama. One species, *spillmanni* Jordan, has been taken in Peru, and the two North American species have been taken in Mexico. The genus is restricted to the western hemisphere.

The genus *Hoplopsyllus* is represented north of Mexico by four species, one of the subgenus *Hoplopsyllus* and three of *Euhoplopsyllus. Hoplopsyllus* (*E.*) *glacialis* is widespread, with three subspecies in the New World, one each in Turkestan and China and one in Panama. *Hoplopsyllus g. exoticus*

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[18] It has been suggested (Hopkins, 1957a, p. 79) that the occurrence of *T. caecigena* in China represents an introduction from South America. The recent description of a second species (*callida*) from Yunnan, China makes this appear dubious. A similar distribution is known for the Histeridae (Coleoptera). The senior author recently received an undescribed species of *Binhister,* collected in Santa Catharina, Brazil, by Fritz Plaumann. The described species are from Japan and Indo-China.

is the only representative of the genus that has been taken in Panama (above 5000 feet, fig. 149). It has not been recorded from South America. The two species of *Euhoplopsyllus—manconis* Jordan from Ecuador and Peru, and *andensis* from Peru—that are known only from South America may be subspecies of *H.* (E.) *glacialis* (Johnson, 1957; Hopkins and Rothschild, 1953).

Family **Malacopsyllidae**

This family contains two monotypic genera, *Malacopsylla* and *Phthiropsylla,* both endemic to Argentina. The principal records of both are from edentates and carnivores. The family is almost certainly relict.

Family **Rhopalopsyllidae**

This family is related to the Malacopsyllidae. The species are restricted to the New World, with the exception of some species of *Parapsyllus.* The Parapsyllini with 42 species and subspecies in eight genera, occur chiefly in the Patagonian Subregion at southern latitudes or high elevations. Their principal host associations are with cricetine and caviomorph rodents, with one genus, *Parapsyllus,* on penguins in South America, in the Falklands, South African coastal islands, other southern hemisphere islands, and Australia. None of this tribe have been taken north of Ecuador.

The Rhopalopsyllini include 54 species and subspecies in three genera in South America. The six species of the genus *Tiamastus* are confined to the Patagonian Subregion, where they occur chiefly on caviomorph rodents. There are a few records from complex-penis-type Cricetinae. The other two genera, *Rhopalopsyllus* and *Polygenis,* include many species that are montane in distribution. They also include a larger number of warm-adapted species, than do most other South American flea genera. Of 41 species of fleas recorded from Brazil (chiefly southern), 26 belonged to these two genera. This climatological range is also reflected in the altitudinal distribution of species taken in Panama (fig. 149).

All of the Rhopalopsyllini taken in Panama also occur in South America (!), with the possible exception of *Rhopalopsyllus* sp. near *mesus.* Johnson (1957) recognized four subspecies of *Rhopalopsyllus australis: R. a. tupinus,* recorded from Panama, Peru, Bolivia, and Brazil; the nominate subspecies described from Mexico and possibly restricted to Middle America; the other two subspecies occurring only in South America.

The host records of *Rhopalopsyllus* are not adequate to establish the principal hosts of most South American species. They appear to be primarily parasites of caviomorph rodents, and edentates, and perhaps to a lesser extent their predators, and some marsupials. The number of specimens taken from various hosts in Panama is shown in table 14. In Panama, *R. a. tupinus* is clearly a characteristic parasite of *Dasyprocta punctata,* and to a lesser extent of *Nasua nasua* and *Tayassu tajacu; R. cacicus saevus* is a parasite of *Dasypus novemcinctus;* and *R. l. lugubris* is a parasite of *Agouti paca* and, at higher elevations, of *Dasyprocta punctata* as well —in place of *R. cacicus saevus!*

TABLE 14. NUMBERS OF FLEAS OF THE GENUS *RHOPALOPSYLLUS* TAKEN IN PANAMA, ACCORDING TO SPECIES OF NATIVE MAMMAL HOSTS.†

Hosts	*R. australis tupinus*	*R. cacicus saevus*	*R. lugubris lugubris*	*R. lugubris cryptoctenes*
Order MARSUPIALIA				
Family Didelphidae				
Philander opossum (109)	1	..	..	..
Metachirus nudicaudatus (41)	..	1	..	..
Didelphis marsupialis (207)	7	18	10	..
Chironectes minimus (2)	6	..	..	..
Order EDENTATA				
Tamandua tetradactyla (7)	4	..	..	..
Dasypus novemcinctus (20)	..	181	..	..
Burrows (**Dasypus**) (20)	..	264	..	..
Order RODENTIA				
Family Sciuridae				
Sciurus granatensis (129)	1	..	..	..
Family Cricetidae				
Zygodontomys microtinus (74)	2	..	..	..
Family Dasyproctidae				
Agouti paca (13)	19	1	32	115
Dasyprocta punctata (35)	226	2	4	36
Family Echimyidae				
Proechimys semispinosus (616)	14	5	..	..
Order CARNIVORA				
Family Procyonidae				
Nasua nasua (27)	63	2	..	..
Galictis allamandi (1)	1	..	..	..
Order ARTIODACTYLA				
Family Tayassuidae				
Tayassu tajacu (1)	30	..	..	..

† numbers in parentheses following hosts = numbers of specimens examined.

The species of *Polygenis* are found on a wide variety of hosts in South America, but the principal associations appear to be with complex-penis-type Cricetinae, and to a lesser extent with caviomorph and other rodents. In Panama, most specimens of *P. atopus* were from *Peromyscus n. nudipes*, but the small numbers taken suggest that this is probably not the principal host. The principal host associations of the other three species (table 15) were as follows: *P. dunni* with *Liomys adspersus* (Heteromyidae); *P. klagesi*

TABLE 15. NUMBERS OF FLEAS OF THE GENUS *POLYGENIS* TAKEN IN PANAMA, ACCORDING TO SPECIES OF NATIVE MAMMAL HOSTS.†

Hosts	*P. atopus*	*P. dunni*	*P. klagesi*	*P. r. beebei*
Order MARSUPIALIA				
Family Didelphidae				
Marmosa robinsoni (108)	..	..	3	3
Philander opossum (109)	..	..	..	3
Metachirus nudicaudatus (41)	..	2	..	1
Didelphis marsupialis (207)	..	..	10	10
Order RODENTIA				
Suborder Sciuromorpha				
Family Sciuridae				
Sciurus granatensis (129)	..	1	..	1
Family Heteromyidae				
Liomys adspersus (62)	..	38	2	..
Suborder Myomorpha				
Family Heteromyidae				
Heteromys australis (21)	..	..	1	..
" **desmarestianus** (80)	..	..	..	1
Family Cricetidae				
Subfamily Cricetinae				
***Oryzomys albigularis** (25)	1	..	..	..
* " **bombycinus** (7)	..	..	2	10
* " **caliginosus** (94)	..	..	..	43
* " **capito** (100)	..	1	4	49
***Nectomys alfari** (3)	..	..	..	6
***Zygodontomys microtinus** (74)	..	2	11	3
***Sigmodon hispidus** (153)	..	1	1	..
Tylomys panamensis (9)	..	..	31	..
Peromyscus nudipes (322)	..	..	..	1
Family Erethizontidae				
Coendou mexicanus (5)	..	..	33	..
Family Dasyproctidae				
Dasyprocta punctata (35)	..	..	4	..
Suborder Caviomorpha				
Family Echimyidae				
Proechimys semispinosus (616)	..	3	2313	4
Hoplomys gymnurus (9)	..	..	81	..
Order CARNIVORA				
Family Procyonidae				
Nasua nasua (27)	..	..	43	..

† numbers in parentheses following hosts = numbers of host specimens examined.
* = complex-penis-type Cricetinae.

probably with *Proechimys* (Echimyidae); and *P. roberti beebei* with *Oryzomys* (Cricetinae). Most other associations of the Middle and North American species appear to be with *Oryzomys* and *Sigmodon*, though one species, *P. floridanus* (Florida), appears to have transferred to *Peromyscus*. The association of *P. klagesi* with *Liomys* is not quantitatively established. The relatively small numbers of *P. dunni* collected, and the small percentage of *Liomys* found parasitized (17.7%) suggest that *Liomys* may not be the principal host. The few available records suggest that in South America it is *Sigmodon hispidus* (the type host, from Panama). However, of 153 specimens of this host that were examined in Panama, only one was positive for this flea.

It seems reasonably clear from the geographic and host distribution records that the species of *Rhopalopsyllus* are recent arrivals from South America. In the case of *Polygenis* it appears that this genus has been present in Middle and North America long enough for endemic species and species groups to develop. Hershkovitz has indicated (p. 735, this volume) that species of the *Oryzomys palustris* complex and of the *Sigmodon hispidus* complex are Middle American descendants of the earliest cricetine invaders from South America. If this is so, then it is quite likely that the invading hosts carried fleas of the genus *Polygenis* with them into Middle America, and that this partly explains the endemism found in this genus north of Panama.

Thus, most species of *Rhopalopsyllus* belong to Hershkovitz's (op. cit.) Stratum III and the *endemic* Middle American species of *Polygenis* to his Stratum IV.

Family **Ceratophyllidae**

This family is primarily holarctic in distribution. The genera of Ceratophyllidae that occur in Panama are *Dasypsyllus, Pleochaetis, Kohlsia, Jellisonia,* and *Ceratophyllus*. The first three are the only genera of Ceratophyllidae, other than introductions, that have been taken in South America.

The species of *Dasypsyllus* are parasites of birds. The genus is widely distributed in the temperate latitudes and altitudes. Seven species are reported from the New World. *Dasypsyllus gallinulae perpinnatus* occurs along the coast of western North America to Panama. Specimens of *gallinulae* have been recorded from Venezuela and Argentina, but have not been identified to subspecies (Johnson, 1957). The nominate subspecies occurs in western Europe. *Dasypsyllus stejnegeri* has been reported from Siberia and the Pribiloff Islands; it has also been taken in Mexico (unpublished record, Traub, pers. comm.) and the Falkland Islands. The other five New World species are South American (chiefly Patagonian); but *Dasypsyllus lasius* is represented by the subspecies *venezuelensis* in montane Venezuela and Panama.

About 17 species of *Ceratophyllus* are known from the New World, 16 from the United States and Canada. One (*gallinae*) was introduced from Europe. Two species have been reported from Mexico, and one (*C. altus*) from the upper montane zone of Panama (fig. 149). None have been reported from South America.

Table 16. Host Associations of Five Middle American Genera of Fleas as Shown by Numbers Collected in Panama, According to Genera of Native Hosts.

Hosts	No. of hosts examined	*Kohlsia* (6 spp.)	*Jellisonia* (2 spp.)	*Pleochaetis* (2 spp.)	*Strepsylla* (*dalmati*)	*Wenzella* (*yunkeri*)
Order Rodentia						
Suborder Sciuromorpha						
Family Sciuridae						
Sciurus (2 spp.)	129	20	..	245†	3	..
Family Heteromyidae						
Heteromys (desmarestianus)	80	1	..	1	..	59
Suborder Myomorpha						
Family Cricetidae						
Subfamily Cricetinae						
***Oryzomys** (3 spp.)	296	14	1	20	..	..
***Nyctomys (sumichrasti)**	4	..	3	..	..	..
Peromyscus (2 spp.)	329	409	9	122	14	..
Scotinomys (2 spp.)	38	3	45	41	5	..
Reithrodontomys (3 spp.)	107	1	3	96	8	..

* = complex-penis-type Cricetinae. † = *Pleochaetis d. dolens.*

The remaining genera—*Pleochaetis*, *Jellisonia* and *Kohlsia*—are of special interest, because they appear to be primarily temperate genera which are restricted to or centered in the highlands of Middle America, chiefly on *Peromyscus* and related simple-penis-type Cricetinae and tree squirrels of the genus *Sciurus*. Their host associations are shown in table 16.

Only two species of the genus *Pleochaetis* are recorded from the (southwestern) United States. One of these, *P. sibynus*, also occurs in Mexico. The other is a subspecies of *P. equatoris*, a species of unusually wide distribution. The nominate form occurs from Peru and Ecuador to Mexico, though it was not taken in Panama. *Pleochaetis dolens* is known from Ecuador (*P. d. quitanus*) and Panama to Mexico (*P. d. dolens*). The only other species known from Panama is *P. altmani*. It was taken chiefly from species of *Reithrodontomys*, *Scotinomys xerampelinus*, and *Peromyscus n. nudipes*, while *P. dolens dolens* was taken chiefly from *Sciurus granatensis chiriquensis* and *Peromyscus nudipes nudipes*, with scattered records from other hosts. The other Middle American species have been taken chiefly from *Peromyscus*. Two species are known only from South America, *P. smiti* and *P. apollinaris*, both from Colombia. They have been taken from various hosts, chiefly complex-penis-type Cricetinae.

With a single exception, the 17 species of the genus *Kohlsia* are limited to Middle America. Six species have been recorded from Panama, only one from South America. This latter species, *K. campaniger* was taken from "*Hesperomys*" sp. in Ecuador. Its generic assignment is doubtful (Traub, 1952). The species of *Kohlsia* appear to be parasites chiefly of *Peromyscus* and other simple-penis-type Cricetinae and of *Sciurus*. Of the Panamanian species, *K. azuerensis* was taken from *Peromyscus flavidus; K. graphis graphis* was taken only from *Sciurus granatensis chiriquensis;* of 18 specimens of *keenani*, eight were from simple-penis-type cricetine rodents (*Peromyscus* and *Scotinomys*) and ten from complex-penis-type cricetines (*Oryzomys*);[19] *K. mojica* is known only from *Peromyscus n. nudipes; K. tiptoni* from *Sciurus granatensis chiriquensis; traubi* chiefly from *Peromyscus n. nudipes*, with scattered records from other hosts.

There are ten known species of *Jellisonia*. Nine have been reported from Mexico; of these, *ironsi* Eads and *bullisi* Traub and Johnson have also been taken in southwestern United States. *Jellisonia johnsonae* is known only from Panama. The genus has not been reported from South America. Most of the species have been taken from *Peromyscus* and related genera of simple-penis-type cricetine rodents, like *Baiomys* and *Reithrodontomys*, but one has been taken from *Microtus* (Microtinae) according to Traub (1952).

Family **Ischnopsyllidae**

Six genera of bat fleas have been reported from the New World. Three of these (*Hormopsylla, Ptilopsylla*, and *Rothschildopsylla*) are known only from the tropical lowlands. *Rothschildopsylla* is known only from South America. Three species of *Hormopsylla* are known from South America, and one (*kyriophila*) from Panama. They are parasites of molossid bats, as is true of the two species of *Ptilopsylla, dunni* from Panama and *leptina* from Brazil. The genus *Sternopsylla* is obviously South American in its relationships. The single species is closely related to those of the preceding two genera (Hopkins and Rothschild, 1956) and like them occurs on molossid bats. It is represented by the subspecies *S. distincta texana* in the United States and Mexico, *S. distincta speciosa* in Panama and Peru, *S. d. distincta* in Paraguay and Parana, Brazil. *Sternopsylla d. speciosa* was taken in the lower montane zone in Panama (fig. 149). The three genera of bat fleas that have been taken in Panama thus appear to be South American in their relationships.

Myodopsylla and *Nycteridopsylla*, the other two genera that occur in the New World, are holarctic. *Nycteridopsylla* does not occur in Middle or South America. The North American *Myodopsylla collinsi* has been taken as far south as Chocoyos (Dept. of Chimaltenango) Guatemala, in the montane zone. Three species of *Myodopsylla* have been described from

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[19] The few species of *Oryzomys* that were parasitized by them had such a scattered representation of flea species, that none can be regarded as characteristic hosts for these fleas.

South America, but none have been reported from between Guatemala and Colombia. The species of both genera parasitize vespertilionid bats of the genus *Myotis*. It seems likely that a species of *Myodopsylla* may be found in the highlands of Panama. The distribution pattern of this genus in the New World somewhat parallels that of certain nycteribiid batflies of the genus *Basilia*, which also occurs chiefly on *Myotis*.

Family **Pygiopsyllidae**

This family is known from the Australian, Oriental, Palaearctic (one species), Ethiopian and Neotropical Regions. Three subfamilies are recognized, two with only one genus each, the third (Pygiopsyllinae) with ±15 genera. Only the Pygiopsyllinae are represented in the New World, by one genus, *Ctenidiosomus*. The three described species are mostly from complex-penis-type cricetine rodents (*Oryzomys, Thomasomys, Rhipidomys, Neomys*). They are montane (Andean) in distribution, with species from Peru, Ecuador and Colombia. Undescribed species are known from South America. One has recently been collected in Costa Rica (det. Traub; Truxal, pers. comm.)! It was not taken in Panama, though it may occur there.

Family **Hystrichopsyllidae**

The Hystrichopsyllidae occur chiefly in the Holarctic Region. At first glance, it might appear that the South American forms represent a recent intrusion of northern hemisphere groups into South America. An analysis of the distributions and relationships does not support this. The South American representatives belong to three subfamilies, as follows:

Subfamily HYSTRICHOPSYLLINAE. *Ctenoparia* is the only genus of the tribe Ctenopariini. The two known species occur on complex-penis-type cricetine rodents in Chile and Argentina.

Subfamily CTENOPHTHALMINAE. No representatives of this subfamily have been taken in Middle America, except *Ctenophthalmus*. There are three genera in South America: *Chiliopsylla* (*allophylla* Rothsch.), whose host is dubious; *Neotyphloceras*, with two species that occur almost exclusively on complex-penis-type cricetine rodents in Argentina and in the Andes north to Colombia; and *Agastopsylla*, with six species all in the Patagonian Subregion, at high elevations or far southern latitudes, chiefly on complex-penis-type cricetines. *Chiliopsylla* and *Neotyphloceras* are the only genera of the tribe Neotyphloceratini, while *Agastopsylla* is the only genus of the tribe Agastopsyllini. The distribution and taxonomic position of these genera, including those whose species are on cricetines suggest a considerable period of isolation in South America.

Subfamily DORATOPSYLLINAE. Smit (1962) lists six genera, representing four tribes: the Idillini, with a single genus *Idilla* from marsupials in Australia; the Acedestini, with a single monotypic genus *Acedestia* from marsupials in Australia; Tritopsyllini, with a single genus *Adoratopsylla*, from marsupials in South and Middle America; and Doratopsyllini with *Doratopsylla, Corrodopsylla*, and *Xenodaeria* from insectivores. *Xenodaeria* is known only from Sikkim. The holarctic *Doratopsylla* and *Corrodopsylla* occur on shrews. The southernmost record of these is a species of *Corrodop-*

sylla from Guerrero, Mexico (Traub, pers. comm.). No fleas of this genus were found on the four specimens of the shrew *Cryptotis* sp. examined in Panama.

Three species of the subgenus *Adoratopsylla* have been taken on South American marsupials, mostly at southern latitudes in Brazil and at intermediate elevations in Venezuela and Colombia. The single species of the subgenus *Tritopsylla* is represented in South America by four subspecies, one of which, *A.* (*T.*) *intermedia copha*, occurs in Panama. A fifth subspecies has been taken in Mexico.

We have dwelt at some length on these doratopsylline fleas because *Doratopsylla* and *Adoratopsylla* have been considered to be very closely related genera, and it seemed that the occurrence of *Adoratopsylla* on marsupials might represent a recent host divergence from the Holarctic *Doratopsylla*. But, as pointed out by Smit (op. cit.), the geographic and host distributions of the genera of Doratopsyllinae and the tribal allocations of the genera suggest that the host associations of these fleas are very old. Thus the occurrence of *Adoratopsylla* in Middle America most likely represents an intrusion from South America.

Subfamily NEOPSYLLINAE. None of the genera of this subfamily have been taken in South America. Only two genera have been reported from Middle America: a species of *Meringis* from Mexico and seven species of *Strepsylla*, six of them from Mexico and one from Panama. The species of *Strepsylla* are montane and occur chiefly on species of the genus *Peromyscus* and related simple-penis-type Cricetinae. The genus appears to be endemic to Middle America.

Subfamily RHADINOPSYLLINAE. This holarctic subfamily is not represented in South America. The genus *Wenzella*, which represents a taxonomically isolated tribe (Traub, 1953; Hopkins and Rothschild, 1962), is known from only two species, *W. obscura* Traub from Guatemala and *yunkeri* n.sp. from Panama. Both were taken at altitudes above 6000 feet on *Heteromys desmarestianus* (Heteromyidae). The genus appears to be an old endemic of the Middle American highlands. The Heteromyidae, too, are primarily Middle American in distribution.

Family **Stephanocircidae**

Two subfamilies are recognized. The Stephanocircinae include a single genus (*Stephanocircus*) with five species, all from Australia and Tasmania, and occuring chiefly on marsupials, but also on *Rattus*. The Craneopsyllinae, with seven genera and 27 described species are known only from South America, with the exception of *Plocopsylla scotinomi* from Panama. Nearly all of them are from the Patagonian Subregion. Many are found at elevations of 10,000 to 16,000 feet in Peru.[20]

Although the species of *Plocopsylla* parasitize caviomorph and myo-

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[20] Because of distinctive conditions in Peru, temperatures at these high altitudes are more comparable to those at lower altitudes in Panama.

morph rodents and marsupials in South America, they appear to occur most frequently on complex-penis-type Cricetinae. The principal host of *P. scotinomi* was clearly *Scotinomys teguina,* a simple-penis-type cricetine. This probably represents a host transfer, similar to that undergone by the species of *Amblyopinus* (rove beetles) in Middle America.

Summary

Perhaps the most notable feature of the flea fauna of Panama (and all Middle America) is that there are no endemic tropical lowland genera. The tropical-subtropical lowland fauna is with few exceptions, predominantly South American, much of it probably of recent origin. Most of it has close relationships—even to the subspecies level—with coastal Colombia, Ecuador, and Peru. Above 5000 feet the fauna is largely Middle and North American or Holarctic in its relationships, but, excluding introduced species, it has few genera in common with the fauna north of Mexico, except for species that occur on ubiquitous or highly vagile hosts, like some bats, rabbits, and birds.

Of the 25 species taken above 5000 feet (fig. 149) 13 (52%) belong to genera that are known only from or are largely centered in Middle America: *Pulex, Juxtapulex, Strepsylla, Wenzella, Kohlsia, Pleochaetis,* and *Jellisonia.* Of 16 species that were taken *only* above 5000 feet, the percentage was considerably higher (approx. 69%). Two others were obviously of northern origin (*Hoplopsyllus glacialis* and *Ceratophyllus altus*). The main point illustrated by these data is that in Middle America there are a number of genera that are endemic or nearly so and nearly all are found at higher altitudes and/or northern latitudes, and chiefly on host genera that are restricted (or nearly so) to Middle and North America.

Of the 18 species that were restricted to the montane zones, or nearly so, only five can be regarded as South American derivatives. They are *Polygenis atopus, Rhopalopsyllus l. cryptoctenes, Sternopsylla speciosa* (bats), *Dasypsyllus l. venezuelensis* (birds), and *Plocopsylla scotinomi.* Two others, which occur in Middle America but were not taken in Panama, are *Hectopsylla knighti* (birds) from Mexico and *Ctenidiosomus* sp. from Costa Rica. With the exception of *Plocopsylla,* none of the South American genera occurred above 6000 feet in Panama. Only three species of Middle or North American genera occurred below 4000 feet, *none* below 2000 feet.

No endemic genera of close South American relationships are known to occur in the montane zones of Panama or elsewhere in Middle America. The converse is true of South America.

The fleas of South America like those elsewhere, are primarily temperate in distribution. Thus, in South America they occur chiefly in the Patagonian Subregion and in the cordilleras. With the exception of a few obviously recent arrivals, a few highly vagile forms, and some introductions, the fauna consists chiefly of endemics or of groups, like the Rhopalopsyllidae, which are predominantly centered in South America but may have dispersed outward. Among these latter are cold temperate forms like *Parapsyllus* (penguin fleas), or genera with warm-adapted species like *Rhopalopsyllus* and *Polygenis,* which occur in Middle and North America, chiefly on hosts of

South American origin. Only a very few temperate South American forms like some bird fleas (e.g., *Dasypsyllus lasius*) and *Plocopsylla scotinomi* and *Ctenidiosomus* sp. occur in Middle America. The relationships of the South American fleas are chiefly with the southern hemisphere of the Old World, especially with the Australian Region, but also with the Ethiopian and Oriental Regions. A few South American genera like *Ctenoparia* and *Adoratopsylla* belong to hystrichopsyllid groups like the Hystrichopsyllinae and Doratopsyllinae which are predominantly Holarctic. However, these genera belong to endemic tribes and are probably relicts.

Very few representatives of the Middle American fauna have penetrated South America, except a few species of *Pleochaetis*, and possibly *Kohlsia* and a few other recent invaders like *Cediopsylla* and *Euhoplopsyllus*, on such vagile hosts as rabbits and possibly squirrels. Since 1), there are no endemic tropical lowland genera in Middle America; 2), the native lowland fleas are overwhelmingly South American or of South American affinities, and 3), there are very few representatives of Middle and North American genera in South America, then *it appears that recent dispersals of small mammals and their fleas have been predominantly from South into Middle America rather than the converse.* An earlier (perhaps pre-Pleistocene) dispersal may account for endemic species of *Rhopalopsyllus* and *Polygenis* in Middle America.

Very few montane forms appear to have moved in either direction across the isthmus. We believe that dispersal across the "bridge" by some of these temperate genera[21] may have been facilitated by lower temperatures than exist at present (see Nygren, 1950; Dorf, 1959, map 5). This may well have been one of the principal factors which permitted dispersal of many forms between the two continents, rather than the elevation of the Bolivar trough.

VII. Zoogeographic Conclusions

With the exception of some conspicuously recent immigrants[22] into South America from Middle America, the distribution patterns shown by the ectoparasites hold true for most of the hosts, too. It is especially striking in the case of the cricetine rodents, those of the montane region being largely simple penis types (Peromyscini), which have barely penetrated South America, while cricetine hosts of the lowland subtropical zones are largely complex penis types of South American relationships, e.g., *Oryzomys, Sigmodon,* and *Zygodontomys.*

Among the ectoparasites, we have found little evidence of endemism in the tropical lowlands of Middle America, except north of Panama, and there, entirely at the species level. It is significant that nearly all of the lowland parasites belong to: 1), genera which otherwise occur only in the lowland

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[21] For example, such South American genera as *Ctenidiosomus* and *Plocopsylla* (fleas) and *Amblyopinus* (staphylinid beetles), and Middle American genera like *Pleochaetis* and *Kohlsia* (fleas).

[22] Like rabbits, some squirrels, cats, deer, shrews, spiny mice (*Heteromys*), camels, bears, etc.

tropics of South America, e.g., the bat fleas *Hormopsylla, Ptilopsylla,* and *Rhynchopsyllus;* or 2), "expanding" South American genera, like *Polygenis* and *Rhopalopsyllus,* which on that continent have both temperate and warm-adapted species.

We do find ample evidence in the fleas, mites, and Streblidae, of the existence of a distinctive Middle American ectoparasite fauna, but in the subtropical and especially the temperate altitudes and latitudes. It is characterized by the flea genera *Pleochaetis, Kohlsia, Jellisonia, Wenzella, Strepsylla,* and probably *Juxtapulex;* by the streblid genus *Joblingia* and the generalized members of the *Trichobius major* group; and by laelaptid mites of the genera *Steptolaelaps* and *Eubrachylaelaps.* Deserts may have isolated many of these genera from North America (north of Mexico) and they may also have been a barrier to the southward dispersal into Mexico of more recent northern temperate groups. They appear to have been more effective barriers for non-host-limited parasites than for their hosts or than for host-limited parasites, probably because of the narrower climatic tolerances of the non-host-limited forms.

What is especially interesting is that these Middle American groups of ectoparasites are largely restricted to simple-penis-type cricetine rodents, especially *Peromyscus, Reithrodontomys,* and *Scotinomys* in Panama, as well as other genera like *Baiomys* and *Neotomodon* farther north. These hosts, too, are primarily temperate (altitudinally and latitudinally) in distribution.

These distribution patterns suggest that the tropical lowland fauna has probably moved between Panama and South America with relative ease, for a considerable time. On the other hand, the fauna of the subtropical and temperate (montane) zones of Middle America shows an increasing degree of endemism, and thus of isolation from South America, the higher the altitudes. This suggests that the extensive "sea" of lowland tropical rain forests in Panama, especially in the Darién, may have been more effective in isolating the distinctive temperate Middle and South American ectoparasites and their hosts than was the waterway between Panama and South America (the Bolivar Portal). Portals and lowlands north of the Isthmus of Panama probably also served as isolating barriers, but we are not concerned with them in this discussion.

It is difficult to reconcile these conclusions with the view of Simpson (1950) and Patterson (1957) that the ancestors of the complex-penis-type South American Cricetinae immigrated into South America over a land bridge which arose in the Pliocene-Pleistocene, and subsequently: 1), evolved into an array of 50 genera and ±300 species; 2), acquired a considerable

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Table 17. Explanation of abbreviations.

AUS. = Australian region; M.AM. = Middle America; COS. = Cosmopolitan; ETH. = Ethiopian region; HOL. = Holarctic Region; N.AM. = North America, north of Mexico; NE. = Nearctic Subregion; NW. = New World; OR. = Oriental Region; PAL. = Palaearctic Subregion; PAN. = Panama; S.AM. = South America; SO. ISLDS. = Islands of the Southern hemisphere.

Table 17. Numbers of Genera (bold face) and Species (roman) of Native Fleas in South, Middle, and North America, according to Family.

	S.AM.	PAN.	MEX.	M.AM.	N.AM.	Distribution
Pulicidae						
TUNGINAE	3/14	2/2	2/2	3/3	..	NEO., PAL.
PULICINAE						
Pulicini	..	2/3	2/5	2/5	2/2	M.AM., HOL., ETH., AUS.
Spilopsyllini	2/3	1/1	2/4	2/4	2/6	HOL., NEO.
Malacopsyllidae	2/2	..	..	..	..	S.AM.
Rhopalopsyllidae						
RHOPALOPSYLLINAE						
Parapsyllini	8/39	..	..	..	..	S.AM., AUS., & SO. ISLDS.
Rhopalopsyllini	3/38	2/7	2/3	2/11	1/2	NEO., NE.
Ceratophyllidae						
CERATOPHYLLINAE	4/12	5/12	13/43	13/54	17/111	HOL., ETH., OR., NEO.
FOXELLIINAE	..	..	2/5	2/5	2/18	NE.
Leptopsyllidae						
AMPHIPSYLLINAE	..	..	..	..	5/6	HOL.
Ischnopsyllidae	5/9	3/3	2/2	3/4	3/8	COS.
Vermipsyllidae	..	..	..	..	1/5	HOL.
Pygiopsyllidae	1/3	..	..	1/1	..	AUS., OR., ETH., NEO.
Hystrichopsyllidae						
HYSTRICHOPSYLLINAE						
Hystrichopsyllini	..	..	2/3	2/3	2/7	HOL.
Ctenopariini	1/2	..	..	..	..	S.AM.
STENOPONIINAE	..	..	1/1	1/1	1/2	HOL.
NEOPSYLLINAE						
Neopsyllini	..	..	1/1	1/1	2/2	HOL., OR.
Phalacropsyllini	..	1/1	2/7	2/6	5/38	HOL.
ANOMIOPSYLLINAE						
Jordanopsyllini	..	..	..	..	1/1	NE.
Anomiopsyllini	..	..	..	..	5/26	HOL.
RHADINOPSYLLINAE						
Corypsyllini	..	..	..	..	2/10	NE.
Rhadinopsyllini	..	..	1/1	1/1	3/11	HOL.
Wenzellini	..	1/1	..	1/2	..	M.AM.
DORATOPSYLLINAE						
Doratopsyllini	..	..	1/1	1/1	2/5	HOL.
Tritopsyllini	1/5	1/1	1/1	1/1	..	NEO.
CTENOPHTHALMINAE						
Ctenophthalmini	..	..	1/4	1/4	1/1	HOL.
Carterettini	..	..	..	..	1/2	NE.
Neotyphloceratini	2/3	..	..	..	..	S.AM.
Agastopsyllini	1/4	..	..	..	..	S.AM.
Stephanocircidae						AUS., NEO.
CRANEOPSYLLINAE	7/26	1/1	..	..	..	NEO.

fauna of South American ectoparasites; 3), moved back (*Oryzomys, Sigmodon,* etc.) into Middle and North America with their newly acquired parasites, where 4), they were isolated long enough to differentiate (as did their parasites) into species that are distinct from the South American ones now inhabiting the lowlands in Panama and elsewhere in Middle America.

With very few exceptions, the ectoparasites of these complex-penis-type cricetine rodents belong to families and tribes or genera which are either restricted to or centered in South America, and whose closest relatives are in most cases Old World forms, especially of the Australian Region, but also of the Oriental and (to a much lesser extent) Ethiopian Regions. Only a very few parasites that are identifiable as Middle or North American, and these are obviously fairly recent intruders, occur on these hosts. Among these are the laelaptine mite *Eubrachylaelaps rotundus,* a few fleas of the genus *Pleochaetis,* another of the genus *Kohlsia,*[23] and several rabbit fleas of the genera *Cediopsylla* and *Hoplopsyllus* (Subg. *Euhoplopsyllus*). The geographic and host distributions of lice like *Hoplopleura,* cited by Vanzolini and Guimarães (1955), must be re-examined.

The complex-penis-type Cricetinae, like *Oryzomys* and *Sigmodon,* that occur north of Panama, can hardly be relicts of an old fauna that dispersed into South America, if their fleas (*Polygenis*) are an indication. *Polygenis* is an "expanding" South American genus which has, quite clearly, dispersed into Middle America along with complex-penis-type Cricetinae and caviomorph rodents from South America. Most of the Panamanian species probably dispersed very recently. In most cases they are not even subspecifically distinct from South American forms.

Further, there seems to be little other reason to accept the Pliocene–Pleistocene transition as the principal time of dispersal[24] of the ancestral complex-penis-type cricetine rodents (and possibly some other mammals, too) into South America. Even if the fossil Cricetinae known from the Upper Pliocene of the Argentine (see following paper) reflect the first appearance of these rodents in southern South America, this may mark the end of a long "trail" of dispersal and evolution rather than the beginning (see Hershkovitz, pp. 727–732).

Because the implications of our distributional data appeared to conflict with prevailing views regarding the dispersal of the Cricetinae into South America, we discussed the problem with Mr. Philip Hershkovitz. His account of their origin, dispersal and radiation (see following paper) generally agrees with our conclusions regarding the ectoparasites.

Acknowledgments

We wish to express our gratitude to the following persons for reading

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[23] Many of the Ceratophyllidae are squirrel fleas (Hopkins 1957a). This is true of some species of *Pleochaetis* and *Kohlsia,* too. The few South American species of these genera may have immigrated on squirrels.

[24] It is important to note that Nygren (1950, p. 2005. See also following paper by Hershkovitz, this volume, p. 725) believes that the Panama land bridge may have been available for passage by terrestrial animals since the close of the Middle Miocene!

portions of the manuscript and offering suggestions and corrections: Mr. Henry Dybas of Chicago Natural History Museum, for reading the section of the manuscript relating to coexistence and competitive displacement; Profs. Alfred E. Emerson and Lynn Throckmorton, of the Department of Zoology, of the University of Chicago, for reading the section on host specificity; Col. Robert Traub, U. S. Army (Ret.), School of Medicine, the University of Maryland, for reading the entire manuscript, and especially the portions dealing with the fleas; and, Mr. Philip Hershkovitz, Chicago Natural History Museum, for reading the entire paper as it relates to mammal hosts. The geologic history, zoogeography and ecology of the cricetine hosts have been discussed at length with Mr. Hershkovitz.

Abstract

The authors discuss host specificity, coexistence and competitive displacement, altitudinal distribution, some epidemiological considerations, and faunal relationships and their zoogeographic implications. The need for new approaches to field sampling and analysis of host and ectoparasite populations is emphasized.

It is suggested that the degree of host-parasite specificity in ectoparasites is largely correlated with the degree to which the parasite is host-limited, i.e., restricted to the host, during its life cycle. Thus, a high degree of host specificity occurs most commonly among hemimetabolous groups whose life cycle is spent on the host; among holometabolous forms whose free-living early stages have been eliminated through ovoviviparity and thus remain closely associated with the host most of the time; or holometabolous forms which are closely confined with the host by the physical nature of its "home", as e.g., in kangaroo rat burrows, pocket gopher burrows, etc. It is further suggested that in host-limited forms, homozygosity for host specificity is achieved quickly, and likewise, speciation and niche specialization, because of inbreeding. This is in contrast with the situation in those ectoparasites which are non-host-limited, like most fleas and heteroxenous ticks, in which there is extensive outbreeding. It is further suggested that polyhaematophagy is selected for in these non-host-limited forms. In such non-host-limited forms either a broadly adaptive genetic variability or balanced polymorphism as regards host specificity would greatly increase the chances of host-finding and thus of survival.

A case of coexistence and possible competitive displacement among streblid batflies parasitic on *Phyllostomus hastatus* is discussed. The data indicate that the altitudinal distribution of host-limited forms parallels that of the hosts closely, while there is a notable lack of concordance between that of non-host-limited parasites and their hosts.

The altitudinal distributions of the ectoparasites when correlated with their systematics and geographic and host relationships indicate that: 1), the tropical lowland faunae of Panama and northern South America are virtually identical, but endemism increases correspondingly with increase in altitude, and is marked in the temperate zones, both altitudinally and latitudinally; 2), this is largely true of the lowlands north of Panama, too, but here species endemism is evident; 3), the temperate (including the montane) fauna of South America is largely precinctive with considerable endemism at the family, subfamily and tribal level, and is Old World, especially Southern Hemisphere in its relationships; 4), the montane fauna of Middle America likewise shows considerable endemism, but chiefly at the generic level, and its relationships are overwhelmingly with the Holarctic Region; 5), very little interchange is evident between the temperate faunae of the two continents, excepting parasites of such vagile hosts as birds, bats, and squirrels; 6), recent dispersals of ectoparasites of small mammal hosts, especially Cricetinae, appear to have been chiefly from South to Middle, rather than from Middle to South America. The data appear to conflict with the views of Simpson (1950) and Patterson (1957, fig. 9), regarding the dispersal and radiation of the Cricetinae in South America, during the Pliocene-Pleistocene. It is suggested that dispersal of these rodents into South America took place in the Miocene or earlier.

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Mice, Land Bridges and Latin American Faunal Interchange[1]

PHILIP HERSHKOVITZ [2]

REVIEW OF THE HISTORY OF SOUTH AMERICAN MAMMALS

The history of South American mammals begins with the Paleocene records from Argentina. The order Marsupialia is represented here by three superfamilies. The didelphoid opossums are known from abundant remains but the family Didelphidae was in North America since the Cretaceous. The carnivore-like borhyaenoids which compose the second superfamily were the principal predators of the South American Tertiary. Fossils of the third superfamily, the small shrew-like caenolestoids, are known from the Eocene of Argentina but species of this group were present in southeastern Brazil during the upper Paleocene. Remains of armadillos which were similar to living species of the edentate order Xenarthra appear in the Argentine Paleocene, while fossils of related glyptodonts, ground sloths, and anteaters, are of a later period in the Tertiary. Members of the extinct order of primitive ungulates, the Condylarthra, and five intimately related orders of peculiar South American hoofed animals had already attained a high level of diversity during the Paleocene. The Notoungulata radiated into animals ranging in size and appearance from the rhinoceros-like to the hare-like. The Litopterna evolved into forms resembling horses, camels, and small antelopes. Some of the Astrapotheria have been compared with rhinoceroses and hippopotami. Little is known of the Paleocene Xenungulata but the few recognized members of this order are among the oldest of South American mammals. The proboscidian-like Pyrotheria date from the Eocene and seem to have been the last of the native South American ungulates to evolve.

Precisely how and when these animals first arrived in South America is unknown. Except for marsupials and condylarths, there is no record of

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the occurrence of such animals in Middle America or northern South America prior to their appearance in southern South America.

Knowledge of what are presently regarded as later invasions is similarly deficient. Rodents of the suborder Caviomorpha appeared nearly full bloom in the Oligocene of the southern half of the continent. Their progenitors must have invaded South America earlier but none of the steps leading to the build-up has been discovered. Monkeys of an organization quite like that of living South American primates appeared as suddenly in the upper Oligocene of southern Patagonia. Nothing is known of their platyrrhine ancestry. There is no record of the evolution and dispersal of neotropical Primates from early Tertiary prosimians of the middle latitudes of North America to Oligocene ceboids of the middle latitudes of South America.

The next records of new faunal elements in the South American Tertiary date from middle or perhaps early Miocene with the appearance of the dolphin *Proinia* True, a genus supposedly of the family Susuidae (order Cetacea). Two genera of this family survive in South American waters with one, *Inia,* confined to fresh water. Whatever the systematic position of *Proinia* (cf. Kellogg, 1942) of the Patagonian marine deposits, the Pliocene *Ischyorhynchus* Ameghino is a true river susuid and very nearly related to *Inia.*

The La Venta fossils discovered in Central Colombia (cf. Stirton, 1953) give an inkling of the great variety and wide dissemination of South American mammals by late Miocene. They include remains of many of the southern forms already known and, in addition, fragments of true cebid monkeys, a bat of the family Phyllostomidae (Chiroptera), and a river manatee of the family Trichechidae (order Sirenia). Late Miocene or early Pliocene saw the arrival of members of the raccoon family, Procyonidae (order Carnivora). Finally in the upper Pliocene, mice of the murid subfamily Cricetinae (Myomorpha, order Rodentia) had already evolved into forms indistinguishable from representatives of living sigmodonts. Evidently, they thrived in great numbers on the plains of northeastern Argentina together with herds of peccaries (Tayassuidae, order Artiodactyla) which had migrated from the north. Skunks of the family Mustelidae (order Carnivora) may also have invaded South America at this time but the oldest fossil, discovered in Eastern Buenos Aires, may be early Pleistocene rather than late Pliocene.

Thus, by the end of the Tertiary, fossil evidence reveals that South America was inhabited by three superfamilies of the order Marsupialia, two of which survive; five superfamilies of the order Xenarthra of which two are now extinct; six orders of ungulates, five native and none with living issue; two families of the order Primates; one family of Cetacea with a genus confined to fresh water; one family each of Chiroptera, Sirenia, Carnivora, and two suborders of Rodentia, the still flourishing Caviomorpha and Myomorpha. The oldest records of all but three of these taxa are from the southern half of the continent. The ancestors of all South American orders or families that originated in North America left no sign of their sojourn in Middle America. With exceptions noted, their first passage through northern South America is also unrecorded. It is practically certain that additional mammalian families either invaded or arose in northern South America during the Tertiary but disappeared without trace. Still others now living in South America almost certainly arrived or evolved there during the late Tertiary but for lack of fossil evidence may be incorrectly adjudged to be post-Tertiary invaders.

Bats may have been the dominant and most diversified of small South American mammals throughout the Tertiary but only one genus of Phyllostomidae is known from that period. The other endemic tropical American chiropteran families are the Noctilionidae, Desmodidae, Natalidae, Furipteridae, and Thyropteridae. They were members of a very ancient fauna but only fragments of some of these have been found in Pleistocene owl pellets. Squirrels (Sciuridae) undoubtedly invaded South America several times from the north. The ancestor of the pygmy squirrel, *Sciurillus,* may well have been the first to arrive, perhaps simultaneously with Middle Tertiary Primates. Successive invasions of dogs, mustelids, and deer may also have occurred but at a later date beginning perhaps with middle or late Pliocene. Tapirs of the order Perissodactyla are known from the Pleistocene but the first may have reached South America during late Pliocene. The same may apply to bears and cats which are also known from the Pleistocene of South America.

Horses and mastodons (order Proboscidea) arrived and disappeared during the Pleistocene but the camels survived.[3] One genus of shrews, *Cryptotis* (Soricidae, Insectivora), one genus of rabbits, *Sylvilagus* (Leporidae, Lagomorpha) and one genus of spiny mouse, *Heteromys* (Heteromyidae, Rodentia) are among the latest arrivals and are representatives of the only other new mammalian families to invade South America since early Pleistocene.

Mice, Movements and Barriers

The advent of mice, or myomorph rodents, in South America is shrouded in mystery. A long history of differentiation in northern North America, Middle America, and South America preceded their appearance in the upper Pliocene of Argentina. Much of the evolution can be reconstructed from the morphology of living forms but the time of invasion and the routes of dispersal must be inferred from recent distributional patterns.

New World mice, the Cricetinae, are recorded from the Oligocene of North America but possibly arose in late Eocene. They may have originated in Eurasia and spread into northern North America, then Middle America and South America. Or, they may have arisen in northern North America and spread northward into the Old World and southward into South America. Insofar as the history of living cricetines is concerned, either hypothesis could be valid, but present knowledge favors the concept of a New World

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[3] The bovine *Colombibos atactodontus* Hernandez Camacho and Porta, said to be from the upper Pleistocene of Colombia, is based, according to Thenius (1964, p. 275, footnote 4), on what seem to be the deciduous teeth of domestic cattle.

origin for cricetines. Whether the center was in northern or southern (*i. e.,* Middle American) latitudes of North America cannot be determined now. It is known that the most primitive of living cricetines are sylvan and the

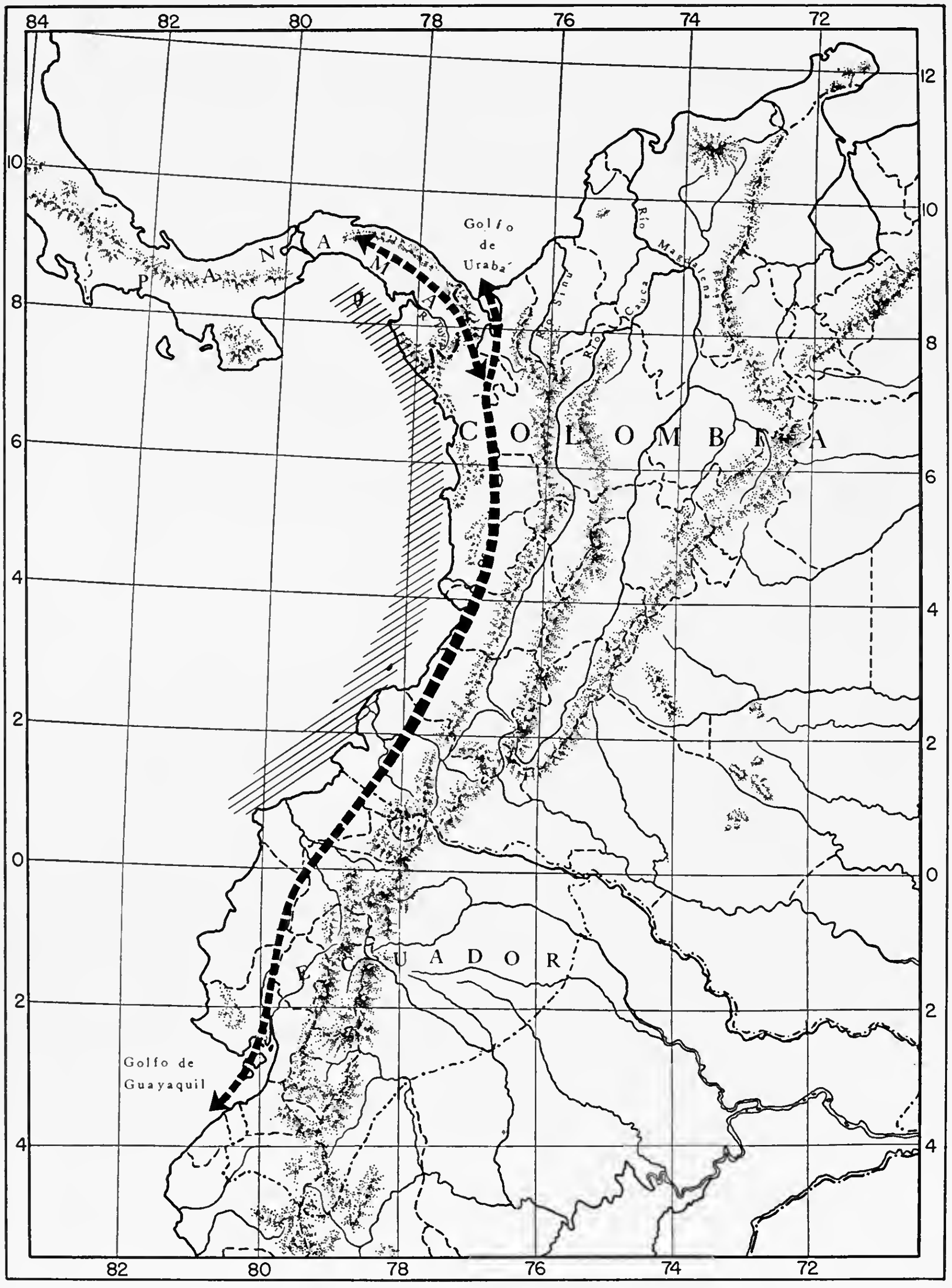

Fig. 151.—Axis of Bolívar syncline (bars) and western Tertiary borderland (diagonals) in Ecuador and Colombia with extension in Panamá. (Adapted from Nygren, 1950, fig. 1)

ancestral form must also have been sylvan with all the morphological characters distinguishing them from pastoral forms (cf. Hershkovitz, 1962, p. 16). Judged by the North American fossil record, it may be assumed that all well defined Recent genera of pastoral cricetines were already differentiated in the Pliocene.

Whatever its geological history during the Tertiary, Middle America must have served variously as a transition zone, a center of evolution and a staging area. From Middle America, cricetines and other New World mammals spread into higher northern latitudes in the wake of retreating glaciers and as suitable habitats became available. Their movements southward were largely controlled by geographic, tectonic, and ecological factors. Spread into South America was accomplished by means of over-water movements, *i. e.*, island hopping and waifing, by swimming or fording; or passively, by shifting land connections or cutoffs. It was finally accomplished via the Isthmian land bridge which only recently became complete at its South American terminal (fig. 152). Actual means or routes of dispersal used by the oldest migrants are hypothetical and need not have been the same or used at the same time by different individuals of the same species or different species.

A broad reconstruction of the history of mammalian faunas in Latin America has been presented by Simpson (1950). His account served as basis for orientation and has been universally accepted as an article of faith. I reproduce herewith the principal section (pp. 379-381) relating to the intercontinental exchange of faunas and the dissemination of cricetines in South America:

> "A change like that going on in the Eocene on the World Continent also occurred in South America, but at a greatly later date, in the late Pliocene and Pleistocene . . . Its cause was the rise of the Central American bridge and the consequent irruption into South America of many derivatives from the fauna of the World Continent. This third broad faunal stratum did not come in all at once, in a single wave. Already in the late Miocene a few northern forms appeared, small arboreal placental carnivores more or less related to the raccoon. Not long thereafter, apparently in early Pliocene times, some South American animals, ground sloths, reached North America. These forerunners do not seem to indicate a continuous land connection but probably utilized the island chain, gaps in which were closing progressively as the Central American and northwestern South American regions rose relative to sea level. The exact moment when the bridge became complete is not established, but this probably occurred during the age called Chapadmalalan in South America and Blancan in North America, placed by some authorities as latest Pliocene and by others as earliest Pleistocene. Even then the exchange was at first rather limited in scope and the full surge of intermigration did not occur until somewhat later, in unequivocally Pleistocene times. Soon or late, at least fifteen (possibly sixteen) families invaded South America in this great episode . . .
>
> "Invasion occurred in both directions. By a moderate tabulation, fifteen families of North American mammals then spread into South America and seven families spread in the reverse direction. The main migrants to the south were rabbits, squirrels, field mice, dogs, bears, raccoons, weasels, cats, mastodons, horses, tapirs, peccaries, camels, and deer, including in most of these cases some variety of related forms."

The spectacle of fifteen or sixteen North American families and seven

South American families awaiting the propitious moment "in unequivocally Pleistocene times" to cross the Panamanian bridge is dramatic. Viewed in the light of fossil records and what is known of the ecological preferences, habits, and vagility of the animals concerned, the stage seems real enough but the scene is less a product of fact than fancy.

The geological and mammalian history of the Americas indicates that the Isthmian water gap was much less effective in isolating faunas than the climatic barrier across northern México. For most mammals the water gap may not have been more than a minor obstacle and for some such as otters and other aquatic and subaquatic animals, an invitation. It was certainly not as much a deterrent as water barriers crossed by mammals in reaching the Antilles, the Galápagos, the Philippines, Australia, New Guinea, and other islands well off the continental shelves. Evidently, many northern families which spread through the Isthmus to the edge of the gap crossed it opportunely. Herds of wandering mastodons, tapirs, horses, peccaries, camels and deer would cross such bodies of water easily and routinely just as their living relatives do today. Island chains and rafts provided others with means of access to opposite shores. Unaquatic mammals such as ground sloths and related edentates were crossing the water gap since middle and probably early Pliocene while monkeys crossed at various times since the Oligocene or perhaps late Eocene. Despite the absence of fossil evidence, there is no reason to assume that many more families of contemporaneous mammals, some better adapted to water than others, were not doing the same. The traffic was both active and passive and from either continent to the other.

Rodents habitually crossed water barriers and colonized continental and oceanic islands throughout the world. Latin American cricetines are no exception. The vole-like terrestrial or pastoral species seem to have been even more successful than their aquatic relatives in crossing water barriers and ranging widely.

At the time of the Pliocene-Pleistocene transition when, according to Simpson's dictum, the intercontinental faunal exchange was about to begin, complex-penis-type genera and tribes of cricetines (see below) had already become differentiated in South America and reached nearly their present limits of natural dispersal in both North and South America. By late Pliocene, *Sigmodon*, the most generalized member of the South American sigmodont group, had invaded North America at least as far as Kansas (Hibbard, 1937, p. 247). At the southern extreme, late Pliocene *Proreithrodon* Ameghino (inseparable from Pleistocene *Ptyssophorus* Ameghino and *Tretomys* Ameghino and from Recent *Reithrodon* Waterhouse) was already one of the most common rodents of Patagonia (Hershkovitz, 1955, p. 639 ff.). Other Pleistocene cricetines of northeastern Argentina are also identical with living forms. The rich and well preserved fossil mammals of the Pleistocene of Minas Gerais, eastern Brazil, discovered in the first half of the last century by the Danish paleontologist Wilhelm Lund, are, for the most part, indistinguishable from living mammals of the same region.

Closure of the Panamanian portal may have facilitated the crossing of

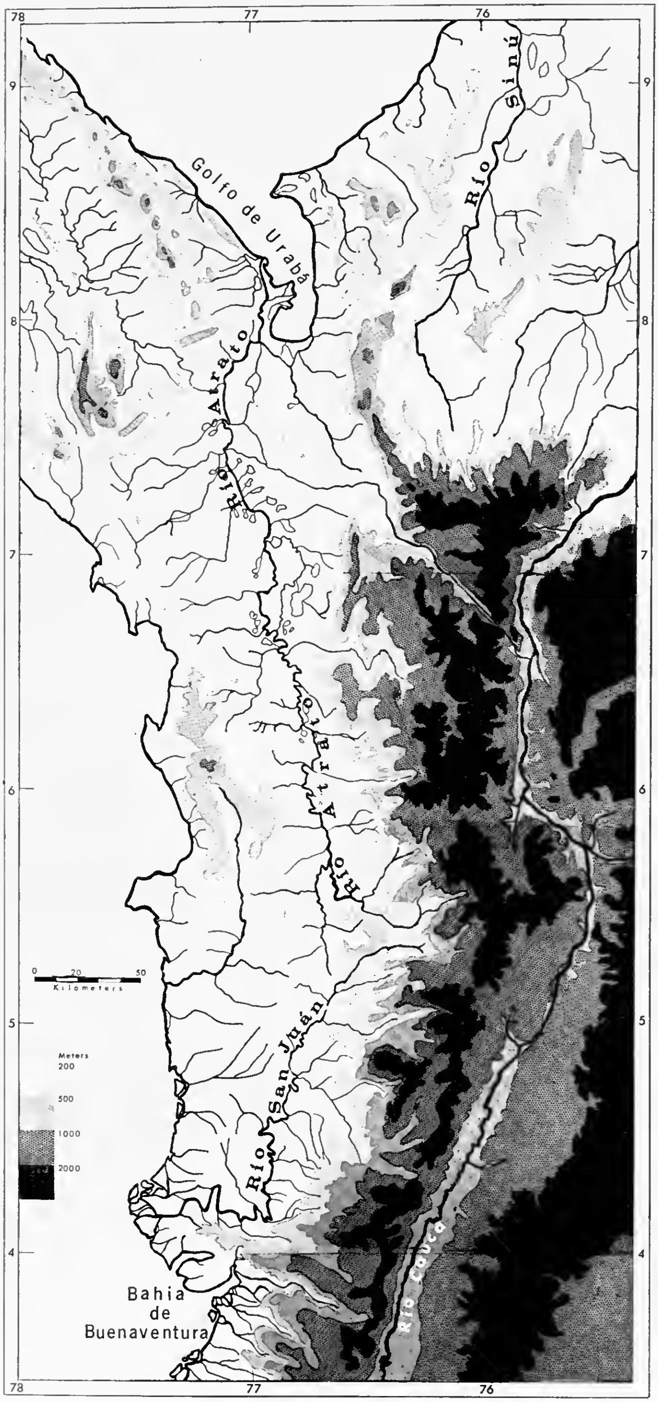

Fig. 152.—Río Atrato-Río San Juan basin, western Colombia. Land bridge connecting North and South America across the western border of the former Isthmian seaway is the *narrow divide* between the two rivers. The river channels follow the axis of the Bolívar geosyncline.

some species but there is no evidence that it resulted in a spectacular increase in the volume of faunal interchange.

The Cricetine Glans Penis in Taxonomy and New World Zoogeography

New and Old World cricetines (Cricetinae) and microtines (Microtinae) are here treated as subfamilies of Muridae. This classification combines, in effect, all categories of the Muridae and Cricetidae of Simpson (1945, pp. 83, 205) or Wood (1955, p. 176) into the single family Muridae as recognized by Ellerman (1941, p. 1).

Recent studies of the glans penis and male accessory reproductive glands support this classification and add considerable data to our knowledge of the interrelationships of many of the species, genera and supergeneric assemblages of murids.

Two basic phallic types within the Muridae are demonstrated by Hooper (1958, 1959, 1960, 1962), Hooper and Hart (1962), Hooper and Musser (1964a, 1964b) and are discussed by Hershkovitz (1966).

The first or complex penis type (fig. 153A) is characterized by a baculum with typically three terminal digits and paired sac-like sinuses of the spongy tissue of the glans. This type predominates in Old World and South American Cricetinae, Murinae, Gerbillinae, Microtinae, and probably others including otomyines and dendromurines. The simple type penis (fig. 153B) is distinguished by the absence of lateral bacular digits and sacculations in the spongy vascular layer of the glans. It characterizes the essentially Holarctic peromyscine Cricetinae comprising the thirteen genera, *Peromyscus, Reithrodontomys, Aporodon, Onychomys, Baiomys, Scotinomys, Ochrotomys, Neotomodon, Nelsonia, Ototylomys, Tylomys, Neotoma,* and *Xenomys.*

Complex and simple phallic types are not restricted to murids and the simple type is not confined to peromyscines. Hooper and Musser (1964a) demonstrate simple or intermediate phallic types among some Old World cricetines (*Myospalax, Mystromys*), South American cricetines (*Nyctomys, Otonyctomys, Scapteromys*), nesomyines (*Macrotarsomys*) and microtines (*Dicrostonyx*), some species of *Microtus, Ellobius* (cf. Hooper and Hart, 1962). Hooper and Musser (1964a, p. 53) also mention a simple type penis among murines but do not identify the species.

The simple penis is derived from the complex and arose independently in all major murid categories (cf. Hershkovitz, 1966). Simplification may be effected by reduction and elimination of the lateral bacular digits, as has occurred in all peromyscines, some murines (Bittera, 1918, p. 414), some microtines (Hooper and Hart, 1962), and some South American cricetines (Hooper and Musser, 1964a; Hershkovitz, 1966). It may also result from reduction and elimination of the middle digit only, as in the South American *Scapteromys, Phyllotis,* and *Zygodontomys* (Hershkovitz, 1966) ; or by fusion of all digits, as in most *Scapteromys* (Hershkovitz, 1966).

Members of the peromyscine group are a diverse lot judged by external, cranial, and dental characters. The penis, although of the simple type is also highly diversified within the group. Hooper and Musser (1964a) divide peromyscines into two groups. Earlier, Hooper (1960) had arranged them in four. The several convergent paths leading to a simple penis increase the probability that peromyscines are polyphyletic. In any case, it is virtually certain that peromyscines, individually or collectively, are derived from the same complex penis type stock now represented by South American cricetines. These two assemblages, the essentially North American

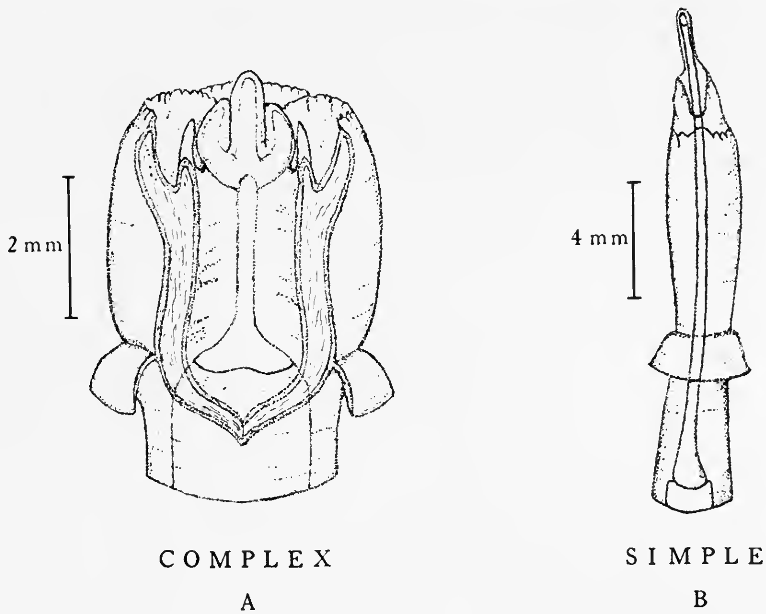

Fig. 153.—Glans penis of New World cricetines. A, complex type with three digitate baculum in *Oryzomys flavescens* (after Hooper, and Musser, 1964a, fig. 1h). Glans of A dissected midventrally to expose baculum. B, simple type with simple rod-like baculum in *Peromyscus pirrensis* (after Hooper and Musser, 1964b, fig. 1e). Glandes cleared and stained to reveal internal structures.

peromyscines with simple penis and the essentially South American cricetines with complex penis, are the primary indicators of inter-American exchanges of mammalian faunas during the late Cenozoic. Their separate dispersal patterns form a mosaic of five faunal strata.

Old North and Middle American cricetines, representing stratum I (fig. 154) migrated over water, i. e., by island hopping or waifing, into South America and radiated there into representatives of stratum II. Descendants of some elements of stratum II returned by over water routes to Middle America and differentiated significantly forming stratum III. Finally, late migrants of South American stock spread over the completed Isthmian land bridge and are identified as stratum IV. North American elements also spread at the same time by the same route into South America and became stratum V. There has been little or no change in the taxonomic grade of either stratum IV or V.

Many mammals and other vertebrates belong to the same faunal strata as the cricetines. The following section, however, describes the five strata in terms of cricetines only.

Latin American Cricetine Faunal Strata

STRATUM I. OLD MIDDLE AMERICAN COMPLEX PENIS TYPES.

Old complex penis types; evolved in situ or migrated from northern North America (fig. 154).

The only Middle American members of this stratum are the following two closely related monotypic genera,

Nyctomys
Otonyctomys

These are possibly relicts of the archaic North or Middle American stock from which the complex-penis-type thomasomyines may be derived on the one hand, and from which the simple-penis-type peromyscines diverged on the other. The male genital tract and the accessory reproductive glands (Arata, 1964, p. 14) of *Nyctomys sumichrasti* and *Otonyctomys hatti* are reduced or simplified and approach those of peromyscines. Otherwise, they most nearly resemble species of the South American genera *Thomasomys* and *Rhipidomys*. The possibility that the stem form of *Nyctomys* and *Otonyctomys* evolved in South America and migrated over water into Middle America (see stratum II) must also be considered.

The Tertiary history of Middle American cricetines is unknown. There is no suggestion that *Eumys* of northern North American Oligocene may be ancestral. According to Clark, Dawson and Wood (1964, p. 42) some element of the *Eumys* complex may have given rise to "hesperomyines." Their phylogenetic chart (op. cit, fig. 5) shows a line leading to *Leidymys* (Oligocene-early Miocene) through *Copemys* (late Miocene-early Pliocene) to *Peromyscus* (upper Pliocene and later). Another branch leads from *Leidymys* to *Miochomys* (late Miocene) then directly to *Onychomys* of the same horizons as *Peromyscus*. It seems that the "hesperomyines" of these authors equals the peromyscines of neomammalogists. The name peromyscine, or the tribal form Peromyscini, is zoologically correct and nomenclatorially valid for North American simple-penis-type cricetines (see nomenclatorial note p. 746).

STRATUM II. SOUTH AMERICAN COMPLEX PENIS TYPES.

Descendants of stratum I; migrated over water from Middle America into South America (fig. 154); *evolution to generic and tribal grades.*

There are approximately 50 genera and 300 species of South American cricetines. Samplings of a large number of genera (*cf.* Hooper and Musser, 1964a) show all to be of the complex penis type. The affinities of the remaining genera are such as to virtually preclude the possibility that any of them are not of the same basic type. Ancestral species arrived in South America during the Tertiary, perhaps from Miocene onward. Subsequent intercontinental movements of complex-penis-type cricetines may have been, until late Pliocene-Pleistocene, almost entirely from South America into North America (see strata III and IV, beyond).

Fossil cricetines congeneric with living South American forms are known from the Pleistocene of southeastern Brazil and the late Pliocene and Pleistocene of northeastern Argentina. There is no likelihood that the evolution of the more highly specialized and geographically restricted species and generic clusters could have taken place anywhere else than *in situ.* The evolution of most of these forms can be reconstructed from the extant South American fauna.

For a discussion of the adaptive radiation, dispersal, and taxonomy of some of the genera and generic groups see Hershkovitz (1944, 1955, 1960, 1962, 1966).

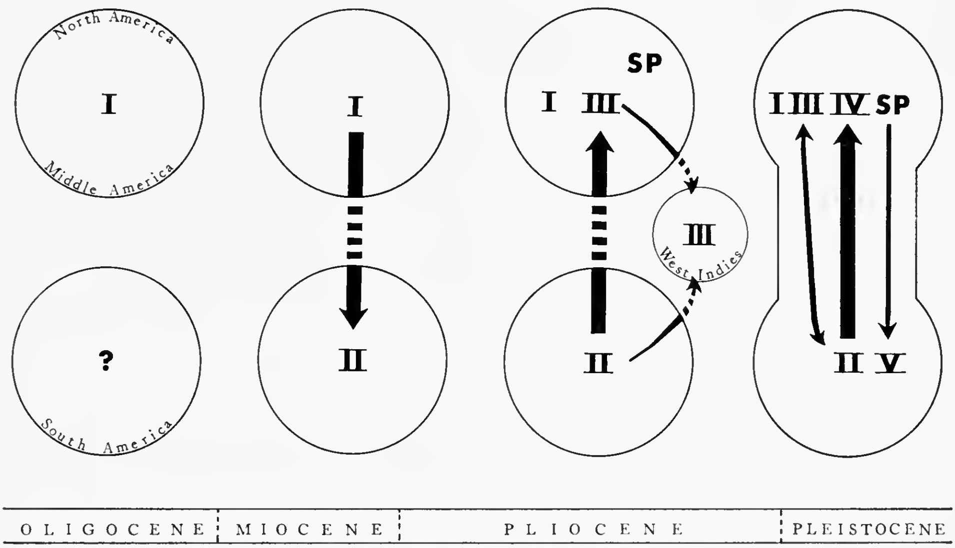

Fig. 154.—Cricetine rodent faunal strata (Roman numerals) in Middle and South America. Broken arrows indicate over water migration, solid arrows over land. Stratum I = old North American complex-penis-type mice. Stratum II = tribes and genera of South American complex-penis-type mice evolved from I. Stratum III = genera and species of Middle American and West Indian complex-penis-type mice differentiated from II. Stratum IV = slightly differentiated Middle American descendents of II. SP = North American simple-penis-type mice. Stratum V = slightly differentiated simple-penis-type migrants in South America.

STRATUM III. OLD SOUTH AMERICAN MIGRANTS IN NORTH AMERICA.

Early descendants of stratum II; migrated over water into Middle America and the West Indies (fig. 154); *evolution to species and generic grades.*

Three genera, *Sigmodon, Oryzomys* and the extinct oryzomyine genus *Megalomys* compose this stratum. They are of the complex penis type and derived from South American stock. *Sigmodon* is represented by several extinct and living species, all closely related and treated here as a single species complex with an intricate geographic history. The genus *Oryzomys* of this stratum includes ten species, one extinct, and two subgenera including the nominate form. The West Indian *Megalomys* is known from the Pleistocene and the Recent but was exterminated in historic time. Remains of one species have been found near those of ground sloths. The North American migrations of *Oryzomys* and *Sigmodon* also coincided largely with the movements of ground sloths, glyptodonts and giant armadillos.

The species groups of *Sigmodon* and *Oryzomys* are listed below in the order of the magnitude of their geographic range from north to south.

Sigmodon hispidus complex

The North American range of *Sigmodon* is greater than that of any other complex-penis-type cricetine. Its present and past distribution in North America points to the cotton rat as one of the earliest over-water migrants from South America. It has been recorded from the upper Pliocene of Kansas (*S. intermedius* Hibbard, 1937, p. 247) and *S. hispidus* was in Florida during Pleistocene. Successive invasions from South America, or reinvasions of South America from Middle America, may account for the continuous distribution of living *Sigmodon hispidus* in Middle and northern South America.

The extinct species of North American *Sigmodon* are properly components of strata III. On the other hand, Recent and Pleistocene *S. hispidus* may be a late arrival and an element of strata IV. The equal if not greater probability is, however, that *Sigmodon hispidus* has been a persistent and pervasive element in all faunas from strata II to V.

The sigmodont upper right molar described but not named by Black (1963, p. 485) from the early Miocene Thomas Farm locality in Gilchrist County, Florida, is tantalizing. The enamel pattern of the tooth most nearly resembles that of *Sigmodon*. The occlusal surface, however, is said to be terraced. The molars of *Sigmodon* are plane, hence more specialized. The Thomas Farm tooth may represent a true sigmodont, a parallel development or, less likely, an extinct side issue of the *Eumys*-peromyscine line.

Oryzomys palustris complex

palustris (= *couesi, azuerensis, cozumelae, gatunensis, antillarum*)

Fossils identified as *O. palustris* are known from the Pleistocene (Illinoisan?) of Florida (Gut and Ray, 1963, p. 325). Examination of the type of *Oryzomys antillarum* Thomas from Jamaica shows it to be a weakly differentiated member of the *palustris* group. It may be treated as a subspecies, *Oryzomys palustris antillarum* Thomas. In reaching Jamaica as a waif it crossed a much wider water gap than any separating the Americas at the Isthmus during the Tertiary.

peninsulae

fulgens

nelsoni

fossilis (extinct)

Described by Hibbard (1955, p. 213) from the Pleistocene interglacial (Sangamon?) of Meade County, southwestern Kansas. The genus *Oryzomys* does not exist in Kansas now, but Hall (1955, p. 246) notes a specimen of *O. palustris* in the U. S. National Museum said to have been collected in Neosho Falls, southeastern Kansas, by B. F. Goss, in 1859.

Oryzomys melanotis

If this proves to be a member of the *O. alfaroi* group it belongs in faunal stratum IV (below). Subgeneric affinities undetermined.

Oryzomys bombycinus

Subgeneric affinities undetermined but near *O. melanotis*.

Oryzomys aphrastus

Known from the type specimen only, a skin with shattered skull. Its nearness to

Nectomys (*Sigmodontomys*) *alfari* suggests that *aphrastus* might belong to faunal stratum IV.

Oryzomys (Micronectomys) dimidiatus

Micronectomys is known from the type specimen only. Should representatives of *O. dimidiatus* be discovered in South America it would be treated as a member of faunal stratum IV.[4]

With the possible exceptions noted, the degree of divergence of the Middle American species of *Oryzomys* from their South American stems implies a long isolation. The morphological differences suggest polyphylety and their geographic distribution indicates successive invasions. Members of the *O. palustris* complex have spread farthest north and are the most differentiated from South American species. They are known from the Pleistocene of southern and central United States. The more southern species of *Oryzomys* are more closely related to their South American relatives.

Megalomys curazensis

Described by Hooijer (1959) from the late Pleistocene of Curaçao. It was contemporaneous with *Paulocnus* Hooijer (1962), a megalonychid ground sloth.

Megalomys desmarestii

Known from the Lesser Antillean islands of Martinique, Santa Lucia and Barbuda (Pleistocene). The species has been exterminated. Its nearest living relative appears to be the scansorial *Oryzomys* (*Macruroryzyomys*) *hammondi* of northwestern Ecuador.

Oryzomys pliocaenicus Hibbard (1939:539) from the Edson Quarry Pliocene of Kansas is not an *Oryzomys* according to Hibbard (*in litt.*). Dr. Hibbard adds that he re-examined the type in 1952 and believes it may prove to be a species of *Bensonomys* Gazin.

Eligmodontia arizonae Gidley, 1922, from the San Pedro Valley Pliocene in Arizona, was made type of the genus *Bensonomys* by Gazin (1943, p. 489). It has nothing to do with *Eligmodontia* Waterhouse, a genus of gerbil-like mice of the southern half of South America.[5]

STRATUM IV. LATE SOUTH AMERICAN MIGRANTS IN MIDDLE AMERICA

Late descendants of stratum II; *spread over Panamanian land bridge into Middle America* (fig. 154); *low grade subspeciation.*

Thirteen complex-penis-type species representing seven cricetine genera are common to North and South America. Their geographic and genetic continuity can be traced across the Panamanian land bridge.

Sigmodon hispidus

Zygodontomys brevicauda (see Hershkovitz, 1962:203, for taxonomy)

Rhipidomys scandens (genus unrevised and Colombian representative of *scandens* not presently determined)

Nectomys alfari

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[4] "*Oryzomys* (*Micronectomys*) *borreroi*" Hernández, from the Río Chucuri Valley, Santander, Colombia, is undoubtedly an *Oryzomys* but, judged by the original description, it is certainly not a *Micronectomys*.

[5] Simpson (1945, p. 84) overlooked the Gazin revision and includes "*Eligmodontia*" in the upper Pliocene fauna of North America.

Neacomys tenuipes (includes *pictus*)
Rheomys trichotis (includes *thomasi, underwoodi, hartmanni* and *raptor*)
Oryzomys alfaroi
Oryzomys capito (= *talamancae*)
Oryzomys albigularis (= *devius, pirrensis*)
Oryzomys concolor (= *tectus*)
Oryzomys bicolor (= *endersi, trabeatus*)
Oryzomys caliginosus
Oryzomys nigripes complex (subgenus *Oligoryzomys;* includes *fulvescens, delicatus, victus, longicaudatus, delticola* and others)

Of the species listed above, only *Sigmodon hispidus* has a range extending north of the Middle American province. Its distribution through faunal strata II-IV inclusive, is discussed in the preceding section. The vole-like *Sigmodon* and *Zygodontomys* are true pastoral forms. The ichthyomine *Rheomys trichotis* is also derived from a pastoral stock but is highly specialized for aquatic life and fish eating. The remaining species are sylvan. *Rhipidomys* is arboreal, *Nectomys* subaquatic, *Neacomys* terrestrial and the species of *Oryzomys* vary from strictly terrestrial (*O. albigularis* and the vole-like *O. caliginosus*) to the arboreal *O. concolor.* Members of the unrevised *Oryzomys nigripes* complex range from southern México to the straits of Magellan. They are terrestrial and scansorial and live in forests, woodlands, bordering fields and open savannas from sea level to above tree line in the Andes. *Oryzomys victus* Thomas, from Saint Vincent, Lesser Antilles, is a well differentiated *Oligoryzomys,* geographically nearest *O. delicatus* of Trinidad. Unless recently imported, it represents faunal stratum IV in the West Indies.

Faunal flow of stratum IV from South America to North America via the Isthmian land bridge seems to have been greater in volume and richer in variety than the flow of stratum V in the opposite direction.

STRATUM V. LATE MIDDLE AMERICAN MIGRANTS IN SOUTH AMERICA

Late descendants of North American simple penis types (peromyscines); spread over Panamanian land bridge into South America contemporaneously with IV (fig. 154); *low grade subspeciation.*

The thirteen (to sixteen) recognized genera of autochthonous North American cricetines, not including *Nyctomys* and *Otonyctomys* (see stratum I, above), are peromyscines. They are characterized by a simple penis and include about 150 species. The geographic range of each of seven of the genera, namely, *Tylomys, Ototylomys, Aporodon, Reithrodontomys, Peromyscus, Scotinomys,* and *Neotoma,* extends into or is restricted to Middle America. Most of the fifty to sixty species assigned to these seven genera in Middle America are unrevised. Only the following two reached South America.

Tylomys nudicaudatus (includes *gymnurus, panamensis, watsoni, tumbalensis*)
Aporodon mexicanus

The two species are scansorial, the first frankly arboreal. Both range into the Andes of Colombia and northern Ecuador, and neither is more than subspecifically differentiated from its nearest Middle American relative. As in the case of the contemporaneous species of stratum IV (above), the geographic and genetic continuity between Middle and South American representatives of these species point to the land bridge migration route.

Peromyscus pirrensis Goldman appears to be a relict species confined to the Panamanian side of the Serranía del Darién. Hall and Kelson (1959, p. 653, map 374) indicate without documentation that the species occurs on the eastern or Colombian side of the Serranía.

Absence of simple-penis-type cricetines in South America except for the two recent invaders proves conclusively that this group originated in North America, perhaps in México.

As compared with Tertiary over water crossings, faunal flow across the Isthmian bridge from North America into South America was anticlimactic.

Water Gaps, Bridges, and Tertiary Faunal Interchange

The American continents during Tertiary were at times connected, at others separated, by a waterway or a complex of islands and straits. The final and crucial barrier separating the faunas of Middle America and South America was the Bolívar geosyncline (fig. 151). According to Nygren (1950:1998, abstract):

> "the Bolivar geosyncline extends through coastal Ecuador and Colombia from southwestern Ecuador to the Golfo de Uraba. Six cross-basin highs separate the deeps within the trough. Marine sedimentation began in the south in the middle Eocene, gradually encroached northward, and continued intermittently on into the upper Miocene. Several unconformities of varying importance are present. Post-Miocene sedimentation is mostly non-marine. During the early Tertiary the sediments were largely derived from the west, but after the lower Miocene they were mostly from the east. *Migration of terrestrial animals could have taken place through this area during the periods from upper Cretaceous to middle Eocene, middle Oligocene, lower Miocene, middle Miocene, and from upper Miocene to Recent* [italics mine]."

The western borderland of the Bolívar geosyncline is described by Nygren (p. 2005) as being a

> "rather wide lowland area up until upper Middle Miocene [when it] was submerged by down-faulting . . . except for a little narrow strip of land close to the present coast line. Remnants such as submerged peaks near Esmeraldas, Ecuador, Gorgona Island, and peaks at Cabo Corrientes still remain . . . The eastern borderland was an area of low relief with embayments extending to the Cauca Valley in upper Oligocene time."

During middle Miocene, the

> "eastern borderland was raised into the high peaks of the western Cordillera [op. cit. p. 2003]."

The north-south flowing Ríos Atrato and San Juan now drain the Colombian or Chocoan portion of the main axis of the Bolívar Trough (fig. 152). The Atrato empties into the Golfo de Urabá in the Caribbean and the San Juan flows into the Bahía de Buenaventura in the Pacific. Except for the low, narrow divide between their heads, *the Ríos Atrato-San Juan now constitute the last water barrier* separating Middle and South American mammals.

As the channels of the Atrato-San Juan became increasingly narrower through sedimentation more animals succeeded in crossing by ferrying, swimming or fording. As the meanders of the rivers became more numerous and sharper. more frequent cutoffs resulted and more habitats with their occupants passed from one side of the water gap to the other. Notwithstanding the accelerated rate of exchange, the mammalian fauna of the west bank of the Atrato-San Juán is still predominantly Middle American and the entire coast from the Carribean Golfo de Urabá in Colombia to the Pacific Golfo de Guayas in Ecuador is zoogeographically an integral part of the Middle American Province (Hershkovitz, 1958, p. 596).

The western or Middle American end of the Isthmian region was probably undergoing comparable changes in geomorphology. There may have been one or several successive straits across the Isthmus of Panama (cf. Lloyd, 1963, p. 88; Fischer and Pessagno, 1965, p. 433). Tertiary mammals on any part of the shifting intercontinental region were, in effect, straddling the two continents. Sooner or later some became established on the mainland of the opposite continent while others retreated or disappeared entirely. By the time the continents were welded in fact, all mammalian interchanges as we know them today on the generic level, and many of them on the specific level, had already been consummated.

Late Pliocene-Pleistocene Faunal Interchange

Precise dating of complete closure of the Isthmian water gap would necessarily be arbitrary and as far as mammalian zoogeography is concerned hardly more than academic. Nevertheless, this date has been a major concern of students of the interrelationships of continental faunas and its determination by Simpson as the period of transition from upper Pliocene to Pleistocene governed the thinking of all zoogeographers. Simpson's (1940, p. 694) reasons are expressed in the following quotation:

> "In the Chapadmalalan [southeastern Buenos Aires Province, Argentina] for the first time many mammals of North American origin appear. They have inevitably undergone some change in the long journey but most or all of them could be derived from middle Pliocene forms in North America. These were the first animals surely to use the bridge. In North America animals of South American origin appear very sparingly in the middle Pliocene, then in more variety in the late Pliocene (Blancan stage). The middle Pliocene immigrants in North America are only a very few small ground sloths which could well have crossed (as did the procyonids in the reverse direction) before the bridge was quite complete and passable for the bulk of the fauna.[12] It was thus complete and passable by Blancan in the North American sequence and by Chapadmalalan in the South American. The evidence is strong for the approximate equivalence of Blancan and Chapadmalalan. The Blancan is now considered the typical late Pliocene in North America." [13] [Footnote 13 follows:] "Some students insist that the earliest beds with any immigrant forms in the two continents should be synchronized, sometimes calling the Chapadmalalan middle Pliocene on this basis. Such a criterion, however, would make the Mesopotamian, not the Chapadmalalan, middle Pliocene, a correlation that is extremely improbable. It is more reasonable and more consistent with all other data to admit that the early stragglers crossed before the bridge was complete and to base synchronization on the beginning of extensive faunal interchange, a point already emphasized by Patterson (1937)."

The point emphasized by Patterson (1937, p. 379) in his abstract of an unpublished paper is that:

> "it has generally been assumed that the Americas were reconnected about the beginning of the Pliocene. The vertebrates appear to oppose this view. Apart from raccoons and didelphines, no northern forms occur in the south until the end of the Pliocene, when a whole immigrant fauna suddenly appears. It is therefore held that the reconnection occurred in late middle Pliocene time at the earliest. Had it occurred earlier a more gradual diffusion southward of northern invaders

should be recorded. The didelphines and raccoons, and the megalonychine sloths found in the Middle Pliocene of North America are regarded as "waif" immigrants [i. e. over water]."

Patterson offers no evidence, but his sources are evidently the same used in Simpson's revision of the mammal-bearing Tertiary of South America. In this work, Simpson (1940, pp. 678-680) names seven families of North American origin in the Chapadmalalan but does not enumerate the Blancan migrants from South America. Stirton (1936, p. 172) whose correlation of North American Pliocene faunas was the consensus for the time, lists an unidentified ground sloth and a glyptodon (*Glyptotherium*) in the Blancan. The only other South American mammals included by Stirton in upper Pliocene are the cricetine *Sigmodon,* a genus then regarded as of North American origin, and the dubious "*Eligmodontia*" (=*Bensonomys*) of supposed South American origin (see p. 737). Regarding the Blancan ground sloth, Simpson (supra cit., p. 694, footnote 12) suggests it was "ancestral to or belonged to *Megalonyx,* a genus that arose in North America from primitive South American ancestors of Miocene or early Pliocene type." The Blancan glyptodont, so far as known, is also North American and therefore may have evolved from an earlier South American migrant. The Benson and Curtis Ranch *Sigmodon* remains as the only undoubted South American immigrant found in the North American late Pliocene. It is intimately related to the Chapadmalalan *Reithrodon.*

The seven Chapadmalalan families treated by Simpson as North American may have originated in North America or Eurasia. Only the history or place of origin of their South American representatives is relevant. These families and five Pampean (Pleistocene) families as listed by Simpson (1940, pp. 678-680), are enumerated as follows and then discussed separately.

Cricetidae (mice)
Procyonidae (raccoons, coatis, etc.)
Ursidae (bears)
Felidae (cats)
Equidae (horses
Tayassuidae (peccaries)
Cervidae (deer)

The following are listed as Pampean or Pleistocene.

Canidae (dogs)
Mustelidae (weasels, otters, etc.)
Tapiridae (tapirs)
Camelidae (llamas, vicugnas)
Gomphotheriidae (mastodons)

The only Cricetidae, more precisely, Cricetinae, known from the Chapadmalalan is *Reithrodon,* an autochthonous mouse of the sigmodont group (see above p. 736). Cricetines ancestral to South American forms diverged from North American stock, possibly in the Oligocene. The initial invasion of South America was probably over water, and judged by the diversity and complexity of subsequent radiations and the pervasiveness of the dispersal may have occurred during early Pliocene or Miocene.

According to Reig (1958, p. 252), the Ursidae and Felidae are not Chapadmalalan. So far as known, South American bears and cats date from the Pleistocene and were subsequently so listed by Simpson (1945, pp. 111, 118).

Two extinct genera of Procyonidae found in the Chapadmalalan are known since Mesopotamian or early Pliocene. This old American family of carnivores may have originated and radiated in Middle America. In any case a distinct species of the nominate genus *Procyon* evolved in South America and two highly specialized and monotypic genera, the prehensile tailed kinkajou (*Potos*) and the olingo (*Bassaricyon*) are certainly tropical American if not specifically South American in origin. Fossil remains of these strictly arboreal animals are unknown.

Simpson had no knowledge of the occurrence of mustelids in the Chapadmalalan but Reig (1958, p. 252) records a species of hog-nosed skunk, *Conepatus*.[6] The Mustelidae are cosmopolitan and well represented in South America. The respective histories of such recent South American mustelids as the giant Amazonian otter (*Pteronura*), the huron (*Lyncodon*) and the grisonella (*Grisonella*) as well as the skunk (*Conepatus*) must reach far back. *Mustela frenata* and *Lutra canadensis* (= *annectens*) are the only certain land bridge migrants from North America corresponding to cricetine stratum V. Whether the tayra (*Eira barbara*) and the grison (*Galictis vittatus*) spread from South to Middle America (stratum IV) or vice versa (stratum V), is moot. In any case, the dispersal of mustelids. particularly of otters, could not have been significantly controlled by minor water gaps.

Absence of canids from the Chapadmalalan or earlier formations may be misleading. The South American radiation of the Canidae culminated in several genera and more living species than evolved on any other continent. Such canids as *Chrysocyon, Atelocynus* and *Speothos* are most highly specialized for particular habitats in South America. The evolutionary history of these dogs is undoubtedly spread over a long span of time but the remains of their forest dwelling ancestors may be lost forever in middle Tertiary formations of tropical America. Among living canids,

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[6] There is some confusion attending the statigraphic position of *Conepatus altiramus* Reig. It was first (1952, p. 45) said to be from lower Chapadmalalan in the Barranca de los Lobos region. Later Reig (1957 , p. 39, footnote 3) reassigned it to the Barranca de los Lobos horizon which is lower Pleistocene. He then changed his mind again (1958, p. 252, footnote) and returned it to the Chapadmalalan on the basis of a personal inspection of the actual site of discovery shown him by the collector of the type specimen. Now, Churcher and Van Zyll de Jong (1965, p. 3) compound the confusion by omitting the distinction between Barranca de los Lobos as a geographic region and as a geological horizon and, without consulting the pertinent literature (cited above, see also Kraglievich, 1952) imply that *Conepatus altiramus* is of lower Pleistocene age. Apart from all this, there are grounds for questioning the occurrence of *Conepatus* in the upper Pliocene of Argentina. The genus was abundant in the Pleistocene and is common throughout South and Middle America today. Scores of "species" have been described but all appear to belong to the same species complex for which the oldest name available is *Conepatus chinga* Molina, 1782.

only the gray fox (*Urocyon*) is an undoubted late or land bridge migrant from Middle America and almost certainly belongs to the cricetine stratum V. The dire wolf *Aenocyon* Merriam, first known from the upper Pleistocene of North America, also appears in the upper Pleistocene of Talara, northwestern Peru (Lesson and Churcher, 1961, pp. 425-426). Like many others of the same faunal stratum it became extinct with the change from a moist to dry climate.

Peccaries are retained by Reig (op. cit., p. 246) in upper Pliocene but the form known to Simpson (*Antaodon chapalmalensis* Ameghino) is excluded. Horses and deer are also excluded. Later, Simpson (1945, pp. 137, 154) recorded the Equidae and Cervidae from the Pleistocene but not the Pliocene of South America. In any case, there is reason to believe that deer, at least, invaded South America during late Tertiary.

The history of the Cervidae parallels that of the Cricetinae. The forest-dwelling spike-antlered pudus and brockets are probably old over-water invaders; the more specialized woodland and savanna branch-antlered deer arrived later. The white-tailed deer, *Odocoileus virginianus*, with a continuous range from southern Canada to the northern half of South America, may have spread from Middle to South America over the completed land bridge (stratum V). One species of brocket (*Mazama americana*) returned over the same route to Middle America (stratum IV).[7]

Three species of tapirs occur in tropical America. The Andean *Tapirus pinchaque* and the lowland *T. terrestris* are confined to forested South America and certainly could have reached that continent by the over water route. *Tapirus bairdi* with a continuous distribution in Middle America and northwestern South America is evidently a late overland arrival and corresponds to cricetine stratum V. In spite of its vagility and aquatic proclivities, Baird's tapir seems to have crossed the Ríos Atrato-San Juan "gap" comparatively recently. So far as known, it has yet to reach the next important water gap, the Río Cauca-Magdalena, only some 100 kilometers distant across the lowlands (Hershkovitz, 1954).

From the foregoing it appears that only one genus of undoubted South American origin, the cricetine cotton rat *Sigmodon*, occurred in the upper Pliocene of North America. Of seven families of North American (and or Eurasian) origin treated by Simpson as Chapadmalalan in the upper Pliocene of South America, only three belong with certainty to that formation. Among their genera, the taxonomic units used here for correlations, only a peccary (*Platygonus*, Tayassuidae) may be of North American origin. All other undoubted Chapadmalalan genera originated in South America.

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[7] The Yucatán Península brocket is a red brocket and should be known as *Mazama americana pandora*. Its generally brownish color (but not its color pattern), backwardly directed nuchal hairs, and small size misled authors, including myself, into regarding *pandora* as a race of the brown brocket, *Mazama gouazoubira*. Pale brown or *pandora*-like red brockets are common enough as individual color variants or as local constants throughout the range of the species. With few exceptions, the white belly sharply defined from chest and flanks distinguishes *Mazama americana* from *M. gouazoubira*.

Cotton rats and peccaries are among the most viable and vagile of New World mammals. The presence of only one migrant genus (or species) in the upper Pliocene of each continent is not "a whole immigrant fauna" (Patterson, 1937, p. 379) or convincing evidence of an "extensive faunal interchange" (Simpson, 1940, p. 694, footnote 13) *after* closure of the Isthmian gap. Interchange there was, but since the Cretaceous, with the volume and variety directly proportional to the diversity of the faunas, and the population pressures at the intercontinental boundary whether or not a land bridge was present.

The notion that first representatives of most families of northern North American origin crossed a land bridge into South America and radiated there in the Quaternary only, is not compatible with the facts. The tendency has been, however, to reject or ignore the facts incompatible with the notion. Patterson (in Stirton and Gidley, 1949, p. 175) thought it likely that a *Megatherium* from the Bone Valley Middle Pliocene of Florida was an accidental inclusion from overlaying Pleistocene because "the Americas were not united until late Pliocene." In the same work Stirton (loc. cit., footnote) points out that "both megalonychid and mylodontid ground sloths did get through from South America in Hemphillian, Middle Pliocene time." Stirton adds that "no megatheres are recorded in those faunas," but this qualification does not validate Patterson's objection. Thinking along the same line, Patterson (1957, p. 45) regarded the differentiation of a gyropid louse species during Pleistocene as remarkable and the evolution of an anopluran louse genus in the same period as "unlikely" because, "sucking lice [on their mammalian hosts] did not reach South America until the Pleistocene faunal interchange."

Hooper (1949, p. 23) was perhaps the first to recognize the existence of two or more faunal strata among South American immigrants of northern North American origin. His observation that the "*Oryzomys*-like and *Akodon*-like forms" were of an older stratum than that containing *Reithrodontomys* (included *Aporodon*), anticipated his classification of complex-penis-type and simple-penis-type cricetines and my present arrangement of them in South American strata II and V, respectively. Nevertheless, in conforming to the Simpson-Patterson time table, Hooper telescoped the history of these strata into the Pliocene-Pleistocene transition. His conclusion that the differentiation of cricetines in South America was of "a low taxonomic level," somewhat follows Simpson's (1945, p. 207) miscalculated appraisal of South American cricetine evolution. Hooper's estimates have since undergone a radical change (*cf.* Hooper and Musser, 1964a, p. 55, and above, p. 734). My previous (1962, p. 18) hypothesis of the time and sequence of the cricetine invasions of South America was also adjusted to the Simpson-Patterson chronology. It now appears unrealistic and must be discarded.

Conclusions and Summary

The evolution of the mammalian fauna of South America began in early Paleocene or late Cretaceous with migrants from Middle America. The first known immigrants were marsupials, condylarths and edentates. Primates and caviomorph rodents appeared in the Middle Tertiary. Evidently, Tertiary Middle America was a transition zone for mammals passing from North America to South America. More importantly, it was an evolutionary center for mammals of North American extraction and a staging area for successive invasions of northern North America and South America by some of the newly evolved forms. This Middle American fauna must have been rich and flourishing but there are no fossil records of the tropical forest species. The meager middle and late Tertiary records of mammals are of essentially temperate zone pastoral faunas (cf. Olson and McGrew, 1941; Stirton, 1954; Whitmore and Stewart, 1965) which parallel the present temperate zone pastoral fauna of the Mexican and Guatemalan highlands. These faunas no more deny the occurrence of a dominant lowland tropical forest fauna throughout Middle America now than in the past. Correspondingly, the presence of a diversified tropical forest fauna in Tertiary South America demands the existence of an earlier and more primitive tropical forest fauna in Middle America.

Intercontinental faunal exchange at first was a flow from Middle America to South America. With increase in their numbers and diversity some of the newly evolved South American mammals trickled into Middle America by middle Tertiary. By late Tertiary the interchange in kind may have been more or less equal, but on a much larger scale than heretofore. Finally, from late Pliocene onward, the faunal flow from South America to Middle America became the greater, to the extent that the latter is a zoogeographic province of the former (Hershkovitz, 1958, p. 806).

The five periods of intercontinental connections, the first in Cretaceous, the last in late Miocene, described by Nygren (1950), may have facilitated the faunal flow for species already on or at the bridge. The intercontinental separations during the intervening periods may have acted as faunal filters but they could never have been barriers comparable in effectiveness to climatic barriers. Virtually all South American mammals, past or present, crossed or could be passed over water gaps such as those which separated the continents during the Tertiary. The crossings must have been continuous with different individuals of the same species crossing at different times and different species of the same genera or families crossing at the same or different times. The volume and rate of mammalian faunal flow at the Isthmus must have always been directly proportional to the diversity of the faunas and their population pressures at the points of interchange.

The last separation between North and South America is the Bolívar geosyncline. This depression formerly extended as a seaway from the Golfo de Urabá in the Caribbean to the Golfo de Guayaquil in the Pacific. Uplift of the Cordillera Occidental and increasing sedimentation reduced the water gap to the Ríos Atrato and San Juan in western Colombia. The Bolívar Trough, nevertheless, still marks the boundary separating many mammalian species, genera, and one family (Geomyidae) of the Middle American Province from the rest of the Neotropical Region.

The late Pliocene-early Pleistocene date generally accepted by zoogeographers for completion of the intercontinental bridge and the beginning of wholesale faunal exchange is not in harmony with the fossil evidence.

Completion of the bridge at whatever date, did not mark the beginning of a rapid and large scale exchange of highly diversified mammalian faunas between Middle and South America. There is slight likelihood that the species and genera of cricetines, canids, procyonids, mustelids, deer, and others could have become peculiarly specialized for isolated niches in South America since the Pleistocene only. The probability is even less that these species and genera invaded South America preadapted for distant and untried habitats and predestined to reach them after trials through hostile environments. The zoological evidence suggests that representatives of all families of northern North American (or Eurasian) origin except those of horses, mastodons, camels, spiny mice, rabbits, shrews and, perhaps, some carnivores (bears, cats), were in South America before the end of the Pliocene. The invasions or, more realistically, the two way traffic, or continental interchange, could have been operative since late Miocene.

South American cricetine rodents are examples of the interchange. Their grade of evolution and the pervasiveness of their adaptive radiation point to long isolation from their North or Middle American ancestors. The history of tropical American cricetines appears in five faunal strata. Stratum I includes the ancestral North and Middle American complex penis stock. Over water migrants from stratum I evolved into the genera and generic groups or tribes of South American stratum II. Some divergent elements of stratum II returned via water routes to Middle and North America and the West Indies. They became the genera, subgenera and species of stratum III. With completion of the land bridge many South American species of stratum II spread overland into Middle America to form stratum IV while two species of a purely North American tribe of simple penis type cricetines invaded South America and became stratum V. There has been little or no change in the taxonomic grade of strata IV and V.

Preliminary analysis of the distribution patterns of a number of other tropical American families with intercontinental range reveals the same or parallel faunal stratifications. As in the case of cricetines, these strata indicate faunal interchange before, during and after completion of the intercontinental land bridge.

Nomenclatorial Note

The Family Group Names of New World Cricetine Rodents

The term Hesperomyini for New World cricetines is the tribal form proposed by Simpson (1945, p. 83) from the family group name Hesperomyinae Murray (1866, p. 358). Neither the family nor tribal name is tenable on nomenclatorial or zoological grounds. Murray's concept of *Hesperomys,* which is the type of his Hesperomyinae and Simpson's Hesperomyini, is based on twenty North American species, most of them referrable to *Peromyscus* and none identical or congeneric with the South American *Hesperomys bimaculatus* Waterhouse, type of the original *Hesperomys* Waterhouse. *Hesperomys* Murray, 1866, therefore, is an invalid homonym of *Hesperomys* Waterhouse, 1839, and unavailable. *Hesperomys* Waterhouse, in turn, has been shown (Hershkovitz, 1962, p.

129) to be a junior synonym of *Calomys* Waterhouse, 1837. Finally, *Calomys* has been treated (op. cit.) as a member of the phyllotine group.

The oldest valid tribal name for New World cricetines is *Sigmodontes* Wagner, 1843 (p. 509). As originally erected, it comprised the genera *Hesperomys* (= *Calomys*), *Reithrodon, Holochilus, Sigmodon* and *Neotoma*. These taxons were employed in the broadest sense to include all New World species then known. *Sigmodon* Gay and Ord, 1825, the type of *Sigmodontes*, is the oldest generic name for a New World cricetine. Its type, *S. hispidus* Gay and Ord, is cited and diagnosed by Wagner (1843, p. 556). *Sigmodontes* was adopted by a number of authors including Baird (1857, pp. xxvii, 445), Coues (1877, p. 7), Thomas (1897, p. 1019 [Sigmodontinae]), and Gyldenstolpe (1932, p. 1 [sigmodont]). Sigmodontinae as the subfamily name and Sigmodontini as a tribal name are available for New World cricetines and supercede Hesperomyinae and Hesperomyini, respectively. The supergeneric names based on *Sigmodon* which is a complex penis-type-cricetine, apply primarily to sigmodonts in particular and South American cricetines in general. Should North American simple-penis-type cricetines be regarded as tribally distinct, the name Peromyscini is available. More study of New and Old World cricetines, living and extinct, is needed, however, before a relatively stable and generally acceptable classification can be reached. For present purposes, current supergeneric group names used informally are adequate and realistic.

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Checklist of the Mammals of Panama

CHARLES O. HANDLEY, JR.[1]

Since Goldman (1920) published his *Mammals of Panama,* and particularly in recent years, much additional information has been gathered on the mammals of the Republic. Now there is need for an up-to-date checklist to supplement the still basic Goldman volume.

Chief among recent contributors to the knowledge of Panamanian mammals have been Robert K. Enders and Oliver P. Pearson of Swarthmore College; Carl M. Johnson, Pedro Galindo, and Eustorgio Méndez of the Gorgas Memorial Laboratory, Panamá; several officers of the United States Army Preventive Medicine Survey Detachment in the Canal Zone: Colonel Franklin S. Blanton, Major Gordon Field, Major Robert Altman, Major Vernon J. Tipton, and Charles M. Keenan; Conrad E. Yunker, Middle America Research Unit; Nathan Gale, Canal Zone Veterinary Office; E. L. Tyson, Florida State University; the former resident naturalist of the Canal Zone Biological Area, Carl B. Koford; and Alexander Wetmore, former Secretary of the Smithsonian Institution.

Since 1952, seven field parties of the Smithsonian Institution have visited Panama to study mammals. These parties have enjoyed the support and cooperation of the Gorgas Memorial Laboratory, the United States Army, the Canal Zone Biological Area, the Middle America Research Unit, and the Chiriqui Land Company (through the Director of its Almirante Hospital, Dr. Gustav Engler). Part of the funds for field work and the preparation of this manuscript have been supplied by the National Science Foundation (grant no. G19415).

The checklist follows the order of Simpson's classification of mammals (Simpson, 1945). As far as possible, the nomenclature adopted in the checklist reflects my study of specimens. Where subspecies are not mentioned in a species account, it may be presumed that the species is thought to be monotypic. Since Goldman (1920) and Hall and Kelson (1959) are

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[1] Smithsonian Institution, Washington, D.C.

the references most likely to be available to persons using this checklist, departures from the nomenclature of these authors are indicated in synonymies. Other synonyms have not been mentioned, except in a few instances in the text. Full synonymies are readily accessible in Miller and Kellogg (1955), Hall and Kelson (1959), and Cabrera (1958 and 1961).

Species that were not known to Goldman (1920) as part of the fauna of Panama are marked with an asterisk (*). Those that were not known within the area covered by North American lists or had not been described when the most recent lists were prepared (Miller and Kellogg, 1955, and Hall and Kelson, 1959) are marked with a dagger (†). In instances where I was not the initial collector of a species here reported in Panama for the first time, I have noted this fact in the account of the species.

Geographic distribution has been determined from specimens and from literature (citations omitted for brevity). Most of the specimens of Panamanian mammals are in the Academy of Natural Sciences of Philadelphia, the American Museum of Natural History, the British Museum (Natural History), the Museum of Comparative Zoology (Harvard University), and the United States National Museum, or in collections in Panama. The brief notes on habits and habitat are based entirely on Panamanian observations.

Order MARSUPIALIA

Family **Didelphidae**

Caluromys derbianus Waterhouse

= *Philander laniger* Goldman

Common at lower elevations (sea level up to at least 3200 feet), probably throughout Panama. Evergreen and deciduous forest; arboreal. Several Panamanian subspecies: (1) *C. d. derbianus* Waterhouse. Darién west to Canal Zone and La Chorrera (Panamá); similar specimens from Guánico (Los Santos), Santiago (Veraguas), and Boquerón and Isla Parida (Chiriquí). (2) *C. d. fervidus* Thomas (=*C. d. centralis* Hollister). Caribbean coast of western Panama (mainland, Isla Bastimentos, and Cayo Agua, Bocas del Toro) and Santa Fé (Veraguas). (3) *C. d. nauticus* Thomas. Islands off the Pacific coast of western Panama (Isla Brava, Chiriquí; Isla Gobernadora and Isla Cébacó, Veraguas); similar specimens from Parita (Herrera), and Panamá Viejo (Panamá). (4) *C. d. pallidus* Thomas. Pacific coast of extreme western Panama (Divalá and Bugaba, Chiriquí).

Monodelphis adusta Thomas

= *Peramys melanops* Goldman
= *Monodelphis melanops* Hall and Kelson

Rare at medium elevations in extreme eastern Panama. Specimens from Cana, 2000 feet, Guayabo, and Tacarcuna Village, 1950 feet (Darién). Trapped among boulders on a dry, partially open gravel bar (Tacarcuna Village) and among rocks on a riverbank in heavy forest (Cana). *Monodelphis adusta* occurs from eastern Panama through Colombia and Ecuador to central Peru without exhibiting geographic variation. *Peramys melanops* Goldman and *Peramys peruvianus* Osgood are synonyms of *adusta*. Their supposed distinctive characteristics are merely individual variations. On the other hand, *Monodelphis osgoodi* Doutt of western Bolivia and southern Peru is probably a distinct species. It has been regarded as a subspecies of *M. adusta*.

* † **Marmosa impavida** Tschudi

Rare. At high elevations in extreme eastern Panama. O. P. Pearson collected specimens on Loma Cana, 4900 feet, and Cerro Pirre, 5300 feet (Darién). The Panamanian subspecies is *M. i. caucae* Thomas.

Marmosa invicta Goldman

Rare. At medium elevations (1500–4000 feet), possibly throughout Panama, in suitable habitats. It has been trapped on the ground, and on or under logs in moist fog forest. Specimens from Cana, Tacarcuna Casita, and Tacarcuna Laguna (Darién); Cerro Azul (Panamá); and Cylindro (Bocas del Toro).

Marmosa mexicana Merriam

= *Marmosa mexicana* Goldman (part.)

Uncommon. In the lowland savannas of western Panama. The subspecies in Panama is *M. m. savannarum* Goldman. The relationship of *M. mexicana* to *M. robinsoni* is not clear.

* † **Marmosa** species

A species resembling *Marmosa phaea* Thomas has been taken at Tacarcuna Casita, 1500 feet (Darién); Armila (San Blas); Salamanca Hydrographic Station (Canal Zone); and Almirante (Bocas del Toro). Evergreen forest; arboreal.

Marmosa robinsoni Bangs

= *Marmosa fulviventer* Goldman
= *Marmosa mexicana* Goldman (part.)
= *Marmosa mitis* Hall and Kelson

Abundant throughout a large part of Panama from sea level to elevations of 4000–6000 feet. Semi-arboreal, but often trapped on the ground. Two subspecies have been reported in Panama: (1) *M. r. fulviventer* Bangs, Isla Saboga and Isla del Rey; (2) *M. r. isthmica* Goldman, mainland. Practically ubiquitous. For use of the name *Marmosa robinsoni* Bangs in place of *M. mitis* Bangs, see Cabrera (1958, p. 24).

Philander opossum Linnaeus

= *Metachirus opossum* Goldman

Locally abundant at lower elevations (up to 2000 feet), possibly throughout Panama. Mostly terrestrial, but also climbs. Evergreen and deciduous forest. The subspecies in Panama is *P. o. fuscogriseus* J. A. Allen.

Metachirus nudicaudatus E. Geoffroy St.-Hilaire

Locally common at lower elevations (up to 2000 feet), possibly throughout Panama. Terrestrial. Evergreen and deciduous forest. The subspecies in Panama is *M. n. dentaneus* Goldman. Where *Metachirus nudicaudatus* and *Philander opossum* occur together one is usually much more abundant than the other.

Didelphis marsupialis Linnaeus

Abundant throughout Panama from sea level up to 5000 feet. Ubiquitous. Terrestrial, but also climbs. Three subspecies are thought to occur in Panama: (1) *D. m. battyi* Thomas, Isla Coiba; (2) *D. m. caucae* J. A. Allen (=*D. m. etensis* J. A. Allen), mainland; (3) *D. m. particeps* Goldman, Isla del Rey.

Chironectes minimus Zimmermann

= *Chironectes panamensis* Goldman
= *Chironectes panamensis* Hall and Kelson

Locally common to abundant throughout, from sea level to 4000 feet, in suitable streams. Aquatic, possibly restricted to streams with large populations of shrimp. Specimens from Boca de Río Paya, Cana, 2000 feet, Guayabo, Río Jaqué, and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000 feet (Panamá); Fort Sherman, New San Juan, and Pedro Miguel (Canal Zone); Cerro Hoya, 1450 feet and Guánico (Los Santos); Río Bubí and Río Viejo, near Soná (Veraguas); Río Colorado, 4000 feet (Chiriquí); and 7 km. SSW. of Changuinola and Sibube (Bocas del Toro). Study of specimens from Brazil, British Guiana, Venezuela, and Central America shows that only one species can be distinguished. Variations in coloration and perhaps in cranial characters as well suggest that the species is polytypic. The Panamanian subspecies is *C. m. panamensis* Goldman.

Order INSECTIVORA

Family **Soricidae**

* **Cryptotis endersi** Setzer

Rare. Known by one specimen from Cylindro (Bocas del Toro). Fog forest. Terrestrial.

Cryptotis nigrescens J. A. Allen

= *Cryptotis merus* Goldman
= *Cryptotis mera* Hall and Kelson
= *Cryptotis tersus* Hall and Kelson
= *Cryptotis zeteki* Hall and Kelson

Rare. At high elevations in evergreen forest. Terrestrial. Subspecies in Panama: (1) *C. n. mera* Goldman, Cerro Pirre, 4500 feet (Darién); (2) *C. n. zeteki* Setzer (=*C. tersus* Goodwin), Cerro Punta, 6500 feet, and Santa Clara, 4200 feet (Chiriquí). These subspecies are poorly differentiated from typical *C. nigrescens* of Costa Rica.

Order CHIROPTERA

Family **Emballonuridae**

Rhynchonycteris naso Wied-Neuwied

= *Rhynchiscus naso* Goldman

Abundant near sea level, probably throughout Panama. Flies over or near forest-bordered streams or lakes; roosts on rocks, logs, or trunks of trees over water. Specimens from Boca de Río Paya, Paya Village, and Río Jesucito (Darién); Armila and Mandinga (San Blas); Barro Colorado Island, Corozal, Fort Gulick, Gamboa, Lagartera, 2 mi. NW. of Pedro Miguel, Río Mandinga, and Summit (Canal Zone); Almirante, 7 km. SSW. of Changuinola, and Sibube (Bocas del Toro); and San Félix (Chiriquí). For use of the generic name *Rhynchonycteris* Peters in place of *Rhynchiscus* Miller, see Husson (1962, p. 35).

Saccopteryx bilineata Temminck

Abundant near sea level, probably throughout Panama; occasionally found to 2000 feet. Flies over or near forest-bordered streams, lakes, or beaches; roosts on trunks of trees, on logs and rocks, and in caves and houses. Specimens from Cituro, Cana, and Cerro Sapo (Darién); Armila (San Blas); Alhajuela, Ancón, Balboa, Barro Colorado Island, Culebra, Fort Kobbe, Fort San Lorenzo, Fort Sherman, 3 mi. SE. of Gamboa, Gatún, Las Cáscadas, Madden Dam, Orchid Island, Río Puente, Summit, Tabernilla, Venado Beach (Canal Zone); Cerro Azul, Chilibre, Chilibrillo Caves, Isla Chapera, Isla San José, La Chorrera, Panamá Viejo, and Isla Taboga (Panamá); Guánico (Los Santos); and Almirante (Bocas del Toro).

Saccopteryx leptura Schreber

Uncommon. Near sea level in the Canal Zone and eastern Panama. Flies over or near forest-bordered streams and lakes. Specimens from Boca de Río Paya and Paya Village (Darién); Pacora (Panamá); and Alhajuela, Barro Colorado Island, Fort Randolph, and Gamboa (Canal Zone).

* **Cormura brevirostris** Wagner

Uncommon. Lowlands of eastern Panama and on the Caribbean coast of western Panama. Evergreen forest. Roosts under logs and rocks. Specimens from Capetí (Darién); Armila (San Blas); and Almirante (Bocas del Toro).

* **Peropteryx kappleri** Peters

Rare. Lowlands of eastern Panama and on the Caribbean coast of western Panama. Roosting in a cave at Río Puente and netted over a stream flowing through a pasture at Almirante. Specimens from Yavisa (Darién); Río Puente (Panamá); and Almirante (Bocas del Toro). The Panamanian subspecies is *P. k. kappleri* Peters.

Peropteryx macrotis Wagner

= *Peropteryx canina* Goldman

Uncommon. Possibly widespread in the lowlands, but presently recorded only in and near the Canal Zone. Roosts in caves and rock crevices near water. Specimens from Buena Vista (Colón); Balboa, Gatún, and Santa Rosa (Canal Zone); and Río Puente (Panamá). The Panamanian subspecies is *P. m. macrotis* Wagner.

Centronycteris maximiliani Fischer

= *Centronycteris centralis* Goldman

Rare. Lowlands of the Canal Zone and the Pacific coast of western Panama. Specimens from Cerro Malí (Darién), Barro Colorado Island and Fort Clayton (Canal Zone), and Bugaba (Chiriquí). The Canal Zone specimens were taken in clearings. The Panamanian subspecies is *C. m. centralis* Thomas.

Diclidurus virgo Thomas

Rare. Canal Zone and Pacific coast of western Panama at low and medium elevations. Specimens from Albrook Field, Fort Gulick, and Gamboa (Canal Zone), and Boquete and Pueblo Nuevo (Chiriquí).

Family **Noctilionidae**

Noctilio labialis Kerr

= *Dirias albiventer* Goldman

Common at lower elevations, probably throughout Panama. Flies over streams and lakes; roosts in hollow trees and houses. Specimens from Boca de Río Paya (Darién); Armila (San Blas); Pacora (Panamá); Nuevo Limón (Colón); Barro Colorado Island, Empire, Fort Gulick, Galeta Island, Gamboa, Juan Mina, and Puma Island (Canal Zone); Guánico (Los Santos); and Almirante, 7 km. SSW. of Changuinola, and Sibube (Bocas del Toro). The Panamanian subspecies is *N. l. labialis* Kerr (= *Noctilio minor* Osgood. See Cabrera, 1958, p. 55).

* **Noctilio leporinus** Linnaeus

Common at lower elevations, probably throughout Panama. Flies over streams, lakes, and sea. Roosts in hollow trees. Specimens from Boca de Río Paya (Darién); Armila (San Blas); Fort Sherman, Río Chagres, and Río Mandinga (Canal Zone); and Almirante and 7 km. SSW. of Changuinola (Bocas del Toro). The Panamanian subspecies is *N. l. mexicanus* Goldman.

Family **Phyllostomidae**

Pteronotus parnellii Gray

= *Chilonycteris rubiginosa* Goldman
= *Chilonycteris parnellii* Hall and Kelson

Abundant throughout the lowlands of Panama and locally up to 4800 feet. Evergreen and deciduous forests and fruit groves. Roosts in caves, tunnels, and probably in hollow trees. Specimens from Río Chucunaque (Darién); Armila (San Blas); Cerro Azul, 2000 feet, and Chilibrillo Caves (Panamá); Buena Vista (Colón); Bas Obispo, Galeta Island, Paraíso, 2 mi. N. of Summit and Vijía (Canal Zone); Cerro Hoya, 1500–2900 feet, and Guánico (Los Santos); Penonomé (Coclé); and Almirante, 7 km. SSW. of Changuinola, head of Río Changena, 4800 feet, and Sibube (Bocas del Toro). I am in full agreement with Burt and Stirton (1961, p. 24) on the synonymy of the generic names *Pteronotus* Gray and *Chilonycteris* Gray. At the species level, my own study of the problem shows that Koopman (1955, p. 111) was right in his contention that *P. parnellii* Gray and *P. rubiginosus* Wagner are conspecific. According to the 1961 International Code of Zoological Nomenclature (Art. 21bii, p. 19) *P. parnellii* must be considered to be the prior name. The Panamanian subspecies is *P. p. fuscus* J. A. Allen.

* **Pteronotus psilotis** Dobson

= *Chilonycteris psilotis* Hall and Kelson

In Panama, known only from the caves at Penonomé (Coclé), where it is numerous, and at Armila (San Blas), where a few have been caught in mist nets set over forest streams. This species occurs without significant variation from Mexico to Trinidad. It may be conspecific with *Chilonycteris personata* Wagner, but specimens that have been positively identified as the latter species have not been available for comparison. The description and measurements of a specimen of *C. personata* from Mato Grosso (Burmeister, 1854, p. 76, and Wagner, 1855, p. 680) agree with those of specimens of *C. psilotis* from Central America and northern South America.

* **Pteronotus suapurensis** J. A. Allen

Locally abundant in lowlands and up to 5300 feet, probably throughout Panama. Roosts in caves. Specimens from Tacarcuna Village, 1950 feet (Darién); Armila (San Blas); Chilibrillo Caves (Panamá); Madden Dam (Canal Zone); Penonomé (Coclé); and Cerro Punta, 5300 feet (Chiriquí).

* **Micronycteris brachyotis** Dobson

= *Micronycteris platyceps* Hall and Kelson

Rare. Evergreen and deciduous forest. Roosts in caves and hollow trees. Specimens from Cerro Azul, 2000 feet (Panamá); Fort San Lorenzo (Canal Zone); and Guánico (Los Santos). For the use of *M. brachyotis* in place of *M. platyceps,* see Goodwin and Greenhall (1961, p. 231).

* **Micronycteris hirsuta** Peters

Rare. Possibly throughout the lowlands of Panama and locally up to 4800 feet elevation. Evergreen and deciduous forests. Roosts in tree holes and buildings. Specimens from Cerro Azul, 2000 feet (Panamá); Orchid Island (Canal Zone); Guánico (Los Santos); and upper Río Changena, 4800 feet (Bocas del Toro).

Micronycteris megalotis Gray

= *Micronycteris microtis* Goldman

Locally common. Probably throughout the lowlands of Panama and up to 5300 feet elevation. Evergreen and deciduous forest. Roosts in houses and culverts and in hollow trees, logs, and stumps. Specimens from Pinogana and Río Jesucito (Darién); Cerro Azul, 2000 feet, Isla San José, Pacora, Isla Taboga, and Isla Taboguilla (Panamá); Barro Colorado Island, Cocoli, Fort Clayton, Fort Kobbe, Fort Randolph, and Orchid Island (Canal Zone); Guánico (Los Santos); Boquete and Cerro Punta, 5300 feet (Chiriquí); and Almirante and Punta de Peña (Bocas del Toro). The Panamanian subspecies is *M. m. microtis* Miller.

* † **Micronycteris minuta** Gervais

Rare. Taken in mist nets over streams in evergreen forest. Specimens from Boca de Río Paya (Darién) and Cerro Hoya, 1800 feet (Los Santos). First taken in Panama by Rudolpho Hinds.

* † **Micronycteris nicefori** Sanborn

Rare. Caribbean coast of eastern Panama. Taken in mist nets over stream in evergreen forest and from roost in concrete building. Specimens from Armila (San Blas) and Fort Gulick (Canal Zone). First taken in Panama by C. M. Keenan.

* **Micronycteris schmidtorum** Sanborn

Rare. Deciduous forest. Known in Panama only by specimens taken by F. M. Greenwell at Guánico (Los Santos).

* **Micronycteris sylvestris** Thomas

Rare. Taken in mist net over stream in evergreen forest at Armila (San Blas).

Lonchorhina aurita Tomes

= *Lonchorina aurita* Goldman

Uncommon, but fairly widespread in Panama. Evergreen and deciduous forest. Roosts in caves and mine tunnels. Specimens from Chilibrillo Caves (Panamá); 2 mi. N. of Summit and Vijía (Canal Zone); and 14 km. SSW. of Changuinola and upper Río Changena, 4800 feet (Bocas del Toro). The Panamanian subspecies is *L. a. aurita* Tomes.

Macrophyllum macrophyllum Schinz

Uncommon, but probably occurs throughout the lowlands of Panama. Flies over forest-bordered streams. Roosts in caves and masonry ruins (Panamá Viejo). Specimens from Jaqué and Boca de Río Paya (Darién); Armila and Puerto Obaldía (San Blas); Chepo, Pacora, Cerro Azul, 1200 feet, and Panamá Viejo (Panamá); Madden Dam, Fort Gulick, Fort Davis, and Salamanca Hydrographic Station (Canal Zone); Cerro Hoya, 1800 feet

(Los Santos); and Almirante and 12 km. SSW. of Changuinola (Bocas del Toro).

*Tonatia bidens **Spix

Rare. Evergreen forest. Specimens from Cerro Azul, 2000 feet (Panamá); Madden Dam (Canal Zone); and Almirante (Bocas del Toro).

***Tonatia minuta** Goodwin

= *Tonatia nicaraguae* Hall and Kelson

Uncommon, but rather widespread in Panama, possibly throughout the lowlands. Evergreen and deciduous forests and fruit groves. Specimens from Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet (Panamá); Fort Sherman (Canal Zone); Guánico and Cerro Hoya, 1800 feet (Los Santos); 7 km. SSW. of Changuinola and Sibube (Bocas del Toro). *Tonatia nicaraguae* Goodwin is a synonym.

Tonatia silvicola D'Orbigny

= *Tonatia amblyotis* Goldman
= *Tonatia sylvicola* Hall and Kelson

Uncommon, but rather widespread in Panama, possibly throughout the lowlands. Evergreen and deciduous forest. Roosts in hollow termite nests. Specimens from Boca de Río Paya, Río Esnápe, and Tacarcuna Village, 1950 feet (Darién); Armila and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet (Panamá); Barro Colorado Island, Corozal, and Rodman Naval Station (Canal Zone); Guánico (Los Santos); and Bugaba (Chiriquí). The Panamanian subspecies is *T. s silvicola* D'Orbigny. For use of the name *T. silvicola* see Husson (1962, p. 87).

***Mimon cozumelae** Goldman

Rare. Evergreen forest. Known in Panama only by specimens found roosting in a small cave on the banks of the Río Changuinola, 20 km. SSW. of Changuinola (Bocas del Toro).

*† **Mimon crenulatum** E. Geoffroy St.-Hilaire

Rare. Found roosting in a hollow, rotting tree stump, and mist-netted over a forest stream and in a cacao grove. Evergreen forest. Specimens from Fort Gulick (Canal Zone) and Almirante and Sibube (Bocas del Toro). The Panamanian subspecies is *M. c. keenani* Handley.

***Phyllostomus discolor** Wagner

Common at lower elevations, probably throughout Panama. Evergreen forest and fruit groves. Specimens from Boca de Río Paya, Paya Village, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet, and Chilibrillo Caves (Panamá); Barro Colorado Island (Canal Zone); Guánico (Los Santos); Almirante, 7 and 14 km. SSW. of Changuinola, and Sibube (Bocas del Toro). The Panamanian subspecies is *P. d. discolor* Wagner.

Phyllostomus hastatus Pallas

Common in lowlands, up to 2000 feet, throughout Panama. Forest and fruit groves. Roosts in hollow trees, caves, and houses. Specimens from Boca de Cupe, Boca de Río Paya, Boca de Río Punusa, Capetí, El Real, and Jaqué (Darién); Armila and Puerto Obaldía (San Blas); Cabima, Cerro Azul, 2000 feet, Chepo, Chilibrillo Caves, Pacora, and Panamá (Panamá); Balboa, Barro Colorado Island, Fort Gulick, Juan Mina, Madden Dam, Paraíso, and Summit (Canal Zone); Guánico (Los Santos); Boquerón (Chiriquí); and Almirante, Boca del Drago, Cayo Agua, Isla Bastimentos, and Sibube (Bocas del Toro). The Panamanian subspecies is *P. h. panamensis* J. A. Allen.

* **Phylloderma stenops** Peters

= *Phylloderma septentrionalis* Hall & Kelson

Rare. Evergreen forest. Specimens from Armila (San Blas). The Panamanian specimens combine the characters of the nominal species *P. stenops* Peters and *P. septentrionalis* Goodwin, but are nearer the former. Thus, the Panamanian subspecies is *P. s. stenops* Peters.

Trachops cirrhosus Spix

Common in lowlands and up to 2800 feet, probably throughout Panama. Flies over forest-bordered streams. Roosts in caves and houses. Specimens from Río Jesucito and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet, Chepo, Chilibrillo Caves, and Pacora (Panamá); Fort Sherman (Canal Zone); Guánico and Cerro Hoya, 2800 feet (Los Santos); and 7–20 km. SSW. of Changuinola, Isla Bastimentos, and Sibube (Bocas del Toro). The Panamanian subspecies is *T. c. cirrhosus* Spix.

* **Chrotopterus auritus** Peters

Rare. Evergreen forest. Specimens from Tacarcuna Casita, 1500 feet (Darién), Armila (San Blas), and Cerro Azul, 2000 feet (Panamá). I doubt that subspecies are recognizable in *C. auritus*.

Vampyrum spectrum Linnaeus

= *Vampyrus spectrum* Goldman

Rare. Netted over forest-bordered streams and in fruit groves. Specimens from Tacarcuna Village, 1950 feet (Darién); Armila (San Blas); Boquerón (Chiriquí); and upper Río Changena, 2400 feet, and Sibube (Bocas del Toro). The subspecies *V. s. nelsoni* Goldman does not appear to be recognizable. I have compared the type with other specimens from Panama (7), Venezuela (4), Trinidad (10), Ecuador (1), and Peru (1). Although the Mexican and Central American specimens average smaller than those from South America, the difference is not great. The dental and cranial characteristics that Goldman supposed would distinguish *nelsoni* all prove to be individual variations.

* † **Glossophaga commissarisi** Gardner

Common in the lowlands of eastern Panama, on the Caribbean coast of western Panama, and at medium elevations, possibly throughout Panama. Evergreen forest. Specimens from Boca de Cupe, Boca de Río Paya, Paya Village, and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Candelaria Hydrographic Station and Cerro Azul, 2000 feet (Panamá); and Almirante, Boca del Drago, Cayo Agua, and Sibube (Bocas del Toro).

Glossophaga soricina Pallas

Abundant in the lowlands in central Panama and on the Pacific coast of western Panama and locally common on the Caribbean coast. Deciduous and evergreen forest. Roosts in caves, culverts, houses, hollow trees, and hollow logs. Specimens from Mandinga (San Blas); Colón and Portobelo (Colón); Isla Saboga, La Chorrera, Nueva Gorgona, Pacora, Panamá, and Panamá Viejo (Panamá); many localities throughout the Canal Zone; El Copé, Río Hato, and Santa Clara (Coclé); Guánico (Los Santos); Isla Canal de Afuera (Veraguas); and Almirante, Boca del Drago, 7 km. SSW. of Changuinola, Isla Bastimentos, Isla Colón, Isla Escudo de Veraguas, and Sibube (Bocas del Toro). The Panamanian subspecies is *G. s. leachii* Gray.

Lonchophylla mordax Thomas

= *Lonchophylla concava* Goldman
= *Lonchophylla concava* Hall and Kelson

Rare. Evergreen forest. Roosts in caves. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); and Armila and Puerto Obaldía (San Blas). The Panamanian subspecies is *L. m. concava* Goldman, which is only slightly differentiated from typical *L. mordax*.

Lonchophylla robusta Miller

Common. Eastern Panama and Caribbean lowlands of western Panama. Evergreen forest. Roosts in caves. Specimens from Cana, 2000 feet, Tacarcuna Casita, 2600 feet, and Tacarcuna Village, 1950 feet (Darién); Armila and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet, Chilibrillo Caves (Panamá); Buena Vista (Colón); Barro Colorado Island, Salamanca Hydrographic Station and Summit (Canal Zone); and Almirante and Isla Bastimentos (Bocas del Toro).

* † **Lonchophylla thomasi** J. A. Allen

Rare. Known in Panama by a single specimen netted in a riverside clearing at Boca de Río Paya (Darién).

* † **Lionycteris spurrelli** Thomas

Rare. Evergreen forest. Specimens from Cana, 2000 feet (Darién) and Armila (San Blas). First taken in Panama by O. P. Pearson.

*† **Anoura cultrata** Handley

Uncommon. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién); Cerro Punta, 5300 feet (Chiriquí); and upper Río Changena, 2400 feet (Bocas del Toro).

* **Anoura geoffroyi** Gray

Uncommon. Evergreen forest. Specimens from Cerro Hoya, 3000 feet (Los Santos); Cerro Punta, 5300 feet (Chiriquí); and upper Río Changena, 4800 feet (Bocas del Toro). The Panamanian subspecies is *A. g. lasiopyga* Peters.

* **Hylonycteris underwoodi** Thomas

Rare. Known in Panama only by a specimen taken at Santa Clara, 4200 feet (Chiriquí) by F. A. Hartman.

* **Lichonycteris obscura** Thomas

Rare. Evergreen forest and fruit groves. Specimens from Tacarcuna Village, 3200 feet (Darién); Armila (San Blas); and Almirante and upper Río Changena, 2400 feet (Bocas del Toro).

Carollia castanea H. Allen

= *Hemiderma castaneum* Goldman
= *Carollia castanea* Hall and Kelson (part.)

Common at lower elevations throughout Panama. Forest and fruit groves. Apparently most abundant in evergreen forest. Found roosting under overhanging stream bank and in mine. Specimens from Boca de Río Paya, Cana, 2000 feet, Paya Village, Río Seteganti, Tacarcuna Casita, 2600 feet, and Tacarcuna Village, 3200 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet (Panamá); Frijolito (Colón); Barro Colorado Island, Chiva Chiva, and Fort Kobbe (Canal Zone); Cerro Hoya, 3000 feet (Los Santos); and Almirante, Boca del Drago, 7 km. SSW. of Changuinola, and Sibube (Bocas del Toro).

Carollia castanea is monotypic. It has been confused with *Carollia subrufa* Hahn, but it can be easily distinguished from that species by its smaller size (forearm usually less than 38 mm.); duller, less sharply defined banding of dorsal hairs; occlusal outline of crown of inner lower incisor usually ovoid (wider than long) rather than triangular (longer than wide); first three lower post-canine teeth graded (increase in size from the first) rather than subequal; M_1 almost flat-crowned (all cusps obsolete), significantly lower than adjacent teeth; second upper premolar without postero-external cusp. *Carollia castanea* ranges from Costa Rica through Panama to northern and western Colombia.

Carollia perspicillata Linnaeus

= *Hemiderma perspicillatum* Goldman

Abundant throughout the lowlands of Panama; uncommon to rare above

3000 feet. Ubiquitous. The Panamanian subspecies is *C. p. azteca* Saussure.

** **Carollia subrufa** Hahn*

= *Carollia castanea* Hall and Kelson (part.)

Locally abundant throughout eastern Panama and at high elevations and on the Caribbean coast of western Panama. Usually the most abundant species of *Carollia* above 3000 feet. Evergreen forest. Roosts in caves and in hollow trees. Specimens from Paya Village, Río Chucunaque, Río Seteganti, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul (Panamá); Cerro Punta, 5300 feet (Chiriquí); and Almirante, Boca del Drago, Cayo Agua, 7 km. SSW. of Changuinola, Isla Bastimentos, Isla Colón, upper Río Changena, 2400–4800 feet, and Sibube (Bocas del Toro).

Carollia subrufa has been confused with *Carollia castanea*, but actually it is most like and is more closely related to *Carollia perspicillata*. From *C. perspicillata*, *C. subrufa* differs in average smaller size (forearm 38–42 mm. *vs.* 41–45 mm.); average hairier forearm, tibia, and foot; average longer, silkier fur; less crowded and posteriorly more divergent tooth rows; reduced cusps of cheek teeth (especially protocone of M^1); outer incisors not reduced; highest point of P^4 well ahead of the mid-length of the tooth. *Carollia subrufa* seems to be monotypic. It ranges from western Mexico to Colombia and Venezuela.

Sturnira lilium E. Geoffroy St.-Hilaire

Abundant at lower elevations (sea level to about 4000 feet) throughout Panama. Forests and fruit groves. Specimens from Boca de Cupe, Boca de Río Paya, Paya Village, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cerro Azul, 1800–2000 feet (Panamá); Quebrada Bonita (Colón); Cerro Hoya and Guánico (Los Santos); Volcán de Chiriquí (Chiriquí); and Almirante and Isla Bastimentos (Bocas del Toro). The Panamanian subspecies is *S. l. parvidens* Goldman. Specimens from Tacarcuna Village are larger than those from lower elevations in Darién and elsewhere in Panama and may represent an undescribed subspecies of *S. lilium.*

* **Sturnira ludovici** Anthony

Abundant at higher elevations. Evergreen forest. Specimens from Cerro Malí, 4700 feet, and Tacarcuna Village, 1950 feet (Darién); Cerro Punta, 4600–5300 feet (Chiriquí); and upper Río Changena, 2400–5000 feet (Bocas del Toro).

Uroderma bilobatum Peters

Abundant at lower elevations throughout Panama. Usually found near streams and in fruit groves. Roosts under palm leaves. Specimens from Boca de Cupe, Boca de Río Paya, Capetí, Chepigana, Jaqué, and Paya

Village (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Candelaria Hydrographic Station, Cerro Azul, 850 feet, Isla Saboga, Isla San José, Isla del Rey, La Chorrera, Pacora, Panamá, and Panamá Viejo (Panamá); Quebrada Bonita and Colón (Colón); Ancón, Barro Colorado Island, France Field, Río Indio, and Summit (Canal Zone); Guánico (Los Santos); El Copé, 1450 feet, and El Potrero (Coclé); Boquerón and Bugaba (Chiriquí); and Almirante, Boca del Drago, 7 km. SSW. of Changuinola, Isla Bastimentos, Punta de Peña, and Sibube (Bocas del Toro). The Panamanian subspecies is *U. b. bilobatum* Peters (= *U. convexum* Lyon).

* † **Vampyrops dorsalis** Thomas

Uncommon. Specimens from Tacarcuna Village, 1950 feet (Darién). Evergreen forest. Netted over forest-bordered stream.

Vampyrops helleri Peters

= *Platyrrhinus helleri* Hall and Kelson

Abundant from sea level to 4000 feet throughout Panama. Forests and fruit groves. Specimens from Boca de Río Paya, Cana, 2000 feet, Jaque, Paya Village, Río Setegantí, Tacarcuna Casita, 1950 feet, Tacarcuna Laguna, 3000 feet, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cabima, Cerro Azul, 2000 feet, Isla del Rey, and Isla San José (Panamá); Bas Obispo, Chiva Chiva, and Paraíso (Canal Zone); Cerro Hoya and Guánico (Los Santos); Isla Cébaco (Veraguas); and Almirante, Boca del Drago, Cayo Agua, 7 km. SSW. of Changuinola, Isla Colón, Punta de Peña, upper Río Changena, 2400 feet, and Sibube (Bocas del Toro). *Vampyrops zarhinus* H. Allen is a synonym.

* **Vampyrops vittatus** Peters

= *Platyrrhinus vittatus* Hall and Kelson

Common at higher elevations. Evergreen forest. Specimens from Cerro Malí, 4700 feet, and Tacarcuna Village, 1950 feet (Darién); Cerro Punta, 5300 feet (Chiriquí); and upper Río Changena, 2400–5000 feet (Bocas del Toro).

Vampyrodes caraccioli Thomas

= *Vampyrodes major* Goldman
= *Vampyrodes major* Hall and Kelson

Common at medium elevations (1500–2500 feet) throughout Panama and usually less common at lower elevations (to sea level) in eastern Panama and on the Caribbean coast of western Panama. Evergreen forest. Specimens from Jaqué, Río Chucunaque, Río Setegantí, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién); Armila and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet (Panamá); Barro Colorado Island and San Pablo (Canal Zone); and Almirante, upper Río Changena, 2300–2600 feet, and Sibube (Bocas del Toro). The Panamanian subspecies is *V. c. major* G. M. Allen (=*V. ornatus* Thomas). *V. c. caraccioli* Thomas averages smaller.

* **Vampyressa nymphaea** Thomas

Uncommon. Lower elevations in eastern Panama and on the Caribbean coast of western Panama. Evergreen forest. Specimens from Río Seteganti, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Candelaria Hydrographic Station and Cerro Azul, 2000 feet (Panamá); Barro Colorado Island (Canal Zone); and Almirante and 7 km. SSW. of Changuinola (Bocas del Toro).

Vampyressa pusilla Wagner

= *Vampyressa minuta* Goldman
= *Vampyressa thyone* Hall and Kelson

Uncommon. Lower elevations, possibly throughout Panama. Evergreen forest. Specimens from Cana, 2000 feet, Río Setegantí, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cabima, Candelaria Hydrographic Station, and Cerro Azul, 2000 feet (Panamá); Barro Colorado Island (Canal Zone); Cerro Hoya, 2400–2800 feet (Los Santos); El Copé, 1400 feet (Coclé); and upper Río Changena, 2300 feet, and Sibube (Bocas del Toro). For the use of the name *V. pusilla* see Goodwin (1963, p. 8). The characters that are supposed to distinguish the subspecies of this species—*V. p. pusilla* Wagner, *V. p. thyone* Thomas (=*V. minuta* Miller), and *V. p. venilla* Thomas—are age rather than geographic variables. Thus, these names should be arranged as synonyms of *V. pusilla* Wagner.

* † **Vampyressa** species

Specimens of an undescribed species of *Vampyressa* have been taken in evergreen forest on the upper Río Changena, 4800 feet (Bocas del Toro).

Chiroderma salvini Dobson

Common at higher elevations. Evergreen forest. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); Cerro Azul, 2000 feet (Panamá); and upper Río Changena, 2400–4800 feet (Bocas del Toro).

* † **Chiroderma trinitatum** Goodwin

Rare. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién); Armila and Puerto Obaldía (San Blas); and upper Río Changena, 2400 feet (Bocas del Toro). The Panamanian subspecies is *C. t. gorgasi* Handley.

Chiroderma villosum Peters

= *Chiroderma isthmicum* Goldman
= *Chiroderma isthmicum* Hall and Kelson

Uncommon at lower elevations throughout Panama. Forest and fruit groves. Specimens from Cana, 2000 feet, Jaqué, and Tacarcuna Village, 1950 feet (Darién); Armila, Mandinga, and Puerto Obaldía (San Blas); Cabima, Cerro Azul, 2000 feet, and Isla del Rey (Panamá); Barro Colorado

Island and Culebra (Canal Zone); Cerro Hoya and Guánico (Los Santos); and Almirante, Cayo Agua, and Sibube (Bocas del Toro). The Panamanian subspecies is *C. v. jesupi* J. A. Allen (= *C. isthmicum* Miller).

* **Ectophylla alba** H. Allen

Rare. Evergreen forest and fruit groves. Specimens from Almirante, upper Río Changena, 2300–2400 feet, and Sibube (Bocas del Toro).

* † **Ectophylla macconnelli** Thomas

Rare. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién) and Almirante and Boca de Río Risco, 12 km. SSW. of Changuinola (Bocas del Toro). For notes on the use of the combination *Ectophylla macconnelli* in place of *Mesophylla macconnelli* see Goodwin and Greenhall (1962, p. 10). Individual variation among the Panamanian specimens exceeds the variation described by Goodwin and Greenhall (*op. cit.*) as geographic.

* **Artibeus aztecus** Andersen

= *Artibeus cinereus* Hall and Kelson (part.)

Rare. Evergreen forest. Specimens from Cerro Punta, 5300 feet (Chiriquí). First collected in Panama by Charles M. Keenan and Vernon J. Tipton.

Artibeus cinereus Gervais

= *Artibeus watsoni* Goldman (part.)
= *Artibeus cinereus* Hall and Kelson (part.)

Abundant. Lower and middle elevations (sea level to 4800 feet) throughout Panama, including off-shore islands. Ubiquitous. Roosts under leaves. The Panamanian subspecies is *A. c. watsoni* Thomas.

Artibeus jamaicensis Leach

= *Artibeus planirostris* Goldman

Abundant at lower elevations (sea level to 3200 feet) throughout Panama, including off-shore islands. Ubiquitous. Roosts in hollow trees, caves, and houses. The Panamanian subspecies is *A. j. jamaicensis* Leach.

* **Artibeus lituratus** Olfers

Abundant at lower elevations (sea level to 3200 feet) throughout Panama, including off-shore islands. Ubiquitous. The Panamanian subspecies is *A. l. palmarum* J. A. Allen and Chapman.

* **Artibeus toltecus** Saussure

= *Artibeus watsoni* Goldman (part.)
= *Artibeus cinereus* Hall and Kelson (part.)

Common at higher elevations. Evergreen forest. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); Cerro Punta, 5300–5700 feet (Chiriquí); upper Río Changena, 2400–4800 feet (Bocas del Toro).

* **Artibeus turpis** Andersen

= *Artibeus watsoni* Goldman (part.)

Common. Lower and middle elevations in eastern Panama and on the Caribbean coast of western Panama. Specimens from Boca de Río Paya, Jaqué, Río Chucunaque, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién); Mandinga (San Blas); Cerro Azul, 2000 feet, and La Chorrera (Panamá); Barro Colorado Island, Fort Gulick, and Gatún (Canal Zone); Quebrada Bonita (Colón); and Almirante, Boca del Drago, and 7 km. SSW. of Changuinola (Bocas del Toro).

* **Enchisthenes hartii** Thomas

Uncommon. Evergreen and deciduous forest. Specimens from Tacarcuna Village, 1950 feet (Darién); Quarry Heights (Canal Zone); and Cerro Hoya, 2600 feet (Los Santos).

* **Centurio senex** Gray

Uncommon. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién); Las Cumbres and Nueva Gorgona (Panamá); Barro Colorado Island and Cristóbal (Canal Zone); Cerro Hoya, 1800 feet (Los Santos); and Almirante and Sibube (Bocas del Toro). First taken in Panama by Carl Koford.

Family **Desmodidae**

Desmodus rotundus E. Geoffroy St.-Hilaire

Locally abundant throughout Panama, and on off-shore islands, from sea level to 5600 feet. Ubiquitous. Roosts in hollow trees, caves, and houses. The Panamanian subspecies is *D. r. murinus* Wagner.

* † **Diaemus youngii** Jentink

Rare. Evergreen forest. Specimens from Armila (San Blas) and Isla Bastimentos (Bocas del Toro). The Panamanian subspecies is *D. y. cypselinus* Thomas.

Diphylla ecaudata Spix

= *Diphylla centralis* Goldman

Rare. Evergreen forest. Specimens from Boquete (Chiriquí) and Almirante and Sibube (Bocas del Toro). *Diphylla ecaudata* is probably monotypic (see Burt and Stirton, 1961, p. 37).

Family **Natalidae**

Natalus stramineus Gray

= *Natalus mexicanus* Goldman
= *Natalus mexicanus* Hall and Kelson

Rare. Roosts in caves. Specimens from Chilibrillo Caves (Panamá); Fort San Lorenzo (Canal Zone); Penonomé (Coclé); Isla Coiba (Veraguas).

The Panamanian subspecies is *N. s. mexicanus* Miller (= *N. s. saturatus* Dalquest and Hall). For the taxonomy of *N. stramineus* see Goodwin (1959).

Family **Furipteridae**

* † **Furipterus horrens** F. Cuvier

Rare. Evergreen forest. Known in Panama only by specimens found roosting with *Mimon cozumelae* in a small cave on the banks of the Río Changuinola, 20 km. SSW. of Changuinola (Bocas del Toro).

Family **Thyropteridae**

* **Thyroptera tricolor** Spix

Rare. Roosts in rolled *Heliconia* leaves. Specimens from Río Jesucito and Tacarcuna Village (Darién); Barro Colorado Island and Corozal (Canal Zone); and on trail from Chiriquicito to Boquete (Bocas del Toro). The Panamanian subspecies is *T. t. albiventer* Tomes (= *T. t. albigula* G. M. Allen).

Family **Vespertilionidae**

* **Myotis albescens** E. Geoffroy St.-Hilaire

Common. Lowlands of eastern Panama and Caribbean coast of western Panama. Evergreen forest. Specimens from Boca de Río Paya and Tacarcuna Village, 1950 feet (Darién); San Pablo and Tabernilla (Canal Zone); and 7–20 km. SSW. of Changuinola and Sibube (Bocas del Toro).

* † **Myotis chiloensis** Waterhouse

Rare. Evergreen forest. Roosts in caves. Known in Panama only by specimens from Cerro Punta, 5300–5800 feet (Chiriquí). First taken in Panama by Charles M. Keenan and Vernon J. Tipton. These specimens represent an undescribed subspecies.

Myotis nigricans Schinz

Abundant throughout at lower elevations, from sea level to at least 3200 feet elevation and perhaps ascending higher in the mountains. Roosts in caves and houses. The Panamanian subspecies is *M. n. nigricans* Schinz. It seems likely that *Myotis nigricans*, as now constituted, is a composite species.

* † **Myotis simus** Thomas

Uncommon. Evergreen forest. Specimens from Boca de Río Paya and Tacarcuna Village, 1950 feet (Darién); Armila (San Blas); and Cerro Azul, 2000 feet (Panamá). The Panamanian subspecies is *M. s. riparius* Handley.

Eptesicus brasiliensis Desmarest

= *Eptesicus propinquus* Goldman

Uncommon, at low elevations in central and western Panama. Evergreen forest. Roosts in houses. Specimens from Cerro Hoya (Los Santos); and 7 km. SSW. of Changuinola and Sibube (Bocas del Toro). The Panamanian subspecies is *E. b. propinquus* Peters.

* **Eptesicus chiriquinus** Thomas

Uncommon, on the Caribbean coast of eastern Panama and at medium elevations throughout. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién); Armila (San Blas); Cerro Azul, 2000 feet (Panamá); Boquete (Chiriquí); upper Río Changena, 2400 feet (Bocas del Toro).

Eptesicus fuscus Palisot de Beauvois

Rare, at high elevations in western Panama. Evergreen forest. Roosts in tree holes. Specimens from El Valle (Coclé); Boquete (Chiriquí); and upper Río Changena, 4800 feet (Bocas del Toro). The Panamanian subspecies is *E. f. miradorensis* H. Allen.

* † **Eptesicus innoxius** Gervais

Rare, at low elevations on the Pacific coastal plain. Specimens from San Pablo (Canal Zone); Tocumen (Panamá); and Boquerón (Chiriquí).

Rhogeessa tumida H. Allen

= *Rhogeessa parvula* Hall and Kelson (part.)

Uncommon, at lower elevations. Open country. Roosts in houses. Specimens from La Palma (Darién); numerous localities (Canal Zone); Santa Clara (Coclé); Guánico (Los Santos); Bugaba (Chiriquí); and Almirante, 7 km. SSW. of Changuinola, and Isla Bastimentos (Bocas del Toro). The Panamanian subspecies is *R. t. tumida* H. Allen (Goodwin, 1958).

Lasiurus borealis Müller

= *Nycteris borealis* Goldman

Uncommon, although widely distributed both geographically and altitudinally. Netted over streams. Specimens from Tacarcuna Village, 1950 feet (Darién); Armila (San Blas); Balboa and Fort Clayton (Canal Zone); Calobré (Veraguas); Cerro Hoya, 1800 feet (Los Santos); and Boquete, 3500 feet, and Cerro Punta, 5300 feet (Chiriquí). The Panamanian subspecies is *L. b. frantzii* Peters.

* † **Lasiurus castaneus** Handley

Rare. Evergreen forest. Specimens from Tacarcuna Village, 1950 feet (Darién) and Armila (San Blas).

Lasiurus ega Gervais

= *Dasypterus ega* Goldman
= *Dasypterus ega* Hall and Kelson

Rare. Specimens from Fort Clayton (Canal Zone); Cerro Hoya, 1800 feet (Los Santos); and Bugaba, 800 feet (Chiriquí). The Panamanian subspecies is *L. e. panamensis* Thomas. For notes on the taxonomy of this species, see Handley (1960, p. 473).

*† **Lasiurus egregius** Peters

Rare. Evergreen forest. A specimen from Armila (San Blas) and the holotype from Santa Catarina, Brazil, described in 1870, are the only known specimens of this species.

Family **Molossidae**

Molossops planirostris Peters

= *Cynomops planirostris* Hall and Kelson

Uncommon. Roosts in houses. Specimens from Pacora and Panamá (Panamá); and Balboa, Cocoli, Fort Amador, Fort Clayton, La Boca, and Miraflores Locks (Canal Zone). The Panamanian subspecies is *M. p. planirostris* Peters. Specimens from Tacarcuna Village (Darién) probably represent another species of *Molossops.*

* **Tadarida brasiliensis** I. Geoffroy St.-Hilaire

Uncommon. Roosts in caves. Specimens from Cerro Punta, 5700 feet, and Río Chiriquí Viejo at Palo Santo, 4200 feet (Chiriquí); and upper Río Changena (Bocas del Toro). The Panamanian subspecies is *T. b. brasiliensis* I. Geoffroy St.-Hilaire.

* **Tadarida yucatanica** Miller

Uncommon. Roosts in houses. Specimens from Pacora and Panamá (Panamá) and Miraflores (Canal Zone).

Molossus bondae J. A. Allen

Common at lower elevations in eastern Panama and on the Caribbean coast of western Panama. Openings in evergreen forest. Roosts in houses. Specimens from Tacarcuna Village (Darién); Escobal and Salud (Colón); Chiva Chiva, Fort Kobbe, Fort Sherman, and Juan Mina (Canal Zone); and Almirante, 7 km. SSW. of Changuinola, and Sibube (Bocas del Toro).

Molossus coibensis J. A. Allen

= *Molossus major* Hall and Kelson (part.)

Abundant at lower elevations in central Panama and on the Pacific coast of western Panama. Open country. Roosts in houses. Specimens from Isla Taboga, La Chorrera, Pacora, and Panamá (Panamá); Ancón, Balboa, Barro Colorado Island, Bohio, Chiva Chiva, Corozal, Culebra, Curundu, Fort Clayton, Fort Sherman, Gamboa, Gatún, Margarita, Paraíso, San Pablo, Summit, and Tabernilla (Canal Zone); Escobal, Frijoles, and Salud (Colón); Isla Coiba and Isla Gobernadora (Veraguas); and Boquerón (Chiriquí). It is possible that there is more than one species of pygmy *Molossus.* Therefore assignment of *M. coibensis* to any particular one on the basis of size alone is premature.

* **Molossus nigricans** Miller

= *Molossus rufus* Hall and Kelson

Uncommon. Roosts in attics of houses. E. L. Tyson took specimens at

Alanje, 50 feet, Boquerón, 600 feet, 2 mi. W. of El Volcán, 4100 feet, and La Concepción, 800 feet (Chiriquí). *M. ater* E. Geoffroy St.-Hilaire (=*M. rufus* E. Geoffroy St.-Hilaire), *M. nigricans* Miller, and *M. pretiosus* Miller are similar and further study may show them to be conspecific.

Molossus sinaloae J. A. Allen

Uncommon at lower elevations in eastern Panama and on the Caribbean coast of western Panama. Roosts in houses. Specimens from Boca de Cupe and El Real (Darién); Fort Amador and Fort Clayton (Canal Zone); and 7 km. SSW. of Changuinola and Punta de Peña (Bocas del Toro). The Panamanian subspecies is *M. s. trinitatus* Goodwin, a form which heretofore has been considered to be a distinct species confined to the island of Trinidad.

* **Promops centralis** Thomas

Rare. Roosts in houses. Specimens have been taken by Charles M. Keenan and Vernon J. Tipton at Corozal, Fort Amador, and Fort Clayton (Canal Zone). *Promops centralis* Thomas, *P. occultus* Thomas, and *P. davidsoni* Thomas may be conspecific. The oldest name is *P. centralis.*

* † **Eumops amazonicus** Handley

Rare. Known in Panama by a single specimen from Tacarcuna Village, 1950 feet (Darién). Netted over forest-bordered stream.

Eumops auripendulus Shaw

= *Eumops glaucinus* Goldman
= *Eumops abrasus* Hall and Kelson

Uncommon. Roosts in houses. Specimens from Frijoles (Colón); Bohio, Empire, Fort Clayton, Fort Kobbe, Paraíso, and Summit (Canal Zone); and 7 km. SSW. of Changuinola (Bocas del Toro). For nomenclature, see Goodwin (1960).

Eumops bonariensis Peters

= *Eumops nanus* Goldman

Rare. Specimens from Boquerón and Bugaba (Chiriquí). The Panamanian subspecies is *E. b. nanus* Miller.

* **Eumops glaucinus** Wagner

Rare. Roosts in attics of houses. E. L. Tyson took specimens at David, 150 feet, and La Concepción, 800 feet (Chiriquí).

Order PRIMATES

Family **Cebidae**

* **Aotus bipunctatus** Bole

Rare. Known only from the type locality, Paracoté, Azuero Peninsula (Veraguas). Very likely conspecific with *A. trivirgatus.*

Aotus trivirgatus Humboldt

= *Aotus zonalis* Goldman

Common in eastern Panama and possibly on the Caribbean coast of western Panama, mostly in evergreen forest. Arboreal. Sleeps in tree holes. Specimens from Boca de Cupe, Boca de Río Paya, Cana, 2000 feet, Tacarcuna Casita, 1500 feet, Tacarcuna Village, 1950 feet, and Tapalisa (Darién); Armila and Mandinga (San Blas); Pacora (Panamá); Alhajuela, Fort Kobbe, Gatún, Madden Dam, and Paraíso (Canal Zone); Salud (Colón); and Isla Bastimentos (Bocas del Toro). The Panamanian subspecies is *A. t. griseimembra* Elliot (= *A. zonalis* Goldman).

Alouatta villosa Gray

= *Alouatta coibensis* Goldman
= *Alouatta palliata* Goldman

Locally abundant throughout Panama from sea level to at least 5100 feet. Arboreal. Several subspecies occur in Panama: (1) *A. v. aequatorialis* Festa (= *A. p. inconsonans* Goldman), mainland (except Azuero Peninsula) and adjacent islands; (2) *A. v. coibensis* Thomas, Isla Coiba; (3) *A. v. trabeata* Lawrence, Azuero Peninsula, north to Capina and Parita (Herrera).

Cebus capucinus Linnaeus

Locally abundant throughout Panama from sea level to at least 6000 feet. Arboreal. Subspecies in Panama: (1) *C. c. capucinus* Linnaeus, from Cerro Bruja (Colón) and Cerro Azul (Panamá) eastward to Colombia; (2) *C. c. imitator* Thomas, from the Canal Zone westward into Costa Rica; Isla Coiba.

Saimiri oerstedii Reinhardt

Common. At low elevations on the Pacific coast of western Panama. Arboreal. Specimens from Boquerón, Bugaba, David, Isla Almijas, Isla Sevilla, and Río Coto region (Chiriquí). The Panamanian subspecies is *S. o. oerstedii* Reinhardt.

Ateles fusciceps Gray

= *Ateles dariensis* Goldman

Common. From near sea level to at least 5200 feet in the Río Bayano, Río Chucunaque, and upper Río Tuira basins in eastern Panama. Arboreal. Specimens from Cituro, Cerro Pirre, 5200 feet, Tapalisa, Río Mono, Río Setegantí, Tacarcuna Casita, 1500 feet, Tacarcuna Laguna, 3000 feet, and Tacarcuna Village, 1950 feet (Darién); and Río Bayano (Panamá). Seen at Armila (San Blas). The Panamanian subspecies is *A. f. robustus* J. A. Allen.

Ateles geoffroyi Kuhl

Uncommon at lower elevations, possibly throughout Panama except in the area inhabited by *A. fusciceps*. Arboreal. More shy and usually in larger and more remote forests than other Panamanian monkeys. Subspecies in Panama: (1) *A. g. azuerensis* Bole, Azuero Peninsula (Veraguas); (2) *A. g. grisescens* Gray (=*Ateles rufiventris* Sclater?), lower portion of the Río Tuira basin and nearby lowlands (Darién); (3) *A. g. panamensis* Kellogg and Goldman, central and western Panama (Panamá, Colón, Canal Zone, Chiriquí, and Bocas del Toro).

Family **Callithricidae**

Saguinus geoffroyi Pucheran

= *Leontocebus geoffroyi* Goldman
= *Marikina geoffroyi* auctorum

Abundant from sea level to at least 2000 feet in the Canal Zone and eastern Panama. Absent or locally distributed in western Panama (has been reported from Río Coto region at the base of the Burica Peninsula). Arboreal. Scrub forest and forest edges.

Order **EDENTATA**

Family **Myrmecophagidae**

Myrmecophaga tridactyla Linnaeus

Rare. Although it may once have occurred throughout the lowlands of Panama, it is now confined to the less disturbed portions. Terrestrial. Specimens from Mandinga (San Blas); Gatún (Canal Zone); and Divalá (Chiriquí). The Panamanian subspecies is *M. t. centralis* Lyon.

Tamandua tetradactyla Linnaeus

= *Tamanduas tetradactyla* Goldman

Common. Probably throughout Panama from sea level to at least 5000 feet. Partly arboreal, partly terrestrial. The Panamanian subspecies is *T. t. chiriquensis* J. A. Allen.

Cyclopes didactylus Linnaeus

Uncommon. Probably at lower elevations throughout Panama. Arboreal; nocturnal. The Panamanian subspecies is *C. d. dorsalis* Gray.

Family **Bradypodidae**

Bradypus infuscatus Wagler

= *Bradypus griseus* Goldman
= *Bradypus griseus* Hall and Kelson
= *Bradypus ignavus* Goldman

Common. Probably throughout Panama, including off-shore islands, at lower elevations (sea level to at least 2000 ft.). Arboreal. The Panamanian subspecies are: (1) *B. i. griseus* Gray, Canal Zone and western Panama; (2) *B. i. ignavus* Goldman, Darién.

Choloepus hoffmanni Peters

Common. Probably throughout Panama from sea level to at least 4800 feet. Arboreal. The Panamanian subspecies is *C. h. hoffmanni* Peters.

Family **Dasypodidae**

Cabassous centralis Miller

Rare. Possibly throughout Panama, but all specimen records are for the Canal Zone and vicinity. Terrestrial and burrowing. Often in rocky areas.

Dasypus novemcinctus Linnaeus

Common. Probably throughout Panama, from sea level to at least 5500 feet. Terrestrial and burrowing. The Panamanian subspecies is *D. n. fenestratus* Peters.

[The specimen of *Dasypus septemcinctus* Linnaeus found at Colón (Hamlett, 1939, p. 333) had probably escaped from captivity.]

Order LAGOMORPHA

Family **Leporidae**

Sylvilagus brasiliensis Linnaeus

= *Sylvilagus gabbi* Goldman

Common. Probably throughout Panama from sea level to at least 5300 feet. Terrestrial. Most often in open or scrubby country, but also in heavy forest. Subspecies in Panama: (1) *S. b. gabbi* J. A. Allen (= *S. b. consobrinus* Anthony). All of Panama except Darién and Isla del Rey. Specimens from Armila and Mandinga (San Blas); Cerro Azul, 2000 feet, and Río Majé (Panamá); Corozal, France Field, Gatún, Las Cáscadas, Lion Hill, and Summit (Canal Zone); Guánico (Los Santos); Isla Gobernadora (Veraguas); Boquerón, Boquete, Bugaba, and Divalá (Chiriquí); and Sibube (Bocas del Toro). (2) *S. b. incitatus* Bangs, Isla del Rey. (3) *S. b. messorius* Goldman. Specimens from Boca de Cupe, Cana, 1800 feet, Jaqué, Tacarcuna Casita, 1500 feet, Tacarcuna Village, 1950 feet, and Tapalisa (Darién). Specimens from Cerro Punta, 5300 feet (Chiriquí) may represent an undescribed subspecies.

Order RODENTIA

Family **Sciuridae**

Sciurus granatensis Humboldt

= *Sciurus hoffmanni* Goldman
= *Sciurus gerrardi* Goldman

Abundant. Throughout Panama at all elevations. Perhaps no other Panamanian mammal is so wide-ranging. In all sorts of forest. Arboreal, but spends much time on the ground. Subspecies in Panama: (1) *S. g.*

chiriquensis Bangs, western Panama, from 6 mi. E. of El Valle (Panamá) and Guánico (Los Santos) west into Costa Rica; (2) *S. g. morulus* Bangs (= *S. g. choco* Goldman), Canal Zone and eastern Panama. The population that has hitherto borne the prior name *S. g. morulus* is an intergrade between the small, plain-colored *S. g. chiriquensis* and the large, varicolored *S. g. choco,* but is more like the latter.

Sciurus variegatoides Ogilby

Abundant at lower elevations in the Canal Zone and western Panama. Fruit groves, scrub, and semi-open country. Arboreal. Panamanian subspecies: (1) *S. v. helveolus* Goldman. Pacific coast of central Panama. Specimens from Chiva-Chiva, Cocoli, Corozal, Empire Range, Fort Clayton, Pacific, Paraíso, and Summit (Canal Zone); Arraiján, La Chorrera, Nuevo Emperador, and Panamá (= Calidonia) (Panamá); Parita (Herrera); and Santiago (Veraguas). (2) *S. v. melania* Gray. Pacific coast of western Panama. Specimens from Guánico (Los Santos); Pesé (Herrera); Isla Cébaco, Río Mariato, and Soná (Veraguas); and Boquerón, Boquete, 2000 feet, Bugaba, David, Divalá, Isla Brava, Isla Insóleta, Isla Sevilla, and Remédios (Chiriquí). (3) *S. v. thomasi* Nelson. Caribbean coast of western Panama. Specimens from Almirante and 7 km. SSW. of Changuinola (Bocas del Toro).

Syntheosciurus brochus Bangs

Rare. Fog forest. Known only from the upper Caribbean slope of the Continental Divide, north of Boquete, 7000 feet (Bocas del Toro).

Microsciurus alfari J. A. Allen

Uncommon. Probably occurs throughout the forested parts of Panama. Arboreal. Diurnal. Subspecies in Panama: (1) *M. a. browni* Bangs. Pacific coast of western Panama. Specimens from Bugaba, 600 feet, Quebrada Santa Clara, 3600–4200 feet, Río Gariché, 5300 feet, Sereno, 3600–3700 feet, and Siolo, 4100–4300 feet (Chiriquí). (2) *M. a. fusculus* Thomas. Extreme southeastern Panama, south and west of the Río Tuira. Specimens from Cana, 2000 feet, Cerro Sapo, and Río Seteganti, 2600 feet (Darién). (3) *M. a. venustulus* Goldman. Central Panama and the Caribbean coast of western Panama. Specimens from Mandinga (San Blas); Portobelo (Colón); Cerro Azul, 2000–2500 feet, and Río Pequení (Panamá); Barro Colorado Island and Gatun (Canal Zone); and Almirante and upper Río Changena, 5000 feet (Bocas del Toro). (4) Specimens from Armila (San Blas) and Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién), represent an undescribed subspecies.

Microsciurus mimulus Thomas

= *Microsciurus boquetensis* Goldman
= *Microsciurus boquetensis* Hall and Kelson
= *Microsciurus isthmius* Goldman
= *Microsciurus isthmius* Hall and Kelson

Rare. In fog forest possibly throughout Panama. Subspecies in Panama: (1) *M. m. boquetensis* Nenson. Cerro Malí, 4900 feet, and Tacarcuna Village, 1950 feet (Darién); Cerro Azul, 2500–3000 feet (Panamá); and high ridges above Boquete (Chiriquí and Bocas del Toro). (2) *M. m. isthmius* Nelson (= *M. m. vivatus* Goldman). Specimens from Cana, 3500 feet, 20 mi. S. of Cana, 5000 feet, Cerro Sapo, 3000 feet, and Río Jaqué (Darién).

Family **Geomyidae**

Macrogeomys cavator Bangs

= *Macrogeomys pansa* Goldman

Locally common. Extreme western Panama. Fossorial. Mostly in fields. Subspecies in Panama: (1) *M. c. cavator* Bangs. Boquete, 4800 feet, and Cerro Punta, 5300–7800 feet (Chiriquí). (2) *M. c. pansa* Bangs. Bugaba, 600 feet (Chiriquí).

Macrogeomys dariensis Goldman

Abundant in the lower Río Chucunaque and upper Río Tuira basins in eastern Panama. Fossorial. Fields, fruit groves, and forest. Specimens from Boca de Cupe, 250 feet, Boca de Río Paya, 500 feet, Cana, 2000–2500 feet, Tacarcuna region, 1500–2500 feet, and Tapalisa (Darién). Mounds seen at Yavisa.

Family **Heteromyidae**

Liomys adspersus Peters

Abundant in the semi-arid savannah country of the Pacific coast of western Panama. Open thorny scrub and weedy fields. Terrestrial. Specimens from Cerro Azul, 1500 feet, and Chepo (Panamá); Albrook Field, Balboa, Chiva Chiva, Cocoli, Curundu, Empire, Farfan, Fort Clayton, Fort Kobbe, Madden Forest, and Summit (Canal Zone); Guánico (Los Santos); and Paracoté and Santa Fé (Veraguas).

Heteromys australis Thomas

Abundant. Lower elevations in eastern Panama. Forest. Terrestrial. Subspecies in Panama: (1) *H. a. conscius* Goldman. Specimens from Boca de Río Paya, 500 feet, Cana, 1800–2000 feet, Río Setegantí, 2600 feet, Tacarcuna Casita, 1500–1700 feet, and Tacarcuna Village, 1950 feet (Darién). (2) *H. a. pacificus* Pearson. Known only from Amagal, 1000 feet, S. of Guayabo Bay (Darién).

Heteromys desmarestianus Gray

Common at higher elevations throughout, and to sea level on the Caribbean coast and in Chiriquí (no specimens have been taken elsewhere on the Pacific coast). Terrestrial. Forest, usually evergreen. Subspecies in Panama: (1) *H. d. chiriquensis* Enders. High elevations in extreme western Panama. Specimens from Cerro Pando and Cerro Punta, 6800–7800 feet (Chiriquí). (2) *H. d. crassirostris* Goldman. High elevations in extreme eastern Panama. Specimens from Cerro Malí (="Mount Tacarcuna"), 4900 feet, and Cerro Pirre, 4500–5000 feet (Darién). (3) *H. d. panamensis* Goldman. Medium elevations in central Panama. Specimens from Cerro Azul, 2000–3000 feet (Panamá); and Cerro Bruja, 2000 feet (Colón). (4) *H. d. repens* Bangs. Lower and middle elevations in western Panama. Specimens from Boquerón and Boquete, 4000 feet (Chiriquí). (5) *H. d. zonalis* Goldman. Lower elevations in central Panama and on the Caribbean coast of western Panama. Specimens from Fort Sherman, Gatun, Madden Dam, and Río Indio (Canal Zone); Cerro Campana, 6 mi. E. of El Valle, and Maxon Ranch, Río Trinidad (Panamá); Salud (Colón); and Almirante, 7 km. SSW. of Changuinola, and upper Río Changena, 2300–2600 feet (Bocas del Toro). (6) Specimens from the San Blas coast represent an undescribed subspecies.

Family **Cricetidae**

Oryzomys albigularis Tomes

= *Oryzomys devius* Goldman
= *Oryzomys devius* Hall and Kelson
= *Oryzomys pirrensis* Goldman
= *Oryzomys pirrensis* Hall and Kelson

Uncommon. High elevations in eastern and western Panama. Fog forest. Terrestrial. Subspecies in Panama: (1) *O. a. devius* Bangs. Specimens from Boquete, 4000–5000 feet, and Cerro Punta, 6800–7800 feet (Chiriquí); and upper Río Changena, 4800–5000 feet (Bocas del Torro). (2) *O. a. pirrensis* Goldman. Specimens from Cerro Malí (="Mt. Tacarcuna"), 4900 feet, and Cerro Pirre, 4500 feet (Darién).

Oryzomys alfaroi J. A. Allen

Uncommon. Higher elevations in eastern and western Panama. Evergreen forest. Terrestrial. Subspecies in Panama: (1) *O. a. alfaroi* J. A. Allen. Specimens from Boquete, 4000 feet, Cerro Punta, 5000–5800 feet, and El Volcán, 4200 feet (Chiriquí); and upper Río Changena, 2400 feet (Bocas del Toro). (2) *O. a. dariensis* Goldman. Specimens from Cana, 2000–2500 feet, Cerro Malí (="Mt. Tacarcuna"), 4800 feet, Tacarcuna Casita, 1500 feet, and Tacarcuna Village, 1950 feet (Darién).

* **Oryzomys bicolor** Tomes

= *Oryzomys endersi* Hall and Kelson
= *Oryzomys trabeatus* Hall and Kelson

Rare. At lower elevations in the Canal Zone and eastern Panama. Evergreen forest. Arboreal. Specimens from Guayabo, Pelisa, 500 feet, and Río Jesucito (Darién); Armila and Puerto Obaldía (San Blas); Cerro Azul, 2000 feet (Panamá); and Barro Colorado Island and Fort Sherman (Canal

Zone). The Panamanian subspecies is *O. b. trabeatus* G. M. Allen and Barbour (= *Oryzomys endersi* Goldman). For notes on the nomenclature of this species see Hershkovitz (1960, p. 518).

Oryzomys bombycinus Goldman

Rare. Middle elevation evergreen forest. Terrestrial. Subspecies in Panama: (1) *O. b. alleni* Goldman. Upper Río Changena, 2400 feet (Bocas del Toro). (2) *O. b. bombycinus* Goldman. Cerro Azul, 2000–3000 feet, and 6 mi. E. of El Valle (Panamá) and Cerro Bruja, 1000 feet (Colón). (3) *O. b. orinus* Pearson. Cerro Pirre (Darién).

Oryzomys caliginosus Tomes

Abundant. Lower elevations in eastern Panama and on the Caribbean coast of western Panama (seemingly absent from most of the Pacific coast of western Panama). Evergreen forest and clearings. Subspecies in Panama: (1) *O. c. chrysomelas* J. A. Allen. Western Panama. Specimens from Bugaba, 600 feet (Chiriquí) and Almirante, Boca del Drago, 7 km. SSW. of Changuinola, Isla Bastimentos, and upper Río Changena, 2400 feet, (Bocas del Toro). (2) *O. c. idoneus* Goldman. Central and eastern Panama. Specimens from Cana, 1800–2800 feet, El Real, Tacarcuna Casita, 1500–1700 feet, Tacarcuna Laguna, 3000 feet, and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000–2500 feet, Cerro Campana, 6 mi. E. of El Valle, and Río Trinidad (Panamá); and Empire Range, Fort Sherman, and Gatún (Canal Zone).

Oryzomys capito Olfers

= *Oryzomys talamancae* Goldman
= *Oryzomys talamancae* Hall and Kelson
= *Oryzomys laticeps* auctorum

Abundant. At lower elevations, probably throughout Panama, but not recorded on the Pacific coast west of the Azuero Peninsula. Forest, both evergreen and deciduous. Terrestrial. Subspecies in Panama: (1) *O. c. carrikeri* J. A. Allen. Caribbean coast of western Panama. Specimens from Almirante and Boca del Drago (Bocas del Toro). (2) *O. c. talamancae* J. A. Allen (= *Oryzomys panamensis* Thomas). Central and eastern Panama. Specimens from Boca de Río Paya, Cana, 2000 feet, Cituro, Jaqué, Río Seteganti, 2600 feet, Tacarcuna Casita, 1500 feet, Tacarcuna Village, 3200 feet, and Tapalisa (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000 feet, Cerro Campana, 6 mi. E. of El Valle, and Río Trinidad (Panamá); Cerro Bruja (Colón); Fort Sherman, Gatún, Madden Road, and Mohinga Valley (Canal Zone); and Cerro Hoya, 3000 feet (Los Santos). For use of the name *capito,* see Hershkovitz (1960, p. 544) and Cabrera (1961, p. 387).

Oryzomys concolor Wagner

= *Oryzomys tectus* Goldman
= *Oryzomys tectus* Hall and Kelson

Uncommon. Lower elevations possibly throughout Panama. Semi-arboreal, in tall grass and herbaceous growth in savannas and forest openings. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Corozal and Madden Road (Canal Zone); and Bugaba, 800 feet (Chiriquí). The Panamanian subspecies is *O. c. tectus* Thomas (= *O. frontalis* Goldman). For notes on the nomenclature of this species see Hershkovitz (1960, p. 515).

Oryzomys fulvescens Saussure

Common. Confined largely to the Pacific slope of central and western Panama. Savannas and forest openings. Terrestrial. Subspecies in Panama: (1) *O. f. costaricensis* J. A. Allen. Lower elevations. Specimens from Cerro Azul, 2000–3000 feet, Cerro Campana, 6 mi. E. of El Valle, La Chorrera, Pacora, and Panamá Viejo (Panamá); Albrook Field, Barro Colorado Island, Curundu, Fort Clayton, and Fort Kobbe (Canal Zone); and Cerro Punta, 4800–5600 feet (Chiriquí). (2) *O. f. vegatus* Bangs. Higher elevations, western Panama. Specimens from Boquete, 3800–4800 feet, and Cerro Punta, 6800–7800 feet (Chiriquí); and upper Río Changena, 4800 feet (Bocas del Toro).

Oryzomys palustris Harlan

= *Oryzomys gatunensis* Goldman
= *Oryzomys gatunensis* Hall and Kelson
= *Oryzomys azuerensis* Hall and Kelson

Rare. Cane fields and marshy areas. Terrestrial. Subspecies in Panama: (1) *O. p. azuerensis* Bole. Specimens from Guánico (Los Santos) and Paracoté (Veraguas). (2) *O. p. gatunensis* Goldman. Specimens from Pacora (Panamá) and Gatún (Canal Zone). Hall (1960, p. 172) has pointed out the conspecificity of *O. couesi* and *O. palustris*. Recently acquired specimens show that *O. azuerensis* and *O. gatunensis*, also, should be treated as subspecies of *O. palustris*.

Neacomys tenuipes Thomas

= *Neacomys pictus* Goldman
= *Neacomys pictus* Hall and Kelson

Rare. In grass and small bushes in clearings and forest openings. Terrestrial. Specimens from Cana, 1800–2000 feet, and Tacarcuna Village, 1950 feet (Darién). The Panamanian subspecies is *N. t. pictus* Goldman. For use of the name *tenuipes* for this species see Cabrera (1961, p. 412). My own studies confirm this usage.

Nectomys alfari J. A. Allen

Common. At lower elevations in eastern Panama and on the Caribbean coast of western Panama. In marshes, abandoned cane fields, and other forest openings. Terrestrial. Subspecies in Panama: (1) *N. a. alfari* J. A. Allen. Specimens from Cerro Azul, 2000 feet, Cerro Campana, 3000 feet, and 6 mi. E. of El Valle (Panamá); Santa Fé (Veraguas); and Almirante and upper Río Changena, 2400 feet (Bocas del Toro). (2) *N. a. efficax* Goldman. Specimens from Boca de Río Paya, Cana, 1800–2000 feet, and Tacarcuna Village, 1950 feet (Darién); and Mandinga (San Blas).

Rhipidomys scandens Goldman

Rare. Known only by the holotype from Cerro Pirre, 5000 feet (Darién). Arboreal.

Tylomys panamensis Gray

Uncommon. At lower elevations possibly throughout Panama. Arboreal. It seems unlikely that there is more than one species of *Tylomys* in Panama, but there are still too few specimens to enable one to be certain of this. *Tylomys panamensis* Gray is the prior name. The nominal species in Panama are: (1) *T. fulviventer* Anthony. Tacarcuna Laguna, 3000 feet, and Tacarcuna Village, 1950–3600 feet (Darién). (2) *T. panamensis* Gray. Cana, 2000 feet, and Boca de Río Paya (Darién). (3) *T. watsoni* Thomas. Specimens from Armila (San Blas); Cerro Bruja, 1000 feet, and Salud (Colón); Cerro Azul, 2000–3000 feet, and 6 mi. E. of El Valle (Panamá); Fort Sherman, Mohinga Valley, and Madden Dam (Canal Zone); Santa Fé (Veraguas); and Boquerón, Boquete, and Bugaba, 800 feet (Chiriquí). A specimen from Isla Bastimentos (Bocas del Toro) may represent an undescribed form.

Nyctomys sumichrasti Saussure

Rare. Evergreen forest of central and western Panama. Arboreal. Specimens from Cerro Azul, 2000 feet (Panamá); Camp Chagres, Madden Lake (Canal Zone); Cerro Punta, 5300 feet, and Boquete, 4000 feet (Chiriquí); and Cayo Agua and upper Río Changena, 2400 feet (Bocas del Toro). May occur also on the Azuero Peninsula. The subspecies in Panama is *N. s. nitellinus* Bangs.

Reithrodontomys creper Bangs

Abundant. High elevations in western Panama. Fog forest and openings. Mainly terrestrial. Specimens from Casita Alta, 7400 feet, Cerro Punta, 6800–7800 feet, and Volcán de Chiriquí, 10,400 feet (Chiriquí).

* **Reithrodontomys darienensis** Pearson

Uncommon, lower elevations on Pacific coast of eastern Panama. Forest clearings and other openings. Mainly arboreal. Specimens from Cana, 2000 feet (Darién); Cerro Azul, 1000 feet, 4 mi. W. of Chepo, and Pacora (Panamá); Gatún (Canal Zone); and Cerro Hoya, 3000 feet (Los Santos). Possibly also Isla Cébaco (Veraguas).

Reithrodontomys mexicanus Saussure

Uncommon. Higher elevations in western Panama. Evergreen forest and forest openings. Partly arboreal. Subspecies in Panama: (1) *R. m.*

garichensis Enders and Pearson. East and north of Río Chiriquí Viejo. Specimens from Boquerón, Boquete, 3500–4000 feet, Cerro Pando, Cerro Punta, 4500–7800 feet, and Río Gariché, 5 mi. SW. of El Volcán, 3200 feet (Chiriquí); and upper Río Changena, 4800 feet (Bocas del Toro). (2) *R. m. potrerograndei* Goodwin. Río Chiriquí Viejo, Wald, 3800 feet (Chiriquí).

Reithrodontomys sumichrasti Saussure

= *Reithrodontomys australis* Goldman

Common. Higher elevations in western Panama. Mostly in fields and forest clearings. Terrestrial. Specimens from Boquete, 4000 feet, Cerro Punta, 5000–7800 feet, El Volcán, and Volcán de Chiriquí, 10,300 feet (Chiriquí). The Panamanian subspecies is *R. s. vulcanius* Bangs.

Peromyscus flavidus Bangs

Rare. Western Panama. Forest. Terrestrial. Specimens from Boquete, 3000–5000 feet (Chiriquí); and upper Río Changena, 4800 feet (Bocas del Toro).

Peromyscus nudipes J. A. Allen

Abundant. High elevations in western Panama. Evergreen forest. Terrestrial. Specimens from Boquete, 4000–7500 feet, Cerro Punta, 5000–7800 feet, and El Volcán (Chiriquí); and upper Río Changena, 2400–4800 feet (Bocas del Toro). The Panamanian subspecies is *P. n. nudipes* J. A. Allen (= *Peromyscus cacabatus* Bangs).

Peromyscus pirrensis Goldman

Uncommon. High elevations in eastern Panama. Evergreen forest. Terrestrial. Specimens from Cerro Malí (="Mt. Tacarcuna"), 4900 feet, Cerro Pirre, 3500–5200 feet, and Tacarcuna Village, 1950 feet (Darién). The large *Peromyscus* inhabiting the higher elevations on the Azuero Peninsula may be this species.

Zygodontomys microtinus Thomas

= *Zygodontomys cherriei* Goldman
= *Zygodontomys cherriei* Hall and Kelson

Abundant. Savannas and cleared lands at low elevations on the Pacific coast. Terrestrial. Subspecies in Panama: (1) *Z. m. cherriei* J. A. Allen. Western Panama. Specimens from Boquerón, Bugaba, and El Banco (Chiriquí). (2) *Z. m. ventriosus* Goldman. Central and eastern Panama. Specimens from El Real (Darién); Cerro Azul, 2000 feet, Pacora, and Panamá Viejo (Panamá); Barro Colorado Island, Chico, Corozal, Curundu, Empire, Fort Clayton, Fort Kobbe, Fort Sherman, France Field, Gamboa, Gatún, Madden Wye, Red Tank, Summit, and Tabernilla (Canal Zone); El Valle (Coclé); Guánico (Los Santos); and Altos Cacao, 1500 feet, and Paracoté (Veraguas). Possibly also Isla Cébaco (Veraguas).

Zygodontomys seorsus Bangs

Abundant. Dense swampy woods. Terrestrial. Isla del Rey.

Scotinomys teguina Alston

Abundant. Middle elevations on the Pacific slope of western Panama. Fields and forest clearings. Terrestrial. Subspecies in Panama: (1) *S. t. apricus* Bangs. Boquete, 4000 feet (Chiriquí). (2) *S. t. episcopi* Enders and Pearson. West of Río Chiriquí Viejo, 3800–5600 feet: Cerro Pando, Río Santa Clara, and Siolo (Chiriquí). (3) *S. t. garichensis* Enders and Pearson. East of Río Chiriquí Viejo, 3200–6000 feet: Cerro Punta, 5300–6000 feet, Llano Verde, and Río Gariché, 3200 feet (Chiriquí). (4) *S. t. leridensis* Enders and Pearson. Boquete, 5000–7000 feet (Chiriquí).

Scotinomys xerampelinus Bangs

Abundant. High elevations in western Panama. Fog forest and forest openings. Terrestrial. Cerro Punta, 6800–7800 feet, and Volcán de Chiriquí, 10,400 feet (Chiriquí).

Sigmodon hispidus Say and Ord

= *Sigmodon hispidus* Goldman
= *Sigmodon austerulus* Goldman

Abundant. Low elevations. Central Panama, the Pacific coast of western Panama, and the western extreme of the Caribbean coast. Savannas and forest openings. Terrestrial. Specimens from the Canal Zone and the Pacific coast are of the subspecies *S. h. chiriquensis* J. A. Allen: Cerro Azul, 1000 feet and Cerro Campana (Panamá); many localities, throughout the Canal Zone; El Valle (Coclé); Cerro Hoya, 3000 feet, and Guánico (Los Santos); Río Mariato and Santa Fé (Veraguas); and Boquerón and Bugaba (Chiriquí). Specimens from Almirante and 7 km. SSW. of Changuinola (Bocas del Toro) represent an undescribed subspecies. The nominal species "*S. austerulus* Bangs", known only by the holotype, is now thought a synonym of *S. h. borucae* J. A. Allen and to have come from Costa Rica, not the summit of Volcán de Chiriquí as labeled (Enders, 1953, p. 508).

* **Rheomys hartmanni** Enders

Rare. Known only by two specimens from the hot springs on the Río Cotito, 4900 feet (Chiriquí). Aquatic.

Rheomys raptor Goldman

Rare. Known only by three specimens from Cerro Pirre, 4500 feet (Darién). Aquatic.

* **Rheomys underwoodi** Thomas

Rare. One specimen from El Volcán (Chiriquí). Aquatic.

Family **Muridae**

* **Rattus norvegicus** Berkenhout

Uncommon. Urban. Terrestrial. Specimens from Cristóbal and Mount Hope (Canal Zone). Introduced.

Rattus rattus Linnaeus

Abundant. Now found around human habitations and in some wild areas throughout much, if not all, of Panama. Partly terrestrial, partly arboreal. Three color phases are encountered: black (= "*R. r. rattus* Linnaeus"), brown with gray belly (= "*R. r. alexandrinus* E. Geoffroy St.-Hilaire"), and brown with white belly ("*R. r. frugivorus* Rafinesque"). Introduced.

Mus musculus Linnaeus

Uncommon. In human habitations. Specimens from El Valle (Coclé) Isla del Rey, Las Cumbres, and Río Avaso (Panamá); Fort Clayton (Canal Zone); and Cerro Punta, 5000 feet (Chiriquí). Introduced.

Family **Erethizontidae**

Coendou mexicanus Kerr

= *Coendou mexicanum* Goldman

In western Panama, from high elevations on the Pacific slope (common) to near sea level on the Caribbean coast (rare). Arboreal. Specimens from Boquete and Cerro Punta, 5300–6200 feet (Chiriquí), and Sibube (Bocas del Toro). The Panamanian subspecies is *C. m. laenatus* Thomas.

Coendou rothschildi Thomas

Uncommon. At lower elevations, possibly throughout Panama, except on the Caribbean coast of western Panama. Arboreal. Specimens from Boca de Río Paya (Darién); Armila (San Blas); Barro Colorado Island, Cativá Road, Fort Davis, Fort Kobbe, Fort Sherman, France Field, Gatún, Río Indio, and Tabernilla (Canal Zone); Parita (Herrera); Guánico (Los Santos); and Boquerón, Isla Brava, and Isla Sevilla (Chiriquí).

Family **Hydrochaeridae**

Hydrochaeris hydrochaeris Linnaeus

= *Hydrochoerus isthmius* Goldman
= *Hydrochaeris isthmius* Hall and Kelson

Uncommon. Eastern Panama. Semiaquatic. Stream banks and marshes. Specimens or observations from El Real, Marragantí, and Río Seteganti, 2600 feet (Darién); 15 mi. E. of Panamá (Panamá); and Juan Mina (Canal Zone). The Panamanian subspecies is *H. h. isthmius* Goldman.

Family **Dasyproctidae**

Agouti paca Linnaeus

= *Cuniculus paca* Goldman

Common throughout Panama except where it has been excessively hunted. Forest. Terrestrial. Specimens from Boca de Río Paya, Cana, 2000 feet (observation), and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000 feet (Panamá); Barro Colorado Island, Gatún, and Río Indio (Canal Zone); Cerro Hoya, 2800–3000 feet (Los Santos); Cerro Punta, 5300 feet, and Divalá (Chiriquí); and Almirante, Boca del Drago, Cayo Agua, Isla Bastimentos, and Sibube (Bocas del Toro). The Panamanian subspecies is *A. p. virgatus* Bangs.

Dasyprocta coibae Thomas

Common. Known only on Isla Coiba. Forest. Terrestrial.

Dasyprocta punctata Gray

= *Dasyprocta callida* Goldman

Common throughout Panama. At all elevations, though more common in lowlands. Forest. Terrestrial. Subspecies in Panama: (1) *D. p. bellula* Kellogg. Isla San José. (2) *D. p. callida* Bangs. Isla Pedro Gonzalez and Isla del Rey. (3) *D. p. dariensis* Goldman. Eastern Panama. Specimens from Aruza, Boca de Cupe, Boca de Río Paya, Cana, Cerro Pirre, 5200 feet, Chepigana, Cituro, El Real, and Río Chucunaque (Darién); Armila and Mandinga (San Blas); and Ancón Hill (Canal Zone). (4) *D. p. isthmica* Alston. Central Panama and at higher elevations in western Panama. Specimens from Cerro Azul, 2000 feet, and Río Trinidad (Panamá); Colón (Colón); Barro Colorado Island, Cocoli, Fort Sherman, Gamboa, Gatún, Madden Dam, Paraíso, and Río Indio (Canal Zone); and Boquete (Chiriquí). (5) *D. p. nuchalis* Goldman. Pacific lowlands of western Panama, except the Azuero Peninsula. Specimens from Bugaba and Divalá (Chiriquí). (6) *D. p. pallidiventris* Bole. Azuero Peninsula. Specimens from Cerro Hoya, 2600–3000 feet, and Guánico (Los Santos); and Isla Cébaco and Paracoté (Veraguas). (7) *D. p. richmondi* Goldman. Caribbean coast of western Panama. Specimens from Almirante, 7 km. SSW. of Changuinola, and Sibube.

Family **Echimyidae**

Proechimys semispinosus Tomes

Abundant throughout the forested portions of Panama at lower elevations. Terrestrial. Subspecies in Panama: (1) *P. s. burrus* Bangs. Isla del Rey. (2) *P. s. goldmani* Bole. Azuero Peninsula. Specimens from Cerro Viejo, Paracoté and Río Mariato (Veraguas). (3) *P. s. ignotus* Kellogg. Isla San José. (4) *P. s. panamensis* Thomas (=*P. s. chiriquinus* Thomas). Lowlands throughout, except on the Azuero Peninsula. Specimens from Boca de Cupe, Boca de Río Paya, Cana, 2000 feet, Cituro, El Real, Río Chucunaque, Tacarcuna Village, 1950 feet, and Tapalisa (Darién); Armila and Mandinga (San Blas); Cerro Azul, Chimán, and Río Trinidad (Panamá); many localities throughout the Canal Zone; Boquerón, Bugaba, 800 feet, and Divalá (Chiriquí); and Almirante, Boca del Drago, 7 km. SSW. of Changuinola, and Isla Bastimentos (Bocas del Toro).

Hoplomys gymnurus Thomas

Locally uncommon to abundant. Eastern Panama and the Caribbean coast of western Panama. Evergreen forest. Terrestrial. Subspecies in Panama: (1) *H. g. goethalsi* Goldman. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000–2100 feet (Panamá); Fort Sherman, Gatún, and Río Indio (Canal Zone), and Almirante, Boca del Drago, Cayo Agua, 7 km. SSW. of Changuinola, Isla Bastimentos, Isla Colón, upper Río Changena, 2400 feet, and Sibube (Bocas del Toro). (2) *H. g. wetmorei* Handley. Isla Escudo de Veraguas (Bocas del Toro).

Diplomys labilis Bangs

= *Diplomys darlingi* Goldman
= *Diplomys darlingi* Hall and Kelson

At low elevations in the Canal Zone and eastern Panama. Arboreal. Nests in tree holes. Subspecies in Panama: (1) *D. l. darlingi* Goldman. Rare. Specimens from Cerro Malí, 5000 feet, Marragantí, and Tapalisa, 400 feet (Darién); Armila and Mandinga (San Blas); and Ancón, Fort Kobbe, and Juan Mina (Canal Zone). (2) *D. l. labilis* Bangs. Common on Isla del Rey (Panamá).

Order CETACEA

Family **Physeteridae**

* **Physeter catodon** Linnaeus

Rare. Definitely recorded only for the Gulf of Panamá, but probably occurs off both coasts. Marine.

Family **Delphinidae**

* **Stenella graffmani** Lönnberg

Common. Gulf of Panamá, Gulf of Chiriquí, and probably other Pacific coastal waters. Marine.

* **Stenella longirostris** Gray

Rare, Pacific. Specimen taken between Panama and Galápagos Islands. Marine. Possibly more pelagic than *S. graffmani.*

* **Stenella plagiodon** Cope

Possibly common. Gulf of San Blas and probably other Caribbean coastal waters. Marine.

* **Tursiops nuuanu** Andrews

Pacific. Specimen taken 70 mi. S. of Panamá. Marine.

* **Globicephala** species?

On 29 March 1962, Dr. Alexander Wetmore observed a group of small whales off Isla Cébaco (Veraguas) which he took to be *Globicephala.*

Family **Balaenopteridae**

* **Balaenoptera physalus** Linnaeus

Possibly uncommon. Caribbean. Marine.

* **Megaptera novaeangliae** Borowski

Uncommon. Pacific. Observed in Gulf of Panamá. Marine.

* **Sibbaldus musculus** Linnaeus

Possibly rare. Caribbean. A dead specimen washed ashore at Cristóbal (Canal Zone). Marine.

Order CARNIVORA

Family **Canidae**

* **Urocyon cinereoargenteus** Schreber

Rare. Canal Zone and Pacific coast of western Panama. Semi-arid savanna and scrub country. Terrestrial. Specimen from 3 mi. W. of Balboa (Canal Zone). The Panamanian subspecies is *U. c. furvus* G. M. Allen and Barbour.

Speothos venaticus Lund

= *Icticyon panamensis* Goldman
= *Speothos panamensis* Hall and Kelson

Rare. Definitely known only in extreme eastern Panama, but reported from Canal Zone, Bocas del Toro, and Chiriquí. Forest. Terrestrial. Specimens from Cerro Pirre, 5000 feet (Darién). The Panamanian subspecies is *S. v. panamensis* Goldman. For use of this name combination, see Hershkovitz (1957, p. 161).

Family **Procyonidae**

Bassariscus sumichrasti Saussure

Rare. Known in Panama only by a specimen from Boquete, 6000 feet (Chiriquí). Arboreal. The Panamanian subspecies is *B. s. notinus* Thomas.

Procyon cancrivorus Cuvier

Uncommon. Eastern Panama and the Caribbean coast of western Panama. It has been reported on the Pacific coast of Costa Rica. Mostly terrestrial. Specimens from Boca de Río Paya, Cana, 2000 feet, Río Pucro, and Tacarcuna Village, 1950 feet (observation only) (Darién) ; Armila (observation only) and Mandinga (San Blas) ; Panamá (Panamá) ; Portobelo (Colón) ; Gatun (Canal Zone) ; and 3.7 miles SE. of Almirante (Bocas del Toro). The Panamanian subspecies is *P. c. panamensis* Goldman.

Procyon lotor Linnaeus

Locally common. Central and western Panama. Mostly arboreal. Subspecies in Panama: (1) *P. l. crassidens* Hollister. Western portion of the Caribbean coast. Specimens from Almirante, 7 and 12 km. SSW. of Changuinola, and Isla Bastimentos (Bocas del Toro). (2) *P. l. pumilus* Miller. Central Panama and Pacific coast of western Panama. Specimens from Chepo (Panamá); Portobelo (Colón); Balboa, Fort Randolph, and Gatún (Canal Zone); and Boquerón, Cerro Punta, 5300 feet, and Pedregal (Chiriquí).

Nasua nasua Linnaeus

= *Nasua narica* Goldman
= *Nasua narica* Hall and Kelson

Locally common. Throughout Panama at all elevations. Forest and forest clearings. Partly arboreal and partly terrestrial. The Panamanian subspecies is *N. n. narica* Linnaeus (= *N. n. panamensis* J. A. Allen). For notes on the nomenclature of *Nasua* see Cabrera (1958, p. 245).

Potos flavus Schreber

Common. Throughout Panama at all elevations. Arboreal. Subspecies in Panama: (1) *P. f. chiriquensis* J. A. Allen. Western Panama and Canal Zone, east to Mandinga (San Blas) and Cerro Azul (Panamá). (2) *P. f. isthmicus* Goldman. Darién.

Bassaricyon gabbii J. A. Allen

Uncommon. Possibly throughout Panama, up to at least 5300 feet elevation (but not recorded on the Pacific coast west of La Chorrera, except at high elevations). Arboreal. Specimens from Boca de Río Paya, Cana, 1800–2000 feet, Cerro Pirre, 5000 feet, and Tacarcuna Casita, 1500 feet (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000 feet, La Chorrera, and Pacora (Panamá); Salud (Colón); Corozal and Gatún (Canal Zone); Cerro Pando, 4800 feet, and Cerro Punta, 5300 feet (Chiriquí); and Almirante (Bocas del Toro). The names that might apply to these populations have not been evaluated: *B. g. gabbii* J. A. Allen, "Talamanca", Costa Rica; *B. g. orinomus* Goldman, Cana, Darién, Panama (a synonym of *B. g. medius* Thomas, Jimenez, Chocó, Colombia?); and *B. pauli* Enders, Cerro Pando, Chiriquí, Panama.

Family **Mustelidae**

Mustela frenata Lichtenstein

= *Mustela affinis* Goldman

Locally distributed throughout Panama. Mostly rare, but evidently fairly common in the highlands of Chiriquí. Forest and agricultural land, probably most numerous in the latter. Terrestrial. Specimens from Cerro Pirre, 5000 feet (Darién); Cerro Azul, 2000 feet (Panamá); Río Indio (Canal Zone); and Boquete, 4000–5800 feet, Cerro Punta, 5000 feet, Río Gariché, 5300 feet, and Siolo (Chiriquí). The Panamanian subspecies is *M. f. panamensis* Hall.

Eira barbara Linnaeus

= *Tayra barbara* Goldman

Uncommon. Probably throughout Panama at lower elevations. Forest and fruit groves. Partly arboreal, partly terrestrial. Specimens from Boca de Río Paya, Boca de Río Pucro, Tacarcuna Village, 1950 feet, and Tapalisa (Darién); Mandinga (San Blas); Cerro Azul, 2000 feet, and Charco del Toro, Río Majé (Panamá); Gamboa and Gatún (Canal Zone); Guánico (Los Santos); Bugaba (Chiriquí); and Sibube (Bocas del Toro). The Panamanian subspecies is *E. b. biologiae* Thomas.

Galictis allamandi Bell

= *Grison canaster* Goldman

Rare. Probably occurs locally throughout Panama. Terrestrial, but perhaps partly arboreal. Specimens from Boca de Río Paya and Cana, 1800 feet (Darién); Chepo (Panamá); Buena Vista (Colón); and Almirante (Bocas del Toro). The Panamanian subspecies is *G. a. canaster* Nelson.

Conepatus semistriatus Boddaert

= *Conepatus tropicalis* Goldman

Rare. Possibly occurs locally throughout, but specimens have been taken only in western Panama: Boquerón, Boquete, 4000 feet, and Cerro Punta, 5000 feet (Chiriquí); and Sibube (Bocas del Toro). Terrestrial. The Panamanian subspecies is *C. s. trichurus* Thomas.

Lutra annectens Major

= *Lutra repanda* Goldman

Uncommon. Probably occurs in suitable streams throughout Panama. Semi-aquatic. Specimens from Boca de Río Paya, Cana, 2000 feet, Tacarcuna Village, 1950 feet, and Tapalisa (Darién); Río Chimán (Panamá); Gamboa and Gatún (Canal Zone); and Río Changuinola (Bocas del Toro). The subspecies in Panama is *L. a. repanda* Goldman.

Family **Felidae**

Felis concolor Linnaeus

= *Felis bangsi* Goldman

Rare and apparently local in distribution, although possibly occurring throughout Panama. Mostly terrestrial. From Tacarcuna Village (Darién); Charco del Toro, Río Majé; La Jagua; and Río Bayano, 10 mi. above mouth of Río Mamoní (Panamá); 4 mi. E. of Gamboa (Canal Zone); and Boquerón; Boquete; and Cerro Punta, 6800 feet (Chiriquí). Reported in San Blas, Los Santos, and Bocas del Toro. The Panamanian subspecies is *F. c. costaricensis* Merriam.

Felis onca Linnaeus

Uncommon. Probably occurs throughout Panama at all elevations. Mostly terrestrial. Specimens from Boca de Cupe (Darién); Río Peluca

(Panamá); Canal Zone; and Rio Changuinola (Bocas del Toro). The subspecies is *F. o. centralis* Mearns.

Felis pardalis Linnaeus

Common. Probably occurs throughout Panama at all elevations. Mostly terrestrial, but often dens in trees. Specimens from Cerro Pirre and El Real (Darién); Armila and Mandinga (San Blas); Cerro Azul, 2000 feet, and Río Majé (Panamá); Gatún (Canal Zone); Salud (Colón); Boquerón and Boquete, 4000 feet (Chiriquí); and 10 km. SSW. of Changuinola, Punta de Peña, and Sibube (Bocas del Toro). The Panamanian subspecies is *F. p. mearnsi* Lyon (= *F. costaricensis* Mearns).

Felis wiedii Schinz

= *Felis pirrensis* Goldman

Uncommon, but possibly occurs throughout Panama. Mostly terrestrial, but often dens in trees. Specimens from Cana, 2000 feet, and Tacarcuna Village, 1950 feet (Darién); Mandinga (San Blas); Cerro Azul, 2000 feet (Panamá); Salud (Colón); Caleobevora (= Calovévora) (Veraguas); and Sibube (Bocas del Toro). The Panamanian subspecies is *F. w. pirrensis* Goldman.

Felis yagouaroundi Geoffroy

= *Herpailurus yagouaroundi* Goldman

Uncommon, but possibly occurs locally throughout Panama. Partly arboreal and partly terrestrial. Specimens from Cana (Darién); Mandinga (San Blas); Empire and Lion Hill (Canal Zone); Boquerón (Chiriquí); and Sibube (Bocas del Toro). The Panamanian subspecies is *F. y. panamensis* J. A. Allen

Order SIRENIA

Family **Trichechidae**

Trichechus manatus Linnaeus

Rare. Aquatic. Probably formerly occurred in the lower reaches of many of the rivers that drain into the Caribbean. Still occurs at least about the mouth of the Río Changuinola and in the inner part of Chiriquí Lagoon (Bocas del Toro) where it is hunted persistently for its meat. Apparently no Panamanian specimen has been preserved. The subspecies on this coast is *T. m. manatus* Linnaeus.

Order PERISSODACTYLA

Family **Tapiridae**

Tapirus bairdii Gill

= *Tapirella bairdii* Goldman

Common at all elevations in eastern Panama and on the Caribbean coast, but now rare or absent on the Pacific coast of western Panama. Largely terrestrial, although often frequenting streams and lake shores. Specimens from Cana, 2000 feet, and Cerro Pirre, 5000 feet (Darién); Mandinga (San Blas); Gatún and Mount Hope (Canal Zone); Boquete, 5000 feet (Chiriquí); and upper Río Changena, 2400 feet (Bocas del Toro).

Order ARTIODACTYLA

Family **Tayassuidae**

Tayassu pecari Link

Uncommon, but probably distributed locally throughout the forested parts of Panama. Terrestrial. Specimens from Río Changuinola (Bocas del Toro). On geographical grounds the subspecies in Panama should be *T. p. spiradens* (Goldman). For notes on the use of the name *Tayassu pecari* Link rather than *Tayassu albirostris* Illiger as recommended by Cabrera (1961, p. 316) see Hershkovitz (1963, p. 85).

Tayassu tajacu Linnaeus

= *Pecari angulatus* Goldman

Common throughout Panama except where it has been excessively hunted. Forest and forest clearings. Terrestrial. Specimens from Boca de Cupe, Boca de Río Paya, El Real, and Tacarcuna Village, 1950 feet (Darién); Barro Colorado Island, Gamboa, Gatún, and Madden Dam (Canal Zone); Escobal (Colón); Paracoté (Veraguas); Boquete (Chiriquí) and Almirante, 7 km. SSW. of Changuinola, Río Teribe, and Sibube (Bocas del Toro). The names *T. t. bangsi* Goldman, Boca de Cupe (Darién), and *T. t. crusnigrum* Bangs, Boquete (Chiriquí), are available for Panamanian populations.

Family **Cervidae**

Odocoileus virginianus Zimmermann

= *Odocoileus chiriquensis* Goldman
= *Odocoileus rothschildi* Goldman
= *Dama virginiana* Hall and Kelson

Uncommon. Pacific coast of central and western Panama, Canal Zone, and western extreme of Caribbean coast. Apparently absent from the remainder of the Caribbean coast and eastern Panama. Terrestrial. Usually in thickets in savannas or in patches of wild cane along rivers, but inhabiting dense forest on the Azuero Peninsula. Subspecies in Panama: (1) *O. v. chiriquensis* J. A. Allen. Specimens from Río Bayano (Panamá); Corozal and Gatún (Canal Zone); Cerro Hoya, 2800 feet (Los Santos); and Boquerón and Boquete (Chiriquí). (2) *O. v. rothschildi* Thomas. Isla Coiba. (3) *O. v. truei* Merriam (= *O. costaricensis* Miller). Sibube (Bocas del Toro).

Mazama americana Erxleben

= *Mazama sartorii* Goldman

Common. Probably throughout the forested parts of Panama. Terrestrial. Subspecies in Panama: (1) *M. a. cerasina* Hollister. Caribbean coast of western Panama. Specimens from Almirante, 14 km. SSW. of Changuinola, Río Teribe, and Sibube (Bocas del Toro). (2) *M. a. reperticia* Goldman. Mainland Panama, except the western Caribbean coast. Specimens from Boca de Cupe, Cana, Chepigana, Cituro, El Real, Río Chucunaque, Tacarcuna Casita, 1600 feet, Tacarcuna Laguna, 3000 feet, Tacarcuna Village, 3200 feet, and Tapalisa (Darién); Maxon Ranch, Río Trinidad (Panamá); Gatún (Canal Zone); and Boquete, 4000–4800 feet (Chiriquí).

* **Mazama gouazoubira** Fischer

Uncommon. Terrestrial. Known in Panama only on Isla San José. The Panamanian subspecies is *M. g. permira* Kellogg.

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Appendix. Classified List of Hosts and Parasites[1]

This list is compiled chiefly from the data given in the preceding papers. However, published and unpublished records of Spelaeorhynchidae (bat mites) and Polyctenidae (bat bugs) have been added, though these groups were not treated in the volume. Common names of hosts have also been added.

Most contributors did not give subspecies identifications of hosts, either because they did not have this information, or because they mistakenly considered it unimportant. Thus, in compiling the list, one could not usually determine the subspecific identity of a particular host. Accordingly, for practical reasons, most hosts, excepting bats, are listed by species only. The subspecies identifications of most of the host bats are known and are given in the list. Subspecies names are also given for a few bird hosts, for which the contributor had originally used subspecies names as species names.

Mr. Emmet R. Blake, Chicago Natural History Museum, advised on the use of some common and scientific names of birds, as did Dr. Charles O. Handley, Jr., Smithsonian Institution, on some common names of mammals, and Mr. Hymen Marx, Chicago Natural History Museum, on names of reptiles and amphibians. Otherwise, Hall and Kelson was followed for common names of mammals, Handley (this volume, pp. 735–795) for scientific names of Mammals and Eisenmann (1955) for common names of birds.

Authors of the new species listed are: *Amblyopinus* (Coleopterg: Staphylinidae), A. Barrera; chigger mites (Trombiculidae), J. M. Brennan and C. E. Yunker; Dermanyssidae, except *Hirstionyssus*, R. W. Strandtmann and C. E. Yunker, and of *Hirstionyssus*, C. E. Yunker and F. J. Radovsky; fleas (Siphonaptera), V. J. Tipton and E. Méndez; Laelaptinae, V. J. Tipton; Nycteribiidae, L. R. Guimarães; Streblidae, R. L. Wenzel.

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[1] Compiled by Rupert L. Wenzel and Vernon J. Tipton, Editors, and Christina Johnson Fowler, Editorial Assistant.

Abbreviations

AN Anoplura (sucking lice)
CO *Amblyopinus* (rove beetles)
DE Dermanyssidae (mites)
HI Hippoboscidae (louse flies)
IX Ixodoidea (ticks)
L Larva
LA Laelaptinae (laelaptid mites)
MA Mallophaga (biting lice)
N Nymph
NY Nycteribiidae (batflies)
PO Polyctenidae (bat bugs)
SI Siphonaptera (fleas)
SP Spinturnicidae (bat mites)
SPE Spelaeorhynchidae (bat mites)
ST Streblidae (batflies)
TR Trombiculidae (chigger mites)

Classified List of Hosts and Parasites

Class AMPHIBIA

Order SALIENTIA
Family Bufonidae

Bufo marinus (Linnaeus)
Giant Toad
IX: *Amblyomma dissimile* Koch

Class REPTILIA

Order TESTUDINATA
Family Testudinidae

Geoemyda annulata (Gray)
Brown Ground Turtle
IX: *Amblyomma sabanerae* Stoll

Geoemyda funeria (Cope)
Striped-bellied Ground Turtle
IX: *Amblyomma sabanerae* Stoll
" sp., N, L

Pseudemys scripta (Schoepff)
Pond Slider
IX: *Amblyomma sabanerae* Stoll
" *dissimile* Koch

Family Kinosternidae

Kinosternon sp.
IX: *Amblyomma sabanerae* Stoll

Order SQUAMATA
Suborder Sauria
Family Iguanidae

Anolis sp.
Anole
TR: *Eutrombicula alfreddugesi* (Oudemans)

Basiliscus basiliscus (Linnaeus)
American Basilisk
IX: *Amblyomma* sp., L

Iguana iguana (Linnaeus)
Common Iguana
IX: *Amblyomma dissimile* Koch
" *sabanerae* Stoll

Sceloporus sp.
Spiny Lizard
TR: *Eutrombicula alfreddugesi* (Oudemans)
Pseudoschoengastia bulbifera Brennan

Family Teiidae

Ameiva ameiva (Linnaeus)
IX: *Amblyomma dissimile* Koch
" sp., N, L

Ameiva bifrontata Cope
DE: *Draconyssus belgicae* n.sp.
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)

Ameiva festiva (Lichtenstein)
TR: *Eurombicula goeldii* (Oudemans)

Ameiva undulata (Wiegmann)
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)

Ameiva sp.
DE: *Draconyssus belgicae* n.sp.

Lizards, probably **Ameiva** spp.
Amblyomma sp., N, L

Suborder Serpentes
Family Boidae

Constrictor constrictor Linnaeus
IX: *Amblyomma dissimile* Koch

Epicrates sp.
IX: *Amblyomma* sp., N, L

Family Colubridae

Chironius carinatus (Linnaeus)
IX: *Amblyomma dissimile* Koch
Oxybelis sp.
Vine Snake
IX: *Amblyomma* sp., N
TR: *Eutrombicula alfreddugesi* (Oudemans)
Pseustes poecilonotus (Günther)
IX: *Amblyomma dissimile* Koch
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)
Spilotes pullatus (Linnaeus)
IX: *Amblyomma dissimile* Koch
TR: *Eutrombicula alfreddugesi* (Oudemans)
Thalerophis richardi (Bory St. Vincent)
South American Green Tree Snake
IX: *Amblyomma* sp., L

Family Viperidae

Bothrops atrox (Linnaeus)
Fer-de-lance
IX: *Amblyomma dissimile* Koch
Lachesis muta (Linnaeus)
Bushmaster
IX: *Amblyomma dissimile* Koch

Class AVES

Order TINAMIFORMES
Family Tinamidae

Crypturellus soui (Hermann)
Little Tinamou
IX: *Amblyomma* sp., L
Crypturellus soui panamensis (Carriker)
Little Tinamou
HI: *Microlynchia crypturelli* J. Bequaert
Ornithoica vicina (Walker)
Tinamou
IX: *Ixodes brunneus* Koch

Order PELECANIFORMES
Family Pelecanidae

Pelecanus occidentalis californicus Ridgeway
Brown Pelican
HI: *Olfersia sordida* Bigot

Family Phalacrocoracidae

Phalacrocorax olivaceus (Humboldt)
Olivaceous or Neotropic Cormorant
HI: *Olfersia sordida* Bigot

Family Anhingidae

Anhinga anhinga (Linnaeus)
Anhinga
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Family Fregatidae

Fregata sp.
Frigatebird
HI: *Olfersia spinifera* (Leach)

Order CICONIIFORMES
Family Ardeidae

Casmerodius albus (Linnaeus)
Common Egret
HI: *Ornithoica confluenta* (Say)
Leucophoyx t. thula (Molina)
Snowy Egret
HI: *Olfersia sordida* Bigot
Nycticorax nycticorax (Linnaeus)
Black-crowned Night Heron
TR: *Blankaartia marui* n.sp.
Nyctanassa violacea (Linnaeus)
Yellow-crowned Night Heron
TR: *Blankaartia wetmorei* n.sp.

Family Cochleariidae

Cochlearius cochlearius (Linnaeus)
Boat-billed Heron
IX: *Amblyomma dissimile* Koch
HI: *Lynchia albipennis* (Say)

Order FALCONIFORMES
Family Cathartidae

Sarcoramphus papa (Linnaeus)
King Vulture
HI: *Olfersia bisulcata* Macquart
Coragyps a. atratus (Bechstein)
Black Vulture
IX: *Amblyomma oblongoguttatum* Koch
HI: *Olfersia bisulcata* Macquart
Cathartes a. aura (Linnaeus)
Turkey Vulture
HI: *Olfersia bisulcata* Macquart

Family Accipitridae

Leptodon cayanensis (Latham)
(= *Odontriorchis palliatus*)
Gray-headed Kite
HI: *Ornithoctona fusciventris* (Wiedemann)

Buteo magnirostris (Gmelin)
Roadside Hawk
IX: *Amblyomma cajennense* (Fabricius)

Leucopternis albicollis costaricensis Sclater
White Hawk
HI: *Lynchia angustifrons* (van der Wulp)
" *wolcotti* (Swenk)

Buteogallus anthracinus (Lichtenstein)
Common Black Hawk
HI: *Lynchia nigra* (Perty)

Hypomorphnus urubitinga (Gmelin)
Great Black Hawk
TR: *Eutromicula batatas* (Linnaeus)

Spizaetus tyrannus (Wied)
Black Hawk-Eagle
IX: *Amblyomma* sp., N

Hawk
HI: *Lynchia wolcotti* (Swenk)

Family Falconidae

Daptrius americanus (Boddaert)
Red-throated Caracara
HI: *Ornithoctona erythrocephala* (Leach)

Caracara plancus (Miller)
Crested Caracara
TR: *Eutrombicula batatas* (Linnaeus)

Falco s. sparverius (Linnaeus)
American Sparrow Hawk or Kestrel
HI: *Lynchia angustifrons* (van der Wulp)

Order GALLIFORMES
Family Cracidae

Crax rubra Linnaeus
Great Curassow
IX: *Amblyomma oblongoguttatum* Koch
" sp., L

Penelope purpurascens Wagler
Crested Guan
IX: *Amblyomma* sp., L

Family Phasianidae

Odontophorus erythrops Gould
Rufous-fronted Wood Quail
TR: *Eutrombicula alfreddugesi* (Oudemans)
Odontacarus fieldi Brennan & Jones
Trombicula dunni Ewing

Gallus gallus (Linnaeus)
Domestic Fowl
DE: *Ornithonyssus bursa* (Berlese)
IX: *Amblyomma* sp., N, L
TR: *Eutrombicula batatas* (Linnaeus)

Chicken coops
IX: *Argas persicus* (Oken)

Order GRUIFORMES
Family Rallidae

Aramides cajanea (P.L.S. Müller)
Gray-necked Wood Rail
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Family Eurypygidae

Eurypyga helias (Pallas)
Sunbittern
HI: *Ornithoctona erythrocephala* (Leach)

Order CHARADRIIFORMES
Family Laridae

Sterna fuscata Linnaeus
Sooty Tern
HI: *Olfersia aenescens* C. G. Thomson

Order COLUMBIFORMES
Family Columbidae

Columba livea Gmelin
Rock Dove or Domestic Pigeon
HI: *Pseudolynchia canariensis* (Macquart)

Columba speciosa Gmelin
Scaled Pigeon
HI: *Stilbometopa ramphastonis* Ferris

Columbigallina talpacoti (Temminck)
Ruddy Ground Dove
DE: *Pellonyssus marui* n.sp.

Leptotila cassinii (Lawrence)
Gray-chested Dove
TR: *Trombicula dunni* Ewing

Order CUCULIFORMES
Family Cuculidae

Crotophaga ani Linnaeus
Smooth-billed Ani
TR: *Eutrombicula batatas* (Linnaeus)

Neomorphus geoffroyi salvini Sclater
Rufous-vented Ground Cuckoo
IX: *Argas persicus* (Oken), N
TR: *Eutrombicula goeldii* (Oudemans)
Odontacarus fieldi Brennan & Jones
Trombicula dunni Ewing

Order STRIGIFORMES
Family Strigidae

Otus guatemalae (Sharpe)
Vermiculated Screech Owl
TR: *Blankaartia sinnamaryi* (Floch & Fauran)
HI: *Lynchia wolcotti* (Swenk)

Bubo virginianus (Gmelin)
Great Horned Owl
HI: *Lynchia americana* (Leach)

Glaucidium jardinii (Bonaparte)
Andean Pygmy Owl
SI: *Ceratophyllus altus* n. sp.

Ciccaba virgata (Cassin)
Mottled Owl
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Ciccaba virgata centralis Griscom
Mottled Owl
HI: *Lynchia wolcotti* (Swenk)

Order CAPRIMULGIFORMES
Family Caprimulgidae

Chordeiles acutipennis (Hermann)
Lesser Nighthawk
HI: *Pseudolynchia brunnea* (Latreille)

Nyctidromus albicollis (Gmelin)
Pauraque
TR: *Eutrombicula batatas* (Linnaeus)
Blankaartia sinnamaryi (Floch & Fauran)

Caprimulgus rufus Boddaert
Rufous Nightjar, "Capacho"
TR: *Blankaartia sinnamaryi* (Floch & Fauran)
HI: *Pseudolynchia brunnea* (Latreille)

Order APODIFORMES
Family Trochilidae

Phaethornis guy (Lesson)
Green Hermit
DE: *Pellonyssus gorgasi* n.sp.

Order TROGONIFORMES
Family Trogonidae

Pharomachrus mocinno de la Llave
Quetzal
HI: *Ornithoctona fusciventris* (Wiedemann)
" *nitens* (Bigot)

Trogon massena Gould
Slaty-tailed Trogon
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Trogon collaris puella Gould
Bar-tailed Trogon
HI: *Ornithoctona nitens* (Bigot)

Trogon sp.
HI: *Ornithoctona nitens* (Bigot)

Order CORACIIFORMES
Family Alcedinidae

Chloroceryle americana (Gmelin)
Green Kingfisher
IX: *Amblyomma* sp., L

Family Momotidae

Electron platyrhynchum (Leadbeater)
Broad-billed Motmot
TR: *Neoschoengastia electron* n. sp.

Baryphthengus ruficapillus (Viellot)
Rufous Motmot
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Momotus momota (Linnaeus)
Blue-crowned Motmot
TR: *Eutrombicula goeldii* (Oudemans)

Order PICIFORMES
Family Bucconidae

Malacoptila panamensis Lafresnaye
White-whiskered Puffin
IX: *Amblyomma longirostre* (Koch), N
TR: *Eutrombicula goeldii* (Oudemans)

Monasa morphoeus (Hahn and Kuster)
White-fronted Nunbird
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Monasa morphoeus grandior Sclater & Salvin
White-fronted Nunbird
HI: *Stilbometopa rhamphastonis* Ferris

Species undetermined
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Family Capitonidae

Capito maculicoronatus Lawrence
Spot-crowned Barbet
IX: *Amblyomma* sp., N

Family Ramphastidae

Aulacorhynchus prasinus (Gould)
Emerald Toucanet
DE: *Ornithonyssus sylviarium* Canestrini & Fanzago

Ramphastos sulfuratus brevicarinatus Gould
Keel-billed Toucan
HI: *Lynchia angustifrons* (van der Wulp)

Ramphastos swainsonii Gould
Chestnut-mandibled Toucan
HI: *Lynchia angustifrons* (van der Wulp)
Ornithoica vicina (Walker)
Stilbometopa ramphastonis Ferris

Ramphastos sp.
IX: *Amblyomma* sp., N

Order Passeriformes
Family Dendrocolaptidae

Dendrocincla homochroa (Sclater)
Ruddy Woodcreeper
HI: *Blankaartia sinnamaryi* (Floch & Fauran)

Xiphorhynchus guttatus (Lichtenstein)
Buff-throated Woodcreeper
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Xiphorhynchus sp.
IX: *Amblyomma longirostre* (Koch), N

Family Furnariidae

Sclerurus guatemalensis (Hartlaub)
Scaly-throated Leafscraper
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Family Formicariidae

Cymbilaimus lineatus
Fasciated Antshrike
IX: *Amblyomma longirostre* (Koch), N

Taraba major (Vieillot)
Great Antshrike
TR: *Eutrombicula alfreddugesi* (Oudemans)
Blankaartia sinnamaryi (Floch & Fauran)

Thamnophilus nigriceps Sclater
Black Antshrike
IX: *Amblyomma* sp., N

Dysithamnus mentalis (Temminck)
Plain Antvireo
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Dysithamnus puncticeps Salvin
Spot-crowned Antvireo
HI: *Ornithoctona fusciventris* (Wiedemann)

Cercomacra tyrannina rufiventris (Lawrence)
Dusky Antbird
HI: *Ornithoctona fusciventris* (Wiedemann)

Family Cotingidae

Rhytipterna holerythra (Sclater & Salvin)
Rufous Mourner
IX: *Amblyomma* sp., N
HI: *Ornithoctona fusciventris* (Wiedemann)

Querula purpurata (Müller)
Purple-throated Fruitcrow
IX: *Amblyomma longirostre* (Koch), N

Family Tyrannidae

Myiodynastes hemichrysus (Cabanis)
Golden-bellied Flycatcher
HI: *Ornithoica vicina* (Walker)

Myiozetetes sp.
TR: *Eutrombicula batatas* (Linnaeus)
Blankaartia sinnamaryi (Floch & Fauran)

Myiarchus ferox (Gmelin)
Short-crested Flycatcher
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Empidonax flavescens Lawrence
Yellowish Flycatcher
HI: *Ornithoctona fusciventris* (Wiedemann)

Family Hirundinidae

Progne chalybea (Gmelin)
Gray-breasted Martin
DE: *Pellonyssus marui* n.sp.

Notiochelidon cyanoleuca (Vieillot)
Blue-and-White Swallow
SI: *Dasypsyllus lasius venezuelensis* (I. Fox & Anduze)

Family Troglodytidae

Thryothorus atrogularis Salvin
Black-throated Wren
HI: *Ornithoctona fusciventris* (Wiedemann)

Troglodytes musculus inquietus Baird
Southern House Wren
HI: *Ornithoctona nitens* (Bigot)

Cyphorhinus aradus phaeocephalus Sclater
Song Wren
TR: *Eutrombicula goeldii* (Oudemans)

Henicorhina leucophrys collina Bangs
Gray-breasted Wood-Wren
HI: *Ornithoctona fusciventris* (Wiedemann)

Wren
HI: *Ornithoctona fusciventris* (Wiedemann)

Family Mimidae

Dumetella carolinensis (Linnaeus)
Common Catbird
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Family Turdidae

Turdus albicollis cnephosus (Bangs)
(= *Turdis tristis cnephosa*)
White-throated Robin
HI: *Ornithoctona fusciventris* (Wiedemann)

Turdus grayi Bonaparte
Clay-colored Robin
DE: *Pellonyssus marui* n.sp.

Turdus plebejus Cabanis
Mountain Robin
HI: *Ornithoctona fusciventris* (Wiedemann)

Hylocichla ustulata (Nuttall)
Swainson's or Olive-backed Thrush
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Catharus mexicanus (Bonaparte)
Black-headed Nightingale Thrush
TR: *Eutrombicula batatas* (Linnaeus)
Blankaartia sinnamaryi (Floch & Fauran)

Family Sylviidae

Microbates cinereiventris (Sclater)
Half-collared Gnatwren
TR: *Trombicula dunni* Ewing
Blankaartia sinnamaryi (Floch & Fauran)

Family Ptilogonatidae

Ptilogonys caudatus Cabanis
Long-tailed Silky Flycatcher
SI: *Dasypsyllus gallinulae perpinnatus* (Baker)

Family Vireonidae

Vireo flavoviridis (Cassin)
Yellow-green Vireo
DE: *Pellonyssus marui* n.sp.

Family Parulidae

Oporornis formosus (Wilson)
Kentucky Warbler
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Geothlypis semiflava Sclater
Olive-crowned Yellowthroat
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

"Yellow water thrush"
HI: *Ornithoctona fusciventris* (Wiedemann)

Family Icteridae

Cacicus uropygialis microrhynchus (Sclater & Salvin)
Scarlet-rumped Cacique
IX: *Amblyomma longirostre* (Koch), N

Cassidix mexicanus (Gmelin)
Boat-tailed Grackle
DE: *Pellonyssus marui* n.sp.

Icterus mesomelas (Wagler)
Yellow-tailed Oriole
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Icterus chrysater (Lesson)
Yellow-backed Oriole
IX: *Amblyomma longirostre* (Koch), N

Family Thraupidae

Ramphocelus passerinii Bonaparte
Scarlet-rumped Tanager
IX: *Amblyomma* sp., N

Piranga rubra (Linnaeus)
Summer Tanager
TR: *Blankaartia sinnamaryi* (Floch & Fauran)

Piranga bidentata sanguinolenta (Lafresnaye)
Flame-colored Tanager
HI: *Ornithoctona fusciventris* (Wiedemann)

Tachyphonus rufus (Boddaert)
White-lined Tanager
IX: *Amblyomma* sp., N
Eucometis penicillata (Spix)
Gray-headed Tanager
IX: *Amblyomma* sp., L

Family Fringillidae

Saltator maximus (P.L.S. Müller)
Buff-Throated Saltator
IX: *Amblyomma longirostre* (Koch), N
Saltator albicollis Vieillot
Streaked Saltator
IX: *Amblyomma longirostre* (Koch), N
Tiaris olivacea pusilla Swainson
(= *Eutheia o. pusilla*)
Yellow-faced Grassquit
HI: *Ornithoctona fusciventris* (Wiedemann)
Sporophila aurita corvina (Sclater)
Variable Seedeater
IX: *Amblyomma* sp., N
TR: *Blankaartia sinnamaryi* (Floch & Fauran)
Pselliophorus tibialis (Lawrence)
Yellow-thighed Finch
HI: *Ornithoctona fusciventris* (Wiedemann)
Atlapetes gutturalis (Lafresnaye)
Yellow-throated Brush Finch
HI: *Ornithoctona fusciventris* (Wiedemann)
Arremonops conirostris (Bonaparte)
Green-backed Sparrow
IX: *Amblyomma ovale* Koch
TR: *Blankaartia arremonops* (Brennan & Jones)

Miscellaneous

No host or undet.
HI: *Olfersia fossulata* Macquart
Ornithoctona fusciventris (Wiedemann)
Stilbometopa ramphastonis Ferris
Bird nests
SI: *Dasypsyllus gallinulae perpinnatus* (Baker)
Dasypsyllus lasius venezuelensis (I. Fox & Anduze)

Class MAMMALIA

Order MARSUPIALIA
Family Didelphidae

Caluromys derbianus (Waterhouse)
(= *Philander laniger* Goldman)
Wooly Opossum
IX: *Amblyomma geayi* Neumann
" sp., N, L
Monodelphis adusta (Thomas)
Short-tailed Opossum
IX: *Ixodes venezuelensis* Kohls
Marmosa mexicana Merriam
Mexican Mouse-Opossum
TR: *Eutrombicula goeldii* (Oudemans)
Pseudoschoengastia bulbifera Brennan
Marmosa robinsoni Bangs
South American Mouse-Opossum
LA: *Tur uniscutatus* (Turk)
DE: *Ornithonyssus wernecki* (Fonseca)
IX: *Amblyomma sabanerae* Stoll
Ixodes luciae Senevet, N
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *manueli* Brennan & Jones
SI: *Adoratopsylla intermedia copha* (Jordan)
Polygenis roberti beebei (I. Fox)
" *klagesi* (Rothschild)
Philander opossum (Linnaeus)
Four-eyed Opossum
LA: *Haemolaelaps glasgowi* (Ewing)
Tur uniscutatus (Turk)
DE: *Ornithonyssus wernecki* (Fonseca)
IX: *Amblyomma auricularium* (Conil)
" *geayi* Neumann
" sp., N, L
Ixodes luciae Senevet
TR: *Crotiscus desdentatus* (Boshell & Kerr)
Euschoengastia nunezi (Hoffmann)

Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *keenani* Brennan & Jones
SI: *Adoratopsylla intermedia copha* (Jordan)
Polygenis roberti beebei (I. Fox)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild

Metachirus nudicaudatus (E. Geoffroy St.-Hilaire)
Brown Opossum
LA: *Haemolaelaps glasgowi* (Ewing)
DE: *Ornithonyssus wernecki* (Fonseca)
IX: *Ixodes loricatus* Neumann
" sp., N
TR: *Eutrombicula goeldii* (Oudemans)
Myxacarus oscillatus n. sp.
Trombicula dunni Ewing
SI: *Adoratopsylla intermedia copha* (Jordan)
Polygenis roberti beebei (I. Fox)
" *dunni* (Jordan & Rothschild)
Rhopalopsyllus cacicus saevus Jordan & Rothschild

Didelphis marsupialis Linnaeus
Opossum, "Zorra"
LA: *Gigantolaelaps inca* Fonseca
" *oudemansi* Fonseca
Haemolaelaps glasgowi (Ewing)
Laelaps pilifer n. sp.
Tur uniscutatus (Turk)
DE: *Ornithonyssus wernecki* (Fonseca)
IX: *Amblyomma auricularium* (Conil)
" *cajennense* (Fabricius)
" *geayi* Neumann
" *varium* Koch
" sp., N, L
Ixodes luciae Senevet
" *boliviensis* Neumann
" *affinis* Neumann
" sp., N, L
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotiscus desdentatus (Boshell & Kerr)
Euschoengastia megastyrax Brennan & Jones
Euschoengastia nunezi (Hoffmann)
" *tragulata* Brennan & Jones
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Hoffmannina handleyi Brennan & Jones
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
Sasacarus furmani (Hoffmann)
Trombicula dunni Ewing
" *keenani* Brennan & Jones
" *longicalcar* Brennan & Jones
" *manueli* Brennan & Jones
SI: *Adoratopsylla intermedia copha* (Jordan)
Ctenocephalides f. felis (Bouché)
Hoplopsyllus glacialis exoticus Jordan & Rothschild
Juxtapulex echidnophagoides Wagner
Pleochaetis d. dolens Jordan & Rothschild
Polygenis klagesi (Rothschild)
" *roberti beebei* (I. Fox)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild
Rhopalopsyllus lugubris cryptoctenes (Enderlein)

Chironectes minimus (Zimmermann)
Water Opossum
IX: *Amblyomma oblongoguttatum* Koch
TR: *Doloisia (Kymocta) chironectes* Yunker & Brennan
SI: *Rhopalopsyllus australis tupinus* Jordan & Rothschild

Order INSECTIVORA
Family Soricidae

Cryptotis nigrescens (J. A. Allen)
Blackish Small-eared Shrew
IX: *? Dermacentor* sp., L
? Ixodes sp., L

Cryptotis sp.
Small-eared Shrew
TR: *Pseudoschoengastia bulbifera* Brennan

Order CHIROPTERA
Suborder Microchiroptera
Superfamily Emballonuroidea
Family Emballonuridae

Saccopteryx bilineata Temminck
Greater White-lined Bat
TR: *Beamerella acutascuta* Brennan
Euschoengastia desmodus Brennan & Dalmat
Trombicula saccopteryx Brennan & Jones
ST: *Strebla alvarezi* n.sp.

Peropteryx macrotis (Wagner)
Lesser Doglike Bat
IX: *Ornithodoros azteci* Matheson, L
TR: *Tecomatlana sandovali* Hoffmann

Family Noctilionidae

Noctilio labialis labialis (Kerr)
Southern or Little Bulldog Bat
IX: *Ornithodoros hasei* (Schulze), N, L
ST: *Noctiliostrebla maai* n.sp.
Paradyschiria parvuloides n.sp.

Noctilio leporinus mexicanus Goldman
Mexican Bulldog Bat
SP: *Periglischrus aitkeni* n.sp.
IX: *Ornithodoros hasei* (Schulze), L
ST: *Neotrichobius stenopterus* n.g., n.sp.
Noctiliostrebla traubi n.sp.
Paradyschiria lineata Kessel

Dirias sp. (**N. labialis**)
ST: *Trichobius joblingi* n.sp.

Superfamily Phyllostomoidea
Family Phyllostomidae
Subfamily Chilonycterinae

Pteronotus parnellii fuscus J. A. Allen
(= *Chilonycteris rubiginosa fusca*)
Parnell's Mustached Bat
SP: *Periglischrus species* "D"
" *elongatus* n.sp.
IX: *Ornithodoros viguerasi* Cooley & Kohls, L
TR: *Alexfainia chilonycteris* Yunker & Jones
Trombicula anophthalma Hoffmann
Vergrandia galei Yunker & Jones
ST: *Nycterophilia parnelli* n.sp.
Speiseria ambigua Kessel
Strebla altmani n.sp.
Trichobius sparsus Jobling
" *yunkeri* n.sp.
" *joblingi* n.sp.
" *costalimai* Guimarães

Pteronotus psilotis (Dobson)
(= *Chilonycteris psilotis* Hall & Kelson)
Dobson's Mustached Bat
IX: *Amblyomma* sp., L
Antricola mexicanus Hoffmann, L
TR: *Alexfainia munozi* n.sp.
Perates insessus Brennan & Dalmat
Trombicula monops Brennan & Jones
ST: *Nycterophilia fairchildi* n.sp.
Trichobius johnsonae n.sp.

Pteronotus suapurensis (J. A. Allen)
Suapuré Naked-backed Bat
SP: *Periglischrus elongatus* n.sp.
TR: *Trombicula tibbettsi* Brennan & White
ST: *Nycterophilia fairchildi* n.sp.
Trichobius johnsonae n.sp.
" *yunkeri* n.sp.

Pteronotus sp.
IX: *Ornithodoros viguerasi* Cooley & Kohls, L

Subfamily Phyllostominae

Micronycteris megalotis microtis Miller
Brazilian Small-eared Bat
SP: *Periglischrus micronycteridis* n.sp.
TR: *Beamerella acutascuta* Brennan
Euschoengastia desmodus Brennan & Dalmat
Perissopalla precaria (Brennan & Dalmat)
ST: *Strebla alvarezi* n.sp.
Trichobius joblingi n.sp.
" *keenani* n.sp.

Micronycteris minuta (Gervais)
SP: *Periglischrus micronycteridis* n.sp.
ST: *Trichobius dugesioides* n.sp.

Micronycteris nicefori Sanborn
ST: *Parastrebla handleyi* n.g., n.sp.
Strebla alvarezi n.sp.

Trichobius joblingi n.sp.
" *keenani* n.sp.

Micronycteris sylvestris Thomas
Brown Small-eared Bat
ST: *Strebla alvarezi* n.sp.

Lonchorhina a. aurita Tomes
Tomes' Long-eared Bat
IX: *Ornithodoros azteci* Matheson, L
ST: *Speiseria ambigua* Kessel
Strebla altmani n.sp.
" *carolliae* n.sp.
Trichobius dugesioides n.sp.
" *joblingi* n.sp.
" *macrophylli* n.sp.
" *yunkeri* n.sp.

Macrophyllum macrophyllum (Schinz)
Long-legged Bat
SP: *Periglischrus* species "G"
ST: *Strebla altmani* n.sp.
" *carolliae* n.sp.
Trichobius joblingi n.sp.
" *macrophylli* n.sp.

Tonatia bidens (Spix)
Round-eared Bat
ST: *Strebla galindoi* n.sp.
Trichobius bequaerti n.sp.

Tonatia minuta Goodwin
(= *T. nicaraguae* Hall & Kelson)
Pigmy Round-eared Bat
ST: *Mastoptera minuta* (Costa Lima)
Pseudostrebla greenwelli n.sp.
Strebla hoogstraali n.sp.
Trichobius mendezi n.sp.

Tonatia s. silvicola (D'Orbigny)
D'Orbigny's Round-eared Bat
(= *T. amblyotis* Goldman, *T. sylvicola* Hall & Kelson)
IX: *Ornithodoros hasei* (Schulze), L
ST: *Mastoptera minuta* (Costa Lima)
Pseudostrebla ribeiroi Costa Lima
Strebla kohlsi n.sp.
Trichobius dybasi n.sp.

Tonatia sp.
ST: *Trichobius dugesioides* n.sp.

Lonchorhina or **Tonatia** sp.
NY: *Basilia tiptoni* n.sp.

Bat "like **Tonatia**"
NY: *Basilia tiptoni* n.sp.

Mimon crenulatum keenani Handley
NY: *Basilia tiptoni* n.sp.

Phyllostomus d. discolor Wagner
ST: *Aspidoptera busckii* Coquillet
Megistopoda aranea (Coquillet)
Strebla hertigi n.sp.
" *mirabilis* (Waterhouse)
Trichobiodes perspicillatus (Pessôa & Galvão)
Trichobius costalimai Guimarães
" *longipes* (Rudow)

Phyllostomus hastatus panamensis J. A. Allen
Spear-nosed Bat
SP: *Periglischrus tiptoni* n.sp.
" *inflatiseta* n.sp.
TR: *Blankaartia sinnamaryi* (Floch & Fauran)
Trombicula carmenae Brennan & Jones
ST: *Mastoptera guimaraesi* n.sp.
Speiseria ambigua Kessel
Strebla carolliae n.sp.
" *hertigi* n.sp.
" *mirabilis* (Waterhouse)
Trichobius joblingi n.sp.
" *longipes* (Rudow)
" *parasiticus* Gervais
" *yunkeri* n.sp.

Phyllostomus sp.
ST: *Mastoptera guimaraesi* n.sp.
" *minuta* (Costa Lima)
Trichobius longipes (Rudow)

Mixed collection of
Phyllostomus and **Pteronotus** spp.
ST: *Trichobius longipes* (Rudow)

Phylloderma s. stenops Peters
Spear-nosed Bat
(= *P. septentrionalis* Hall & Kelson)
ST: *Strebla christinae* n.sp.

Trachops c. cirrhosus (Spix)
Fringe-lipped Bat
SP: *Periglischrus tiptoni* n.sp.
" *vargasi* Hoffmann
IX: *Ornithodoros brodyi* Matheson, L
" *hasei* (Schulze), L
ST: *Speiseria ambigua* Kessel
Strebla altmani n.sp.
" *carolliae* n.sp.
" (?) *mirabilis* (Waterhouse)
Trichobius dugesii Townsend
" *dugesioides* n.sp.
" *joblingi* n.sp.

Chrotopterus auritus (Peters)
Peters' False Vampire Bat
ST: *Trichobius dugesioides* n.sp.

Vampyrum spectrum (Linnaeus)
Linnaeus' False Vampire Bat
TR: *Trombicula longicalcar* Brennan & Jones
" *vesperuginis* Brennan & Jones

Subfamily Glossophaginae

Glossophaga soricina leachii (Gray)
Pallas' Long-tongued Bat
DE: New genus, n.sp. no. 1
SP: *Periglischrus caligus* Kolenati
SPE: *Spelaeorhynchus* sp.
TR: *Euschoengastia desmodus* Brennan & Dalmat
Trombicula vesperuginis Brennan & Jones
ST: *Eldunnia breviceps* Curran
Speiseria ambigua Kessel
Strebla carolliae n.sp.
Trichobius dugesii Townsend
" *joblingi* n.sp.
" *uniformis* Curran

Lonchophylla robusta Miller
Panama Long-tongued Bat
SP: *Periglischrus* species "K"
ST: *Anastrebla nycteridis* n.sp.
Eldunnia breviceps Curran
Speiseria ambigua Kessel
Strebla carolliae n.sp.
Trichobius joblingi n.sp.
" *johnsonae* n.sp.
" *lonchophyllae* n.sp.

Lionycteris spurrelli Thomas
ST: *Trichobius lionycteridis* n.sp.

Anoura cultrata Handley
SP: *Periglischrus vargasi* Hoffmann
ST: *Anastrebla mattadeni* n.sp.
Exastinion clovisi (Pessôa & Guimarães)

Anoura geoffroyi lasiopyga Peters
Geoffroy's Tailless Bat
SP: *Periglischrus vargasi* Hoffman
ST: *Anastrebla mattadeni* n.sp.
" *modestini* n.sp.
Exastinion clovisi (Pessôa & Guimarães)

Subfamily Carolliinae

Carollia castanea H. Allen
Allen's Short-tailed Bat
DE: *Radfordiella* n.sp. no. 2
TR: *Euschoengastia desmodus* Brennan & Dalmat
ST: *Speiseria ambigua* Kessel
Strebla carolliae n.sp.
Trichobius joblingi n.sp.

Carollia perspicillata azteca Saussure
Seba's Short-tailed Bat
DE: *Radfordiella* n.sp. no. 2
New genus, n.sp. no. 3
SP: *Periglischrus* sp.
SPE: *Spelaeorhynchus* sp.
IX: *Amblyomma tapirellum* Dunn
Ornithodoros brodyi Matheson, L
TR: *Alexfainia chilonycteris* Yunker & Jones
Beamerella acutascuta Brennan
Euschoengastia megastyrax Brennan & Jones
Trombicula vesperuginis Brennan & Jones
ST: *Aspidoptera busckii* Coquillet
Mastoptera guimaraesi n.sp.
Megistopoda aranea (Coquillet)
Metelasmus pseudopterus Coquillet
Nycterophilia parnelli n.sp.
Paratrichobius dunni (Curran)
Speiseria ambigua Kessel
Strebla altmani n.sp.
" *carolliae* n.sp.
" *mirabilis* (Waterhouse)
" *vespertilionis* (Fabricius)
Trichobius costalimai Guimarães
" *dugesii* Townsend
" *dugesioides* n.sp.
" *joblingi* n.sp.
" *johnsonae* n.sp.
" *longipes* (Rudow)
" *macrophylli* n.sp.
" *sparsus* Kessel
" *urodermae* n.sp.
" *yunkeri* n.sp.

Mixed collection of
Carollia p. azteca and
Lonchorhina a. aurita
DE: *Radfordiella* n.sp. no. 2

Mixed collection of
Carollia p. azteca and
Glossophaga s. leachii
ST: *Speiseria ambigua* Kessel
Trichobius dugesii Townsend
" *dugesioides* n.sp.
" *joblingi* n.sp.

Carollia subrufa Hahn
(= *C. castanea* Hall & Kelson, part.)
SPE: *Spelaeorhynchus* sp.
TR: *Euschoengastia colombiae* (Boshell & Kerr)
Euschoengastia desmodus (Brennan & Dalmat)
ST: *Speiseria ambigua* Kessel
Strebla carolliae n.sp.
Trichobius dugesioides n.sp.
" *joblingi* n.sp.

Mixed collection of
Carollia sp. and
Natalus s. mexicanus
ST: *Trichobius dugesioides* n.sp.

Subfamily Sturnirinae

Sturnira lilium parvidens Goldman
Yellow-shouldered Bat
SP: *Periglischrus aitkeni* n.sp.
ST: *Aspidoptera delatorrei* n.sp.
Megistopoda proxima (Séguy)
Paradyschiria parvuloides n.sp.
Trichobioides perspicillatus (Pessôa & Galvão)

Sturnira ludovici Anthony
Anthony's Bat
DE: New genus, n.sp. no. 2
SP: *Periglischrus aitkeni* n.sp.
TR: *Pseudoschoengastia bulbifera* Brennan
Trombicula carmenae Brennan & Jones
" *soucouyanti* n.sp.
ST: *Megistopoda theodori* n.sp.
Trichobius brennani n.sp.
" *yunkeri* n.sp.

Sturnira sp.
SP: *Periglischrus aitkeni* n.sp.

Subfamily Stenoderminae

Uroderma bilobatum Peters
Tent-making Bat
SP: *Periglischrus iheringi* Oudemans
IX: *Ornithodoros hasei* (Schulze), L
ST: *Neotrichobius stenopterus* n.g., n.sp.
Paratrichobius dunni (Curran)
Trichobius costalimai Guimarães
" *joblingi* n.sp.
" *keenani* n.sp.
" *urodermae* n.sp.

Vampyrops helleri Peters
(= *Platyrrhinus helleri* Hall & Kelson)
Heller's Broad-nosed Bat
SP: *Periglischrus iheringi* Oudemans
IX: *Amblyomma cajennense* (Fabricius)
" sp., N
Ornithodoros hasei (Schulze), L
ST: *Paratrichobius* sp. B

Vampyrops vittatus (Peters)
(= *Platyrrhinus vittatus* Hall & Kelson)
White-lined Bat
DE: *Ichoronyssus* (group II) n.sp.
SP: *Periglischrus iheringi* Oudemans
ST: *Paratrichobius* sp.
Speiseria ambigua Kessel
Trichobius vampyropis n.sp.

Vampyrodes caraccioli major G. M. Allen
(= *V. major* Goldman; *V. major* Hall & Kelson)
SP: *Periglischrus iheringi* Oudemans
ST: *Strebla vespertilionis* (Fabricius)

Vampyressa nymphaea Thomas
ST: *Aspidoptera busckii* Coquillet
Metelasmus pseudopterus Coquillet

Vampyressa pusilla (Wagner)
Little Yellow-eared Bat
(= *V. minuta* Goldman, *V. thyone* Hall & Kelson)
SP: *Periglischrus iheringi* Oudemans
TR: *Trombicula dunni* Ewing
ST: *Neotrichobius stenopterus* n.g., n.sp.

Vampyressa sp.
ST: *Paratrichobius dunni* Curran

Chiroderma salvini Dobson
Salvin's White-lined Bat
SP: *Periglischrus iheringi* Oudemans
IX: *Amblyomma* sp., N
ST: *Paratrichobius salvini* n.sp.

Chiroderma villosum jesupi J. A. Allen
(= *C. isthmicum* Goldman; *C. isthmicum* Hall & Kelson)
ST: *Aspidoptera busckii* Coquillet
Paratrichobius sp. A
Trichobius joblingi n.sp.

Artibeus aztecus Andersen
Fruit-eating Bat
(= *A. cinereus* Hall and Kelson, part.)
ST: *Paratrichobius* sp.

Artibeus cinereus (Gervais)
Fruit-eating bat
(= *A. watsoni* Goldman, part., *A. cinereus* Hall & Kelson, part.)
SP: *Periglischrus iheringi* Oudemans
ST: *Neotrichobius stenopterus* n.g., n.sp.
Paratrichobius lowei n.sp.

Artibeus j. jamaicensis Leach
Jamaican Fruit-eating Bat
(= *A. planirostris* Goldman)
DE: *Ichoronyssus kochi* Fonseca
SP: *Periglischrus iheringi* Oudemans
SPE: *Spelaeorhynchus* sp.
NY: *Basilia wenzeli* Guimarães & D'Andretta
ST: *Aspidoptera busckii* Coquillet
Megistopoda aranea (Coquillet)
Metelasmus pseudopterus Coquillet
Neotrichobius stenopterus n.g., n.sp.
Paratrichobius longicrus (M. Ribeiro)

Strebla carolliae n.sp.
" *vespertilionis* (Fabricius)
" *hertigi* n.sp.
Trichobius joblingi n.sp.
" *longipes* (Rudow)
" *uniformis* Curran

Artibeus lituratus palmarum J. A. Allen & Chapman
Big Fruit-eating Bat
SP: *Periglischrus iheringi* Oudemans
ST: *Aspidoptera busckii* Coquillet
Megistopoda aranea (Coquillet)
Metelasmus pseudopterus Coquillet
Paratrichobius longicrus (M. Ribeiro)
Speiseria ambigua Kessel
Trichobius costalimai Guimarães
" *joblingi* n.sp.
" *lonchophyllae* n.sp.
" *vampyropis* n.sp.
" *yunkeri* n.sp.

Artibeus toltecus (Saussure)
Fruit-eating Bat
(= *A. watsoni* Goldman, part., *A. cinereus* Hall & Kelson, part.)
DE: *Ichoronyssus kochi* Fonseca
TR: *Leptotrombidium panamensis* (Ewing)
ST: *Paratrichobius* sp.

Artibeus sp.
IX: *Ixodes* sp., L

Enchisthenes hartii (Thomas)
Little Fruit-eating Bat
DE: *Periglischrus iheringi* Oudemans
ST: *Paratrichobius sanchezi* n.sp.

Phyllostomid bat
DE: New genus, n. sp. no. 1

Family Desmodidae

Desmodus rotundus murinus Wagner
Vampire Bat
DE: *Radfordiella* n.sp. no. 1
SP: *Periglischrus iheringi* Oudemans
" *desmodi* n.sp.
IX: *Ornithodoros azteci* Matheson, L
" *brodyi* Matheson, L
ST: *Megistopoda aranea* (Coquillet)
Speiseria ambigua Kessel
Strebla vespertilionis (Fabricius)
" *hertigi* n.sp.
Trichobius costalimai Guimarães
" *dugesioides* n.sp.
" *joblingi* n.sp.
" *parasiticus* Gervais
" *uniformis* Curran
Trichobioides perspicillatus (Pessôa & Galvão)

Diaemus youngii cypselinus Thomas
ST: *Strebla diaemi* n.sp.
Trichobius parasiticus Gervais

"Vampire bats"
ST: *Trichobius parasitus* Gervais

Superfamily Vespertilionoidea
Family Natalidae

Natalus stramineus mexicanus Miller
Mexican Funnel-eared Bat
SP: *Periglischrus natali* n.sp.
ST: *Nycterophilia natali* n.sp.
Speiseria ambigua Kessel
Strebla carolliae n.sp.
Trichobius dugesioides n.sp.
" *galei* n.sp.
" *joblingi* n.sp.

Natalus sp.
ST: *Trichobius galei* n.sp.

Family Vespertilionidae
Subfamily Vespertilioninae

Myotis albescens (E. Geoffroy St.-Hilaire)
Paraguay Myotis
SP: *Spinturnix americanus* (Banks)
NY: *Basilia dunni* Curran

Myotis chiloensis (Waterhouse)
DE: *Ichoronyssus crosbyi* (Ewing & Stover)
" (group III) n.sp. no. 1
SP: *Periglischrus tiptoni* n.sp.
Spinturnix americanus (Banks)
ST: *Anatrichobius scorzai* n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Myotis n. nigricans (Schinz)
Black Myotis
DE: *Ichoronyssus robustipes* (Ewing)
" (group III) n.sp. no. 1
SP: *Spinturnix americanus* (Banks)
" sp.
IX: *Antricola mexicanus* Hoffmann, L
Dermacentor halli McIntosh, N
TR: *Trombicula monops* Brennan & Jones
SI: *Sternopsylla distincta speciosa* Johnson
NY: *Basilia anceps* Guimarães & D'Andretta
Basilia myotis Curran
" *dunni* Curran

ST: *Anatrichobius scorzai* n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Mixed lots of
Myotis nigricans and
Myotis chiloensis
DE: *Ichoronyssus crosbyi* (Ewing & Stover)
SP: *Paraspinturnix globosus* Rudnick
Spinturnix americanus (Banks)
SI: *Sternopsylla distincta speciosa* Johnson
ST: *Anatrichobius scorzai* n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Myotis simus riparius Handley
SP: *Spinturnix americanus* (Banks)
NY: *Basilia anceps* Guimarães & D'Andretta

Myotis sp.
TR: *Trombicula soucouyanti* n.sp.
ST: *Anatrichobius scorzai* n.g., n.sp.
Joblingia schmidti Dybas & Wenzel

Eptesicus brasiliensis propinquus (Peters)
Brazilian Brown Bat
NY: *Basilia wenzeli* Guimarães & D'Andretta

Rhogeessa tumida H. Allen
Little Yellow Bat
SP: *Spinturnix subacuminatus* n.sp.

Lasiurus borealis frantzii (Peters)
Red Bat
NY: *Basilia ferruginea* M. Ribeiro

Lasiurus castaneus Handley
NY: *Basilia handleyi* n.sp.

Lasiurus egregius Peters
ST: *Strebla carolliae* n.sp.
" *vespertilionis* (Fabricius)

Family Molossidae

Molossops p. planirostris (Peters)
PO: *Hesperoctenes fumarius* (Westwood)

Tadarida b. brasiliensis (I. Geoffroy St.-Hilaire)
Brazilian Free-tailed Bat
DE: *Ichoronyssus robustipes* (Ewing)
SP: *Spinturnix* sp.
SI: *Sternopsylla d. speciosa* Johnson

Tadarida yucatanica (Miller)
Yucatan Free-tailed Bat
SI: *Hormopsylla kyriophila* n.sp.
Ptilopsylla dunni Kohls
Rhynchopsyllus megastigmata Traub & Gammons
Sternopsylla d. speciosa Johnson

Molossus bondae J. A. Allen
Bonda Mastiff Bat
ST: *Trichobius dunni* n.sp.

Molossus coibensis J. A. Allen
DE: *Ichoronyssus venezolanus* (Vitzthum)
SI: *Hormopsylla kyriophila* n.sp.
Ptilopsylla dunni Kohls
PO: *Hesperoctenes* sp.

Molossus sp.
IX: *Ornithodoros hasei* (Schulze), L

"Eumops bonariensis nanus"
(? *E. amazonicus* Handley)
PO: *Hesperoctenes* sp.

"Eumops glaucinus" (Wagner)
(? *E. auripendulus* Shaw)
PO: *Hesperoctenes angustatus* Ferris & Usinger

Molossid bat
DE: *Ichoronyssus haematophagus* (Fonseca)

Miscellaneous

Bat
DE: *Ichoronyssus venezolanus* (Vitzthum)
Steatonyssus occidentalis (Ewing)
SPE: *Spelaeorynchus latus* Banks
TR: *Alexfainia munozi* n.sp.
Euschoengastia desmodus Brennan & Dalmat
Euschoengastia megastyrax Brennan & Jones
Eutrombicula goeldii (Oudemans)
Tecomatlana sandovali Hoffmann
Trombicula longicalcar Brennan & Jones
" *monops* Brennan & Jones
" *vesperuginis* Brennan & Jones

Bat guano from roosting place of
Myotis nigricans, M. chiloensis, and
Tadarida brasiliensis
SI: *Sternopsylla distincta speciosa* Johnson
ST: *Joblingia schmidti* Dybas & Wenzel

Bat guano from roosting place of
Tadarida yucatanica
SI: *Hormopsylla kyriophila* n.sp.
Ptilopsylla dunni Kohls
Rhynchopsyllus megastigmata Traub & Gammons

Bat guano from roosting place of
Pteronotus psilotis
IX: *Antricola mexicanus* Hoffman

Order PRIMATES
Family Cebidae

Aotus trivirgatus (Humboldt)
Night Monkey
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)

Alouatta villosa (Gray)
Howler Monkey
AN: *Pediculus atelophilus* Ewing

Cebus capucinus (Linnaeus)
Capuchin
AN: *Pediculus atelophilus* Ewing
" *chapini* Ewing

Ateles fusciceps Gray
Black Spider Monkey
(=*A. dariensis* Goldman)
AN: *Pediculus atelophilus* Ewing

Ateles geoffroyi Kuhl
Geoffroy's Spider Monkey
AN: *Pediculus atelophilus* Ewing

Family Callithricidae

Saguinus geoffroyi (Pucheran)
Geoffroy's Tamarin
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)
Pseudoschoengastia bulbifera Brennan

Family Hominidae

Homo sapiens Linnaeus
IX: *Amblyomma tapirellum* Dunn
" *cajennense* (Fabricius)
" *oblongoguttatum* Koch
" *ovale* Koch
" *naponense* (Packard)
" *parvum* Aragão
" *sabanerae* Stoll
" sp., N
Dermacentor latus Cooley
" *imitans* Warburton
Ixodes boliviensis Neumann
Rhipicephalus sanguineus (Latreille)
TR: *Eutrombicula batatas* (Linnaeus)
AN: *Pediculus humanus* Linnaeus
Phthirus pubis (Linnaeus)
SI: *Ctenocephalides f. felis* (Bouché)
Juxtapulex echidnophagoides Wagner
Pulex simulans Baker
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus l. lugubris Jordan & Rothschild
Rhopalopsyllus l. cryptoctenes (Enderlein)

Order EDENTATA
Family Myrmecophagidae

Myrmecophaga tridactyla Linnaeus
Giant Anteater
IX: *Amblyomma calcaratum* Neumann
" *nodosum* Neumann
" *oblongoguttatum* Koch
" *pictum* Neumann
" *tapirellum* Dunn
" sp., N

Tamandua tetradactyla (Linnaeus)
Tamandua, Common Anteater
IX: *Amblyomma auricularium* (Conil)
" *cajennense* (Fabricius)
" *calcaratum* Neumann
" *naponense* (Packard)
" *nodosum* Neumann
" *oblongoguttatum* Koch
" *parvum* Aragão
" sp., N, L
SI: *Rhopalopsyllus australis tupinus* Jordan & Rothschild

Cyclopes didactylus (Linnaeus)
Two-toed Anteater,
Pygmy or Silky Anteater
IX: *Amblyomma* sp., N, L

Family Bradypodidae

Bradypus infuscatus Wagler
Gray Three-toed Sloth, "Perico lijero"
IX: *Amblyomma geayi* Neumann
" *varium* Koch
" sp., N, L
TR: *Trombicula pecari* Brennan & Jones
" *dunni* Ewing

Choloepus hoffmanni Peters
Two-toed Sloth, "Perico lijero"
IX: *Amblyomma calcaratum* Neumann
" *geayi* Neumann
" *oblongoguttatum* Koch
" *varium* Koch

Family Dasypodidae

Cabassous centralis (Miller)
Central American Five-toed Armadillo
IX: *Amblyomma auricularium* (Conil)
TR: *Blix cabassoi* n.sp.

Dasypus novemcinctus Linnaeus
Nine-banded Armadillo
IX: *Amblyomma auricularium* (Conil)
" *cajennense* (Fabricius)
" *oblongoguttatum* Koch
" *ovale* Koch
" sp., N, L
Ixodes sp., L
TR: *Aniatrus bifax* Brennan & Jones
Eutrombicula goeldii (Oudemans)
Myxacarus oscillatus n.sp.
Pseudoschoengastia apista n.sp.
" *dasypi* n.sp.
Trombicula dunni Ewing
Vargatula hispida n. sp.
SI: *Juxtapulex echidnophagoides* Wagner
Rhopalopsyllus cacicus saevus Jordan & Rothschild

Miscellaneous

Animal burrows (probably Armadillo)
SI: *Rhopalopsyllus cacicus saevus* Jordan & Rothschild

Order Lagomorpha
Family Leporidae

Sylvilagus brasiliensis (Linnaeus)
Forest Rabbit
IX: *Amblyomma* sp., N
Dermacentor sp., N
Haemaphysalis leporispalustris (Packard)
Ixodes pomerantzi Kohls
Ornithodoros puertoricensis Fox, L
TR: *Trombicula dunni* Ewing
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
SI: *Ctenocephalides f. felis* (Bouché)
Hoplopsyllus glacialis exoticus Jordan & Rothschild
Rhopalopsyllus australis tupinus Jordan & Rothschild

Oryctolagus cuniculus Linnaeus
Domestic Rabbit
IX: *Rhipicephalus sanguineus* (Latreille)

Order Rodentia
Suborder Sciuromorpha
Family Sciuridae

Sciurus granatensis Humboldt
Tropical Red Squirrel, "Ardilla"
LA: *Haemolaelaps glasgowi* (Ewing)
DE: *Hirstionyssus keenani* n.sp.
IX: *Amblyomma* sp., N, L
Ixodes tiptoni Kohls and Clifford
" sp., probably *tiptoni*, L
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *goeldii* (Oudemans)
Odontacarus fieldi Brennan & Jones
Trombicula dicrura Brennan & Jones
" *dunni* Ewing
" *keenani* Brennan & Jones
" *manueli* Brennan & Jones
AN: *Enderleinellus* sp. (*longiceps* group)
Neohaematopinus sp. (*sciurinus* group)
SI: *Dasypsyllus gallinulae perpinnatus* (Baker)
Juxtapulex echidnophagoides Wagner
Kohlsia g. graphis (Rothschild)
" *tiptoni* Mendez & Altman
" *traubi* Tipton & Mendez
Pleochaetis d. dolens Jordan & Rothschild
Polygenis dunni (Jordan & Rothschild)
Polygenis roberti beebei (I. Fox)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus sp.
Strepsylla dalmati Traub & Barrera

Sciurus granatensis chiriquensis Bangs
DE: *Hirstionyssus keenani* n.sp.
Sciurus variegatoides Ogilby
Variegated Squirrel
DE: *Hirstionyssus keenani* n.sp.
AN: *Neohaemotopinus* sp. (*sciurinus* group)
Microsciurus alfari (J. A. Allen)
Alfaro's Pygmy Squirrel
TR: *Eutrombicula goeldii* (Oudemans)
Trombicula dunni Ewing

Family Geomyidae

Macrogeomys cavator Bangs
Chiriqui Pocket Gopher
MA: *Geomydoecus* n.sp.

Family Heteromyidae

Liomys adspersus
Panama Spiny Pocket Mouse
LA: *Haemolaelaps glasgowi* (Ewing)
Steptolaelaps heteromys (Fox)
DE: *Hirstionyssus microchelae* n.sp.
Ornithonyssus bacoti (Hirst)
IX: *Amblyomma* sp., L
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotonasis fissa n.sp.
Eutrombicula goeldii (Oudemans)
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi Brennan & Jones
Polylopadium kramisi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula liomys Brennan & Jones
Vanidicus tricosus Brennan & Jones
AN: *Fahrenholzia fairchildi* Johnson
SI: *Ctenocephalides f. felis* (Bouché)
Polygenis dunni (Jordan & Rothschild)
" *klagesi* (Rothschild)
Heteromys australis Thomas
Southern Spiny Pocket Mouse
LA: *Steptolaelaps heteromys* (Fox)
Haemolaelaps glasgowi (Ewing)
TR: *Eutrombicula goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia bulbifera Brennan
Pseudoschoengastia zona Brennan
Trombicula dunni Ewing
" *keenani* Brennan & Jones
SI: *Polygenis klagesi* (Rothschild)
Heteromys desmarestianus Gray
Desmarest's Spiny Pocket Mouse
LA: *Eubrachylaelaps jamesoni* Furman
Haemolaelaps glasgowi (Ewing)
Steptolaelaps heteromys (Fox)
Tur uniscutatus (Turk)
DE: *Hirstionyssus heteromydis* n.sp.
" *lunatus* n.sp.
" *microchelae* n.sp.
" *minutus* n.sp.
" *panamensis* n.sp.
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotiscus desdentatus (Boshell & Kerr)
Euschoengastia belgicae n.sp.
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Hoffmannina handleyi Brennan & Jones
Doloisia (Kymocta) teratarsalis Yunker & Brennan
Pseudoschoengastia bulbifera Brennan
" *finitima* n.sp.
Sasacarus furmani (Hoffmann)
Trombicula dicrura Brennan & Jones
" *dunni* Ewing
" *keenani* Brennan & Jones
Vanidicus tricosus Brennan & Jones
AN: *Fahrenholzia fairchildi* Johnson
" *hertigi* Johnson
SI: *Kohlsia traubi* Tipton & Mendez
Pleochaetis d. dolens (Jordan & Rothschild)
Polygenis roberti beebei (I. Fox)
Wenzella yunkeri n.sp.
Heteromys sp.
IX: *Amblyomma* sp., N, L
Dermacentor sp., N

Suborder Myomorpha
Family Cricetidae

Oryzomys albigularis (Tomes)
(= *O. devius* Goldman, *O devius* Hall & Kelson)

White-breasted Rice Rat
LA: *Gigantolaelaps inca* Fonseca
Laelaps thori Fonseca
TR: *Pseudoschoengastia bulbifera* Brennan
CO: *Amblyopinus emarginatus* Seevers
SI: *Kohlsia keenani* Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Polygenis atopus Jordan & Rothschild

Oryzomys alfaroi (J. A. Allen)
Alfaro's Rice Rat
LA: *Haemolaelaps glasgowi* (Ewing)
Gigantolaelaps gilmorei Fonseca
" *inca* Fonseca
" *oudemansi* Fonseca
Laelaps castroi Fonseca
" *paulistanensis* Fonseca
TR: *Eutrombicula alfreddugesi* (Oudemans)
Pseudoschoengastia bulbifera Brennan
SI: *Kohlsia keenani* Tipton & Mendez
" *traubi* Tipton & Mendez
Pleochaetis d. dolens (Jordan & Rothschild)
Polygenis roberti beebei (I. Fox)

Oryzomys bicolor (Tomes)
LA: *Gigantolaelaps oudemansi* Fonseca
Laelaps sp.

Oryzomys bombycinus Goldman
Silky Rice Rat
LA: *Haemolaelaps glasgowi* (Ewing)
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
Laelaps pilifer n.sp.
TR: *Leptotrombidium panamensis* (Ewing)
Pseudoschoengastia bulbifera Brennan
SI: *Polygenis roberti beebei* (I. Fox)
" *klagesi* (Rothschild)

Oryzomys caliginosus (Tomes)
Dusky Rice Rat
LA: *Haemolaelaps glasgowi* (Ewing)
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Laelaps dearmasi Furman & Tipton
" *pilifer* n.sp.
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Eutrombicula goeldii (Oudemans)
Intercutestrix tryssa (Brennan & Jones)
Leptotrombidium panamensis (Ewing)
Polylopadium confirmatum n.sp.
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula dunni Ewing
AN: *Hoplopleura oryzomydis* Pratt & Lane
SI: *Adoratopsylla intermedia copha* (Jordan)
Polygenis roberti beebei (I. Fox)
Ctenocephalides f. felis (Bouché)
Rhopalopsyllus l. lugubris Jordan & Rothschild

Oryzomys capito (Olfers)
(= *O. talamancae* Goldman, *O. talamancae* Hall and Kelson, *O. laticeps* auct.)
LA: *Gigantolaelaps gilmorei* Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman & Tipton
" *pilifer* n.sp.
" *thori* Fonseca
Mysolaelaps parvispinosus Fonseca
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Euschoengastia cunctata Brennan & Jones
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Intercutestrix tryssa (Brennan & Jones)
Leptotrombidium panamensis (Ewing)
Myxacarus oscillatus n.sp.
Pseudoschoengastia abditiva Brennan
" *bulbifera* Brennan
Trombicula dunni Ewing
" *keenani* Brennan & Jones
SI: *Jellisonia* sp.

Polygenis roberti beebei (I. Fox)
" *klagesi* (Rothschild)
" *dunni* (Jordan & Rothschild)

Oryzomys fulvescens (Saussure)
Pygmy Rice Rat
LA: *Eubrachylaelaps jamesoni* Furman
Gigantolaelaps oudemansi Fonseca
" *wolffsohni* (Oudemans)
Haemolaelaps glasgowi (Ewing)
Laelaps castroi Fonseca
Mysolaelaps parvispinosus Fonseca
TR: *Trombicula caccabulus* Brennan & Jones
SI: *Kohlsia keenani* Tipton & Mendez
" *traubi* Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Strepsylla dalmati Traub & Barrera

Oryzomys sp.
LA: *Steptolaelaps heteromys* (Fox)
TR: *Eutrombicula alfreddugesi* (Oudemans)
Pseudoschoengastia bulbifera Brennan
IX: *Amblyomma ovale* Koch
" sp., N, L
Dermacentor sp., L
Ixodes luciae Senevet
" *venezuelensis* Kohls
" sp., N, L

Nectomys alfari (J. A. Allen)
Alfaro's Water Rat
LA: *Echinolaelaps lowei* n.sp.
Gigantolaelaps gilmorei Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Haemolaelaps glasgowi (Ewing)
TR: *Crotiscus desdentatus* (Boshell & Kerr)
Eutrombicula goeldii (Oudemans)
Pseudoschoengastica bulbifera Brennan
SI: *Polygenis roberti beebei* (I. Fox)

Tylomys panamensis (Gray)
Panama Climbing Rat
LA: *Haemolaelaps glasgowi* (Ewing)
Steptolaelaps heteromys (Fox)
SI: *Polygenis klagesi* (Rothschild)

Tylomys watsoni Thomas
Watson's Climbing Rat
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Euschoengastia enhebra n.sp.
Intercutestrix tryssa (Brennan & Jones)
Doloisia (*Kymocta*) *teratarsalis* Yunker & Brennan
Pseudoschoengastia zona Brennan
Sasacarus furmani (Hoffmann)

Nyctomys sumichrasti (Saussure)
Sumichrast's Vesper Rat
LA: *Haemolaelaps glasgowi* (Ewing)
SI: *Pleochaetis d. dolens* (Jordan & Rothschild)

Reithrodontomys creper Bangs
Chiriqui Harvest Mouse
LA: *Eubrachylaelaps jamesoni* Furman
Haemolaelaps glasgowi (Ewing)
TR: *Hoffmannina suriana* (Hoffmann)
Trombicula dicrura Brennan & Jones
" *keenani* Brennan & Jones
CO: *Amblyopinus tiptoni* n. sp.
SI: *Jellisonia johnsonae* Tipton & Mendez
Juxtapulex echidnophagoides Wagner
Kohlsia traubi Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Strepsylla dalmati Traub & Barrera

Reithrodontomys creper and
Reithrodontomys spp.
IX: *Amblyomma* sp., L
Dermacentor sp., N, L
Ixodes sp., N

Reithrodontomys mexicanus (Saussure)
Mexican Harvest Mouse
LA: *Haemolaelaps glasgowi* (Ewing)
TR: *Eutrombicula alfreddugesi* (Oudemans)
Hoffmannina handleyi Brennan & Jones
Trombicula caccabulus Brennan & Jones
" *dicrura* Brennan & Jones

Trombicula keenani Brennan & Jones
SI: *Jellisonia johnsonae* Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Strepsylla dalmati Traub & Barrera

Reithrodontomys sumichrasti (Saussure)
Sumichrast's Harvest Mouse
LA: *Gigantolaelaps gilmorei* Fonseca
Haemolaelaps glasgowi (Ewing)
TR: *Hoffmannina suriana* (Hoffmann)
SI: *Jellisonia johnsonae* Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Strepsylla dalmati Traub & Barrera

Reithrodontomys sp.
TR: *Eutrombicula batatas* (Linnaeus)
Hoffmannina handleyi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
Trombicula chiriquensis Brennan & Jones
AN: *Hoplopleura hesperomydis* Osborn

Peromyscus flavidus (Bangs)
Yellow Deer Mouse
LA: *Gigantolaelaps inca* Fonseca
" *oudemansi* Fonseca
Laelaps thori Fonseca
TR: *Eutrombicula alfreddugesi* (Oudemans)
Trombicula dunni Ewing
CO: *Amblyopinus emarginatus* Seevers
SI: *Kohlsia azuerensis* n. sp.

Peromyscus n. nudipes (J. A. Allen)
Naked-footed Deer Mouse
LA: *Eubrachylaelaps jamesoni* Furman
Gigantolaelaps inca Fonseca
Haemolaelaps glasgowi (Ewing)
Laelaps castroi Fonseca
DE: *Hirstionyssus galindoi* n. sp.
TR: *Cordiseta mexicana* (Hoffmann)
Euschoengastia libertatis Brennan & Jones
" *spissa* Brennan & Jones
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi Brennan & Jones
" *suriana* (Hoffmann)
Pseudoschoengastia bulbifera Brennan
Trombicula caccabulus Brennan & Jones
" *dicrura* Brennan & Jones
" *dunni* Ewing
" *keenani* Brennan & Jones
" *tiptoni* Brennan & Jones
AN: *Hoplopleura hesperomydis* Osborn
CO: *Amblyopinus tiptoni* n. sp.
SI: *Ctenocephalides f. felis* (Bouché)
Jellisonia johnsonae Tipton & Mendez
Kohlsia keenani Tipton & Mendez
" *mojica* n.sp.
" *traubi* Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Polygenis atopus (Jordan & Rothschild)
" *roberti beebei* (I. Fox)
Strepsylla dalmati Traub & Barrera

Peromyscus sp. ? **pirrensis**
SI: *Kohlsia azuerensis*

Peromyscus sp.
IX: *Amblyomma* sp., N, L
Dermacentor sp., N, L
Haemaphysalis leporispalustris (Packard), L
Ixodes sp., N, L
TR: *Polylopadium kramisi* Brennan & Jones
Pseudoschoengastia bulbifera Brennan
Trombicula chiriquensis Brennan & Jones

Zygodontomys microtinus (Thomas)
(=*Z. cherriei* Goldman, *Z. cherriei* Hall & Kelson)
Cane Rat
LA: *Gigantolaelaps gilmorei* Fonseca
" *goyanensis* Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oud.)

Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman & Tipton
DE: *Ornithonyssus bacoti* (Hirst)
IX: *Ixodes luciae* Senevet, N
" *venezuelensis* Kohls
Amblyomma ovale Koch, N
" sp., N, L
TR: *Eutrombicula alfreddugesi* (Oudemans)
" *batatas* (Linnaeus)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
AN: *Fahrenholzia hertigi* Johnson
SI: *Polygensis dunni* (Jordan & Rothschild)
" *klagesi* (Rothschild)
" *roberti beebei* (I. Fox)
Rhopalopsyllus australis tupinus J. & R.
" *l. lugubris* Jordan & Rothschild

Scotinomys teguina (Alston)
Alston's Brown Mouse
LA: *Haemolaelaps glasgowi* (Ewing)
TR: *Cordiseta mexicana* (Hoffmann)
Eutrombicula alfreddugesi (Oudemans)
Hoffmannina handleyi Brennan & Jones
Trombicula caccabulus Brennan & Jones
" *chiriquensis* Brennan & Jones
" *dicrura* Brennan & Jones
" *keenani* Brennan & Jones
AN: *Hoplopleura hesperomydis* Osborn
SI: *Jellisonia johnsonae* Tipton & Mendez
Kohlsia keenani Tipton & Mendez
Pleochaetis d. dolens (Jordan & Rothschild)
Plocopsylla scotinomi n. sp.

Scotinomys xerampelinus (Bangs)
Chiriqui Brown Mouse
LA: *Haemolaelaps glasgowi* (Ewing)
DE: *Hirstionyssus galindoi* n. sp.
IX: *Ixodes* sp., L
Dermacentor sp., L
?Amblyomma sp., L
TR: *Eutrombicula alfreddugesi* (Oudemans)
Hoffmannina suriana (Hoffmann)
Pseudoschoengastia bulbifera Brennan
Trombicula dicrura Brennan & Jones
SI: *Jellisonia johnsonae* Tipton & Mendez
Kohlsia keenani Tipton & Mendez
Pleochaetis altmani Tipton & Mendez
" *d. dolens* (Jordan & Rothschild)
Plocopsylla scotinomi n. sp.
Strepsylla dalmati Traub & Barrera

Sigmodon hispidus Say & Ord
Hispid Cotton Rat
LA: *Gigantolaelaps gilmorei* Fonseca
" *oudemansi* Fonseca
" *wolffsohni* (Oudemans)
Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman & Tipton
DE: *Acanthonyssus dentipes* (Strandtmann & Eads)
Ornithonyssus bacoti (Hirst)
IX: *Amblyomma auricularium* (Conil), N
" sp., N, L
?Ixodes sp., L
TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotiscus desdentatus (Boshell & Kerr)
Eutrombicula alfreddugesi (Oudemans)
" *batatas* (Linnaeus)
" *goeldii* (Oudemans)
Intercutestrix tryssa (Brennan & Jones
Leptotrombidium panamensis (Ewing)
Odontacarus fieldi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
" *zona* Brennan
Trombicula dunni Ewing
MA: *Gliricola panamensis* Werneck
AN: *Hoplopleura hirsuta* Ferris
SI: *Polygenis dunni* (Jordan & Rothschild)
" *klagesi* (Rothschild)

Family Muridae

Rattus norvegicus (Berkenhout)
Norway Rat
LA: *Laelaps nuttalli* Hirst
SI: *Pulex simulans* Baker

Rattus rattus (Linnaeus)
Black Rat
LA: *Echinolaelaps echidninus* (Berlese)
Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman & Tipton
" *nuttalli* Hirst
DE: *Ornithonyssus bacoti* (Hirst)
TR: *Eutrombicula goeldii* (Oudemans)
AN: *Polyplax spinulosa* (Burmeister)
SI: *Xenopsylla cheopis* Rothschild

Rattus sp.
IX: *Ornithodoros puertoricensis* Fox, L

Mus musculus Linnaeus
House Mouse
SI: *Pleochaetis d. dolens* (Jordan & Rothschild)

Family Erethizontidae

Coendou mexicanus (Kerr)
Mexican Porcupine
IX: *Dermacentor halli* McIntosh
Ixodes boliviensis Neumann
" sp., N, L
TR: *Trombicula keenani* Brennan & Jones
MA: *Eutrichophilus maximus* Bedford
SI: *Ctenocephalides f. felis* (Bouché)
Juxtapulex echidnophagoides Wagner
Polygenis klagesi (Rothschild)

Coendou rothschildi Thomas
Rothschild's Porcupine
DE: *Ornithonyssus coendou* n. sp.
IX: *Amblyomma longirostre* (Koch)
" sp., N, L
Haemaphysalis juxtakochi Cooley, N
TR: *Euschoengastia tragulata* Brennan & Jones
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Leptotrombidium panamensis (Ewing)
Pseudoschoengastia mermeriza n. sp.
Speleocola secunda Brennan & Jones
Trombicula dicrura Brennan & Jones
" *longicalcar* Brennan & Jones
MA: *Eutrichophilus maximus* Bedford

Family Caviidae

Cavia porcellus (Linnaeus)
Guinea Pig (Domestic)
MA: *Gliricola ovalis* Burmeister
" *porcelli* (Schrank)
Trimenopon hispidum (Burmeister)

Family Hydrochaeridae

Hydrochaeris hydrochaeris (Linnaeus)
Capybara
IX: *Amblyomma auricularium* (Conil)
Rhipicephalus sanguineus (Latreille)
TR: *Blankaartia alleei* (Ewing)
Eutrombicula alfreddugesi (Oudemans)
" *batatas* (Linnaeus)

Family Dasyproctidae

Agouti paca (Linnaeus)
Paca, "Conejo pintado"
IX: *Amblyomma coelebs* Neumann
" *pacae* Aragão
" sp., N
Ixodes lasallei Mendez & Ortiz
" sp., N, L
TR: *Eutrombicula alfreddugesi* (Oudemans)
MA: *Macrogyropus costalimai* (Werneck)
SI: *Rhopalopsyllus australis tupinus* Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild
Rhopalopsyllus l. cryptoctenes (Enderlein)
Rhopalopsyllus l. lugubris (Jordan & Rothschild)

Dasyprocta punctata Gray
Agouti, "Ñequi"
IX: *Amblyomma obongoguttatum* Koch
" *pacae* Aragaõ
" sp. N, L
Ixodes lasallei Mendez & Ortiz
" sp., N
TR: *Eutrombicula goeldii* (Oudemans)
Trombicula dasyproctae Ewing
" *dunni* Ewing

SI: *Polygenis klagesi* (Rothschild)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild
Rhopalopsyllus l. lugubris Jordan & Rothschild

Suborder Hystricomorpha
Family Echimyidae

Proechimys semispinosus (Tomes)
Tomes' Spiny Rat

LA: *Tur uniscutatus* (Turk)
Gigantolaelaps gilmorei Fonseca
Haemolaelaps glasgowi (Ewing)
Laelaps dearmasi Furman & Tipton
" *nuttalli* Hirst
" *pilifer* n. sp.

DE: *Acanthonyssus dentipes* (Strandtmann & Eads)
Ornithonyssus bacoti (Hirst)

IX: *Amblyomma ovale* Koch, N
" sp., N, L
Haemaphysalis juxtakochi Cooley, N
Ixodes sp., N

TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotiscus desdentatus (Boshell & Kerr)
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Intercutestrix tryssa (Brennan & Jones)
Leptotrombidium panamensis (Ewing)
Myxacarus ocillatus n.sp.
Odontacarus chiapanensis (Hoffmann)
" *fieldi* Brennan & Jones
Polylopadium kramisi Brennan & Jones
Pseudoschoengastia bulbifera Brennan
Sasacarus furmani (Hoffmann)
Trombicula cribanus Brennan & Jones
" *dunni* Ewing
" *keenani* Brennan & Jones

MA: *Gliricola panamensis* Werneck
Gyropus setifer Ewing
Harrisonia uncinata Ferris

SI: *Adoratopsylla intermedia copha* (Jordan)
Polygenis dunni (Jordan & Rothschild)
" *klagesi* (Rothschild)
" *roberti beebei* (I. Fox)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild
Rhopalopsyllus l. lugubris Jordan & Rothschild

Hoplomys gymnurus (Thomas)
Porcupine Rat

LA: *Haemolaelaps glasgowi* (Ewing)
Tur uniscutatus (Turk)
" *anomalus* n. sp.

DE: *Ornithonyssus* sp.

IX: *Amblyomma* sp., L

TR: *Ascoschoengastia dyscrita* Brennan & Jones
Crotiscus desdentatus (Boshell & Kerr)
Eutrombicula goeldii (Oudemans)
Doloisia (*Kymocta*) *teratarsalis* Yunker & Brennan
Leptotrombidium panamensis (Ewing)
Myxacarus oscillatus Brennan & Yunker
Pseudoschoengastia bulbifera Brennan
Trombicula dunni Ewing
" *keenani* Brennan & Jones
" *punctata* Boshell & Kerr

MA: *Gliricola* sp. (near *panamensis*)
Gyropus setifer Ewing

AN: *Pterophthirus audax* (Ferris)

SI: *Polygenis klagesi* (Rothschild)

Miscellaneous

Rodent nests

SI: *Jellisonia johnsonae* Tipton & Mendez
Pleochaetis d. dolens (Jordan & Rothschild)

Rat

AN: *Hoplopleura nesoryzomydis* Ferris

Mouse

TR: *Eutrombicula alfreddugesi* (Oudemans)
Trombicula dicrura Brennan & Jones

Order CARNIVORA
Family Canidae

Canis familiaris Linnaeus
Domestic Dog, "Perro"
IX: *Amblyomma auricularium* (Conil)
" *cajennense* (Fabricius)
" *oblongoguttatum* Koch
" *ovale* Koch
" sp., N, L
Ixodes affinis Neumann
" *boliviensis* Neumann
Rhipicephalus sanguineus (Latreille)
MA: *Heterodoxus spiniger* (Enderlein)
Trichodectes canis (De Geer)
SI: *Ctenocephalides f. felis* (Bouché)
Juxtapulex echidnophagoides Wagner
Pulex simulans Baker
Rhopalopsyllus australis tupinus Jordan & Rothschild

Family Procyonidae

Procyon cancrivorus (Cuvier)
Crab-eating Raccoon
IX: *Amblyomma naponense* (Packard)
" *oblongoguttatum* Koch
" *ovale* Koch
" sp., N, L

Procyon lotor (Linnaeus)
Raccoon
IX: *Amblyomma ovale* Koch
Ixodes boliviensis Neumann
" *rubidus* Neumann
MA: *Trichodectes octomaculatus* Paine
SI: *Pleochaetis d. dolens* (Jordan & Rothschild)

Nasua nasua (Linnaeus)
Coati, "Gato solo"
LA: *Tur uniscutatus* (Turk)
IX: *Amblyomma auricularium* (Conil)
" *cajennense* (Fabricius)
" *naponense* (Packard)
" *oblongoguttatum* Koch
" *ovale* Koch
" sp., N, L
Ixodes boliviensis Neumann
" *rubidus* Neumann
" sp., N, L
Haemaphysalis juxtakochi Cooley
TR: *Euschoengastia tragulata* Brennan & Jones
Eutrombicula alfreddugesi (Oudemans)
" *goeldii* (Oudemans)
Trombicula dunni Ewing
MA: *Neotrichodectes pallidus* (Piaget)
SI: *Ctenocephalides f. felis* (Bouché)
Dasypsyllus gallinulae perpinnatus (Baker)
Hoplopsyllus glacialis exoticus Jordan & Rothschild
Pleochaetis d. dolens (Jordan & Rothschild)
Polygenis klagesi (Rothschild)
Rhopalopsyllus australis tupinus Jordan & Rothschild
Rhopalopsyllus cacicus saevus Jordan & Rothschild
Rhopalopsyllus lugubris cryptoctenes (Enderlein)

Potos flavus (Schreber)
Kinkajou
IX: *Amblyomma* sp., N

Potos flavus chiriquensis J. A. Allen
MA: *Trichodectes potus* Werneck

Bassaricyon gabbii J. A. Allen
Bushy-tailed Olingo
IX: *Ixodes rubidus* Neumann
SI: *Jellisonia johnsonae* Tipton & Mendez
Pleochaetis d. dolens (Jordan & Rothschild)

Family Mustelidae

Mustela frenata Lichtenstein
Long-tailed Weasel
IX: *Ixodes rubidus* Neumann
MA: *Neotrichodectes minutus* (Paine)?
SI: *Pleochaetis d. dolens* (Jordan & Rothschild)

Eira barbara (Linnaeus)
(=*Tayra barbara* Goldman)
Tayra
IX: *Amblyomma oblongoguttatum* Koch
" *ovale* Koch
Ixodes rubidus Neumann
SI: *Ctenocephalides f. felis* (Bouché)
Rhopalopsyllus australis tupinus Jordan & Rothschild

Galictis allamandi Bell
(=*Grison canaster* Goldman)
Grisón

IX: *Amblyomma ovale* Koch
" sp., N
MA: *Trichodectes galictidis* Werneck
SI: *Rhopalopsyllus australis tupinus* Jordan & Rothschild

Conepatus semistriatus (Boddaert)
Striped Hog-nosed Skunk
IX: *Ixodes rubidus* Neumann
SI: *Ctenocephalides f. felis* (Bouché)
Pulex irritans Linnaeus

Lutra annectens Major
Southern River Otter
IX: *Ixodes* sp., L

Family Felidae

Felis cattus Linnaeus
Domestic Cat, "Gato"
IX: *Amblyomma oblongoguttatum* Koch
" *parvum* Aragão
" sp., N, L
Ixodes boliviensis Neumann
Rhipicephalus sanguineus (Latreille)
MA: *Felicola subrostratus* (Burmeister)
SI: *Ctenocephalides f. felis* (Bouché)

Felis concolor Linnaeus
Mountain Lion, "Puma," "Leon," "Tigre colorado"
IX: *Amblyomma ovale* Koch

Felis onca Linnaeus
Jaguar, "Tigre"
IX: *Amblyomma ovale* Koch
" sp., N
Ixodes affinis Neumann
" *boliviensis* Neumann
SI: *Ctenocephalides f. felis* (Bouché)
Juxtapulex echidnophagoides Wagner

Felis pardalis Linnaeus
Ocelot, "Manigordo"
IX: *Amblyomma ovale* Koch
" sp., N, L
Ixodes affinis Neumann
TR: *Eutrombicula goeldii* (Oudemans)
Odontacarus fieldi Brennan & Jones
Trombicula dunni Ewing

Felis yagouaroundi Geoffroy
Jaguarundi
IX: *Amblyomma ovale* Koch

Order PERISSODACTYLA
Family Tapiridae

Tapirus bairdii (Gill)
Baird's Tapir, "Vaca de Monte," "Macho de Monte"
IX: *Amblyomma cajennense* (Fabricius)
" *coelebs* Neumann
" *oblongoguttatum* Koch
" *ovale* Koch
" *tapirellum* Dunn
" sp., N
Dermacentor latus Cooley
Haemaphysalis juxtakochi Cooley
Ixodes boliviensis Neumann
" *tapirus* Kohls

Family Equidae

Equus caballus Linnaeus
Domestic Horse, "Caballo"
IX: *Amblyomma cajennense* (Fabricius)
" *coelebs* Neumann
" *oblongoguttatum* Koch
" *ovale* Koch
" *tapirellum* Dunn
" sp., N
Anocentor nitens (Neumann)
Boophilus microplus (Canestrini)
MA: *Bovicola equi* (Denny)

Order ARTIODACTYLA
Family Tayassuidae

Tayassu tajacu (Linnaeus)
Collared Peccary, "Saino"
IX: *Amblyomma cajennense* (Fabricius)
" *naponense* (Packard)
" *oblongoguttatum* Koch
" *pecarium* Dunn
" *tapirellum* Dunn
" sp., N, L
Dermacentor imitans Warburton
Haemaphysalis juxtakochi Cooley
TR: *Eutrombicula alfreddugesi* (Oudemans)
Trombicula dunni Ewing
" *pecari* Brennan & Jones

Tayassu tajacu bangsi Goldman
MA: *Macrogyropus dicotylis* (Macalister)

Family Suidae

Sus scrofa Linnaeus
Domestic Hog, "Puerco"
IX: *Anocentor nitens* (Neumann)
Boophilus microplus (Canestrini)
Amblyomma cajennense (Fabricius)
" *coelebs* Neumann
" *oblongoguttatum* Koch
" *ovale* Koch
" *tapirellum* Dunn
" sp., N
AN: *Haematopinus suis* (Linnaeus)
SI: *Tunga penetrans* (Linnaeus)

Family Cervidae

Odocoileus virginianus (Zimmermann)
White-tailed Deer, "Venado"
IX: *Amblyomma cajennense* (Fabricius)
" *oblongoguttatum* Koch
Anocentor nitens (Neumann)
Haemaphysalis juxtakochi Cooley
Ixodes affinis Neumann
" *boliviensis* Neumann
AN: *Solenopotes panamensis* (Ewing)
" *bipinilosus* (Fahrenholz)
HI: *Lipoptena mazamae* Rondani

Mazama americana (Erxleben)
Red Brocket, "Cabra de Monte"
IX: *Amblyomma calcaratum* Neumann
Amblyomma oblongoguttatum Koch
" sp., N
Haemaphysalis juxtakochi Cooley
Ixodes affinis Neumann
TR: *Eutrombicula batatas* (Linnaeus)
HI: *Lipoptena mazamae* Rondani

Mazama sp.
HI: *Lipoptena mazamae* Rondani

Family Bovidae

Bos taurus Linnaeus
Domestic Cattle, "Ganado"
IX: *Amblyomma cajennense* (Fabricius)
" *oblongoguttatum* Koch
" *parvum* Aragão
" sp., N, L
Anocentor nitens (Neumann)
Boophilus microplus (Canestrini)
Ixodes boliviensis Neumann
MA: *Bovicola bovis* (Linnaeus)
AN: *Haematopinus eurysternus* (Nitsch)
(? *H. quadripertusus* Fahrenholz)

Capra hircus Linnaeus
Domestic Goat
IX: *Amblyomma cajennense* (Fabricius)
" *oblongoguttatum* Koch
Boophilus microplus (Canestrini)
MA: *Bovicola limbatus* (Gervais)

Ovis aries Linnaeus
Domestic Sheep
HI: *Melophagus ovinus* (Linnaeus)

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Index

In this volume, the scientific names of hosts are referred to so frequently in the host data for numerous species of parasites, that it is impractical to index each occurrence. We have therefore indexed host names where they occur: in host-parasite lists; in discussions; or in reference to non-Panamanian species. They are indexed under their generic names.

Specific common names of hosts are indexed only if they appear in the text. All others may be found in the "Classified List of Hosts and Parasites," on pages 797–824.

Names of new taxa that are described in the text are indicated by bold face type, as are principal or important page references for an entry.

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