ABSTRACT

A REVISION OF THE GENUS LOMAMYIA BANKS (PLANIPENNIA: BEROTHIDAE) WITH AN EMPHASIS ON THE WESTERN UNITED STATES SPECIES

By

David K. Faulkner

December 1992

A taxonomic revision of the genus Lomamyia is given, concentrating on species of the western United States. Thirteen species are recognized including two new taxa, while the species L. luciana Alayo is synonymized with L. hamata (Walker). A diagnosis, biology, distribution, and figures of wing and genitalic structures are presented for each taxon. Cladistic analysis applying out-group comparisons is used to create a character state table and generate a phylogenetic tree. A key is developed for identification of Lomamyia species.

A REVISION OF THE GENUS LOMAMYIA BANKS (PLANIPENNIA: BEROTHIDAE) WITH AN EMPHASIS ON THE WESTERN UNITED STATES SPECIES

A THESIS

Presented to the Department of Biology

California State University, Long Beach

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

By David Kevin Faulkner

BA, University of California, Santa Barbara,

1975

December 1992

WE, THE UNDERSIGNED MEMBERS OF THE COMMITTEE,

HAVE APPROVED THIS THESIS

A REVISION OF THE GENUS LOMAMYIA BANKS (PLANIPENNIA: BEROTHIDAE) WITH AN EMPHASIS ON THE WESTERN UNITED STATES SPECIES

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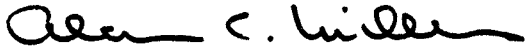

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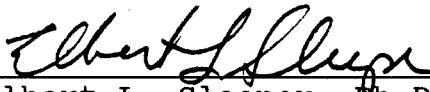

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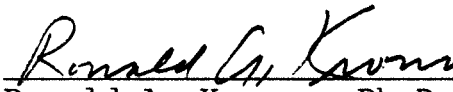

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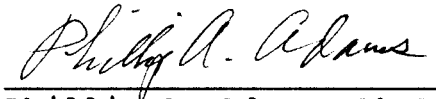

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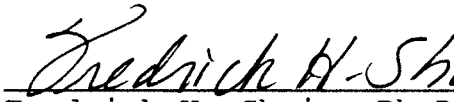

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December 1992

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ACKNOWLEDGEMENTS

Research travel was provided in part by D. Weissman through Island Packers, Inc., Ventura, and other independent carriers during numerous trips to the Pacific and Gulf of California islands of Baja California, Mexico. J. Larsen, Staff Environmental Engineer, Naval Air Station, North Island, San Diego, arranged for transportation and lodging on San Clemente Island.

Transportation and support for over seven years of collecting efforts in western Mexico were provided by N. Bloomfield.

M. Hager, Executive Director of the San Diego Natural History Museum provided the time and support needed to complete this project. Past Museum Director, C. McLaughlin approved trips to Mexico, South Africa, and Namibia that provided valuable material used in this revision.

J. Brown collected numerous specimens in San Diego County and northwestern Mexico, which were used in this project, along with invaluable assistance with the cladistical analysis of the genus.

I am thankful to E. MacLeod for the opportunity to examine specimens and to take the time to provide insight on the biology and systematics of Neuroptera.

I am grateful to the following individuals for providing specimens and data for this study: N. Bloomfield, J. Brushwein, R. Cave, K. Cooper, H. Dozier, J. Johnson, V. Lee, D. Lightfoot, R. Miller, J. Mitchell, V. Monserrat, N. Penny, L. Stange, P. Sullivan, and F. Werner.

The members of my committee are thanked for their patience during the course of this research. R. Kroman provided me with the background needed for studying the relationships of these insects; P. Adams allowed me to use his office, laboratory, photographic equipment, specimens, and personal library, along with critical reviews of the manuscript; E. Sleeper for supporting me throughout the program and his persistance in seeing it to completion.

Finally, to the individuals who helped me complete this study by reminding me that it could be done, I thank G. Cosgrove, D. and K. Gillen, C. Mack, J. Tobiska, R. Watts, and also to my mother, Ramona, who always believed this paper would be finished, she just never knew when.

LIST OF FIGURES

ABBREVIATIONS

Specimens of Lomamyia were borrowed or provided for this study by both individuals and research institutions with collections. Label data were adjusted for uniformity of dates and localities, but measurements were left as either metric or English. The following abbreviations identify these holdings and is adapted from Arnett and Samuelson (1969).

(AMNH) American Museum of Natural History, R. Schuh

(ASUC) Arizona State University, M. Cazier

(BMNH) British Museum of Natural History, P. Barnard

(CASC) California Academy of Sciences, N. Penny

(CDFA) California Department of Food and Agriculture, A. Hardy

(CISC) California Insect Survey Collection, J. Chemsak

(CSLB) California State University Long Beach, L. Sleeper

(CSSJ) California State University San Jose, J. Tilden

(EMUS) Entomology Museum, Utah State University, W. Hanson

(FMNH) Field Museum of Natural History, A. Newton

(FSCA) Florida State Collection of Arthropods, L. Stange

(HMOU) Hope Museum, Oxford University, D. Smith

(IEEM) Instituto Espanol de Entomologia, V. Monserrat

(INHS) Illinois Natural History Survey, E. MacLeod

(KUIC) Kansas University Insect Collection, G. Byers

(LACM) Los Angeles County Museum of Natural History, R. Snelling

(MCZC) Museum of Comparative Zoology, F. Carpenter

(MEMU) Mississippi State University, R. Brown

(NSDA) Nevada State Department of Agriculture, R. Bechtel

(OMNH) Oakland Museum of Natural History, C. MacNeill

(OSUO) Oregon State University, J. Lattin

(PAAC) P. A. Adams Collection

(PSIC) P. Sullivan Collection

(RBMC) R. B. Miller Collection

(SDMN) San Diego Natural History Museum, R. Watts

(SLOC) California Polytechnic San Luis Obispo, R. Alexander

(TAMU) Texas A & M University, E. Riley

(UAIC) University of Arizona Insect Collection, F. Werner

INTRODUCTION

The beaded lacewing genus Lomamyia Banks consists of 12 species distributed throughout the New World, with most of the diversity occurring in the nearctic region of North America. The adult insects are both crepuscular and nocturnal in their activity and have been readily collected using ultraviolet light traps. Immature stages can occasionally be collected in association with termite nests.

Lomamyia is a genus of the planipennian family Berothidae, which is represented on all continents except Antarctica. The Berothinae, one of 4 subfamilies and consisting of 66 recognized species, is the most widespread (Aspock, 1986), while the other subfamilies are restricted to South America and Africa (Cyrenoberothinae), and Africa (Nosybinae, Rhachiberothinae) according to Aspock (1986) and Aspock and Aspock (1988). Currently, Lomamyia has been recorded in North America, Central America, the Caribbean, and Brazil in South America.

The Berothinae is a rather heterogeneous assemblage of genera (Aspock, 1986) characterized primarily by features

of wing venation, especially the number and location of gradate crossveins. More recently, genital morphology, relying on non-eidonomic characters, has been used to establish systematic relationships.

Information relating to the biology of this genus is minimal. Only a single western United States species (Toschi, 1964; Tauber and Tauber, 1968) and two species from the eastern United States (Gurney, 1947; Brushwein, 1987) have been studied. Larvae for three other nearctic species have been collected by Brushwein and Miller (pers. comm.) with additional biological data gathered by F. Werner (pers. comm.).

Literature Review

Banks (1905b) erected the genus Lomamyia in a revision of the nearctic Hemerobiidae and included one species previously placed in the genera Hemerobius (Walker, 1853) and Micromus (Hagen, 1861) and a single species from the genus Berotha (Banks, 1897). Five additional species were eventually described or recognized as belonging to Lomamyia (Walker, 1853; Brauer, 1864; Banks, 1905b; Navas, 1913, 1929; Kruger, 1922). The genus was not truly delineated until Carpenter's (1940) comprehensive revision where 10 species were included in Lomamyia, and information was given on their distribution and affinities. An additional species was described from Brazil by Penny (1983).

The first published account of the biology of the immature stages was by Gurney (1947), followed by Toschi (1964), Tauber and Tauber (1968), Johnson and Hagen (1981), Brushwein (1987), and Minter (1990).

Research on the placement of Lomamyia within the subfamily Berothinae was conducted by Comstock (1918), Kruger (1922), Navas (1929), MacLeod (1967), MacLeod and Adams (1967), and Aspock (1986).

Acker (1960) attempted to interpret the external genitalic morphology of the male Neuroptera, based in part on the work of Tjeder (1954), and illustrated the genus Lomamyia.

METHODS AND MATERIALS

The present study reflects nearly 10 years of field collecting and examination of over 1,200 specimens of both larval and adult Lomamyia, mostly representing species indigenous to the western United States, and northwestern Mexico, including Baja California. I have collected examples of all but three of the previously described species and have also examined specimens representing the subfamilies Nosybinae, Rhachiberothinae, and Cyrenoberothinae.

All borrowed specimens were stored in sealed California Academy style drawers and fumigated with paradichlorobenzene or Vapona to prevent insect infestation and retard mildew growth. Specimens were individually labelled with an abbreviation of the lending institution.

Field collecting involved the capture of flying adults at dusk using an aerial insect net and employing 12 volt DC or 110 AC ultraviolet fluorescent lights, at times in conjunction with a mercury vapor light, to attract adults onto a sheet where they could be collected, or into a poisoned trap. Alcohol or other liquid traps were avoided

because of potential damage to the specimens. Lacewings were also detached from the adhesive used in Jackson traps by applying carbon tetrachloride. Sweeping and beating of vegetation resulted in few specimen captures. Immature stages were found in association with termite colonies, usually in galleries adjacent to current termite activity. Some eggs were recovered from termite infested logs. Termites were also collected and placed into 70% ethyl alcohol.

Live adults were maintained in small glass vials with a cotton stopper and provided with sugar water mixed with honey. Termite infested wood and termite frass was included in the vials to stimulate oviposition. Live larvae were placed individually in petri dishes lined with filter paper and given live Reticulitermes on which to feed. Pupal specimens were removed to smaller vials to monitor adult emergence.

Species identification was based on characters of wing venation and both external and internal genitalic structures of males and females. Genitalic configurations alone were diagnostic for all species examined and, for some, were the only consistent features. Males were separated on the basis of the mediuncus complex and the 9th coxopodite. Females were determined by the structure of the 8th abdominal sternite and the complexity of the

fertilization canal and the size of the spermatheca. Most researchers since Carpenter (1940) place more taxonomic weight on genitalic structures than on characters of wing venation, the one exception being Alayo (1968).

To allow for critical viewing of the male and female terminalia, dried abdomens from pinned specimens were carefully removed with pointed forceps at the metathorax and abdomen juncture. Abdomens were then placed in a solution of cool 10% potassium hydroxide (KOH) and allowed to soak for 24 hrs, at which time abdomens were transferred into 70% ethyl alcohol and cleared of most dissolved materials, leaving in place the heavily scleritized structures. Abdomens were then returned to the KOH for another 24 hrs to continue the process, removed and washed with 70% ethyl alcohol. They were then transferred into glass genitalic vials containing glycerine to prevent drying and distortion. Vials were then sealed with a silicone rubber stopper. The vials were then reassociated with the pinned specimen from which they originated.

Examination was accomplished using a binocular dissecting microscope with a 10 mm ocular grid at magnifications between 10X and 50X. Illustrations were executed using a compound microscope with a magnification of 120X and a camera lucida attachment. Illustrations were rendered initially as sketches and later transferred and

redrawn on acetate with .18 mm and .25 mm Rapidograph pens and India ink.

Wing photographs were taken with black and white Technical Pan film from slide mounted right forewings and hindwings using an Olympus OM2, 72 mm lens and bellows attachment.

Measurements were made with an ocular grid and a 10 mm mini-scale. Body length was measured from the anterior end at the frons to the abdominal apex. Wing length was determined from the base of the forewing at the thorax to its apex. Width was measured at the widest part of the forewing from the anterior costal border to the posterior wing margin.

Both external and internal morphological characters were then correlated, along with geographic distribution, to more concisely define the taxon. A minimum of 10 specimens of each species, if available, were dissected and examined to understand individual variation and possible preparation damage that could result in misinterpretation.

Entomological terminology used is that of Torre-Bueno (1973), while more specific genitalic nomenclature is based in part on the work of Tjeder (1954) and Acker (1960), but more closely follows the interpretation of MacLeod (1967) and MacLeod and Adams (1967). Species descriptions are adjusted from Carpenter's (1940) revisional study but are

based on a clearer delineation of species' characters and individual variation owing to the larger number of specimens available. The key to Lomamyia species combines both the male and female taxa into a single dichotomous arrangement.

TAXONOMIC TREATMENT

Genus Lomamyia Banks

Lomamyia Banks, 1904:207; Banks, 1905b:26; Banks, 1907:23; Comstock, 1918:187; Kruger, 1922:50; Navas, 1929:25; Carpenter, 1940:258; Gurney, 1947:145; Tjeder, 1959:258; Acker, 1960:31; Toschi, 1964:24; MacLeod and Adams, 1967:243; MacLeod, 1967:349; Alayo, 1968:24; Tauber and Tauber, 1968:623; Penny, 1977:14; Johnson and Hagen, 1981:506; Penny, 1983:689; Aspock, 1986:87; Brushwein, 1987:150; Adams, 1989:187; New, 1989:24; Aspock, 1990:105; Minter, 1990:127.

Diagnosis. Berothinae; forewing elongate and usually incised below apex, subcostal and radial veins meet at pterostigma, two-six radial crossveins, radial sector with five branches, one series of four-five gradate crossveins beginning under the pterostigma and angled toward the wing base; hindwing only slightly incised below apex, usually two radial crossveins, three gradate veins, radial sector with six branches; pronotum longer than wide; male

gonocoxite medially narrowed, mediuncus with posterior projecting bristles; female eighth sternite complex with a number of sclerotized processes.

Type species: Hemerobius flavicornis Walker

Taxonomic Characters

Thorax. The thorax lacks useful characters for species level separation with the exception of the presence and distribution of squamae (scales). Problems can arise when female specimens have lost squamae owing to careless handling or long-term alcohol storage.

Color. Maculation, pattern, and color are of limited value as taxonomic characters, although certain species are definitely dark. Care must be taken to work with non-teneral specimens.

Wings. Interpretation of wing features are of critical importance in species determination. In the forewing, the number of radial crossveins, number and margination of outer gradate crossveins, wing shape, costal area width, wing maculation, and the presence and location of squamae, exclusive to females, need to be assessed. The application of the term "broad" refers to widths that are half as wide as length, with "narrow" meaning less than half as wide as wing length. Hindwing characters, with the exception of squamae, are of lesser value.

Genitalia. With males, the configuration and position of the mediuncus and gonocoxite are extremely useful. In females, the size and complexity of the spermatheca and the structure of the eighth sternite are of importance. The circular spermatheca is termed "large" if it approaches 0.5 mm in diameter, while "small" is a lesser measurement. Coils are the convolutions of the fertilization canal and are considered "complex" if there are three or more coils, while less than this number was termed "simple."

Key to the Species of Lomamyia (modified from Carpenter, 1940)

1. Forewing with two radial crossveins 2

1'. Forewing with three or more radial crossveins 10

2(1). Anterior margin of forewing concave 3

2'. Anterior margin of forewing straight or tapering (Figure 34) (western United States) . . . . . occidentalis

3(2). Forewing half as wide as long; wing margin incised and falcate below apex; membrane yellow-brown maculated (Figure 29) 4

3'. Forewing less than half as wide as long, incised but not falcate, membrane hyaline or with distal brown maculation 5

4(3). Costal area with six distinct brown spots, moderately narrow (Figure 29); female squamae on forewing, hindwing, forecoxae, and mesopleura (western United States) . . . . . fulva

4'. Costal area without distinct brown spots, very narrow (Figure 30), female squamae on forewing and forecoxae (southeastern United States, Cuba) . . . . . hamata

5(3'). Face light yellow; forewing costal margin moderately broad, membrane hyaline 6

5'. Face dark yellow to fuscus; forewing costal margin narrow, membrane with brown maculation (eastern United States) 7

6(5). Forewing width narrow, deeply incised beyond apex (southwestern United States) 8

6'. Forewing width broad, incised beyond apex (western United States) 9

7(5'). Face dark yellow; mediuncus narrow and straight; squamae absent; spermatheca small . flavicornis

7'. Face fuscous; mediuncus narrow and strongly curved; squamae present on forecoxae; spermatheca large . . . . . banksi

8(6). Forewing gradate crossveins margined, reduced brown spots on costal margin, falcate beyond apex, membrane brown maculation dense on distal third; squamae on forewings, hindwings, and scattered on forecoxae . . . . . tenuis

8'. Forewing gradate crossveins heavily margined, six conspicuous brown spots on costal margin before pterostigmata, membrane with extensive brown maculation; squamae on forewings and compressed on forecoxae . . . . . texana

9(6'). Forewing with brown maculation, gradate veins lightly margined; squamae on forewing and hindwing only . . . . . latipennis

9'. Forewing membrane hyaline, gradate veins unmargined; squamae on wings and forecoxae . . . . . N sp. 1

10(1'). Forewing with three radial crossveins 11

10'. Forewing with four or more radial crossveins 12

11(10). Forewings rounded, not incised beyond apex; squamae absent (southeastern United States) . . . . . longicollis

11. Forewings deeply incised beyond apex; squamae present on forewing, hindwing, plural area of thorax, and femora (southwestern United States, Mexico, Central America) . . . . . squamosa

12(10'). Forewing broad, deeply incised, five-six radial crossveins (Mexico) . . . . . N sp. 2

12. Forewing narrow, incised, four-five radial crossveins (Brazil) . . . . . trombetensis

Lomamyia banksi Carpenter

(Figures 2, 14, 27, 41)

Lomamyia banksi Carpenter, 1940:260; Carpenter, 1942:50; Gurney, 1947:152; Brushwein, 1987:152.

Diagnosis. Vertex of head yellow with fuscous spots; clypeus, labrum yellow, palpi fuscous; antennae yellow with scapes basally fuscous; frons setae black and white.

Pronotum yellow with fuscous spots; mesonotum with scattered fuscous spots; metanotum yellow with brown maculation. Female with patch of dense black squamae on forecoxae.

Femora and tibiae white with fuscous spots and white setae; tarsomeres fuscous-margined.

Average forewing (Figure 27) length 9.8 mm; width 4.1 mm. Membrane hyaline with brown maculation; anterior margin concave; costal area with five-six brown spots; outer margin incised below apex; pterostigma reddish; gradate crossveins without marginations; black setae

present on crossveins and junctions of wing veins, other veins covered with brown and white setae; two radial crossveins. Hindwing hyaline; three gradate crossveins and distal radial crossvein maculate, not margined.

Genitalia (Figures 2, 14). Male ninth coxopodites with pair of anterior processes ventrally, short processes dorsally; lateral lobes join to form a narrow bridge; mediuncus elongated into a sigmoidal curve anteriorly. Female hypocaudae long; eighth sternite with a pair of short processes extending posteriorly, pair of flattened lobes anteriorly; rods long and prominent; spermatheca large; spermathecal coils complex.

Holotype (MCZC). Male, in good condition. South Carolina: Clemson College, 28-V-1931, D. Duncan.

Distribution (Figure 41). Eastern, southern, and midwestern United States.

Material examined. ARKANSAS: Logan Co.: Mt. Magazine, E. end, 9-V-1988 (SDMN); Sharp Co.: Spring River W. M. A. (SDMN). FLORIDA: Alachua Co.: Gainesville, 31-VII-1978, 11-IV-1979 (FSCA); Hillard, 28-VII-1934 (KUIC); Liberty Co.: Torreya St. Pk., 30-VIII-1978, 11-IV-1978 (FSCA), 22-IV-1981 (CISC). ILLINOIS: Macon Co.: 14-VI-1981 (FSCA). KANSAS: Douglas Co.: vic. Lawrence, 24-IX-1957 (TAMU). MISSISSIPPI: Falton, 14-VII-1930 (KUIC); Hamilton, 15-VII-1930 (KUIC). OKLAHOMA: Latimer Co.: 6/22-IV-1988, 10/16-X-

1988 (SDMN). SOUTH CAROLINA: "Dovehaven," 7 mi. NE. Pickens, 15-V-1977, 19-VII-1980, 23-VIII-1980, 9&26-VI-1983, 18&23-IX-1983 (SDMN); Greenville, 25-VIII-1985, 21-VII-1986, 17&22-VIII-1986 (LACM). TEXAS: 10 mi. S. Elkhart, 26-V-1982 (TAMU). VIRGINIA: Fallschurch, 11-VIII (paratype) (KUIC).

Remarks. This species was confused with flavicornis, but can easily be separated from it by the narrower wings and female forecoxal squamae. Genitalically, there is considerable difference in both male and female characters; banksi males possess a longer anterior dorsal process on the coxopodites and an almost sigmoid mediuncus, while the females show a less convoluted fertilization canal and more expanded eighth sternite. A widespread eastern species, banksi extends to Kansas in the midwest and north into Michigan. A single specimen recorded by Carpenter (1940) from Arizona is tenuis. Larvae have been reared on termites (Reticulitermes flavipes) by Brushwein (pers. comm.).

Lomamyia flavicornis (Walker)

(Figures 3, 15, 28, 41)

Hemerobius flavicornis Walker, 1853:278; Aspock, 1986:87.
Micromus flavicornis; Hagen, 1861:198.
Lomamyia flavicornis; Banks, 1905b:27; Banks, 1907:23; Smith, 1923:131; Banks, 1924:430; Navas, 1929:26; Smith,

1934:128; Carpenter, 1940:259; Gurney, 1947:152; Toschi, 1964:24; MacLeod and Adams, 1967:246; Alayo, 1968:24; Brushwein, 1987:152.

Isocelipteron pennsylvanica Brauer, 1864:879.

Lomamyia pennsylvanicum; Kruger, 1922:74.

Lomamyia nearctica Navas, 1913:19; Navas, 1929:26.

Diagnosis. Vertex and frons yellow with brown spots; setae brown and white; clypeus and labrum yellow with brown spots; palpi brown; antennae yellow, scapes with brown spots, single brown spot on ventral surface of first segment beyond scapes; setae yellow.

Pronotum and mesonotum yellow with brown spots; metanotum with dorsal brown maculation.

Femora and tibiae light yellow with brown spots; basal tarsomere with distal brown band; setae brown, white and long.

Average forewing (Figure 28) length 9.2 mm; width 3.3 mm. Membrane hyaline; costal margin slightly concave, six brown spots before pterostigma; pterostigma white with brown maculation; incised below apex; two radial crossveins; gradate crossveins dark, margined; black setae in tufts on vein junctions. Hindwing hyaline; crossveins and gradate veins brown.

Abdomen yellow with brown maculation.

Genitalia (Figures 3, 15). Male eighth gonocoxite with anterior pair of processes ventrally, lobed posteriorly with a pair of curved processes; mediuncus slightly expanded and curved anteriorly. Female with eighth sternite lobes joined by a narrow bridge medially; rods present, weak; spermatheca small, fertilization canal coils complex.

Holotype (BMNH). Female (?), abdomen missing. "North America."

Distribution. (Figure 41) Eastern United States.

Material examined. ARKANSAS: Washington Co.: Fayetteville, Markham Hill, 25-IX-1987 (SDMN). FLORIDA: Alachua Co.: Gainesville, Doyle Conner Building, 22/26-V-1987 (FSCA); Monteoca, 8-VI-1977 (FSCA); Escambia Co: Ft. Pickens, 25/28-V-1989 (SDMN); Highlands Co.: Highlands Hammock St. Park, 30-IV-2-V-1978 (FSCA); Liberty Co.: Torreya St. Pk., 21-IV-1981 (CISC); Tampa, 2-V-1908 (CASC). GEORGIA: Habersham Co.: 5 mi. N. Batesville, 20-VI-1987 (FSCA). LOUISIANA: Caddo Park, 18-VIII-1928 (KUIC). MARYLAND: Montgomery Co.: Takoma Park, 1-VII-1970 (CSSJ). NORTH CAROLINA: Southern Pines, 29-VII (KUIC). SOUTH CAROLINA: Greenville, 27-VIII-1966, 10-VIII-1986 (LACM); 7 mi. NE. Pickens, "Dovehaven," 13-VIII-1983 (SDMN). TEXAS: Dallas Co.: Irving, 28-VII-1975 (FSCA)(aberrant). VIRGINIA: Fallschurch, 4-VI-1962 (USNM).

Remarks. Based on Walker's (1853) description, this species and banksi were considered conspecific until Carpenter (1940) clarified their status. Type "a" flavicornis in the British Museum is undoubtedly this species as designated by Carpenter. The distal third of the forewing, however, is rather aberrant in the extensive amount of brown maculation forming streaks across the wing. L. flavicornis can be separated from banksi by the complete absence of squamae on the wings, forecoxae, and thorax, and by the diagnostic male and female genitalia; flavicornis males possess a shorter anterior dorsal process on the gonocoxites and a less curved mediuncus, while females have five-six convolutions to the fertilization canal and eighth sternite is not as broad posteriorly. The holotype of Brauer's (1864) species I. pennsylvanica has been examined and is clearly flavicornis as was synonymized along with nearctica by Navas (1929). Larvae have been reared on immature termites (Reticulitermes) by Brushwein (pers. comm.).

Lomamyia fulva Carpenter

(Figures 4, 16, 29, 41)

Lomamyia fulva Carpenter, 1940:264.

Description. Vertex, frons yellow with fuscous spots; setae red; clypeus, labrum yellow with fuscous spots; palpi

brown; antennae yellow with fuscous spots restricted to scapes, setae red and yellow.

Pronotum, mesonotum yellow with fuscous spots; metanotum yellow with fuscous maculation; setae mostly white; squamae black and white on pleura of metathorax.

Femora, tibiae yellow with fuscous spots; tarsomeres yellow; setae red and white; forecoxae of female with appressed white and black squamae.

Average forewing (Figure 29) length 12.8 mm; forewing width 8 mm. Membrane hyaline, maculation reddish brown; costal area narrow, margin concave, six fuscous spots before pterostigma; pterostigma reddish; wing margin strongly incised below apex; two radial crossveins; gradate veins unmargined; vein setae predominately red and white; female squamae dorsal on anterior medial vein, branches of the posterior medial vein, base of the radial sector. Hindwing hyaline; pterostigmal radial crossvein margined; gradated crossveins unmargined.

Genitalia (Figures 4, 16). Male gonocoxites laterally lobed, broadly connected, with paired narrow, straight anterior ventral processes; mediuncus narrow, only slightly curved anteriorly. Female hypocaudae long; eighth sternite lobes narrowly joined; rods weak; spermatheca large, coils of fertilization canal complex.

Holotype (MCZC). Female, good condition. CALIFORNIA: Riverside Co.: San Jacinto Mts., 21-VII-1929, R.H. Beamer.

Distribution. (Figure 41) California and Guadalupe Island, Mexico.

Material examined. CALIFORNIA: Kern Co.: Tehachapi Mt. Pk., 8 km SW. Tehachapi, 5,000 ft., 17-VII-1979 (CISC); Los Angeles Co.: Devil's Punch Bowl Co. Pk., 31-VIII-1975 (SDMN); Glendale, VI-1944 (CISC); La Habra Heights, 2-XI-1976 (CSLB); Long Beach, 19-XI-1976 (CSLB); Los Angeles, 6-VII-1976 (LACM); Santa Monica Mtns., 5 mi. N. Beverly Hills, Benedict (Canyon), 16-V-1956, 13-VIII-1957, 14-VIII-1957 (LACM); Ranch 2.5 mi. SSW. Valyermo, 21-VI-1963 (LACM); Napa Co.: Spanish Flat, Lake Berryessa, 3-VIII-1970 (CASC); Orange Co.: Anaheim, 4 mi. E. Olive, 21-V-1980, 16-VII-1980 (SDMN); Riverside Co.: Palm Springs, Chino Cyn., 19-V-1960 (CISC); Riverside, 13-IX-1980, 2-VI-1974, 25-VI-1972, 29-VII-1977, 13-VIII-1980, 27-VI-1984 (SDMN); San Jacinto Mtns., Idyllwild, 5-VII-1950 (CASC), 6-VII-1950 (CISC); San Timoteo Canyon, 8-IX-1974 (UCRC); Tool Box Springs P. C., 11-IX-1971 (CSLB); San Bernardino Co: Forest Falls, Mill Creek, 9-VII-1966 (PAAC); 1 mi. N. Upland, 2-VI-1968 (PAAC); Wrightwood, 13-VI-1964 (UCDC); San Diego Co.: Alpine, 25-VI-1988, 18-VII-1988, 20-VII-1989, 26-IV-1990, 10-V-1990, 26-VI-1990, 18-VII-1990, 5-VIII-1990 (SDMN); Boulevard, 23-IX-1979 (SDMN); La Jolla, 22-VI-1963

(UCDC); Pine Valley, 17-IX-1-X-1929 (SDMN); San Vicente Res., S. end, 15-VII-1976 (SDMN); San Luis Obispo Co.: Cal Poly, 9-V-1978 (SLOC); 2 mi. E. Rinconada, 27-VI-1970 (SLOC); Hays, 31-V-1968 (SLOC); San Luis Obispo, Res. Canyon, 20-VIII-1976; Santa Barbara Co.: 1 mi. N. San Marcos Pass, 4&19-VII-1965 (CISC); 3 mi. N. Refugio Beach, 9-VII-1965 (UCDC); Santa Cruz Island, Central Valley, 25&26-IX-1978 (CISC); Tulare Co.: Cannel Meadows, 28-VII-1973 (PAAC); Yolo Co.: Putah Canyon, 10-VIII-1970 (UCDC). MEXICO: Guadeloupe Island, Pacific Ocean, 1875 (CASC).

Remarks. Similar to fulva are latipennis and N. sp. 1, but can be separated from both species by the reddish color of the wing membrane, wing width, distribution of squamae, and distinctive male and female genitalic characters; male dorsal and ventral coxopodite processes are equally long and the mediuncus is narrow and not anteriorly enlarged, while the females possess a narrow connection medially of the eighth sternite and a tightly coiled fertilization canal. Of this genus, fulva is the only species recorded from the Channel Islands, having been collected on Santa Cruz Island, and from Guadalupe Island, Mexico, known from a single damaged specimen stored in glycerine. This species has not been reared successfully, but eggs were deposited by a single female and first instar larvae were maintained for a short period of time. One

first instar larva was obtained from a berlese sample in association with Reticulitermes termites.

Lomamyia hamata (Walker)

(Figures 5, 17, 30, 31, 42)

Hemerobius hamata Walker, 1853:278.

Micromus hamatus; Hagen, 1861:199.

Lomamyia flavicornis Banks, 1905b:48; Banks, 1907:23.

Lomamyia hamata; Kruger, 1922:49; Navas, 1929:19; Carpenter, 1940:265; Brushwein, 1987:152.

Lomamyia hubbardi Banks, 1924:430; Carpenter, 1940:265.

Lomamyia luciana Alayo, 1968:24; Penny, 1977:14.(New Synonymy).

Description. Vertex and frons yellow with reddish spots, setae white; clypeus, labrum yellow, palpi yellow with red maculation; antennae, scapes yellow.

Pronotum, mesonotum yellow with red spots; metanotum with red maculation, forming a dorsal band medially.

Femora yellow, tibiae with red spots on upper surface, first tarsomere with distal red band; female forecoxae with appressed black and white squamae, oily.

Average forewing (Figure 30) length 10.6 mm; width 5.1 mm. Membrane hyaline, fuscous maculation; costal area narrow, margin concave, no distinct spots before pterostigma; pterostigma reddish; wing margin incised to falcate beyond apex; two radial crossveins; gradate

crossveins unmargined; setae on veins yellow; female squamae ventral, at base of radial sector and anterior media. Hindwing somewhat hyaline; pterostigmal crossvein margined.

Genitalia (Figures 5, 17). Male gonocoxites broadly lobed, connected by a wide medial bridge; two long anterior processes ventrally, two short processes dorsally; mediuncus narrow, curved, widening anteriorly. Female hypocaudae long; eighth sternite narrowly joined medially; rods prominent; spermatheca small; fertilization canal coils complex.

Holotype (BMNH). Male, abdomen and left forewing and hind wing missing. "North America."

Distribution (Figure 42). Florida, Cuba.

Material examined. FLORIDA: Punta Gorda, 1-V-1941, 20-IV-1956 (FSCA); Highlands Co.: Lake Placid, Archbold Bio. Station, 26-III-1962 (PAAC), 30-IV-1981, 6-VI-1986 (CISC), 20&22-X-1978, 6&8-I-1979, 21-I-1979 (FSCA), 8-15-V-1964 (SDMN); Lake Co.: Ocala Nat'l. Forest, Alexander Spring, 16-VI-1986 (CISC); Levy Co.: 3.8 mi. SW. Archer, 23-IV-1987 (FSCA); Marion Co.: Ocala Nat'l. Forest, vic. Hopkins Prairie, 11/18-IV-1979, 18/23-V-1979 (FSCA); Putman Co.: University Reserve, Welska, 9-IV-1962 (PAAC), 9-VI-1986 (CISC).

Remarks. This is the most distinctive species of typical Lomamyia recorded from the southeastern United States, easily identified by the broad, reddish, and falcate forewings, along with the diagnostic genitalic characters; males possess a single pair of anterior projections ventrally on the coxopodites and a short mediuncus with long setae, while the females have a elongate and twisted posterior processes on the eighth sternite and a small spermatheca with enlarged portions of the fertilization canal. Periodically, aberrant specimens are collected with extensive pigmentation on the apical third of the forewing (Figure 31) and have been considered as a different species; however, careful examination of additional characters proves this is not the case. Similar conditions have occurred with flavicornis, including type "a" in the British Museum. All specimens recorded have been collected in Florida with the exception of Alayo's (1968) species luciana from Cuba, which is conspecific with hamata. Although Alayo's type was unavailable for examination, his description and wing illustration leave little doubt as to the identity of luciana. Larvae have been reared on termites (Reticulitermes) by Brushwein (pers. comm.) and Neotermes, which occurs in Florida in the southeast.

Lomamyia latipennis Carpenter

(Figures 6, 18, 32, 42)

Lomamyia latipennis Carpenter, 1940:262; Toschi, 1964:21; Tauber and Tauber, 1968:623; Johnson and Hagen, 1981:506; Aspock, 1986:87; Brushwein, 1987:152.

Description. Face yellow, few brown spots; clypeus, labrum yellow; palpi brown; vertex, frons yellow with brown spots, short white setae, longer black setae; antennae yellow, scapes yellow with black and white setae.

Pronotum, mesonotum yellow with brown spots, maculation; metanotum yellow, extensive brown maculation.

Femora, tibiae, tarsomeres yellow with brown spots; setae brown and white.

Average forewing (Figure 32) length 10.9 mm; width 5 mm. Membrane hyaline with brown maculation; costal area broad, margin concave, six brown spots before pterostigma; pterostigma red, white distally; wing margin below apex incised; two radial crossveins, tufts of black setae present; gradate crossveins lightly margined; veins covered with black, brown setae; female squamae dorsally on proximal anterior media, base of the medial sector, branches of the posterior media. Hindwing hyaline, pterostigmal crossvein margined, gradate crossveins unmargined.

Genitalia (Figures 6, 18). Male ninth coxopodites broadly joined, anterior pair of processes lateral, narrow, dorsal processes short and attenuated; mediuncus narrow, slightly curved anteriorly; female hypocaudae long; eighth sternite lobes broadly joined; rods absent; spermatheca large and fertilization canal coils complex.

Holotype (CASC). Male, good condition. CALIFORNIA: Marin Co.: Phoenix Lake, 4-VII-1927, H. H. Kiefer.

Distribution (Figure 42). Western United States.

Material examined. ARIZONA: Yarnell, 29-VII-1933 (KUIC); Pima Co.: Sabino Cyn., 23-IX-1963 (UCDC). CALIFORNIA: Calavaras Co.: 4 mi. E. Murphy's, 3000 ft., 12-VII-1963 (CISC); Contra Costa Co.: Moraga, 29-VII-1977 (UCDC); El Dorado Co.: Blodgett Forest, 13 mi. E. Georgetown, 29-VI-1967 (CISC); Marin Co.: Cazadero, 3-IX-1918 (CASC); Mill Valley F. T., 1/4-X-1965 (CASC); Novato, 19-VIII-1961 (CASC); Mendocino Co.: 5 mi. N. Branscomb, 24&25-V-1976 (CISC); Eel River Rest Stop, Mendocino Nat'l For., 1500 ft., 13-VI-1972 (CISC); Modoc Co.: Upper Rush Creek Campground, 28-VII-1980 (CISC); Mono Co.: Mono Lake, 11-VII-1968 (CISC); Monterey Co.: Arroyo Seco Camp, 1000 ft., 15-V-1976 (UCDC); Napa Co.: N. side Howell Mt., 2 mi. NNE. Angwin, 1300 ft., 5/9-VIII-1974, 9&20-X-1974, 9-VIII-1975, 4-X-1975 (CASC); Nevada Co.: Green Valley, 5-VIII-1965 (UCDC); Sagehen Creek, 1-VII-1970, 8-VII-1970, 15-VII-

1970, 1-VII-1970, 5-VII-1972, 12-VII-1972, 14-VII-1976, 5-VII-1978, 12-VII-1978 (UCDC); Sagehen Creek, nr. Hobart Mills, 4\5-VII-1962, 27-VI-1964, 20-VII-1964 (CISC), 29-VI-1962, 12-VII-1962 (PAAC); Orange Co.: Trabuco Canyon, Santa Ana Mtns., 17-VII-1977 (PAAC); Plumas Co.: 2 mi. W. Greenville, 2-VII-1963 (CISC); Keddie, 7-VII-1941 (CASC); 1 mi. S. Meadow Valley, 4100 ft., 9-16-IX-1983 (CISC); San Diego Co.: Pine Valley, 21-VIII-1927 (SDMN); San Luis Obispo Co.: Santa Lucia Range, 2 mi. NW. Cuesta Pass, 4-V-1982 (CISC); Santa Clara Co.: Chemeketa Park, 8-VIII-1955 (CSSJ); Loma Prieta Mt., 23-VI-1968 (USNM); Shasta Co.: Big Bend, 2800 ft., 3/4-VII-1965 (CASC); Hat Creek P. O., 14-VII-1955 (UCDC); 25-VI-1955, 12&15-VII-1955, 19-VII-1955, 16-VIII-1956 (CISC); 1 mi. NE. Montgomery Ck., 8&14-VIII-1969 (CASC); Mountain Gate, 1000 ft., 15/17-V-1977 (PAAC); Solano Co.: G. L. Stebbins Cold Canyon Res., 15-IX-1989 (CISC), 31-VII-1991 (UCDC); Toulumne Co.: Sonora, 14-VI-1962 (USNM); Twain Harte, 3500 ft., 3-IV-1962, 19-VIII-1965, 4&23-VII-1966, 4&18-VIII-1966, 22&26-VIII-1967, 5-IX-1967, 5-VII-1968, 31-VIII-1985, 4-IX-1987 (OMNH), 31-VII-1966, 1968, 7&27-X-1963 (CASC); 20-VIII-1960, 1-IX-1961 (CISC); Yuba Co.: Camp Far West Res. Dam, 6-V-1980 (CISC). NEVADA: Elko Co.: LaMoille Cyn., 4-VIII-1964 (UCDC); Lander Co.: 30 mi. S. Austin, Kingston Camp, 7300 ft., 15-VII-1966 (AMNH); Washoe Co.: 9 mi. S. Reno, 9&10-VII-1965 (UCDC);

Reno, 20-VI-1975 (PAAC). OREGON: Jefferson Co.: Pelton Dam, 24-VI-1962 (CISC).

Remarks. Dark maculation, broadness of the forewing along with distribution of squamae and characters of the male and female genitalia separate latipennis from occidentalis and N sp. 1, both of which occur sympatrically. Males of latipennis possess a narrow anterior ventral process on the coxopodites and a short mediuncus, while females eighth sternite is wide medially and the spermatheca is very large with numerous coils to the fertilization canal. The primarily southern California species fulva can be distinguished from latipennis using the same characters. There has been some confusion with this species and N sp. 1, with many workers considering them to be conspecific. However, N. sp. 1 can be separated from latipennis by the presence of squamae on the forecoxae of the female, which latipennis lacks. One publication by Johnson and Hagen (1981) on the production of an aggressive allomone by latipennis probably refers to the other species. Larvae have been reared by Tauber and Tauber (1968) using the dampwood termite, Zootermopsis angusticollis.

Lomamyia longicollis (Walker)

(Figures 7, 19, 33, 42)

Hemerobius longicollis Walker, 1853:281; Hagen, 1861:200. Lomamyia longicollis; Carpenter, 1940:267; Carpenter, 1942:50; Brushwein, 1987:150.

Description. Face yellow, brown maculation; clypeus dark yellow, labrum yellow with red spots, palpi reddish; vertex and frons dark yellow; antennae yellow, brown spots on each segment, scapes yellow with a single basal brown streak; setae reddish-brown.

Pronotum yellow, brown maculation forming four longitudinal bands dorsally; mesonotum and metanotum diffuse brown; pleural area yellow.

Femora and tibiae pale white with brown spots; distal end of first and fifth tarsomeres with brown bands.

Average forewing (Figure 33) length 9.4 mm; width 4.2 mm. Membrane hyaline, brown maculation; costal area broad, margin straight, six brown spots before pterostigma; pterostigma reddish; wing margin rounded beyond apex; three radial crossveins, one directly below the pterostigma; gradate crossveins unmargined, tufts of black setae conspicuous. Hindwing membrane hyaline; no maculation on radial crossveins or gradate veins.

Genitalia (Figures 7, 19). Male ninth coxopodites narrowly joined medially, pair of ventral processes long

and tapered, dorsal processes short, both pairs directed anteriorly; mediuncus basally enlarged, curved. Female hypocaudae long, thin; lobes of eighth sternite reduced, joined in a broad bridge medially; eighth gonocoxite prominent; rods small; spermatheca small; fertilization canal coils simple.

Holotype (BMNH). Female cotypes, antennae missing from one specimen along with a tear in the right forewing, other specimen in good condition with the exception of missing right antenna. "Georgia," Abbot.

Distribution. Southeastern United States.

Material examined. FLORIDA: Alachua Co.: Gainesville, Austin Cory Forest, 14-IX-1976 (FSCA); Okaloosa Co.: FAM (sic!) Biol. Station, 3 mi. NW. Holt, 8-11-VIII-1979 (FSCA). GEORGIA: Clarke Co.: 2-IV-1974 (UICM). MARYLAND: Prince Georges Co.: Beltsville, 24-IX-1964 (CASC).

Remarks. This rather unique nearctic species can be identified by the presence of three radial crossveins and the rounded character of the forewing. Genitalic features of the males include a short but anteriorly expanded mediuncus, while the females possess a much reduced eighth sternite with no projections or significant lobes, and a small spermatheca with two convolutions of the fertilization canal coils. Type specimens in the British Museum are actually female, not male as stated by Carpenter

(1940). Few specimens of longicollis were available from institutions, owing to the fact that this species closely resembles hemerobiids and is often misplaced in collections. Brushwein (1987) found cocoons of this species in association with the eastern subterranean termite Reticulitermes flavipes, which is possibly its larval host. No larvae have yet been recorded for this species.

Lomamyia occidentalis (Banks)

(Figures 8, 20, 34, 43)

Berotha occidentalis Banks, 1903:240 (nom. nud.); Banks, 1905a:89.

Lomamyia occidentalis; Banks, 1905b:48; Banks, 1907:23; Carpenter, 1940:263; Spencer, 1942:26; Toschi, 1964:24 (nom. conf.).

Description. Face dark yellow; clypeus, labrum dark yellow; palpi brown; vertex, frons dark yellow with central brown spot, scattered brown spots; antennae, scapes, setae yellow; head setae black.

Pronotum, mesonotum gray with brown spots; metanotum dark yellow with gray maculation.

Femora, tibiae gray with brown spots; first and fifth tarsomeres with distal brown bands.

Average forewing (Figure 34) length 11.8 mm; width 4.9 mm. Membrane hyaline, numerous brown maculation; costal

area wide, margin almost straight, six brown spots before pterostigma; pterostigma reddish; wing margin incised beyond apex; two radial crossveins; gradate crossveins margined, tufts of stout black setae; other wing veins with white and black hairs; female squamae dorsally at base of radial sector, anterior and posterior media. Hindwing membrane hyaline; radial crossveins and gradate crossveins margined; squamae restricted to radial sector base.

Genitalia (Figures 8, 20). Male ninth coxopodite lobes narrowly joined medially, pair of long ventral processes, enlarged anteriorly, pair of short dorsal processes; mediuncus curved and expanded anteriorly; female eighth sternite lobes large, joined in a narrow bridge medially, posterior processes long; rods prominent; spermatheca small, fertilization canal coils complex.

Holotype (MCZC). Female, lectotype designation by Carpenter (1940). NEVADA: Ormsby Co.: C. F. Baker

Distribution. (Figure 43) Western North America.

Material examined. CALIFORNIA: (no county) Clayton, 20-VII-1935 (KUIC) (allotype designation on specimen incorrect); Lassen Co.: Susanville, 17-VII-1937 (LACM); Nevada Co.: Sagehen Creek, 5-VII-1962 (LACM); Plumas Co.: 4 mi. W. Quincy, 14-VII-1949 (PAAC); San Bernardino Co.: Lake Arrowhead, 12-VII-1953 (LACM); Camp O-ongo, nr. Running Sprs., 24/28-VIII-1969 (LACM); San Diego Co.: San Diego, 5-