WILLIAM L. PETERS

A Revision of the Leptophlebiidae of the West Indies (Ephemeroptera)

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ABSTRACT

Peters, William L. A. Revision of the Leptophlebiidae of the West Indies (Ephemeroptera). *Smithsonian Contributions to Zoology,* 62:1–48, 1971.—This study is a revision of the West Indian Leptophlebiidae and is based on reared or associated nymphs and adults. Three new genera, *Farrodes, Careospina,* and *Traverina* are established; the genera *Neohagenulus, Hagenulus,* and *Borinquena* are considered valid. Two subgenera, *Borinquena* sensu stricto and *Australphlebia,* are established for *Borinquena.* Eleven new species are described, *Farrodes hyalinus, F. grenadae, F. bimaculatus, Careospina hespera, C. minuta, C. annulata, Hagenulus jamaicensis, H. morrisonae, H. rangelae, Traverina cubensis,* and *Borinquena (A.) traverae.* The phylogeny and relationships of the West Indian genera are discussed.

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Introduction

Sufficient collections of Leptophlebiidae are not available from most parts of the world to contemplate species revisions of a genus or group of related genera. Especially, reared or associated nymphs and adults are not available and are difficult to obtain. This study is rather unique as a good quantity of leptophlebiid material is available from the West Indies, including many associated or reared nymphs and adults. While undoubtedly more species of the West Indian Leptophlebiidae are yet to be found and described, the present study does provide an addition to the species revision of the Neotropical Leptophlebiidae.

The term "West Indies" as used herein includes all islands in the Caribbean Archipelago extending from Florida in North America and Yucatan in Central America to Venezuela in South America. The term "Greater Antilles" includes Cuba, Hispaniola (Haiti and Dominican Republic), Jamaica, and Puerto Rico, and the term "Lesser Antilles" consists of an irregular chain of islands including Trinidad between the Greater Antilles and South America. Although the Bahamas are usually included as the third group of islands in the West Indies, no mayflies were available from the Bahamas for study.

Traver (1938) published the only detailed study of the Leptophlebiidae from any part of the West Indies. From Puerto Rico she established two new genera of the Leptophlebiidae—*Neohagenulus* with three new species and *Borinquena* with two new species. The only other known leptophlebiid genus from the West Indies is *Hagenulus,* which was originally established by Eaton (1882) from female imagos and a male subimago of a new species collected in Cuba. Morrison (1919) questionably described the nymphs of *Hagenulus* from Cuba and later Traver (1938) discussed the possibility that these nymphs were not *Hagenulus.* Until recently *Hagenulus* was considered a wide-ranging genus occurring in the West Indies and the Eastern Hemisphere. As pointed out herein, *Hagenulus* is restricted to the Neotropical region.

The following terms and procedures used in the generic descriptions of the imagos and nymphs require further explanation. The lengths of the body and fore wings of the male and female imagos are given as the total observed variation within a genus. Venational terminology used is as indicated in Figures 4 and 5. Each segment of the fore legs of the male imagos is compared to the length of the fore tibiae and expressed as a ratio; the average length in millimeters of the fore tibiae is given in parentheses. In the figures of the labia of the genera, the ventral surface is shown on the right-hand side of the drawing, and the dorsal surface is shown on the left.

The research on which this report is based was supported by grants from the National Science Foundation to the University of Utah, Salt Lake City, and Florida Agricultural and Mechanical University, Tallahassee, William L. Peters, Principal Investigator. Specimens collected by the author in Jamaica were from a field trip supported by a Grant-in-Aid of Research from the Society of the Sigma Xi.

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I thank Dr. George F. Edmunds, Jr., University of Utah, for permitting me to use his collections and facilities during a part of this study and for information on types at the Museum of Comparative Zoology. I wish to thank Dr. Jay R. Traver, Amherst, Massachusetts, for continuous help during this study and for permission to republish some of her illustrations. The completion of this work was dependent upon the following persons for the loan or gift of specimens: Dr. Alayo; Dr. P. J. Darlington, Jr., and Dr. Howard E. Evans, Museum of Comparative Zoology, Cambridge; Dr. Thomas H. Farr; Dr. Oliver S. Flint, Jr., National Museum of Natural History; Dr. V. Landa, Institute of Entomology, Czechoslovakian Academy of Science, Prague; Dr. L. L. Pechuman, Cornell University, Ithaca; and Dr. Jay R. Traver. I wish to thank Drs. Traver, Edmunds, Alayo, Farr, and Flint for critical reading of part or all of the manuscript. Thanks are expressed to Mrs. William L. Peters and Mr. Steven L. Jensen, University of Utah, for preparation of the illustrations under my supervision.

TABLE 1.—Verification of Mature Nymphs

			Maxillary palpi		*Labial palpi*				
Genus	*Distribution*	*Denticles on labrum*	*Length segment 2 to 1*	*Length segment 3 to 2*	*Length segment 2 to 1*	*Length segment 3 to 2*	*Denticles on claws*	*Abdominal gills*	*Posterolateral spines on abdominal segments*
Farrodes	Jamaica, Cuba, Grenada	5 small, =sized	1⅓	⅓–½	1⅓	⅓–½	Progressively larger apically, apical denticle larger	Long & slender (2 lamellae)	8–9
Traverina	Cuba	4–5 small, =sized	1⅓	½	little longer	⅕–¼	Progressively larger apically	Platelike, terminated with 3 filaments (2 lamellae)	6–9
Careospina	Cuba	4–5 small, =sized	1¼	½	little longer	¼	Progressively larger apically	Long & slender (deeply forked)	5 or 6–9
Neohagenulus	Puerto Rico	4–5 small, =sized	=	½–¾	little longer –1⅓	⅕–¼	Progressively larger apically	Long & slender (deeply forked)	3–9
Hagenulus	Cuba, Haiti, Jamaica, Puerto Rico	3–5 small, =sized	=or 1½–2	½	little longer –less than 2	¼	Progressively larger apically	Long & slender (deeply forked)	5–9
Borinquena	Puerto Rico, Dominica, St. Lucia	2 large, =sized & 1–3 small, ≠ sized	1¼–1½	⅓–½	little longer	⅕–⅓	Progressively larger apically, apical denticle larger	Long & slender (1 lamella or deeply forked	6 or 7–9
B. (Borinquena)	Puerto Rico							Long & slender (1 lamella)	
B. (Australphlebia)	Dominica, St. Lucia							Long & slender (deeply forked)	

Keys to the Genera of the Leptophlebiidae from the West Indies

Imagos

1. Apical two-thirds of penes of male genitalia divided, a ventral appendage arising from apex of each penis lobe (Figures 73–78); ninth sternum of female entire (Figure 104). ***Farrodes,*** new genus

   Penes of male genitalia not as above (Figures 79–96); ninth sternum of female cleft (Figures 105–110) 2

2. Terminal filament greatly reduced, with 6–7 segments (Figure 121); penes of male genitalia without subapical, ventral spines (Figures 80–83) ..... ***Careospina,*** new genus

   Terminal filament longer than cerci; penes of male genitalia with subapical, ventral spines (Figures 79, 84–87, 89–96), except for *Hagenulus morrisonae* (Figure 88) 3

3. Penes of male genitalia divided, basal half of penis lobes connected by a sclerotized membrane (Figures 84–86); apex of costal projection of hind wings extending past apex of wings (Figures 34–35, 37–42) ..... ***Neohagenulus***

   Penes of male genitalia divided, no sclerotized membrane connecting penis lobes (Figures 79, 87–96); costal projection of hind wings, if present, not extending past apex of wings (Figures 16–17, 19–20, 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66, 68–71) 4

4. Apex of hind wings broad and angularly truncated (Figures 16–17, 19–20); male genitalia as in Figure 79; female with a short ovipositor or egg guide extending to anterior margin of abdominal segment 8 (Figure 111) ..... ***Traverina,*** new genus

   Apex of hind wings, if present, rounded (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66, 68–71); male genitalia as in Figures 87–96; female with a well-developed ovipositor or egg guide extending to at least anterior margin of abdominal segment 10 (Figures 114–120) 5

5. Cross veins in fore wings of female surrounded with dark clouds (Figures 46, 52, 55, 61); few to many cross veins in fore wings of male surrounded with dark clouds (Figures 43, 49, 64) or fringed with darker color (Figure 58) ..... ***Hagenulus***

   Cross veins in fore wings of male and female not surrounded with dark clouds (Figures 67, 72) ..... (***Borinquena***) 6

6. Hind wings present (Figures 68–71) ..... ***B.*** (***Borinquena,*** sensu stricto)

   Hind wings absent ..... ***B.*** (***Australphlebia***), new subgenus

Mature nymphs

1. Abdominal gills on segments 1–7 alike, dorsal and ventral lamellae platelike and terminated in three processes, with median projection longer than laterals (Figure 205). ***Traverina,*** new genus

   Abdominal gills not as above (Figures 204, 206–210); each lamella slender or deeply forked 2

2. Anterior margin of labrum fringed with an even or uneven band of hair (Figures 186, 188, 190) ..... ***Hagenulus***

   Two even rows of hair on anterior margin of labrum (Figures 176, 181, 183, 192, 195) 3

3. Posterolateral spines on abdominal segments 3–9, spines progressively larger posteriorly. ***Neohagenulus***

   Posterolateral spines on abdominal segments 5 or 6 to 9, spines progressively larger posteriorly 4

4. Two large, equal-sized denticles and sometimes 1 to 3 small unequal-sized denticles on anteromedian emargination of labrum (Figures 193–194, 196) ..... (***Borinquena***) 5

   Four to five small, equal-sized denticles on anteromedian emargination of labrum (Figures 177, 182) 6

5. Abdominal gills on segments 1–7 alike, each gill consists of 1 long, slender portion (Figure 209) ..... ***B.*** (***Borinquena,*** sensu stricto)

   Abdominal gills on segments 1–7 alike, each gill deeply forked (Figure 210). ***B.*** (***Australphlebia***), new subgenus

6. Posterolateral spines on abdominal segments 8 and 9 (Figure 211); denticles on claws progressively larger apically except apical denticle much larger (Figure 197).
Farrodes, new genus

Posterolateral spines on abdominal segments 5 or 6 to 9 (Figure 212); denticles on claws progressively larger apically (Figure 199) ..... ***Careospina,*** new genus

La clave los generos de Leptophlebiidae de las Antillas

Imagos

1. Machos con los penes divididos en sus ⅔ apicales, y con un apéndice ventral naciendo del ápice de cada lóbulo penial (Figuras 73–78); hembras con el noveno esternito abdominal entero (Figura 104) ..... ***Farrodes,*** nuevo género

Machos con los penes en otra forma (Figuras 79–96); hembras con el noveno esternito abdominal hendido (Figuras 105–110) 2

2. Filamento terminal muy reducido, con 6–7 segmentos (Figura 121); machos con los penes desprovistos de espinas ventrales subapicales (Figuras 80–83) ... ***Careospina,*** nuevo género

Filamento terminal mas largo que los ceros caudales; machos con los penes provistos de espinas ventrales subapicales (Figuras 79, 84–87, 89–96), excepto en *Hagenulus morrisonae* (Figura 88) 3

3. Machos con los penes divididos, mitad basal de los lóbulos peniales conectada por una membrana esclerotizada (Figuras 84–86); ápice de la proyección costal de las alas posteriores prolongada más allá del ápice del ala (Figuras 34–35, 37–42). ***Neohagenulus***

Machos con los penes divididos, lóbulos peniales no conectados por una membrana esclerotizada (Figuras 79, 87–96); la proyección costal de las alas posteriores, si existe, no sobrepasa el ápice del ala (Figuras 16–17, 19–20, 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66, 68–71) 4

4. Apice de las alas posteriores amplia y angularmente truncado (Figuras 16–17, 19–20); genitalia de los machos como en la Figura 79; hembras con un corto ovipositor que llega hasta el margen anterior del octavo segmento abdominal (Figura 111).
Traverina, nuevo género

Apice de las alas posteriores (si éstas existen), redondeado (Figuras 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66, 68–71); genitalia de los machos como en las Figuras 87–96; hembras con un bien desarrollado ovipositor que llega por lo menos hasta el margen anterior del décimo segmento abdominal (Figuras 114–120) 5

5. Hembras con las nervuras transversales de las alas anteriores rodeadas por una manchita oscura (Figuras 46, 52, 55, 61); machos con pocas o muchas nervuras transversales de las alas anteriores rodeadas por manchitas oscuras (Figuras 43, 49, 64) a bordeadas por un color mas oscuro (Figura 58) ..... ***Hagenulus***

Machos y hembras con las nervuras transversales de las alas anteriores no rodeadas por manchitas oscuras (Figuras 67, 72) ..... (***Borinquena***) 6

6. Alas posteriores presentes (Figuras 68–71) ..... ***B. (Borinquena,*** sensu stricto)
Alas posteriores ausentes ..... ***B. (Australphlebia),*** nuevo subgénero

Ninfas maduras

1. Branquias abdominales de los segmentos 1–7 iguales, con sus lamelas dorsal y ventral en forma de láminas lanceoladas, y terminadas en tres procesos, el del medio mas largo que los laterales (Figura 205) ..... ***Traverina,*** nuevo género

Branquias abdominales de otra forma (Figuras 204, 206–210); cada lamela muy delgada u hondamente bifurcada 2

2. Margen anterior del labro provisto de una franja de pelos pareja o dispareja (Figuras 186, 188, 190) ..... ***Hagenulus***

Margen anterior del labro con dos hileras parejas de pelos (Figuras 176, 181, 183, 192, 195). 3

3. Segmentos abdominales 3–9 con espinas posterolaterales, éstas progresivamente mayores. ***Neohagenulus***

Segmentos abdominales 5 ó 6 hasta el 9 con espinas posterolaterales, éstas progresivamente mayores 4

4. Dos dentículos grandes de tamaño igual y algunas veces de uno a tres más, pequeños y disparejos, en la emarginación ántero-media del labro (Figuras 193–194, 196). (***Borinquena***) 5

De 4 a 5 dentículos pequeños e iguales en la emarginación ántero-media del labro (Figuras 177, 182) 6

5. Branquias abdominales de los segmentos 1–7 iguales, cada branquia de forma alargada y delgada, no bifurcada (Figura 209) ..... ***B. (Borinquena,*** sensu stricto)

Branquias abdominales de los segmentos 1–7 iguales, cada una hondamente bifurcada (Figura 210) ..... ***B. (Australphlebia)***, nuevo subgénero

6. Segmentos abdominales 8 y 9 con espinas posterolaterales (Figura 211); dentículos de las garras progresivamente mayores hacia el ápice, excepto el dentículo apical que es mucho mayor (Figura 197) ..... ***Farrodes,*** nuevo género

Segmentos abdominales 5 ó 6 hasta el 9 con espinas posterolaterales (Figura 212); dentículos de las garras progresivamente mayores hacia el ápice (Figura 199). ***Careospina,*** nuevo género

Farrodes Peters, new genus

FIGURES 6–14, 73–78, 97, 104, 122–124, 139, 148, 157, 166, 176–177, 197, 204, 211

IMAGO.—Length of male: body, 4.2–5.5 mm.; fore wings, 4.0–6.2 mm. Length of female: body, 4.2–5.8 mm.; fore wings, 5.2–5.6 mm. Eyes of male meet on meson of head, upper portion of eyes on short stalk, lower portion of eyes two-thirds length of upper portion; eyes of female separated on meson of head by a length 4 times maximum width of an eye. Wings (Figures 6–14): vein R_4 of fore wings forked one-third of distance from base to margin; vein MA forked more than half of distance from base to margin, fork asymmetrical; vein MP forked less than half of distance from base to margin, fork symmetrical; cubital area as in Figures 6, 9, and 12; cross veins few. Costal projection of hind wings acute, short, and well developed (Figures 7–8, 10–11, 13–14), apex located half to more than half the distance from base; apex of wings broad and angularly truncated (Figures 7–8, 10–11, 13–14); cross veins few. Legs: ratios of segments in male fore legs, 0.45: 1.00 (2.30 mm.): 0.05: 0.36: 0.27: 0.11: 0.07. Claws of a pair dissimilar, one apically hooked (Figure 97), other obtuse, padlike. Male genitalia (Figures 73–78): segments 2 and 3 of forceps short, basal segment of forceps narrow, strongly bowed; styliger plate deeply cleft apically and extends posteriorly dorsal to forceps (Figures 73–78); apical two-thirds of penes divided, a ventral appendage arising from apex of each penis lobe as in Figures 73–78. Ninth sternum of female entire (Figure 104). Terminal filament longer than cerci.

MATURE NYMPH.—Head prognathous. Antennae 2½ times maximum length of head. Mouthparts (Figures 139, 148, 157, 166, 176–177): dorsal hair on labrum as in Figure 176; submedian and anterolateral areas of hair ventrally; 5 equal-sized denticles on anteromedian emargination (Figure 177). Clypeus as in Figure 176. Left mandible as in Figure 166. Lingua of hypopharynx with well-developed lateral processes (Figure 157), anterior margin deeply cleft; superlingua of hypopharynx as in Figure 157, with a row of hair along anterior margin. Segment 2 of maxillary palpi one and one-third length of segment 1; segment 3 one-third to half the length of segment 2, triangular; a V-shaped ridge near the ventral, inner anterolateral margin of maxillae; hair on maxillae as in Figure 148. Labium as in Figure 139; segment 2 of palpi equal to one and one-third length of segment 1; segment 3 one-third to half the length of segment 2, triangular; paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax only. Legs (Figure 197): claws apically hooked, denticles on claws progressively larger apically except apical denticle much larger. Gills (Figure 204): gills on segments 1–7 alike; each portion of gills long and slender. Posterolateral spines on abdominal segments 8–9, spines progressively larger posteriorly. Terminal filament slightly longer than cerci.

ETYMOLOGY.—Genus is named for Dr. Thomas H. Farr, Institute of Jamaica, Kingston, who has

greatly contributed to and encouraged my work on the West Indian Leptophlebiidae.

TYPE SPECIES.—*Farrodes hyalinus* Peters, new species.

DISCUSSION.—*Farrodes*, new genus, can be distinguished from other West Indian genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) a ventral appendage arises from the apex of each penis lobe of the males (Figures 73–78), (2) the base of vein ICu_1 of the fore wings does not connect with vein CuP (Figures 6, 9, 12), and (3) the hind wings are well developed and each has a short, well-developed costal projection (Figures 7–8, 10–11, 13–14). In the nymphs (1) the denticles on the claws are progressively larger apically, except the apical denticle is much larger (Figure 197), (2) 5 equal-sized denticles are present on the anteromedian emargination of the labrum (Figure 177), and (3) posterolateral spines are present on abdominal segments 8–9 (Figure 211). *Farrodes* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) the fork of vein MP of the fore wings is symmetrical (Figures 6, 9, 12), (2) the base of vein ICu_1 of the fore wings does not attach to vein CuA or CuP (Figures 6, 9, 12), (3) the tarsal claws of a pair are dissimilar, one is apically hooked while the other is obtuse, padlike (Figure 97), and (4) the styliger plate of the male imagos is deeply cleft apically and extends posteriorly dorsal to the forceps (Figures 73–78). In the nymphs (1) abdominal gills on segments 1–7 are alike and each portion of the gills is long and slender (Figure 204), (2) the denticles on the claws are progressively larger apically except the apical denticle is much larger (Figure 197), (3) 5 equal-sized denticles are present on the anteromedian emargination of the labrum (Figure 177), and (4) a V-shaped ridge is present near the ventral, inner anterolateral margin of the maxillae (Figure 148).

Key to the Species of *Farrodes* Peters, new genus

IMAGOS

1. Thorax of male buff, sutures lighter; a large, longitudinal, dark brown band on pleura of thorax of female subimago; ventral appendages on penes of male as in Figures 75–76; Grenada ..... ***F. grenadae***, new species

   Thorax of male brown, sutures lighter; no darker bands on pleura of thorax of female; appendages on penes of male as in Figures 73–74, 77–78 2

2. Submedian, dark brown maculae near anterior margin on terga 2–6 of male; femora of legs of female uniformly pale; ventral appendages on penes of male as in Figures 77–78; Cuba. ***F. bimaculatus***, new species

   Terga 2–6 of male without submedian maculae; apex of femora of legs of female darker brown than remaining portion of femora; ventral appendages on penes of male as in Figures 73–74; Jamaica ..... ***F. hyalinus***, new species

MATURE NYMPHS

1. Posterior margin of abdominal terga 1–8 with a narrow darker band (Figure 211); Jamaica. ***F. hyalinus***, new species

   Abdominal terga 1–8 uniformly dark brown; Grenada ..... ***F. grenadae***, new species

Clave para las Especies de *Farrodes* Peters, nuevo género

IMAGOS

1. Machos con el tórax de color amarillo pajizo, con las suturas mas claras; subimagos hembras con una faja grande y longitudinal, pardo-oscura, en las pleuras del tórax; apéndices ventrales en los penes del macho como en la Figuras 75–76; Grenada. ***F. grenadae***, nuevo especie

   Machos con el tórax de color pardo, con las suturas mas claras; hembras sin fajas oscuras pleurales; apéndices en los penes del macho como en las Figuras 73–74, 77–78 2

2. Macho con manchas pardo-oscuras submedianas cercanas al margen anterior de los tergitos 2–6; hembra con los fémures uniformemente pálidos; apéndices ventrales en los penes del macho como en las Figuras 77–78; Cuba ..... ***F. bimaculatus,*** nuevo especie

Macho sin manchas submedianas en los tergitos 2–6; hembra con el ápice de los fémures de un color pardo mas oscuro que el resto del segmento; apéndices ventrales en los penes del macho como en las Figuras 73–74; Jamaica ..... ***F. hyalinus,*** nuevo especie

NINFAS MADURAS

1. Margen posterior de los tergitos abdominales 1–8 con una estrecha banda oscura; Jamaica. ***F. hyalinus,*** nuevo especie

Tergitos abdominales 1–8 uniformemente pardo-oscuros; Grenada. ***F. grenadae,*** nuevo especie

Farrodes hyalinus Peters, new species

FIGURES 6–8, 73–74, 97, 104, 139, 148, 157, 166, 176–177, 197, 204, 211

MALE IMAGO (in alcohol).—Length: body, 4.4–5.0 mm.; fore wings, 4.6–5.0 mm. Upper portion of eyes and stalks brown, lower portion black. Head light brown. Base of ocelli black, remainder white. Thorax and coxae of legs brown, sutures paler. Prothoracic and mesothoracic legs pale, apex of femora light brown; metathoracic legs pale, apex of femora brown. Wings (Figures 6–8): longitudinal veins of fore and hind wings light brown, cross veins paler; membrane of fore and hind wings hyaline, except distal third of cells C and Sc of fore wings translucent, and base of wings brown. Abdomen: segments 1–6 hyaline washed lightly with brown, posterior margin of terga 1–6 with a narrow black band, terga 3–6 with a narrow, black, longitudinal streak; spiracles and tracheae black on segments 1–8; segments 7–9 opaque, terga 7–9 washed with dark brown, sterna 7–9 paler. Genitalia (Figures 73–74): basal half of forceps segment 1 brown, remainder of forceps and penes paler. Caudal filaments pale.

FEMALE IMAGO (in alcohol).—Length: body, 4.2–4.4 mm.; fore wings, 5.2–5.6 mm. Eyes black. Head brown. Color of thorax and legs as in male imago, except apex of metathoracic femora light brown. Wings: longitudinal and cross veins of fore and hind wings brown, membrane hyaline. Abdomen: brown, posterior margin of segments 1–8, spiracles and tracheae darker. Caudal filaments light brown.

MATURE NYMPH (in alcohol).—Head brown, venter paler. Thorax brown, sterna paler, lateral margins of terga black. Legs pale, markings as in male and female imagos. Abdomen brown, sterna paler, markings as in Figure 211. Gills gray, tracheae black. Caudal filaments pale.

Holotype male imago, Jamaica: Trelawny Parish, Martha Brae River, Good Hope, 23–24 September 1963; allotype female imago: same data as for holotypes; paratopotypes: 33 male imagos, 16 female imagos, 49 male subimagos, 38 female subimagos, 20 nymphs. All types were collected by W. L. Peters and T. H. Farr and are in alcohol. Four male imaginal, two female imaginal, six male subimaginal, five female subimaginal, and four nymphal paratopotypes were deposited in each of the collections of National Museum of Natural History, University of Utah, and Institute of Jamaica. Holotype, allotype, and remaining paratopotypes have been deposited in the collections of Florida A & M University.

ETYMOLOGY.—Latin hyalinus, meaning transparent.

DISCUSSION.—*Farrodes hyalinus* can be distinguished from the other two described species of *Farrodes* by the following characters. In the imagos (1) the shape of the ventral appendages on the penes of the male imagos is as given in Figures 73–74, (2) the basal half of forceps segment 1 of the male genitalia is brown, remainder of forceps is paler, and (3) the color pattern on the abdominal terga of the male and female imagos is as given in the descriptions. In the nymphs (1) a narrow dark brown band is present on the posterior margin of abdominal terga 1–8 (Figure 211), and (2) the apex of the femora of the prothoracic and mesothoracic legs is dark brown. The nymphs and adults of *F. hyalinus* are associated by rearing.

Mature nymphs are found among submerged plants near the banks of the river. The nymphs of *F. hyalinus* emerge at dusk. Subimagos molt at sun-

rise and mating occurs in the morning in full sunlight.

Farrodes grenadae Peters, new species

FIGURES 9–11, 75–76, 122–123

MALE IMAGO (in alcohol).—Length: body, 4.2 mm.; fore wings, 4.0–4.2 mm. Upper portion of eyes, stalks, and head buff, lower portion of eyes black. Base of ocelli black, remainder white. Thorax and coxae of legs buff, sutures paler. Remainder of legs pale, except apex of metathoracic femora brown, and a brown macula on outer surface of metathoracic femora. Wings (Figures 9–11): longitudinal veins of fore and hind wings buff, cross veins paler; membrane of fore and hind wings hyaline, except distal third of cells C and Sc of fore wings translucent. Abdomen: segments 1–7 hyaline, terga 1–7 washed with dark brown as in Figures 122–123, remainder of terga 1–7 and sterna 1–7 washed with light buff; spiracles and tracheae dark brown on segments 1–8; segments 8 and 9 opaque, terga 8 and 9 uniformly washed with buff, sterna 8 and 9 paler. Genitalia (Figures 75–76): buff. Caudal filaments pale.

FEMALE IMAGO.—Unknown.

FEMALE SUBIMAGO (in alcohol).—Length: body, 3.8–4.5 mm.; fore wings, 4.5–4.7 mm. Eyes black. Head light buff. Thorax buff, sutures, sterna, and prothorax paler; submedian, oblique, dark brown bands on notum of prothorax, lateral margins of prothoracic notum dark brown; a large, longitudinal dark brown band on pleura of thorax. Legs: buff, color markings as in male imago, except the brown macula on outer surface of metathoracic femora smaller. Wings: color as in male imago. Abdomen: buff, terga 1–9 washed with dark brown as terga 1–7 of male imago. Caudal filaments pale.

MATURE NYMPH (in alcohol).—Head brown, venter paler. Thorax brown, venter paler, lateral margins of prothoracic notum darker. Legs pale, color markings as in male imago. Abdomen brown, sterna paler. Gills gray, tracheae black. Caudal filaments pale.

Holotype male imago, Grenada: Balthazar, 7 August 1963; paratopotypes: 10 male imagos, 107 male subimagos, 89 female subimagos; paratypes: 1 nymph, Grenada: Great River, Balthazar, 8 August 1963; 1 male imago, 6 male subimagos, 2 female subimagos, Grenada: 2 miles east of Lago Grand Etang, 8 August 1963. All types were collected by O. S. Flint, Jr., and are in alcohol. Three male imaginal, 20 male subimaginal, and 15 female subimaginal paratopotypes were deposited in each of the collections of Florida A & M University and the University of Utah; the remaining types were deposited in the collections of the National Museum of Natural History.

ETYMOLOGY.—Species is named for the island of Grenada.

DISCUSSION.—*Farrodes grenadae* can be distinguished from the other two described species of *Farrodes* by the following characters. In the imagos (1) the shape of the ventral appendages on the penes of the male imagos is as given in Figures 75–76, (2) forceps segment 1 of the male genitalia is entirely buff, and (3) the color pattern on the abdominal terga of the male and female imagos is as given in the descriptions and Figures 122–123. In the nymphs (1) abdominal terga 1–8 are uniformly brown, and (2) the prothoracic and mesothoracic legs are entirely pale. The nymphs and adults of *F. grenadae* are associated by the developing wing pads and color markings on the metathoracic legs of the nymphs collected from the same locality as the adults.

Farrodes bimaculatus Peters and Alayo, new species

FIGURES 12–14, 77–78, 124

MALE IMAGO (in alcohol).—Length: body, 5.5 mm.; fore wings, 6.2 mm. Upper portion of eyes and stalks brown, lower portion black. Head brown, base of ocelli brown, remainder white. Thorax and coxae of legs brown, sutures paler, carinae darker. Prothoracic, mesothoracic, and metathoracic legs pale. Wings (Figures 12–14): longitudinal veins and membrane of fore and hind wings hyaline. Abdomen: tergum 1 hyaline, lateral margins washed with dark brown, terga 2–6 hyaline, posterior margin with a narrow, transverse, dark brown band, submedian, dark brown maculae near anterior margin on each segment, spiracles and tracheae dark brown, tergum 7 light brown, darker brown markings similar to those of female as in Figure 124, terga 8 and 9 dark brown; sterna 1–7 hyaline, sterna 8 and 9 dark brown. Genitalia (Figures 77–

78): forceps segment 1 brown, remainder of forceps and penes paler. Caudal filaments pale.

FEMALE IMAGO (in alcohol).—Length: body, 5.8 mm.; fore wings, 5.6 mm. Eyes gray. Head light brown. Thorax light brown, sutures paler, carinae darker on pleura. Legs uniformly pale. Wings: longitudinal veins of fore and hind wings light brown, cross veins paler; membrane of fore and hind wings hyaline, except distal third of cells C and Sc of fore wings translucent. Abdomen: terga light brown, terga 2–7 with darker color markings as in Figure 124; sterna light brown. Caudal filaments broken off and missing.

MATURE NYMPH.—Unknown.

Holotypes male imago, Cuba: La Habana Prov., Güines (field no. 43), March 1966; allotype female imago, Cuba: La Habana Prov., Güines (field no. 42), March 1966; paratopotypes: 3 male imagos. All types were collected by P. Alayo D. and are in alcohol. Holotype, allotype, and 1 paratopotype were deposited in the collection of the Institute of Biology, Academy of Science of the Republic of Cuba. Remaining paratopotypes were deposited in the collections of Florida A & M University.

ETYMOLOGY.—Latin bis, meaning two; Latin macula, meaning spot.

DISCUSSION.—*Farrodes bimaculatus* can be distinguished from the other two described species of *Farrodes* by the following characters. In the imagos (1) the shape of the ventral appendages on the penes of the male imagos is as given in Figures 77–78, (2) forceps segment 1 of the male genitalia is uniformly brown, and (3) the color pattern on the abdominal terga of the male and female imagos is as given in the descriptions and Figure 124.

Traverina Peters, new genus

FIGURES 15–20, 79, 98, 105, 111, 125–126, 140, 149, 158, 167–168, 178–180, 198, 205

IMAGO.—Length of male: body, 6.4 mm.; fore wings, 6.3 mm. Length of female: body, 6.1 mm.; fore wings, 6.9 mm. Eyes of male meet on meson of head, upper portion of eyes on short stalk, lower portion of eyes three-fourths length of upper portion; eyes of female separated on meson of head by a length 3 times maximum width of an eye. Fore wings of male (Figure 15): vein R_s of fore wings forked one-fourth of distance from base to margin; vein MA forked half of distance from base to margin, fork asymmetrical, distal portion of vein MA sagged posteriorly; vein MP forked less than one-third of distance from base to margin, fork symmetrical; cubital area as in Figure 15; cross veins few. Fore wings of female (Figure 18): vein R_s of fore wings forked less than one-fifth of distance from base to margin; vein MA forked less than half of distance from base to margin, fork symmetrical; vein MP forked one-fifth of distance from base to margin, fork symmetrical; fork of veins MA and MP narrower than those forks in male wings; cubital area as in Figure 18; cross veins few. Costal projection of hind wings of male and female acute, short, and well developed (Figures 16–17, 19–20), apex of projection located half of distance from base; apex of wings broad and angularly truncated (Figures 16–17, 19–20); cross veins few. Legs: ratios of segments in male fore legs, 0.56: 1.00 (2.5 mm.): 0.07: 0.36: 0.22: 0.16: 0.09. Claws of a pair dissimilar, one apically hooked (Figure 98), other obtuse, padlike. Male genitalia (Figure 79): segments 2 and 3 of forceps short; basal segment of forceps bowed, base of forceps broad, its inner margin forming an angular bend; length of styliger plate along median line one-third length of maximum width; penes divided except at base, divided portions flared laterally and tubular, a subapical, ventral spine on each lobe. Ninth sternum of female deeply cleft (Figure 105). Female with a short ovipositor or egg guide extending to anterior margin of segment 8 (Figure 111). Terminal filament longer than cerci.

MATURE NYMPH.—Head prognathous. Antennae 3 times maximum length of head. Mouthparts (Figures 140, 149, 158, 167–168, 178–180): dorsal hair on labrum as in Figure 178; submedian and anterolateral areas of hair ventrally; 4 to 5 small, equal-sized denticles on anteromedian emargination (Figures 179–180). Clypeus as in Figure 178. Left mandible as in Figures 167–168. Lingua of hypopharynx with well-developed lateral processes (Figure 158), anterior margin deeply cleft; superlingua of hypopharynx as in Figure 158, with a row of hair along anterior margin. Segment 2 of maxillary palpi one and one-third length of segment 1; segment 3 half the length of segment 2, triangular; a V-shaped ridge near the ventral, inner anterolateral margin of maxillae; hair on maxillae as in

Figure 149. Labium as in Figure 140; segment 2 of palpi a little longer than length of segment 1; segment 3 a little less than one-fourth to one-fourth length of segment 2, triangular; paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax only. Legs (Figure 198): claws apically hooked, denticles on claws progressively larger apically. Gills (Figure 205): gills on segments 1–7 alike; dorsal and ventral lamellae platelike and terminated in 3 processes, with median projection longer than laterals (Figure 205). Posterolateral spines on abdominal segments 6–9, spines progressively larger posteriorly. Terminal filament longer than cerci.

ETYMOLOGY.—Genus named for Dr. Jay R. Traver, Amherst, Massachusetts, in honor of her significant contribution in the study of Ephemeroptera.

TYPE-SPECIES.—*Traverina cubensis* Peters and Alayo, new species.

DISCUSSION.—*Traverina,* new genus, can be distinguished from other West Indian genera of the Leptophlebiidae by the following combination of characters. In the imago (1) the costal projection of the hind wings is acute, short, and well developed (Figures 16–17, 19–20), (2) the penes of the male genitalia are divided except at the base and the divided portions are flared laterally (Figure 79), and (3) the females possess a short ovipositor or egg guide extending to the anterior margin of segment 8 (Figure 111). In the nymphs (1) the dorsal and ventral lamellae of abdominal gills 1–7 are platelike and terminated in 3 processes, with median projection longer than the laterals (Figure 205), (2) posterolateral spines are present on abdominal segments 6–9, and (3) the claws are apically hooked and the denticles on the claws are progressively larger apically (Figure 198). *Traverina* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) a subapical, ventral spine is present on each penis lobe of the male genitalia (Figure 79), (2) the base of vein ICu_1 of the fore wings is attached to vein CuP (Figures 15, 18), (3) the females possess a short ovipositor or egg guide extending to the anterior margin of segment 8 (Figure 111), and (4) the tarsal claws of a pair are dissimilar, one is apically hooked while the other is obtuse, padlike (Figure 98). In the nymphs (1) the dorsal and ventral lamellae of abdominal gills 1–7 are platelike and terminate in 3 processes, with median projections longer than the laterals (Figure 205), (2) 4–5 equal-sized denticles are present on the anteromedian emargination of the labrum (Figures 179–180), (3) the claws are apically hooked and the denticles on the claws are progressively larger apically (Figure 198), and (4) a V-shaped ridge is present near the ventral, inner anterolateral margin of the maxillae (Figure 149).

Traverina cubensis Peters and Alayo, new species

FIGURES 15–20, 79, 98, 105, 111, 125–126, 167, 178–179, 205

MALE IMAGO (in alcohol).—Length: body, 6.4 mm.; fore wings, 6.3 mm. Upper portion and stalks of eyes dark brown, lower portion black. Head light brown, anterior margin darker. Basal half of ocelli dark brown, apical half white. Thorax brown, sutures paler, pleura with dark brown markings, especially in diagonal streaks posteromedially from leg bases. Legs light brown; femora and tibiae of prothoracic legs washed lightly with dark brown, large transverse darker brown, median and apical maculae on femora; large transverse dark brown, median and apical maculae on femora of mesothoracic and metathoracic legs, median macula lighter on dorsal surface of femora. Wings (Figures 15–17): longitudinal veins of fore wings brown, cross veins lighter except in cells C, Sc, and R_1, membrane transparent, washed with light brown; longitudinal veins of hind wings brown, cross veins lighter, membrane transparent, washed with light brown. Abdomen: terga 1–10 light brown, terga 1 and 10 uniformly washed with dark brown, color markings as in Figures 125–126, markings lighter on terga 7–9, spiracles and tracheae dark brown; sterna light brown. Genitalia (Figure 79): forceps and penes light brown, basal segment of forceps washed lightly in darker brown. Caudal filaments brown, dark brown annulations at articulations, except alternate annulations lighter.

FEMALE IMAGO (in alcohol).—Length: body, 6.1 mm.; fore wings, 6.9 mm. Eyes black. Head brown, anterior margin darker. Color and markings of thorax and legs as in male imago. Abdomen: terga brown, tergum 1 uniformly washed with darker brown, posterior margin of tergum 10 darker brown, terga 2–9 with darker brown markings as in

Figures 125–126, markings lighter on terga 8 and 9, spiracles and tracheae darker; sterna light brown. Caudal filaments broken off and missing.

MATURE NYMPH (in alcohol).—Head brown, venter paler. Thorax brown, sterna paler, lateral margins of terga darker. Legs brown, markings as in male and female imagos. Abdomen: brown, sterna paler, markings as in male and female imagos. Gills gray, tracheae black. Caudal filaments light brown.

Holotype male imago, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 57), March 1964; allotype female imago, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 25), March 1965; paratypes: 2 nymphs, Cuba: Pinar del Río Prov., Soroa (field no. 51), June 1965; 2 nymphs, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 4), March 1965. All types were collected by P. Alayo D. and are in alcohol. Holotype was deposited in the collections of the Institute of Biology, Academy of Sciences of the Republic of Cuba. Two paratypes (1 from field no. 51 and 1 from field no. 4) were deposited in the collections of the University of Utah. Remaining types were deposited in the collections of Florida A & M University.

ETYMOLOGY.—Species is named for the island of Cuba.

DISCUSSION.—The nymphs and adults of *T. cubensis* are associated by the developing wing pads and color markings on the legs and abdomen of the nymphs collected from the same locality as the adults. We have seen nymphal specimens of *Traverina* which appear to represent an undescribed species. The abdominal color markings are entirely different than those of *T. cubensis*. The specimens are recorded from Cuba: Rio de San Antonio, by Charco Azul, Trinidad Mts., 23–29 March 1939, J. G. Needham. Four specimens were deposited in each of the collections of the University of Utah and Florida A & M University.

Careospina Peters, new genus

FIGURES 21–32, 80–83, 99, 106, 112, 121, 127–128, 141, 150, 159, 169, 181–182, 199, 206, 212

IMAGO.—Length of male: body, 3.2–6.5 mm.; fore wings, 3.8–6.5 mm. Length of female: body, 5.1 mm.; fore wings, 5.2 mm. Eyes of male separated on meson of head by a length half maximum length of median ocellus, upper portion of eyes on short stalk, lower portion of eyes a little more than two-thirds length of upper portion; eyes of female separated on meson of head by a length 3½ times maximum width of an eye. Fore wings of male (Figures 21, 24, 27): vein R_s of fore wings forked less than one-fourth of distance from base to margin; vein MA forked less than to more than half of distance from base to margin, fork asymmetrical, distal portion of vein MA sagged posteriorly; vein MP forked one-third to more than a third of distance from base to margin, fork symmetrical; cubital area as in Figures 21, 24, and 27; cross veins few. Fore wings of female (Figure 30): vein R_s of fore wings forked less than one-fourth of distance from base to margin; vein MA forked less than half of distance from base to margin, fork symmetrical; vein MP forked one-fifth of distance from base to margin, fork symmetrical; fork of veins MA and MP narrower than those forks in male wings; cubital area as in Figure 30; cross veins few. Costal projection of hind wings of male and female acute, short, and well developed (Figures 22–23, 25–26, 28–29, 31–32), apex of projection located less than half to half distance from base; apex of wings broad and angularly truncated (Figures 22–23, 25–26, 28–29, 31–32); cross veins few. Legs: ratios of segments in male fore legs, 0.50: 1.00 (3.0 mm.): 0.04: 0.32: 0.29: 0.18: 0.11. Claws of a pair dissimilar, one apically hooked (Figure 99), other obtuse, padlike. Male genitalia (Figures 80–83): segments 2 and 3 of forceps short; base of forceps broad, its inner margin forming an angular bend; length of styliger plate along median line less than one-third to greater than one-third length of maximum width; penes divided, tubular. Ninth sternum of female deeply cleft (Figure 106). Female with a short ovipositor or egg guide extending to anterior third of segment 8 (Figure 112). Terminal filament greatly reduced, with 6–7 segments, basal 3 segments short and remaining apical segments long (Figure 121).

MATURE NYMPH.—Head prognathous. Antennae 2½ times maximum length of head. Mouthparts (Figures 141, 150, 159, 169, 181–182): dorsal hair on labrum as in Figure 181; submedian and anterolateral areas of hair ventrally; 4 to 5 equal-sized denticles on anteromedian emargination (Figure 182). Clypeus as in Figure 181. Left mandible as in Figure 169. Lingua of hypopharynx with well-developed lateral processes (Figure 159), anterior

margin deeply cleft; superlingua of hypopharynx as in Figure 159, with a row of hair along anterior margin. Segment 2 of maxillary palpi 1¼ times length of segment 1; segment 3 a little less than half to half length of segment 2, triangular; a V-shaped ridge near the ventral, inner anterolateral margin of maxillae, hair on maxillae as in Figure 150. Labium as in Figure 141; segment 2 of palpi a little longer than length of segment 1; segment 3 one-fourth length of segment 2, triangular; paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax only. Legs (Figure 199): claws apically hooked, denticles on claws progressively larger apically. Gills (Figure 206): gills on segments 1–7 alike, each portion of gills long and slender. Posterolateral spines on abdominal segments 5 or 6 to 9, spines progressively larger posteriorly. Terminal filament a little longer than cerci.

ETYMOLOGY.—Latin careo, meaning to be deprived of; Latin spina, meaning spine.

TYPE-SPECIES.—*Careospina hespera* Peters and Alayo, new species.

DISCUSSION.—*Careospina,* new genus, can be distinguished from other West Indian genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) the terminal filament is greatly reduced and with only 6–7 segments (Figure 121), (2) the penes of the male genitalia are divided and tubular (Figures 80–83), and (3) the costal projection of the hind wings is acute, short, and well developed (Figures 22–23, 25–26, 28–29, 31–32). In the nymphs (1) posterolateral spines are present on abdominal segments 5 or 6 to 9 (Figure 212), (2) the tarsal claws are apically hooked; the denticles on the claws are progressively larger apically (Figure 199), and (3) 4 to 5 equal-sized denticles are present on the anteromedian emargination of the labrum (Figure 182). *Careospina* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) the base of vein ICu_1 of the fore wings is attached to vein CuP (Figures 21, 24, 27, 30), (2) the penes of the genitalia are divided and tubular (Figures 80–83), (3) the terminal filament is greatly reduced, and with only 6–7 segments (Figure 121), and (4) the eyes of the males are separated on the meson of the head by a length half the maximum width of the median ocellus. In the nymphs (1) the abdominal gills are alike on segments 1–7, each portion of the gills is long and slender (Figure 206); (2) 4 to 5 equal-sized denticles are present on the anteromedian emargination of the labrum (Figure 182); (3) the tarsal claws are apically hooked, the denticles on the claws are progressively larger apically (Figure 199); and (4) posterolateral spines are present on abdominal segments 5 or 6 to 9 (Figure 212).

Key to the Species of *Careospina* Peters, new genus

MALE IMAGOS

1. Forceps of genitalia 3½ times length of penes (Figure 83); Haiti ... ***C. annulata,*** new species
   Forceps of genitalia a little longer than length of penes (Figures 80, 82); Cuba 2
2. Basal two-thirds and apex of prothoracic femora darker in color; color markings on abdominal segments 5 and 6 as in Figure 127; Pinar del Río Prov., Cuba.
   C. hespera, new species
   Apex of prothoracic femora darker in color; color markings on abdominal segments 5 and 6 as in Figure 128; Trinidad Mountains, Cuba ..... ***C. minuta,*** new species

Clave para las Especies de *Careospina* Peters, nuevo género

IMAGOS MACHOS

1. Pinzas de la genitalia 3½ veces del largo de los penes (Figura 83); Haiti.
   C. annulata, nuevo especie
   Pinzas de la genitalia solo algo más largas que la longitud de los penes (Figuras 80, 82); Cuba 2
2. Fémures protorácicos con los ⅔ basales y el ápice, de color mas oscuro que el resto; marcas de color en los segmentos abdominales 5 y 6 como en la Figura 127; Prov. de Pinar del

Río, Cuba ..... *C. hespera*, nuevo especie
Fémures protorácicos únicamente con los ápices de color mas oscuro que el resto; marcas de color en los segmentos abdominales 5 y 6 com en la Figura 128; montañas de Trinidad, Cuba ..... *C. minuta*, nuevo especie

Careospina hespera Peters and Alayo, new species

FIGURES 21–23, 80–81, 99, 121, 127, 141, 150, 159, 169, 181–182, 199, 206, 212

MALE IMAGO (in alcohol).—Length: body, 6.0–6.5 mm.; fore wings, 6.0–6.5 mm. Upper portion of eyes and stalks brown, lower portion black. Head brown, carinae blackish brown. Base of ocelli blackish brown, remainder white. Thorax and coxae of legs brown, sutures paler, carinae blackish brown. Trochanters, femora, and tibiae of prothoracic legs brown, apexes of femora and tibiae darker, remainder of legs paler; mesothoracic and metathoracic legs pale, femora with median and apical darker brown maculae. Wings (Figures 21–23): longitudinal veins of fore and hind wings brown, cross veins paler; membrane of fore and hind wings hyaline. Abdomen: terga 1 and 2 dark brown, terga 3–9 light brown, posterior margin of terga 3–7 darker, color markings on terga 3–9 as in Figure 127, spiracles and tracheae blackish brown on segments 3–9; sterna light brown. Genitalia (Figures 80–81): forceps segment 1 dark brown, forceps segment 2 washed with brown, remainder of forceps and penes paler; forceps a little longer than length of penes. Caudal filaments pale.

FEMALE IMAGO.—Unknown.

MATURE NYMPH (in alcohol).—Head brown, venter paler. Thorax brown, sterna paler, lateral margins of terga black. Legs pale, markings as in male imagos. Abdomen brown, sterna paler, markings as in male imagos (Figure 212). Gills gray, tracheae black. Caudal filaments pale.

Holotype male imago, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 24), March 1965; paratopotypes: 4 male imagos; paratypes: 2 male imagos, Cuba: Pinar del Río Prov., Arroyo Pinar de Viñales (field no. 22); 2 nymphs, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 3), March 1965; 2 nymphs, Cuba: Pinar del Río Prov., Viñales (field no. 11), October 1964; 3 nymphs, Cuba: Pinar del Río Prov., Soroa (field no. 13), December 1964. All types were collected by P. Alayo D. and are in alcohol. Holotype and one nymphal paratype were deposited in the collections of the Institute of Biology, Academy of Sciences of the Republic of Cuba. One paratopotype, one male imaginal paratype, and two nymphal paratypes are in the collections of the University of Utah. One paratopotype and two nymphal paratypes were deposited in the collections of the National Museum of Natural History. All remaining types are deposited in the collections of Florida A & M University.

ETYMOLOGY.—Latin hesperus, meaning west.

DISCUSSION.—*Careospina hespera* can be distinguished from the other two described species of *Careospina* by the following characters. In the male imagos (1) the forceps of the genitalia are a little longer than the length of the penes (Figure 80), (2) the basal two-thirds and apex of the prothoracic femora are darker brown in color, and (3) the color markings on abdominal segments 5 and 6 are as in Figure 127. The nymphs and adults of *C. hespera* are associated by the developing wing pads and color markings on the legs and abdomen of the nymphs collected from the same locality as the adults.

Imagos of this species were observed by Dr. P. Alayo D. flying along a shady stream, on a clear and sunny spring morning at about 11 A.M. All the specimens were males, and they were flying leisurely at about four to five feet above the stream. Dr. Alayo walked along the stream about twenty meters, and the flight covered all the water. He reports that this species is not very common, being very local and living in only a small fraction of the bodies of water visited.

Careospina minuta Peters, new species

FIGURES 24–26, 82, 128

MALE IMAGO (pinned).—Length: body, 3.2 mm.; fore wings, 3.8 mm. Upper portion of eyes and stalks dark brown, lower portion black. Head dark brown. Base of ocelli dark brown, remainder white. Thorax dark brown, sutures paler, pleura with contrasting pale and dark areas. Coxae of legs dark brown; prothoracic legs brown, basal two-thirds and

apex of femora darker, apex of tibiae darker, tarsi paler; mesothoracic and metathoracic legs light brown, a wide median, and narrow subapical darker bands on femora, apex of tibiae and tarsi darker. Wings (Figures 24–26): longitudinal and cross veins of fore and hind wings brown; membrane of fore and hind wings hyaline, washed lightly with brown; costal projection of hind wings acute, short and well developed, base of projection narrow (Figures 25–26). Abdomen: light brown, segments 1, 9, and 10 darker; posterior margin of segments 2–8 darker; submedian and sublateral dark brown markings projecting anteriorly to near anterior margin of terga 2–8 as in Figure 128. Genitalia (Figure 82): light brown; forceps a little longer than length of penes. Caudal filaments light brown, annulations at articulations darker.

FEMALE IMAGO.—Unknown.

MATURE NYMPH.—Unknown.

Holotype male imago, Cuba: Trinidad Mountains, Mina Carlota, 22 March 1935; paratopotype: 1 male imago; paratypes: 5 male imagos, Cuba (no other data), C. Wright. Holotype, paratopotype, and paratypes pinned. One paratype was deposited in each of the collections of Florida A & M University, University of Utah, and National Museum of Natural History. Remaining types are deposited in the collections of the Museum of Comparative Zoology.

ETYMOLOGY.—Latin minutus, meaning small.

DISCUSSION.—*Careospina minuta* can be distinguished from the remaining species of *Careospina* by the following characters. In the male imagos (1) the forceps of the genitalia are a little longer than the length of the penes (Figure 82), (2) the apex of the prothoracic femora is darker brown in color, and (3) the color markings on abdominal segments 5 and 6 are as in Figure 128.

The four male imagos with spotless wings considered as a possible new species by Eaton (1882, 1884) in the discussion on *Hagenulus caligatus* are the specimens collected by C. Wright and described herein as *C. minuta*. An additional unreported specimen of this series is included herein.

I have seen nymphs and one female subimago of *Careospina* which appear to represent an undescribed species. The abdominal color markings are entirely different than those of the described species of *Careospina*. The specimens are recorded from various localities in Oriente Province, Cuba. The one female subimago is used in the generic description. Nymphal specimens of this undescribed species were deposited in the collections of the University of Utah and Florida A & M University; the female subimago was deposited in the collections of Florida A & M University.

Careospina annulata Peters, new species

FIGURES 27–29, 83

MALE IMAGO (pinned).—Length: body, 4.0 mm.; fore wings, 4.6 mm. Upper portion of eyes and stalks dark brown, lower portion black. Head dark brown. Base of ocelli dark brown, remainder white. Thorax dark brown, sutures paler. Coxae of legs dark brown, trochanters paler, remainder of legs broken off and missing. Wings (Figures 27–29): longitudinal veins of fore and hind wings brown, cross veins paler; membrane of fore and hind wings hyaline; costal projection narrow (Figures 28–29). Abdomen: dark brown, a little paler on anterior margin of segments 2–7; posterior margin of segments 2–7 with a narrow, darker brown band and a little paler band ahead of posterior band, thus giving the abdomen an annulated appearance. Genitalia (Figure 83): brown; forceps 3½ times length of penes. Caudal filaments light brown, annulations at articulations darker.

FEMALE IMAGO.—Unknown.

MATURE NYMPH.—Unknown.

Holotype male imago, Haiti: Mt. La Hotte, 1,000 feet, Roche Croix, 14 October 1934, P. J. Darlington, Jr. Holotype pinned and deposited in the collections of the Museum of Comparative Zoology.

ETYMOLOGY.—Latin annulus, meaning annulated.

DISCUSSION.—*Careospina annulata* can be distinguished from the remaining species of *Careospina* by the following characters. In the male imagos (1) the costal projection of the hind wings is acute, short, and well developed; the base of the projection is narrow (Figures 28–29), (2) the genital forceps are 3½ times the length of the penes (Figure 83), and (3) the color pattern on the abdominal segments is as given in the description.

Genus *Neohagenulus* Traver, 1938

FIGURES 33–42, 84–86, 100, 107, 113, 142, 151, 160, 170, 183–185, 200, 207.

Neohagenulus Traver, 1938, p. 8; 1959, p. 4.

TYPE-SPECIES.—*Neohagenulus julio* Traver, by original designation.

SPECIES INCLUDED.—*Neohagenulus julio* Traver, 1938, p. 9; *N. luteolus* Traver, 1938, p. 13; *N. tinctus* Traver, 1938, p. 12.

DISTRIBUTION.—Puerto Rico.

IMAGO.—Length of male: body, 5.0–7.0 mm.; fore wings, 5.5–7.0 mm. Length of female: body, 5.0–6.0 mm.; fore wings, 5.0–6.3 mm. Eyes of male meet on meson of head, lower portion of eyes two-thirds length of upper portion; eyes of female separated on meson of head by a length 4 to 7 times maximum width of an eye. Fore wings of male (Figure 33): vein R_s of fore wings forked one-fifth to less than one-fourth of distance from base to margin; vein MA forked half of distance from base to margin, fork asymmetrical, distal portion of vein MA sagged posteriorly; vein MP forked less than half of distance from base to margin, fork symmetrical; cubital area as in Figure 33; cross veins few. Fore wings of female (Figure 36): vein R_s of fore wings forked one-sixth to one-fifth of distance from base to margin; vein MA forked less than half to two-thirds of distance from base to margin, fork a little asymmetrical, distal portion of vein MA a little sagged posteriorly; vein MP forked one-third of distance from base to margin, fork symmetrical; fork of veins MA and MP narrower than those forks in male wings; cubital area as in Figure 36; cross veins few. Costal projection of hind wings of male and female acute, long, and well developed (Figures 34–35, 37–42), apex of projection located past apex of wings; apex of wings narrow and rounded (Figures 34–35, 37–42); cross veins few. Legs: ratios of segments in male fore legs, 0.52: 1.00 (2.1 mm.): 0.05: 0.29: 0.21: 0.14: 0.10. Claws of a pair dissimilar, one apically hooked (Figure 100), other obtuse, pad-like. Male genitalia (Figures 84–86): segments 2 and 3 of forceps short; basal segment of forceps greatly bowed, base of forceps broad, its inner margin forming an angular bend; length of styliger plate along median line less than one-fourth to less than one-third length of maximum width; penes divided, tubular, apex of each penis lobe bulbous, basal half of lobes connected by a sclerotized membrane, a subapical, ventral spine on each lobe. Ninth sternum of female deeply cleft (Figure 107). Female with a short ovipositor or egg guide extending to anterior margin of segment 8 (Figure 113). Terminal filament longer than cerci.

MATURE NYMPH.—Head prognathous. Antennae 3 times maximum length of head. Mouthparts (Figures 142, 151, 160, 170, 183–185): dorsal hair on labrum as in Figure 183; submedian and anterolateral areas of hair ventrally; 4 to 5 small equal-sized denticles on anteromedian emargination (Figures 184–185). Clypeus as in Figure 183. Left mandible as in Figure 170. Lingua of hypopharynx with well-developed lateral processes (Figure 160), anterior margin deeply cleft; superlingua of hypopharynx as in Figure 160, with a row of hair along anterior margin. Segment 2 of maxillary palpi equal to length of segment 1; segment 3 one-half to a little shorter than length of segment 2, triangular; a V-shaped ridge near the ventral inner anterolateral margin of maxillae; hair on maxillae as in Figure 151. Labium as in Figure 142; segment 2 of palpi a little longer to one and one-third times length of segment 1; segment 3 one-fifth to one-fourth times length of segment 2, triangular; paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax only. Legs (Figure 200): claws apically hooked, denticles on claws progressively larger apically. Gills (Figure 207): gills on segments 1–7 alike; each gill deeply forked (Figure 207). Posterolateral spines on abdominal segments 3–9, spines progressively larger posteriorly. Terminal filament longer than cerci.

DISCUSSION.—Traver (1938) established *Neohagenulus* for three species she described from Puerto Rico. Excellent descriptions are given in Traver (1938) for these three species. Included herein are keys written by Traver (1938) for the three species and nymphs of two undescribed species of *Neohagenulus* and Spanish translations of the keys.

Key to the Species of *Neohagenulus* Traver

Imagos

1. Wings of both sexes distinctly brown-tinged throughout; cross vein prominent. ***N. tinctus*** Traver
   Wings not distinctly brown-tinged throughout; cross veins less prominent, except along costal margin 2
2. Longitudinal veins in wing of male yellowish along costal margin, elsewhere paler; costal band in wing of female rather dark red brown ..... ***N. luteolus*** Traver
   Longitudinal veins, also cross veins of costal area and apical third of wing brown; costal band in wing of female pale brown, usually paler toward apex ..... ***N. julio*** Traver

Mature nymphs

1. Pale areas on head between eyes and ocelli distinctly divided by a grayish black line; spines on fore femur and on hind tibia relatively short ..... ***N. luteolus*** Traver
   Pale areas on head between eyes and ocelli not divided by a dark line; spines on fore femur and hind tibia longer 2
2. Second joint of antenna pale; ventral markings, when present, usually confined to lateral part of posterior margins of sternites 3
   Second joint of antenna blackish, at least in apical half; ventral markings more extensive. 4
3. Ventral markings usually absent; abdominal tergites of female largely yellowish. *N.* species 2
   Ventral markings usually present; abdominal tergites of female largely reddish brown. ***N. julio*** Traver
4. Body (female) 7 to 8 mm. in length ..... *N.* species 1
   Body (female) 6 to 6½ mm. in length ..... ***N. tinctus*** Traver

Clave para las Especies de *Neohagenulus* Traver

Imagos

1. Alas en ambos sexos distintamente teñidas de pardo en toda su extensión; nervuras transversas prominentes ..... ***N. tinctus*** Traver
   Alas no distintamente teñidas de pardo en toda su extensión; nervuras transversas menos prominentes, excepto a lo largo del margen costal 2
2. Nervuras longitudinales de las alas del macho amarillentas a lo largo del margen costal, el resto más pálido; banda costal en las alas de la hembra de un color pardo rojizo oscuro. ***N. luteolus*** Traver
   Nervuras longitudinales, y también las transversales del área costal y tercio apical del ala, pardas; banda costal en las alas de la hembra de color pardo pálido, usualmente más pálida hacia el ápice ..... ***N. julio*** Traver

Ninfas maduras

1. Areas pálidas en la cabeza, entre los ojos y ocelos, distintamente divididas por una línea grisáceonegra; espinas del fémur anterior y tibia posterior relativamente cortas. ***N. luteolus*** Traver
   Areas pálidas en la cabeza, entre los ojos y ocelos, no divididas por una línea oscura; espinas en el fémur anterior y la tibia posterior más largas 2
2. Segundo segmento antenal pálido; marcas ventrales, si existen, usualmente confinades a la parte lateral de los márgenes posteriores de los esternitos 3
   Segundo segmento antenal negruzco, por lo menos en su mitad apical; marcas ventrales más extensas 4
3. Marcas ventrales usualmente ausentes; tergitos abdominales de la hembra mayormente amarillentos ..... *N.* especie 2

Marcas ventrales usualmente presentes; tergitos abdominales de la hembra mayormente pardorojizos ..... *N. julio* Traver

4. Longitud cuerpo (hembra) 7–8 mm ..... *N.* especie 1
Longitud cuerpo (hembra) 6–6½ mm ..... *N. tinctus* Traver

Genus *Hagenulus* Eaton, 1882

FIGURES 1–3, 43–66, 87–91, 101, 108, 114–118, 129–138, 143–145, 152–154, 161–163, 171–173, 186–191, 201, 208

Hagenulus Eaton, 1882, p. 207; 1884 (1883–1888), p. 113.—Morrison, 1919, p. 144.—Ulmer, 1920, p. 117.—Needham and Murphy, 1924, pp. 10, 11.—Ulmer, 1932, p. 203.—Traver, 1938, p. 7; 1959, p. 2.—Peters, Gillies, and Edmunds, 1964, p. 117.

TYPE-SPECIES.—*Hagenulus caligatus* Eaton, by original designation.

SPECIES INCLUDED.—*Hagenulus caligatus* Eaton, 1882, p. 207; *H. eatoni* Banks, 1924, p. 423; *H. jamaicensis,* new species; *H. morrisonae,* new species; *H. rangelae,* new species.

DISTRIBUTION.—Cuba, Haiti, Jamaica, Puerto Rico.

IMAGO.—Length of male: body, 4.2–6.5 mm.; fore wings, 4.8–7.2 mm. Length of female: body, 4.5–6.2 mm.; fore wings, 5.6–7.0 mm. Eyes of male separated on meson of head by a length equal to width of median ocellus, lower portion of eyes two-thirds length of upper portion; eyes of female separated on meson of head by a length 4 times maximum width of an eye. Wings (Figures 43–66): vein R_s of fore wings forked less than one-fourth to one-third of distance from base to margin, fork wider in male; vein MA forked less than one-third to half of distance from base to margin, fork wider in male, fork symmetrical to a little asymmetrical in female, fork a little asymmetrical to asymmetrical in male, distal portion of vein MA sagged posteriorly in male and female; vein MP forked less than one-fourth to half of distance from base to margin, fork wider in male, fork symmetrical in male and female; cubital area as in Figures 43, 46, 49, 52, 55, 58, 61, 64; cross veins few; several to many cross veins in fore wings of female surrounded with dark clouds (Figures 46, 52, 55, 61); several cross veins in fore wing of male surrounded with dark clouds (Figures 43, 49, 58, 64). Costal projection of hind wings acute, long, and well developed, base of projection wide, apex located near middle to apex of wings (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66); apex of wings narrow to broad and rounded (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66); cross veins few. Legs: ratios of segments in male fore legs, 0.61: 1.00 (1.8 mm.): 0.06: 0.36: 0.28: 0.17: 0.08. Claws of a pair dissimilar, one apically hooked (Figure 101), other obtuse, padlike. Male genitalia (Figures 87–91): segments 2 and 3 of forceps short; basal segment of forceps long, base of forceps broad, its inner margin forming an angular bend (Figures 87–89); length of styliger plate along median line less than half to more than half length of maximum width; penes divided, tubular, a subapical, ventral spine present (Figures 87, 89–91) or absent (Figure 88) on each lobe. Ninth sternum of female deeply cleft (Figure 108). Female with a well-developed ovipositor or egg guide extending to just past posterior margin of segment 10 (Figures 114–118). Terminal filament longer than cerci.

MATURE NYMPH.—Head prognathous. Antennae 2 to 2½ times maximum length of head. Mouthparts (Figures 143–145, 152–154, 161–163, 171–173, 186–191): dorsal hair on labrum as in Figure 190, or Figures 186, 188; submedian and anteromarginal areas of hair ventrally; 3 to 5 small blunt equal-sized denticles on anteromedian emargination (Figures 187, 189, 191); labrum a little (Figure 190) to greatly (Figures 186, 188) expanded laterally. Clypeus as in Figures 186, 188, 190. Left mandible as in Figure 171, or 172, or 173. Lingua of hypopharynx with well-developed lateral processes (Figures 161–163), anterior margin shallowly to deeply cleft; superlingua of hypopharynx as in Figures 161–163, with a row of hair along anterior margin. Segment 2 of maxillary palpi equal to length of segment 1; segment 3 less than one-half times length of segment 2, triangular; maxillary palpi a little expanded and extending anteriorly past labrum (Figure 154); a V-shaped ridge on the ventral, inner anterolateral margin of maxillae; hair on maxillae as in Figure 154; to segment 2 of maxillary palpi 1½ to less than 2 times length of segment 1; segment 3 one-half times length of segment 2, triangular; maxillary palpi greatly elongated (Figures 152–153); a large toothlike projection on the inner

anterolateral margin of maxillae; hair on maxillae as in Figures 152–153. Labium as in Figure 145; segment 2 a little longer than length of segment 1; segment 3 one-fourth times length of segment 2, triangular; paraglossae ventral to glossae; to labium as in Figures 143–144; segment 2 less than 2 times length of segment 1; segment 3 one-sixth to one-eighth times length of segment 2, triangular; labial palpi greatly elongated (Figures 143–144); paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax; long hair on inner and dorsal surfaces of prothoracic tibiae present (Figures 1–2), or absent (Figure 3). Legs (Figures 1–3, 201): claws apically hooked, denticles on claws progressively larger apically. Gills (Figures 1, 208): gills on segments 1–7 alike, each gill deeply forked. Posterolateral spines on abdominal segments 5–9, spines progressively larger posteriorly. Terminal filament longer than cerci.

Discussion.—Eaton (1882) established *Hagenulus* for the single species *H. caligatus,* which was described only from the adults. Morrison (1919) described what she thought were the nymphs of *Hagenulus.* Later Banks (1924) described a second species, *H. eatoni,* which is known only from female imagos. Traver (1938) discussed the relationships of *Hagenulus* with other West Indian genera of the Leptophlebiidae. Various authors between 1892 and 1956 assigned six new species of the Eastern Hemisphere Leptophlebiidae to *Hagenulus.* Peters, Gillies, and Edmunds (1964) placed four of these species, *H. turbinatus* Ulmer (1909), *H. scotti* Eaton (1913), *H.* (?) *duliti* Demoulin (1954), and *H. fasciatus* Kimmins (1956), in other genera occurring only in the Eastern Hemisphere, but tentatively retained *H. monstratus* Eaton (1892) and *H. karnyi* Ulmer (1939) in *Hagenulus.* I have examined the type series of both *H. monstratus* and *H. karnyi* and neither species represents *Hagenulus.* Both species will be transferred to other genera in a future paper. The true genus *Hagenulus* is actually restricted to the West Indies.

In 1963, I reared *Hagenulus* in Jamaica. The nymphs of this reared material are morphologically similar to nymphs discussed and keyed by Traver (1938) as "Jamaica species." The labrum is only moderately expanded (Figures 3, 190) and the palpi of the labium (Figure 145) and maxillae (Figures 3, 154) are only moderately elongated. The outer edge of the mandibles is smoothly curved (Figures 3, 173). These nymphs appear to be adapted to feed on attached periphyton. As this species is known only from the nymphs and reared female subimagos, the naming of this species is delayed until male and female imagos are known. Specimens were collected at a small stream, 1⅛ miles southwest crossing Dick's Pond Trail, Hardwar Gap, St. Andrew Parish, Jamaica, and specimens were deposited in the collections of the University of Utah and Florida A & M University.

The Jamaican nymphs do not resemble the nymphs described by Morrison (1919) as *Hagenulus.* The labrum of the nymphs described by Morrison (1919) is greatly expanded laterally (Figures 1, 186), and the palpi of the labium (Figure 143) and maxillae (Figures 1, 152) are greatly elongated. The outer edge of the mandibles is strongly angular (Figures 1, 171). Also long hair is present on the prothoracic tibiae (Figure 1). The remaining morphological structures are similar to those of the Jamaican nymphs. These nymphs appear to strain their food from the current. The Morrison-type nymph is herein described as *H. caligatus.*

Nymphs of another Cuban species are intermediate between the Jamaican and Morrison types. The labrum is a little expanded laterally (Figures 2, 188), but the palpi of the labium (Figure 144) and maxillae (Figures 2, 153) are greatly elongated. The outer edge of the mandibles is not greatly angular (Figure 2, 172). Long hair is present on the prothoracic tibiae (Figure 2). This intermediate is described herein as the nymph of *H. morrisonae.*

A probable evolutionary shift from feeding on attached periphyton to straining food from the current has occurred among species of *Hagenulus.* As a shift in type of feeding and the associated changes in mouthpart morphology of the nymphs are the only characters separating the two groups in the nymphs or adults, all species are included within the genus *Hagenulus.*

Traver (1938) questioned whether the nymphs described by Morrison were *Hagenulus.* Eaton's (1884) figure of the penes of *H. caligatus* showed no subapical ventral spines; however, the developing penes dissected by Traver from the nymphs described by Morrison possessed such spines. As indicated herein the penes of *H. caligatus* possess spines.

Hagenulus can be distinguished from other West Indian genera of the Leptophlebiidae by the fol-

lowing combination of characters. In the imagos (1) the costal projection of the hind wings is long, acute and well developed (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66), (2) the penes of the male genitalia usually possess subapical ventral spines (Figures 87–91), and (3) few to many of the cross veins of the fore wings of the males and females are surrounded with dark clouds (Figures 43, 46, 49, 52, 55, 58, 61, 64). In the nymphs (1) hair on the dorsal surface of the labrum is not in two even rows (Figures 1–3, 186, 188, 190), (2) the denticles on the claws are progressively larger apically (Figure 201), and (3) posterolateral spines are present on abdominal segments 5–9; the spines are progressively larger posteriorly. *Hagenulus* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) well-developed hind wings are present (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66), (2) the females have a well-developed ovipositor or egg guide extending just past the posterior margin of segment 10 (Figures 114–118), (3) the penes of the male genitalia usually possess subapical spines (Figures 87–91), and (4) few to many of the cross veins of the fore wings of the males and females are surrounded with dark clouds (Figures 43, 46, 49, 52, 55, 58, 61, 64). In the nymphs (1) the abdominal gills on segments 1–7 are alike; each gill is deeply forked (Figures 1, 208), (2) the denticles on the claws are progressively larger apically (Figure 201), (3) the labrum is a little (Figures 3, 190) to greatly (Figures 1–2, 186, 188) expanded laterally, and (4) 3 to 5 equal-sized, blunt denticles are present on the anteromedian emargination of the labrum (Figures 187, 189, 191).

Key to the Species of *Hagenulus* Eaton

Imagos

1. Cross veins in apical third of cells C, Sc, and R_1 of male fringed with brown color (Figure 58); male genitalia as in Figures 89–90; shape of hind wings as in Figures 59–60, 62–63; costal projection extremely long; Jamaica ..... ***H. jamaicensis,*** new species

   Few to many cross veins of fore wings of male with dark clouds but not as above (Figures 43, 49, 64); male genitalia as in Figures 87–88, 91; shape of hind wings as in Figures 44–45, 47–48, 50–51, 53–54, 56–57, 65–66; costal projection not extremely long 2

2. Cross veins in basal half of cells C and Sc of fore wings of male surrounded with dark brown clouds (Figure 43); ovipositor or egg guide of female extending just past abdominal segment 10 (Figure 114); Cuba ..... ***H. caligatus*** Eaton

   Cross veins in fore wings of male not as above (Figures 49, 64); ovipositor or egg guide of female extending to posterior margin of segment 10 (Figures 115–116) 3

3. Membrane of fore and hind wings of male hyaline, gray; pleura of thorax of male pale with dark brown markings, especially in diagonal streaks posteromedially from leg bases; Puerto Rico ..... ***H. rangelae,*** new species

   Membrane of fore and hind wings hyaline, light brown; pleura of thorax of male not as above 4

4. Sterna 2–9 of female with a median, longitudinal and submedian, longitudinal, black lines; Haiti ..... ***H. eatoni*** Banks

   Sterna 2–9 of female uniformly light brown; Cuba ..... ***H. morrisonae,*** new species

Clave para las Especies de *Hagenulus* Eaton

Imagos

1. Macho con las nervuras transversas en el tercio apical de las celdillas C, Sc, y R_1 de las alas anteriores, rodeadas de color pardo (Figura 58); genitalia del macho según las Figuras 89–90; forma de las alas posteriores según las Figuras 59–60, 62–63; proyección costal de misma extremadamente larga; Jamaica ..... ***H. jamaicensis,*** new species

   De pocas a muchas nervuras transversas rodeadas de color pardo en las alas anteriores del macho, pero no como se describe en el inciso anterior (Figuras 43, 49, 64); genitalia del

macho según Figuras 87–88, 91; forma de las alas posteriores según las Figuras 44–45, 47–48, 50–51, 53–54, 56–57, 65–66; proyección costal de la misma no extremadamente larga 2

2. Macho con las nervuras transversas en la mitad basal de las celdillas C y Sc de las alas anteriores, rodeadas por manchitas pardo-oscuras (Figura 43); ovipositor de la hembra sobrepasando el segmento abdominal 10 (Figura 114); Cuba ..... ***H. caligatus*** Eaton

Nervuras transversas de las alas anteriores del macho no como en el inciso anterior (Figuras 49, 64); ovipositor de la hembra llegando solamente al margen posterior del segmento abdominal 10 (Figuras 115–116) 3

3. Machos con la membrana de ambas alas, hialina, gris; pleuras del tórax pálidas con marcas pardo-oscuras, especialmente en forma de trazos diagonales desde las bases de las patas; Puerto Rico ..... ***H. rangelae,*** nuevo especie

Membrana de ambos pares de alas, hialina, pardo-clara; pleuras torácicas del macho no como se describen en el inciso anterior 4

4. Esternitos 2–9 de la hembra con una linea media negra longitudinal y otra submedia; Haití ***H. eatoni*** Banks

Esternitos 2–9 de la hembra uniformemente pardo-claros; Cuba. ***H. morrisonae,*** nuevo especie

Hagenulus caligatus Eaton

FIGURES 1, 43–48, 87, 101, 108, 114, 129–130, 143, 152, 161, 171, 186–187, 201.

Hagenulus caligatus Eaton, 1882, p. 207; 1884 (1883–1888), p. 113.

MALE IMAGO (in alcohol).—Length: body, 6.5 mm.; fore wings, 7.2 mm. Upper portion of eyes light brown, lower portion black. Head light brown. Base of ocelli black, remainder white. Thorax light brown, sutures paler, sterna and carinae darker, diagonal streaks posteromedially from bases of prothoracic legs. Coxae, trochanters, femora and basal half of tibiae of prothoracic legs light brown, remainder of legs paler, except apexes of tibiae dark brown, large dark brown median and apical maculae on femora; mesothoracic and metathoracic legs pale, except large dark brown median and apical maculae on femora, apex of tibiae dark brown. Wings (Figures 43–45): longitudinal and cross veins of fore and hind wings hyaline, except cross veins in basal half of cells C and Sc of the fore wings surrounded with dark brown clouds; membrane of fore and hind wings hyaline except bases of wings brown. Abdomen: terga light brown, terga 1 and 9 uniformly washed with dark brown, terga 2–8 with dark brown markings as in Figures 129–130; sterna light brown. Genitalia (Figure 87): apical half of forceps segment 1 dark brown, segment 2 brown, remainder of forceps and penes paler; penes with subapical, ventral spines. Caudal filaments pale, basal half of filaments with wide, dark brown annulations at alternate articulations, apical half of filaments with annulations at every third articulation.

FEMALE IMAGO (pinned).—Length: body, 5.0–5.8 mm.; fore wings, 7.0 mm. Eyes black. Head and thorax light brown, carinae darker. Color and markings of legs as in male imago. Wings (Figures 46–48): longitudinal and cross veins of fore and hind wings light brown, membrane hyaline, washed lightly with brown in cells C and Sc in fore wings; cross veins of fore wings surrounded with black clouds. Abdomen: light brown; tergum 1 uniformly washed with dark brown; posterior margin and lateral sides of terga 2–9 with a dark brown band, at posterolateral angles bands rounded off where they meet. Ovipositor or egg guide extending just past posterior margin of segment 10. Color and markings of caudal filaments as in male imago.

MATURE NYMPH (in alcohol).—Head light brown. Mouthparts (Figures 143, 152, 161, 171, 186–187): dorsal hair on labrum as in Figure 186; labrum greatly expanded laterally (Figures 1, 186). Left mandible as in Figure 171. Maxillary palpi greatly elongated (Figures 1, 152); a large toothlike projection on the inner anterolateral margin of maxillae. Labial palpi greatly elongated (Figure 143). Thorax light brown, lateral margins of terga black. Legs light brown, markings as in male and female imagos. Abdomen light brown, markings as in Figure 1. Gills gray, tracheae black. Caudal filaments light brown, markings as in male and female imagos.

DISCUSSION.—Eaton (1882) described *H. caligatus* from a male subimago and a series of female imagos.

The above redescription of *H. caligatus* is based on the type series examined by me in the Museum of Comparative Zoology and additional specimens as listed below. Although the figure of the genitalia of the male subimaginal type made by Eaton (1884) shows no subapical, ventral spines on the penes, examination of this type indicates the presence of spines as in Figure 87.

The labrum of the immature nymphs of *H. caligatus* is not as greatly expanded laterally as the labrum of the mature nymphs. The remaining mouthparts of the immature nymphs are similar to those of mature nymphs. Also the labrum of mature male nymphs is not as greatly expanded laterally as the labrum of mature female nymphs.

Hagenulus caligatus can be distinguished from the remaining species of *Hagenulus* by the following characters. In the imagos (1) the cross veins in basal half of cells C and Sc of the fore wings of the male are surrounded with dark brown clouds (Figure 43), (2) the ovipositor or egg guide of the female extends just past the posterior margin of abdominal segment 10 (Figure 114), and (3) the color pattern on the abdomen of the male is as in Figures 129–130. In the nymphs (1) long hair is present on the inner and dorsal surfaces of the prothoracic tibiae (Figure 1), (2) the labrum is greatly expanded laterally (Figures 1, 186), and (3) the left mandible is as in Figure 171. The nymphs and adults of *H. caligatus* are associated by developing wing pads and color markings on the legs and abdomen of the nymphs collected from the same locality as the adults.

Additional localities for *H. caligatus* are: 1 male imago, Cuba: La Habana Prov., Güines (field no. 33), March 1966, P. Alayo D.; 1 male imago, Cuba: Pinar del Río Prov., Arroyo Pinar de Viñales (field no. 23), P. Alayo D.; 1 female subimago, Cuba: La Habana Prov., Güines (field no. 33), March 1966, P. Alayo D.; 9 nymphs, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 1), March 1965, P. Alayo D.; 1 nymph, Cuba: Pinar del Río Prov., Río Cuzco, near Soroa (field no. 2), March 1965, P. Alayo D.; 14 nymphs, Cuba: La Habana Prov., Güines (field no. 5), March 1966, P. Alayo D.; 3 nymphs, Cuba: Pinar del Río Prov., stream, Viñales (field no. 11), October 1964, P. Alayo D.; 48 nymphs, Cuba: La Habana Prov., Melena del Sur (field no. 44), February 1965, P. Alayo D.; 62 nymphs, Cuba: La Habana Prov., Güines (field no. 56), March 1966, P. Alayo D.; 2 nymphs, Cuba: Pinar del Río Prov., brook, 29 October 1965, V. Landa; 29 nymphs, Cuba: La Habana Prov., Vento, 20 April 1930, J. G. Needham; 10 nymphs, Cuba: Pinar del Río Prov., Santa Cruz de los Pinos, 24–28 March 1939, J. G. Needham. All specimens are in alcohol. One male imago and 45 nymphs are deposited in the collections of the Institute of Biology, Academy of Sciences of the Republic of Cuba. One male imago, 1 female subimago, and 33 nymphs were deposited in the collections of Florida A & M University. Thirty-four nymphs were deposited in each of the collections of the University of Utah, Museum of Comparative Zoology, and National Museum of Natural History.

The nymphs of *H. caligatus* live in the stony areas of free flowing rivers and streams, clinging from the underside of the stones, sometimes in considerable numbers. Dr. Alayo has found imagos and subimagos resting in branches overhanging the water, 6–8 feet high. He has collected in early morning a regular number of specimens by sweeping the vegetation near the water and found that subimagos are more numerous than imagos. Subimagos moult in about 24 hours.

Hagenulus morrisonae Peters and Alayo, new species

FIGURES 2, 49–54, 88, 115, 131–132, 144, 153, 162, 172, 188–189, 208

MALE IMAGO (in alcohol).—Length: body, 5.2–5.8 mm.; fore wings, 6.2–7.2 mm. Upper portion of eyes brown, lower portion black. Head brown. Basal half of ocelli black, remainder white. Prothorax light brown, a median, and submedian, longitudinal black bands on notum, lateral margins of notum black; remaining portion of thorax brown, except pleura lighter, carinae at bases of wings and legs black. Coxae dark brown, femora and tibiae brown, remainder of legs paler; a median and apical dark brown maculae on femora, apexes of tibiae dark brown. Wings (Figures 49–51): longitudinal and cross veins of fore and hind wings brown, cross veins in cells C, Sc, and R_1 of the fore wings faintly edged in dark brown; membrane of fore and hind wings hyaline, light brown. Abdomen: light brown; tergum 1 uniformly washed with dark brown, posterior margin of terga 2–9 dark brown, dark brown anteromedian markings on terga 2–9 as in Figures

131–132, markings lighter on terga 2 and 3. Genitalia (Figure 88): apical half of forceps segment 1 dark brown, segment 2 brown, remainder of forceps and penes paler; penes without subapical, ventral spines. Caudal filaments pale, dark brown annulations at articulations, annulations broader on alternate segments.

FEMALE IMAGO (in alcohol).—Length: body, 4.5–6.2 mm.; fore wings, 5.8 mm. Eyes black. Head brown. Thorax light brown, color markings on thorax as in male imago. Legs light brown, dark brown markings as in male imago except bases and apex of tibiae dark brown. Wings (Figures 52–54): longitudinal and cross veins of fore and hind wings brown, cross veins in fore wings surrounded with dark brown clouds, clouds lighter along posterior margin of wings; membrane of fore and hind wings light brown, membrane in cells C and Sc of the fore wings translucent, remaining membrane in fore and hind wings transparent. Abdomen: light brown, dark brown markings as in male imago. Ovipositor or egg guide extending to anterior margin of segment 10 (Figure 115). Caudal filaments as in male imago.

MATURE NYMPH (in alcohol).—Head light brown. Mouthparts (Figures 144, 153, 162, 172, 188, 189): dorsal hair on labrum as in Figure 188; labrum a little expanded laterally (Figures 2, 188). Left mandible as in Figure 172. Maxillary palpi greatly elongated (Figure 153); a large toothlike projection on the inner anterolateral margin of maxillae. Labial palpi greatly elongated (Figure 144). Thorax light brown, color markings as in male and female imagos. Legs light brown, color markings as in male and female imagos. Abdomen light brown, color markings as in male and female imagos. Gills gray, tracheae black. Caudal filaments light brown, markings as in male and female imagos.

Holotype male imago, Cuba: Oriente Prov., Río Boniatico, San Luis (field no. 27), November 1964; allotype, Cuba: Las Villas Prov., Río Anaya, Ciego Montero, Rodas (field no. 31), December 1965; paratypes: 2 female imagos, same data as for allotype; 1 male subimago, 1 female subimago, Cuba: Las Villas Prov., Río Anaya, Ciego Montero, Rodas (field no. 32), December 1965; 1 male imago, 1 male subimago, 1 female subimago, Cuba: Oriente Prov., Río Guantanamo (field no. 30); 2 nymphs, Cuba: Oriente Prov., Río Nagua, near Turquino (field no. 16), May 1965; 2 nymphs, Cuba: Oriente Prov., Río Yara, Central Estrada Palma, Manzanillo (field no. 17), November 1964; 4 nymphs, Cuba: Oriente Prov., Río Boniatico, San Luis (field no. 26), November 1964; 10 nymphs, same data as for allotype; 6 nymphs, Cuba: Oriente Prov., Río San Rafael, San Luis, 16 November 1964, V. Landa. All specimens are in alcohol and all were collected by P. Alayo D., except as marked. Holotype, allotype, and eight nymphs are deposited in the collections of the Institute of Biology, Academy of Sciences of the Republic of Cuba. One male imago, one male subimago, one female imago, one female subimago, and eight nymphs were deposited in the collections of Florida A & M University. One male subimago, one female imago, one female subimago, and four nymphs were deposited in the collections of the University of Utah. Four nymphs were deposited in the collections of the National Museum of Natural History.

ETYMOLOGY.—Species named for Mrs. Emily R. Morrison who correctly associated the nymphs and adults of *Hagenulus*.

Hagenulus morrisonae can be distinguished from the remaining species of *Hagenulus* by the following characters. In the imago (1) the cross veins in cells C, Sc, and R_1 of the fore wings are surrounded with dark brown clouds (Figures 49, 52), (2) the penes of the male genitalia possess no subapical ventral spines (Figure 88), and (3) the color pattern on the abdomen of the male and females is as in Figures 131–132. In the nymphs, (1) long hair is present on the inner and dorsal surfaces of the prothoracic tibiae (Figure 2), (2) the labrum is a little expanded laterally (Figures 2, 188), and (3) the left mandible is as in Figure 172. The nymphs and adults of *H. morrisonae* are associated by the developing wing pads and color markings on the legs and abdomen of the nymphs collected from the same locality as the adults.

Nymphs of this species are commonly found in free-flowing rivers, under stones in places where the water is clear and only about six inches to one foot deep. Nymphs cling to the underside of the stones. Subimagos are easily found by turning stones at the margins of the river where nymphs are plentiful. Dr. Alayo has found these subimagos at every hour of the day, resting under the stones and, when disturbed, running a little or making a short flight. In the evening, about five or six

o'clock, but in full daylight, he has seen swarms of adults flying and dancing in the air very near the water, about one foot or less from the water's surface and always near the stony places of the river. Each swarm includes about 30 or 40 individuals, forming a mass in the air about the size of a ball measuring 1 to 1½ feet in diameter. As the darkness grows, these groups are more and more numerous.

Dr. Alayo observes that subimagos apparently molt during the day shortly after their emergence, as he has found the imago several times under stones beside the discarded subimagal skin.

Hagenulus eatoni Banks

FIGURES 55–57, 116, 133–134

Hagenulus eatoni Banks, 1924, p. 423.

FEMALE IMAGO (pinned).—Length: body, 5.6 mm.; fore wings, 6.7 mm. Eyes black. Head light brown. Thorax light brown; submedian, longitudinal black bands on pronotum; pleura with black markings, especially in diagonal streaks posteromedially from leg bases. Legs light brown; median and apical transverse black bands on femora; apex of tibiae and tarsi black. Wings (Figures 55–57): longitudinal and cross veins of fore and hind wings brown; membrane of fore and hind wings hyaline, washed lightly with brown especially in cells C and Sc of fore wings, cross veins in fore wings surrounded with black clouds except in anal area. Abdomen: light brown; tergum 1 uniformly washed with black, terga 2–9 with black markings as in Figures 133–134; sterna 2–9 with a median, longitudinal and submedian, longitudinal, black lines. Ovipositor or egg guide extends to posterior margin of segment 10 (Figure 116). Caudal filaments light brown, black annulations at articulations.

DISCUSSION.—The above redescription of *H. eatoni* is based on the type series of 11 females collected from Diquini, Haiti. These types are deposited in the collections of the Museum of Comparative Zoology. The species is known only from the female imago.

One of these specimens possesses fore wings with distinct black clouds surrounding the cross veins only in cells C, Sc, and R_1 as in Figure 55. All specimens are more yellowish than the type.

I have seen one female imago from Ennery, Haiti, which appears to represent an undescribed species of *Hagenulus*. The abdomen is light brown, except the anterior half of terga 2–9 is black. Also the female ovipositor or egg guide extends past abdominal segment 10 by one-fourth its length. This specimen is deposited in the collections of the Museum of Comparative Zoology and is pinned.

Hagenulus jamaicensis Peters, new species

FIGURES 58–63, 89–90, 117, 135–136

MALE IMAGO (in alcohol).—Length: body, 4.2–5.7 mm.; fore wings, 4.8–5.4 mm. Upper portion of eyes light brown, lower portion black. Head light brown. Base of ocelli black, remainder light brown. Thorax light brown, sutures paler, pleura with contrasting pale and dark areas. Coxae, trochanters, and femora of prothoracic legs brown; large, darker, apical, median, and distal maculae on dorsal and ventral surfaces of femora, remainder of legs pale, apexes of tibiae darker; mesothoracic and metathoracic legs pale, large, darker median and distal maculae on dorsal and ventral surfaces of femora, apexes of tibiae darker. Wings (Figures 58–60): longitudinal and cross veins of fore and hind wings hyaline, washed lightly with brown; cross veins in apical third of cells C, Sc, and R_1 of fore wings surrounded with brown clouds; costal projection of hind wings acute, long, and well developed (Figures 59–60). Abdomen: terga hyaline, washed lightly with brown, terga 1, 8–10 darker, posterior margin of terga 1–9 each with a darker transverse band, lateral margins of terga 1–8 with a darker longitudinal band, spiracles and tracheae darker, terga 2–8 with darker, sublateral, diagonal bands (Figures 135–136); sterna hyaline, washed lightly with brown, sterna 8–9 darker. Genitalia (Figures 89–90): light brown, apex of basal segment of genital forceps darker; penes with subapical, ventral spines. Caudal filaments light brown, wide annulations at articulations darker.

FEMALE IMAGO (in alcohol).—Length: body, 4.6 mm.; fore wings, 5.6 mm. Eyes black. Head light brown. Color of thorax and legs as in male imago, except apex of tibiae light brown. Wings (Figures 61–63): longitudinal and cross veins of fore and hind wings light brown, membrane hyaline, washed lightly with brown; cross veins of fore wings sur-

rounded with dark brown clouds, clouds lighter in posterior portion of wings. Abdomen: light brown, darker color markings as in male imago. Ovipositor or egg guide extending to just past segment 10 (Figure 117). Caudal filaments as in male imago.

MATURE NYMPH.—Unknown.

Holotype male imago, Jamaica: Clarendon Parish, Rio Minho, Frankfield, 7 January 1955, T. H. Farr; allotype, same data as holotype except collected 10 March 1954; paratopotypes, 18 male imagos, 4 female imagos. All types are in alcohol. Four male and one female paratopotypes were deposited in each of the collections of Florida A & M University, University of Utah, and National Museum of Natural History. Remaining types deposited in the collections of the Science Museum, Institute of Jamaica.

ETYMOLOGY.—Species named for Jamaica.

DISCUSSION.—*Hagenulus jamaicensis* can be distinguished from the remaining species of *Hagenulus* by the following characters. In the imagos (1) cross veins in apical third of cells C, Sc, and R_1 of fore wings of males are surrounded with brown clouds (Figures 58, 61), (2) the costal projection of the hind wings is acute, long, and well developed (Figures 59–60, 62–63), and (3) the color pattern on the male and female abdominal segments is as in Figures 135–136.

Hagenulus rangelae Peters, new species

FIGURES 64–66, 91, 137–138

MALE IMAGO (pinned).—Length: body, 4.3 mm.; fore wings, 5.0 mm. Eyes gray; eyes separated on meson of head by a length equal to maximum width of a lateral ocellus. Head light brown. Base of lateral ocelli light brown, remainder white; base of median ocellus dark brown, remainder white. Thoracic nota and sterna light brown, pleura paler with dark brown to fuscus markings, especially in diagonal streaks posteromedially from leg bases. Legs light yellowish brown, becoming paler apically; femora with broad, transverse, dark brown bands in middle and apical portions; apical one-fifth of prothoracic and mesothoracic tibiae dark brown; apex of each segment of prothoracic tarsi dark brown. Wings (Figures 64–66): longitudinal veins and cross veins in fore wings dark brown in anterior portion of wings, fading to light brown in posterior portion, light brown cross veins may be washed lightly with black, but occur in no particular pattern on wings; vein Sc of hind wings dark brown, basal half of all other longitudinal veins dark brown, apical half light brown, cross veins light brown; membrane of fore and hind wings hyaline, gray; cells C, Sc, and R_1 of fore wings surrounded with black clouds. Abdomen: tergum 1 dark brown, terga 2–7 pale yellowish brown with dark brown color markings as in Figures 137–138, terga 8 and 9 similar to tergum 7, but obscured with extensive median brown markings, tergum 10 light brown; sterna light yellowish brown, the posterolateral angles a little darker, especially on sterna 8 and 9. Genitalia (Figure 91): penes pale yellowish brown; penes with subapical, ventral spines; forceps broken off and missing. Caudal filaments broken off and missing.

FEMALE IMAGO.—Unknown.

MATURE NYMPH.—Unknown.

Holotype male imago, Puerto Rico: San Rangel, 27 June, Otero. Holotype pinned and deposited in the collections of the Museum of Comparative Zoology, Cambridge.

ETYMOLOGY.—Species is named for type locality, San Rangel.

DISCUSSION.—*Hagenulus rangelae* can be distinguished from the remaining species of *Hagenulus* by the following characters. In the male imagos (1) the cross veins in cells C, Sc, and R_1 of the fore wings are surrounded with black clouds (Figure 64), (2) the membrane in the fore and hind wings is hyaline, gray, and (3) the color pattern on the abdominal terga is as given in the descriptions and Figures 137, 138.

Genus *Borinquena* Traver, 1938

FIGURES 67–72, 92–96, 102–103, 109–110, 119–120, 146–147, 155–156, 164–165, 174–175, 192–196, 202–203, 209–210

Borinquena Traver, 1938, p. 16; 1959, p. 2.

TYPE-SPECIES.—*Borinquena (B.) carmencita* Traver, by original designation.

SPECIES INCLUDED.—*Borinquena (B.) carmencita* Traver, 1938, p. 18; *B. (B.) contradicens* Traver, 1938, p. 20; *B. (A.) traverae*, new species.

DISTRIBUTION.—Puerto Rico, Dominica, St. Lucia.

IMAGO.—Length of male: body, 5.5–5.7 mm.; fore wings, 5.2–5.6 mm. Length of female: body, 3.5–6.0

mm.; fore wings, 5.0–6.0 mm. Eyes of male separated on meson of head by a length 1 to 3 times maximum width of a lateral ocellus or eyes meet on meson of head, lower portion of eyes two-thirds to three-fourths length of upper portion; eyes of female separated on meson of head by a length 4 to 5 times maximum width of an eye. Wings (Figures 67–72): vein R_s of fore wings forked less than one-fourth to one-fourth of distance from base to margin, vein MA forked half of distance from base to margin, fork asymmetrical, distal portion of vein MA sagged posteriorly; vein MP forked a little less than half of distance from base to margin, fork symmetrical; cubital area as in Figures 67, 72; cross veins few. Hind wings present (Figures 68–71), or absent. When present, hind wings well developed, costal projection acute, long, and well developed, apex of projection located half distance from base, apex of wings narrow and rounded (Figures 70–71), cross veins few (Figures 70–71), or hind wings reduced, no costal projections or cross veins (Figures 68–69), apex of wings pointed (Figures 68–69). Legs: ratios of segments in male fore legs, 0.52: 1.00 (2.2 mm.): 0.05: 0.29: 0.29: 0.27: 0.23. Claws of a pair dissimilar; one apically hooked (Figures 102–103), other obtuse, padlike. Male genitalia (Figures 92–96): segments 2 and 3 of forceps short, basal segment of forceps long and narrow, slightly bowed at apex, its inner margin forming an angular bend; length of styliger plate along median line one-third to half length of maximum width; penes divided, tubular, a subapical, ventral spine on each penis lobe. Ninth sternum of female deeply cleft (Figures 109–110). Female with a well-developed ovipositor or egg guide extending to posterior margin of segment 10 (Figure 120) to past posterior margin of segment 10 by half its length (Figure 119). Terminal filament longer than cerci.

MATURE NYMPH.—Head prognathous. Antennae 3 times maximum length of head. Mouthparts (Figures 146–147, 155–156, 164–165, 174–175, 192–196): dorsal hair on labrum as in Figures 192, 195; submedian and anterolateral areas of hair ventrally; 2 large equal-sized denticles and sometimes 1 to 3 small unequal-sized denticles on anteromedian emargination (Figures 193–194, 196). Clypeus as in Figures 192 and 195. Left mandible as in Figures 174 and 175. Lingua of hypopharynx with well-developed lateral processes (Figures 164–165), anterior margin shallowly to deeply cleft; superlingua of hypopharynx as in Figures 164–165, with a row of hair along anterior margin. Segment 2 of maxillary palpi one and one-fourth to one and one-half times length of segment 1; segment three one-third to half length of segment 2, triangular; a V-shaped ridge near the ventral, inner anterolateral margin of maxillae; hair on maxillae as in Figures 155–156. Labium as in Figures 146–147; segment 2 of palpi equal to a little longer than length of segment 1; segment three one-fifth to one-third length of segment 2, triangular; paraglossae ventral to glossae. Fine hair on anterolateral margins of prothorax only. Legs (Figures 202–203): claws apically hooked, denticles on claws progressively larger apically except apical denticle much larger. Gills (Figures 209–210): gills on segments 1–7 alike; each gill consists of one long, slender portion (Figure 209), or each gill deeply forked (Figure 210). Posterolateral spines on abdominal segments 6 or 7–9, spines progressively larger posteriorly. Terminal filament slightly longer than cerci.

DISCUSSION.—Traver (1938) established *Borinquena* for two species described by her from Puerto Rico. Excellent descriptions of these two species, *B. carmencita* and *B. contradicens,* are given in Traver (1938). Herein one new species of *Borinquena* is described, *B. traverae,* from Dominica. Collections recently made available to me contain another new species from St. Lucia; however, this species is not described herein, as it is known only from the male and female subimagos and nymphs.

The adults of *B. traverae* and the undescribed species from St. Lucia possess no hind wings, the adults of *B. carmencita* possess reduced hind wings (Figures 68–69), and the adults of *B. contradicens* possess well-developed hind wings (Figures 70–71). I have found no other adult morphological character that successfully separates *B. traverae* and the species from St. Lucia from the remaining described species of *Borinquena.* The abdominal gills of the nymphs of *B. traverae* and the undescribed species from St. Lucia are deeply forked (Figure 210), while the abdominal gills of the nymphs of *B. carmencita* and *B. contradicens* consist of one long, slender portion (Figure 209). I have found no other nymphal morphological character that successfully separates *B. traverae* and the undescribed species from the remaining described species of *Borinquena.* Herein a new subgenus, *Australphlebia,* is established for the species *traverae.*

Borinquena can be distinguished from other West Indian genera of the Leptophlebiidae by the following combination of characters. In the imago (1) the penes of the male genitalia are divided, tubular and a subapical ventral spine occurs on each penis lobe (Figures 92–96), (2) the female possesses a well-developed ovipositor or egg guide and it extends to at least past the anterior margin of abdominal segment 10 (Figures 119–120), and (3) the cross veins in the fore wings of the male and female are not surrounded with dark clouds (Figures 67, 72). In the nymphs (1) the denticles on the claws are progressively larger apically except the apical denticle is much larger (Figures 202–203), (2) 2 large equal-sized denticles and sometimes 1 to 3 small unequal-sized denticles occur on the anteromedian emargination of the labrum (Figures 193–194, 196), and (3) posterolateral spines occur on abdominal segments 6 or 7–9. *Borinquena* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos (1) the base of vein ICu_1 of the fore wings attaches to vein CuA (Figures 67, 72), (2) the penes of the male genitalia are divided, tubular and a subapical ventral spine occurs on each penis lobe (Figures 92–96), (3) the female possesses a well-developed ovipositor or egg guide and it extends to at least past the anterior margin of abdominal segment 10 (Figures 119–120), and (4) the length of the styliger plate of the male along the median line is one-third to half the length of the maximum width (Figures 92, 94, 96). In the nymphs (1) a V-shaped ridge occurs near the ventral, inner anterolateral margin of the maxillae (Figures 155–156), (2) 2 large equal-sized denticles and sometimes 1 to 3 small unequal-sized denticles occur on the anteromedian emargination of the labrum (Figures 193–194, 196), (3) the denticles on the claws are progressively larger apically except the apical denticle is much larger (Figures 202–203), and (4) posterolateral spines occur on abdominal segments 6 or 7–9.

Key to the Species of *Borinquena* Traver

Imagos

1. Hind wings absent; apex of penes of male imago acute (Figure 96); Dominica. ***B. (A.) traverae,*** new species
   Hind wings present, although sometimes greatly reduced (figures 68–71); apex of penes of male imago blunt (Figures 92–95) ..... ***Borinquena*** sensu stricto 2
2. Hind wings reduced, with 2 longitudinal veins, costal projection absent (Figures 68–69); paired, small submedian protuberances on posterior margin of styliger plate of male genitalia (Figure 92); Puerto Rico ..... ***B. (B.) carmencita*** Traver
   Hind wings well developed, with 4 longitudinal veins, well developed costal projection (Figures 70–71); 1 small median protuberance on posterior margin of styliger plate of male genitalia (Figure 94); Puerto Rico ..... ***B. (B.) contradicens*** Traver

Mature nymphs

1. Abdominal gills 1–7 deeply forked (Figure 210); abdominal terga 2–7 with a pale, narrow, median, longitudinal band; Dominica ..... ***B. (A.) traverae,*** new species
   Abdominal gills 1–7 each consists of 1 long, slender portion (Figure 209); abdominal terga 2–7 not as above ..... ***Borinquena*** sensu stricto 2
2. Two large equal-sized denticles and 3 small unequal-sized denticles on anteromedian emargination of labrum (Figure 194); a wide, blackish, band across head between lateral ocelli, usually extending lateral to eyes; Puerto Rico ..... ***B. (B.) carmencita*** Traver
   Two large equal-sized denticles only on anteromedian emargination of labrum (Figure 193); color markings on head not as above; Puerto Rico ..... ***B. (B.) contradicens*** Traver

Clave para las Especies de *Borinquena* Traver

Imagos

1. Alas posteriores ausentes; penes del imago macho con el ápice agudo (Figura 96); Dominica. ***B. (A.) traverae,*** nuevo especie

Alas posteriores presentes, aunque a veces muy reducidas (Figuras 68–71); penes del imago macho con el ápice romo (Figuras 92–95) ..... ***Borinquena*** sensu stricto 2

2. Alas posteriores reducidas, con solo dos nervuras longitudinales y la proyección costal ausente (Figuras 68–69); genitalia del macho con un par de pequeñas protuberancias submedias en el margen posterior del styliger (Figura 92); Puerto Rico ..... ***B. (B.) carmencita*** Traver

Alas posteriores bien desarrolladas, con 4 nervuras longitudinales y la proyección costal bien desarrollada (Figuras 70–71); genitalia del macho con una pequeña protuberancia media en el margen posterior del styliger (Figura 94); Puerto Rico .. ***B. (B.) contradicens*** Traver

NINFAS MADURAS

1. Branquias abdominales 1–7 profundamente bifurcadas (Figura 210); tergitos abdominales 2–7 con una estrecha banda media longitudinal de color claro; Dominica. ***B. (A.) traverae***, nuevo especie

Branquias abdominales 1–7 no bifurcadas, consistentes en unas largas y delgadas cintas (Figura 209); tergitos abdominales 2–7 no como se describen en el inciso anterior. ***Borinquena*** sensu stricto 2

2. Labrum con das dentículos grandes de tamaño igual y tres dentículos pequeños y desiguales en su emarginación ántero-media (Figura 194); una ancha banda negruzca a través de la cabeza, entre los ocelos laterales, usualmente extendida en los lados hasta los ojos; Puerto Rico ..... ***B. (B.) carmencita*** Traver

Labrum con solo dos dentículos grandes de tamaño igual en su emarginación ántero-media (Figura 193); coloración de la cabeza distinta a la descrita en el inciso anterior; Puerto Rico ..... ***B. (B.) contradicens*** Traver

Subgenus *Borinquena* sensu stricto Traver, 1938

FIGURES 67–71, 92–95, 102, 109, 119, 146, 155, 164, 174, 192–194, 202, 209

IMAGO.—Hind wings well developed, costal projection acute, long, and well developed, apex of projection located half distance from base, apex of wings narrow and rounded (Figures 70–71), cross veins few (Figures 70–71) or hind wings reduced, no costal projection or cross veins (Figures 68–69), apex of wings pointed (Figures 68–69). Female with a well-developed ovipositor or egg guide extending to past posterior margin of segment 10 by half its length (Figure 119).

MATURE NYMPH.—Abdominal gills on segments 1–7 alike, each gill consists of one long, slender portion (Figure 209).

DISCUSSION.—The subgenus *Borinquena* sensu stricto occurs in Puerto Rico. The characters above will distinguish it from the subgenus *Australphlebia*.

Australphlebia, new subgenus

FIGURES 72, 96, 103, 110, 120, 147, 156, 165, 175, 195–196, 203, 210

IMAGO.—Hind wings absent. Female with a well-developed ovipositor or egg guide extending to posterior margin of segment 10 (Figure 120).

MATURE NYMPH.—Abdominal gills on segments 1–7 alike, each gill deeply forked (Figure 210).

ETYMOLOGY.—Latin australis, meaning southern; Greek phlebo, meaning vein.

TYPE-SPECIES.—*Borinquena (A.) traverae* Peters, new species.

Borinquena (Australphlebia) traverae Peters, new species

FIGURES 72, 96, 103, 110, 120, 147, 156, 165, 175, 195–196, 203, 210

MALE IMAGO (in alcohol).—Length: body, 5.5–5.7 mm.; fore wings, 5.2–5.6 mm. Upper portion of eyes light brown, lower portion black; eyes separated on meson of head by a length equal to maximum width of a lateral ocellus. Head light brown, carinae darker. Base of lateral ocelli light brown, remainder white; base of median ocellus dark brown, remainder white. Thorax and coxae of legs brown, except prothoracic notum and carinae darker, sutures paler. Legs pale, outer surface of femora and apex of tibiae of prothoracic legs dark brown; apex of metathoracic femora dark brown, remainder of femora washed lightly with dark brown. Wings (Figure 72): longitudinal veins of fore wings brown, cross veins paler; membrane of fore wings hyaline, except distal third of cells C and

Sc translucent; hind wings absent. Abdomen: terga dark brown, terga 2–7 with a paler, narrow, median, longitudinal, band; sterna paler. Genitalia (Figure 96): brown, styliger plate darker. Caudal filaments light brown; basal half of filaments with darker annulations at articulations.

FEMALE IMAGO.—Unknown.

FEMALE SUBIMAGO (in alcohol).—Length: body, 6.0 mm.; fore wings, 6.0 mm. Eyes black. Head dark brown. Color of thorax as in male imago. Color and markings on legs as in male imago, except apex of prothoracic tibiae paler; outer surfaces of metathoracic femora washed with dark brown, apex of inner surface dark brown. Wings: longitudinal veins of fore wings light brown, paler posteriorly, cross veins pale; membrane of fore wings transparent; hind wings absent. Abdomen: dark brown, color markings as in male imago, sterna paler. Ovipositor extending just past posterior margin of abdominal segment 10 (Figure 120). Caudal filaments broken off and missing.

MATURE NYMPH (in alcohol).—Head and thorax brown, venter paler. Legs pale, brown color markings as in male imago and female subimago, except prothoracic tibiae entirely pale. Abdomen dark brown, sterna paler, color markings on terga as in male imago and female subimago. Gills gray, tracheae black. Caudal filaments pale.

Holotype male imago, Dominica: 0.4–0.5 mile east of Pont Casse, 8 April–24 July 1964; paratopotypes, 4 male imagos, 8 male subimagos, 1 female subimago, 13 nymphs; paratypes, 1 male subimago, 5 nymphs, Dominica: Dleau Gommier, 17 April 1964. All types were collected by O. S. Flint, Jr., and are in alcohol. One male imaginal, three male subimaginal, and four nymphal paratopotypes were deposited in each of the collections of Florida A & M University and the University of Utah. Remaining types deposited in the collections of the National Museum of Natural History.

ETYMOLOGY.—Species is named for Dr. Jay R. Traver, Amherst, Massachusetts, who has greatly contributed to the knowledge of the West Indian Ephemeroptera.

DISCUSSION.—The subgenus *Australphlebia* occurs in Dominica and St. Lucia. The characters above will distinguish it from the subgenus *Borinquena* sensu stricto. The nymphs and adults of *B. traverae* are associated by the developing wing pads, the color markings on the legs, and the color pattern on the terga of nymphs collected from the same locality as the adults.

Phylogeny and Relationships of the West Indian Genera

The phylogeny and relationships of the West Indian genera of Leptophlebiidae will not be fully understood until these genera are compared in greater detail with the remaining genera occurring in the Neotropical region. At present, study of all Neotropical Leptophlebiidae, the dominant mayfly family in South and Central America, is not complete enough to make adequate comparisons. Some phylogenetic conclusions, however, can now be drawn relative to the West Indian genera.

All six leptophlebiid genera occurring in the West Indies possess similarities. Venation of the adult fore wings of all genera is similar (Figures 15, 21, 33, 43, 67), except for the cubital area of the fore wings of *Farrodes* (Figures 6, 9, 12). The penes of the male genitalia are partially to entirely divided (Figures 73–96). In the nymphs, denticles are present on the anteromedian emargination of the labrum (Figures 176–196), and a V-shaped ridge is present on the dorsal surface of the maxillae near the inner anterolateral margin (Figures 148–156). Except for those species of *Hagenulus* with nymphs specialized for straining food from the current, the mouthparts of the nymphs are morphologically similar. The abdominal gills are long and slender (Figures 204, 206–210), except for the platelike gills possessed by *Traverina* (Figure 205).

While similarities do occur, there are basic morphological differences, especially in the adults. The first cubital intercalary attaches to vein CuP in the fore wings in all genera (Figures 15, 21, 33, 43, 67), except *Farrodes*. In *Farrodes* the first cubital intercalary is independent of both veins CuA and CuP (Figures 6, 9, 12). The penes of the male genitalia of *Farrodes* possess large apical appendages (Figures 73–78), while the penes of the remaining genera possess either subapical ventral spines (Figures 79, 84–87, 89–96) or no spines (Figures 80–83, 88). No female ovipositor or egg guide occurs in *Farrodes;* a short ovipositor or egg guide occurs in *Neohagenulus, Careospina,* and *Traverina* (Figures 111–113); and a long and well-developed ovipositor or egg guide is present in the remaining genera (Figures 114–120). The females of all genera except

Farrodes possess a ninth abdominal sternum that is deeply cleft apically (Figures 105–110). The ninth sternum of the female of *Farrodes* is entire (Figure 104). The terminal filament in *Careospina* is greatly reduced and has only 6 or 7 segments (Figure 121), but the terminal filament in all other genera is longer than the cerci. It is apparent that the six West Indian genera are not all closely related.

Farrodes appears to be the most primitive genus occurring in the West Indies and may represent a separate line of evolution. However, it appears to be a member of the same complex. The first intercalary in the cubital area of the adult fore wings is not connected either to vein CuA or CuP (Figures 6, 9, 12), but the first intercalary connects to vein CuP (Figures 15, 21, 33, 43, 67) in all other West Indian genera. The female imagos possess no ovipositor or egg guide. A large ventral appendage arises from the apex of each penis lobe of the male genitalia (Figures 73–78). The ninth sternum of the female is entire apically (Figure 104), but the ninth sternum is greatly cleft in all other West Indian genera (Figures 105–110). Nymphs of *Farrodes* are morphologically similar to the other West Indian genera. No representative from the surrounding continental area has been found that is closely related to *Farrodes*.

Traverina appears to be more specialized than *Farrodes* and may represent a line of evolution separate from *Farrodes*. The first intercalary in the cubital area of the adult fore wings connects to vein CuP (Figures 15, 18). The female imagos possess an ovipositor or egg guide extending to the anterior margin of abdominal segment 8 (Figure 111). Each penis lobe of the male genitalia possesses a subapical, ventral spine (Figure 79). It is reasonable to assume the ventral appendage in *Farrodes* has reduced to a ventral spine in *Traverina*. The ninth sternum of the female is greatly cleft apically (Figure 105). Nymphs of *Traverina* are morphologically similar to nymphs of the other West Indian genera except for the abdominal gills. The gills are platelike and terminate in 3 processes, with the median projection longer than the laterals (Figure 205). No representative from the surrounding continental area has been found that is closely related to *Traverina*.

Careospina appears to be closely related to *Traverina* but is more apomorphic. The female imagos possess an ovipositor or egg guide extending to the anterior third of abdominal segment 8 (Figure 112). The subapical, ventral spines are secondarily lost on the penes of the male genitalia (Figures 80–83). The terminal filament is greatly reduced, with 6–7 segments; the basal 3 segments are short, but the remaining segments are long (Figure 121). All other genera from the West Indies possess a terminal filament that is at least a little longer than the cerci. Nymphs of *Careospina* are morphologically similar to the other West Indian genera. No representative from the surrounding continental area has been found that is closely related to *Careospina*.

Neohagenulus appears to be related to *Traverina* and *Careospina* but is much more specialized. The female ovipositor or egg guide extends to the anterior margin of abdominal segment 8 (Figure 113). The costal projection of the hind wings, however, is acute, long, and well developed (Figures 34–35, 37–42). While the costal projection in *Traverina* and *Careospina* is well developed, it is much shorter in length (Figures 16–17, 22–23). Subapical ventral spines occur on the penes of the male genitalia; however, the penes are shorter than those of *Traverina* and *Careospina* and the basal half of the penis lobes is connected by a sclerotized membrane (Figures 84–86). Nymphs of *Neohagenulus* are morphologically similar to the other West Indian genera. No representative from the surrounding continental area has been found that is closely related to *Neohagenulus*.

Hagenulus and *Borinquena* appear to be closely related. Both seem to be related to *Neohagenulus*, but the genera appear to be more apomorphic than *Neohagenulus*. It is difficult to determine which of the two genera, *Hagenulus* or *Borinquena*, is more primitive. The adults of both genera are specialized. The female ovipositor or egg guide is well developed and extends to at least the posterior margin of abdominal segment 10 (Figures 114–120). The length of the styliger plate in the males is one-third to more than half its maximum width (Figures 87–89, 91–92, 94, 96). Subapical, ventral spines occur on the penes of the male genitalia (Figures 87, 89–96). All known species of *Hagenulus*, however, possess well-developed hind wings (Figures 44–45, 47–48, 50–51, 53–54, 56–57, 59–60, 62–63, 65–66) with a long and well-developed costal projection similar to that of *Neohagenulus*. The hind wings of *Borinquena (B.) contradicens* are well developed

(Figures 70–71) and similar to those of *Neohagenulus* and *Hagenulus,* but the hind wings of *B. (B.) carmencita* are greatly reduced and without a costal projection (Figures 68–69), while the hind wings of *B. (A.) traverae* are entirely absent. The nymphs of *Hagenulus* and *Borinquena* are morphologically similar to the other West Indian genera. The nymphs of *Hagenulus,* however, appear more primitive than those of *Borinquena.* The denticles on the tarsal claws of *Hagenulus,* as well as those of *Neohagenulus, Careospina,* and *Traverina,* are progressively larger apically (Figures 198–201), but the denticles on the tarsal claws of *Borinquena* are progressively larger apically, except the apical denticle is much larger (Figures 202–203). At least 3 small, equal-sized denticles occur on the anteromedian emargination of the labrum of *Hagenulus,* as well as the labrum of *Neohagenulus, Careospina,* and *Traverina* (Figures 178–191). Two large equal-sized denticles and sometimes 1 to 3 small unequal-sized denticles occur on the anteromedian emargination of the labrum of *Borinquena* (Figures 192–196). It appears *Hagenulus* is more primitive than *Borinquena.*

Nymphs of two species of *Hagenulus* have mouthparts secondarily specialized for straining food from the current. It appears that this specialized type of feeding has evolved in situ since the West Indies broke up into several isolated islands. Only the Cuban species have such feeding modifications, being fully developed in *H. caligatus* and partially developed in *H. morrisonae.* Based on the highly specialized mouthparts, Traver (1960) suggested *Hagenulus* (as described by Morrison) is closely related to the Central and South American genera *Hermanella, Ulmeritus,* and *Traverella,* and to the Asian genus, *Choroterpides.* The foregoing study has shown that *Hagenulus* is most closely related to the other West Indian genera. Preliminary investigation indicates that *Hermanella* and *Traverella* are closely related and both may be closely related to *Ulmeritus.* Recent research by Peters (in manuscript) shows *Choroterpides* is most closely related to the Asian species of *Choroterpes.*

Adults of the six West Indian genera of Leptophlebiidae are extremely varied except for the venation of the adult fore wings. The nymphs of these six genera, however, are all morphologically similar except for the type of mouthparts in two species of *Hagenulus* and the abdominal gills of *Traverina.* These six genera are some of the best examples, in the Leptophlebiidae, of differential rates of evolution between adults and nymphs. Based on similarity of nymphal morphology and the venation of the adult fore wings, all six genera belong to the same complex, and based on total morphology of the nymphs and adults they appear to represent at least two diverging lines of evolution.

No North American leptophlebiid genus appears closely related to the West Indian genera, even though Cuba is in close proximity to Florida. Many groups of insects indicate a faunal connection between Florida and the West Indies. Berner (1950) stated that although other species of insects have become established both in Florida and in the West Indies, the mayflies have been unable to do this principally because of the ecological conditions of southern Florida. He further stated that a great majority of mayflies described from the West Indies are inhabitants of mountain streams, and even if these mayflies were accidentally introduced into Florida, establishment would be impossible in the sandy bottomed streams. Almost the entire mayfly fauna of Florida appears to be Nearctic in nature. Families and genera of mayflies occurring in Florida are Siphlonuridae (*Isonychia*), Baetidae (*Baetis, Callibaetis, Centroptilum, Cloeon, Pseudocloeon*), Oligoneuriidae (*Homoeoneuria*), Heptageniidae (*Heptagenia, Pseudiron, Stenonema*), Ametropodidae (*Siphloplecton*), Leptophlebiidae (*Choroterpes, Habrophlebia, Habrophlebiodes, Leptophlebia, Paraleptophlebia*), Ephemerellidae (*Ephemerella*), Tricorythidae (*Tricorythodes*), Behningiidae (*Dolania*), Ephemeridae (*Ephemera, Hexagenia, Pentagenia*), Polymitarcidae (*Tortopus*), Neoephemeridae (*Neoephemera*), Caenidae (*Brachycercus, Caenis*), and Baetiscidae (*Baetisca*). Of these only the widespread American genera *Baetis, Callibaetis, Centroptilum, Tricorythodes,* and *Caenis* occur in the West Indies.

Leptophlebiidae and Baetidae are the only families possessing endemic West Indian genera. Traver (1938) established *Cloeodes* for three new species from Puerto Rico. Based on published reports and collections available to me, the remaining West Indian mayfly fauna is composed of species of the widespread genera *Baetis, Callibaetis, Centroptilum, Paracloeodes, Lachlania, Leptohyphes, Tricorythodes, Euthyplocia,* and *Caenis.* All of these genera occur in the Nearctic and Neotropical regions, ex-

cept *Euthyplocia,* which occurs only in the Neotropical region. Although representatives of the families Siphlonuridae (*Isonychia* only), Heptageniidae (as a montane extension from the Nearctic), Ephemeridae, and Polymitarcidae have been reported in the tropics of the New World, none of these families are known to occur in the West Indies.

Based on large collections of Leptophlebiidae available to me from Central and South America, no species of *Neohagenulus, Borinquena, Hagenulus, Traverina, Farrodes,* or *Careospina* occur in Central or South America. However, *Hagenulopsis* Ulmer (1919) and three undescribed genera appear to be closely related to *Borinquena. Hagenulopsis* occurs from Brazil northward to Honduras, while the new genera are known from Northern Brazil. Reared or associated nymphs and adults of these four genera are available. The mouthparts, tarsal claws, and abdominal gills of the nymphs of all these genera are morphologically similar to *Borinquena.* The fore wing venation and tarsal claws of the adults of these genera are also morphologically similar. The hind wings are absent in all four of the South American genera. *Hagenulopsis* and the undescribed genera possess long female ovipositors or egg guides and the associated elongated male genital forceps and styliger plate. The penes of the males are tubular and divided, with a subapical, ventral spine on each lobe, much as those of *Borinquena.* Preliminary investigation indicates *Hagenulopsis* and the undescribed genera are apomorphic to *Borinquena.* In the future, I plan to study the relationships of these four genera to the West Indian genera and to other South American genera in detail.

According to Ross (1967) many inter-American tropical elements of the Trichoptera appear to have evolved an unusual number of species in the area around the Caribbean and adjacent parts of Mexico and South America. The best evidence for this regional evolution is the increasing number of endemic caddisfly genera being found in the West Indies that are closely related to tropical elements in the surrounding continental areas. Further, Ross (1967) stated it is becoming probable that Central America and the West Indies have been connected at times and broken up into several isolated land masses at other times, at least since mid-Cretaceous, and possibly with the fracturing reaching its maximum degree during mid-Tertiary. At the present the relationships of the West Indian Leptophlebiidae clearly appear to be with those of Central and South America.

Ross (1967) stated that each element of the Trichoptera of the inter-American and circum-Caribbean area has arisen from a temperate ancestor and evolved into a primarily tropical lineage. Until all genera of the Leptophlebiidae occurring in South and Central America have been studied, the probable ancestor of the West Indian genera and related continental genera is not known with certainty.

Resumen

Este trabajo es una revisión de la familia Leptophlebiidae (Ephemeroptera) de las Antillas. La revisión se ha basando en gran cantidad de ninfas y adultos criados o asociados, colectados en varias localidades de las Antillas.

Tres nuevos géneros, *Farrodes, Careospina* y *Traverina,* son estableciodos; también los generos *Neohagenulus, Hagenulus,* y *Borinquena* son considerados válidos. Dos subgéneros, *Borinquena* s.s. y *Australphlebia,* son establecidos dentro de *Borinquena.* El género *Farrodes* contiene las nuevas especies *F. hyalinus* de Jamaica, *F. grenadae* de Grenada, y *F. bimaculatus* de Cuba. *Careospina* se establece para las nuevas especies *C. hespera* y *C. minuta* de Cuba, y *C. annulata* de Haití. *Traverina* es monotípico, e incluye a *T. cubensis* de Cuba.

Neohagenulus fué creado por Traver (1938) para tres especies de Puerto Rico, *N. julio, N. luteolus,* y *N. tinctus.* Eaton (1882) estableció el género *Hagenulus* para la especie cubana *H. caligatus.* Posteriormente Banks (1924) describió otra especie, *H. eatoni* de Haití. En el presente trabajo se describen tres especies más, *H. jamaicensis* de Jamaica, *H. morrisonae* de Cuba, y *H. rangelae* de Puerto Rico. La ninfa descrita por Morrison como de *Hagenulus* se establece como perteneciente a la especie *Hagenulus caligatus.* Se discute un probable cambio evolutivo en los hábitos alimenticios de las ninfas de *Hagenulus,* desde alimentarse del periphyton fijo hasta llegar al proceso de colar materias alimenticias de la corriente fluvial. *Borinquena* fué establecido por Traver (1938) para dos especies de Puerto Rico, *B. carmencita* y *B. contradicens.* En el presente trabajo se describe una especie más, *B.*

traverae de Dominica en el subgénero *Australphlebia*.

Se discute la filogenia y relaciones de estos géneros antillanos. Basándose en similaridades de morfología ninfal y venación de las alas anteriores de los adultos, estos seis géneros pertenecen al mismo complejo, pero basándose en la total morfología de ninfas y adultos, aparentemente representan por lo menos dos líneas evolutivas.

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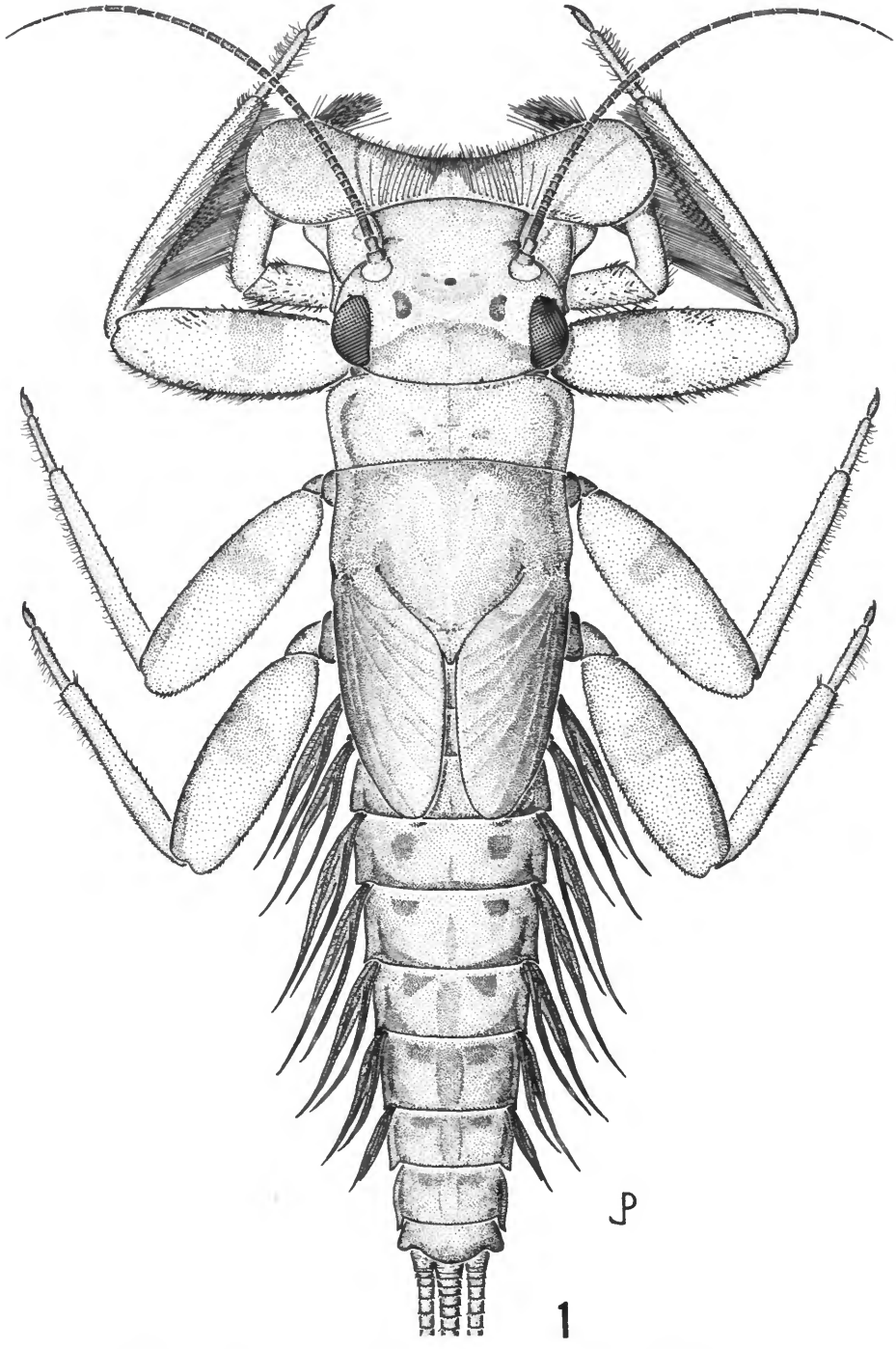

FIGURE 1.—*Hagenulus caligatus* Eaton, dorsal view of mature female nymph.

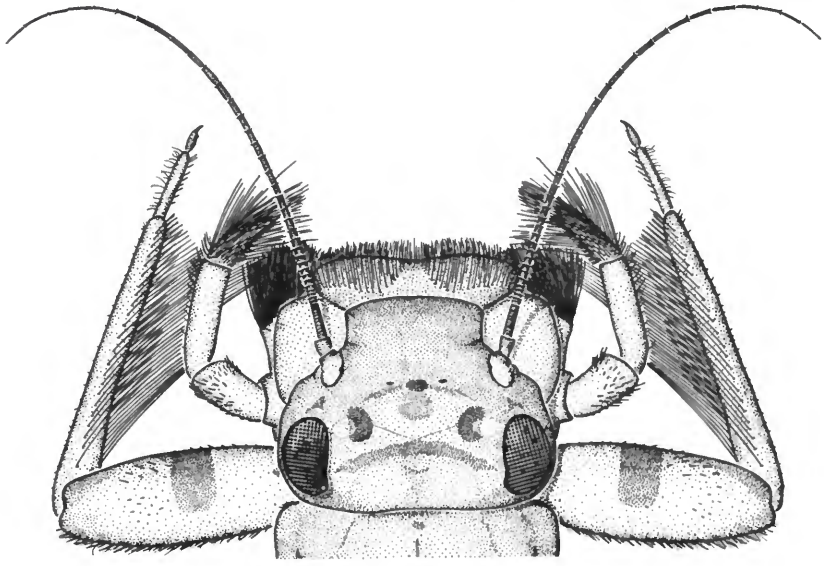

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FIGURE 2.—*Hagenulus morrisonae*, new species, dorsal view of mature female nymph.

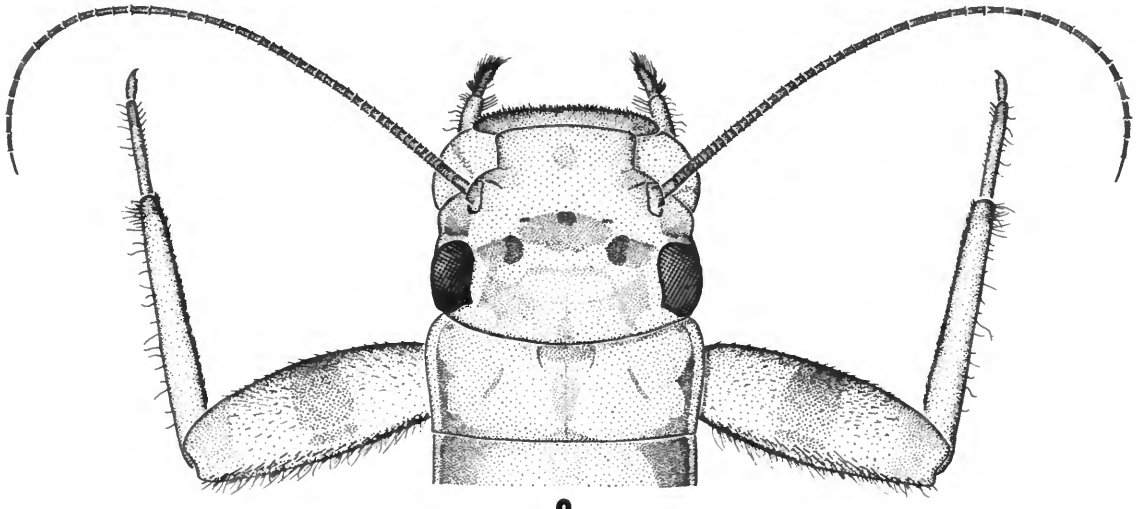

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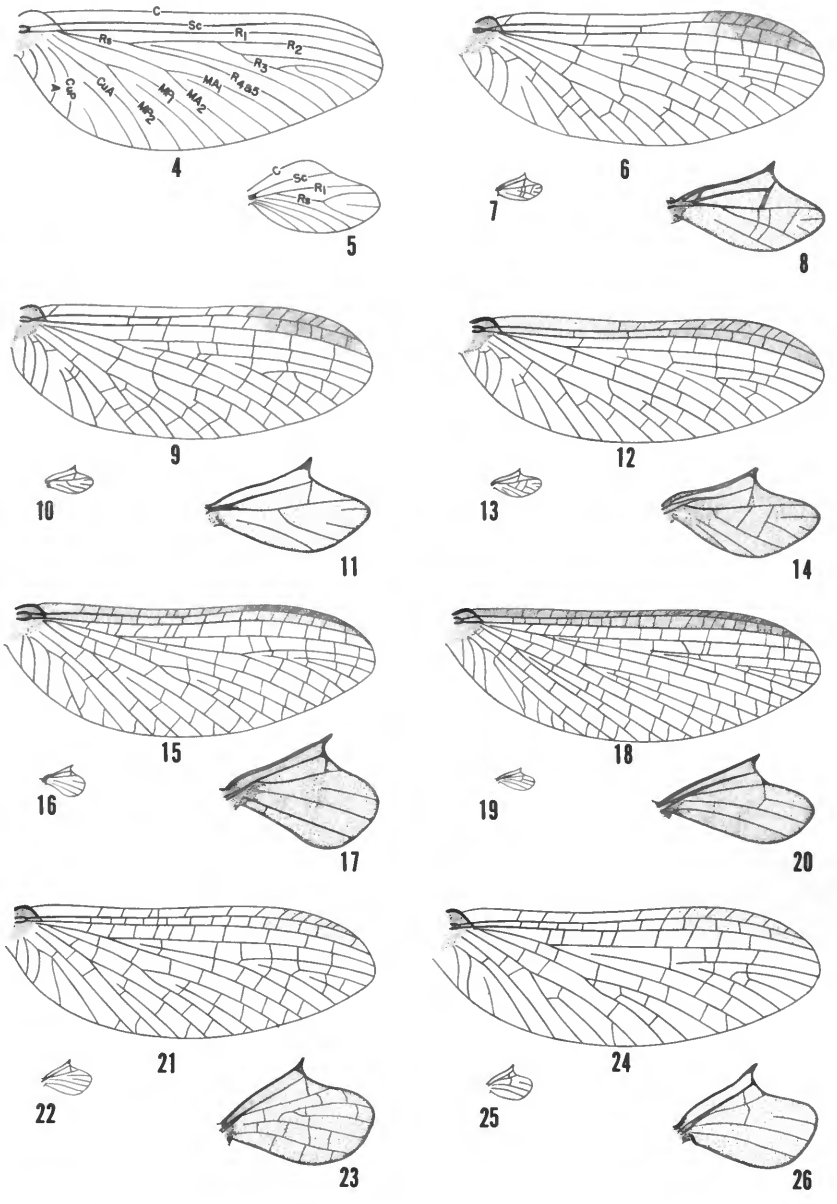
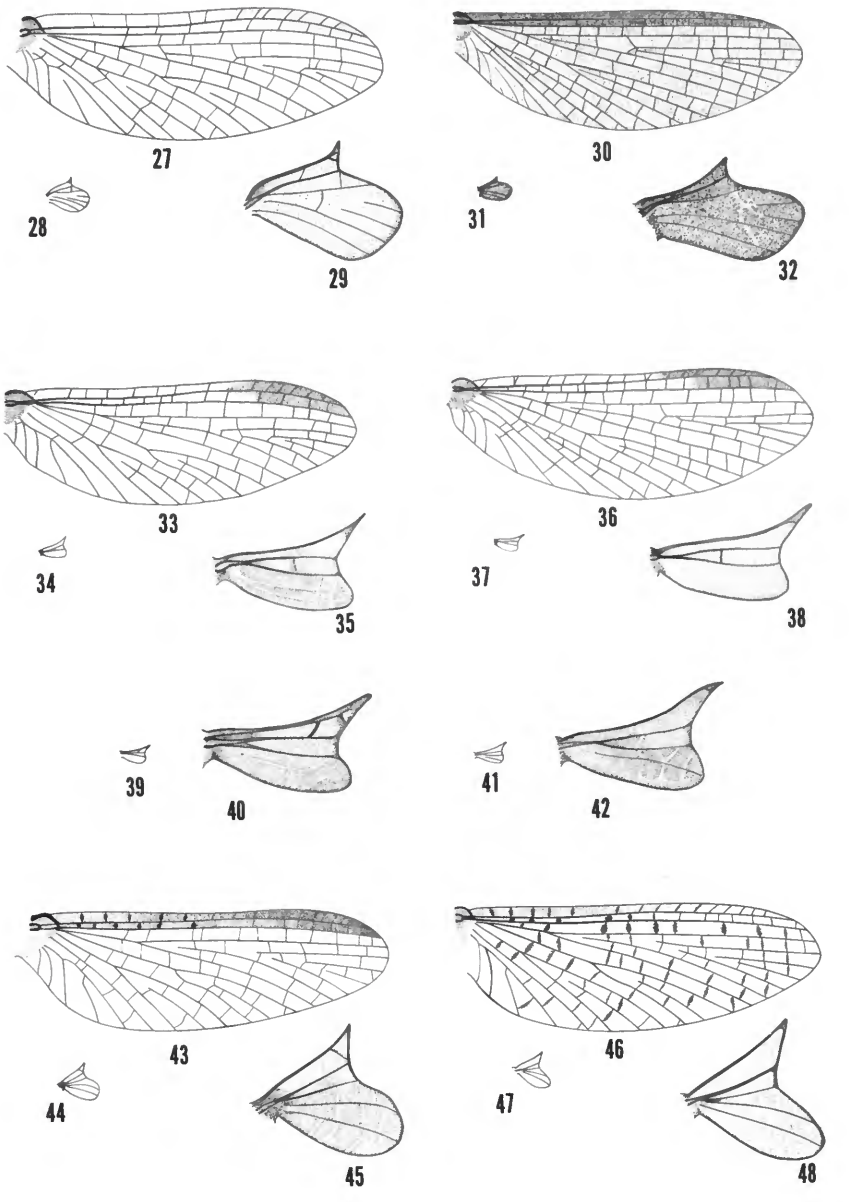
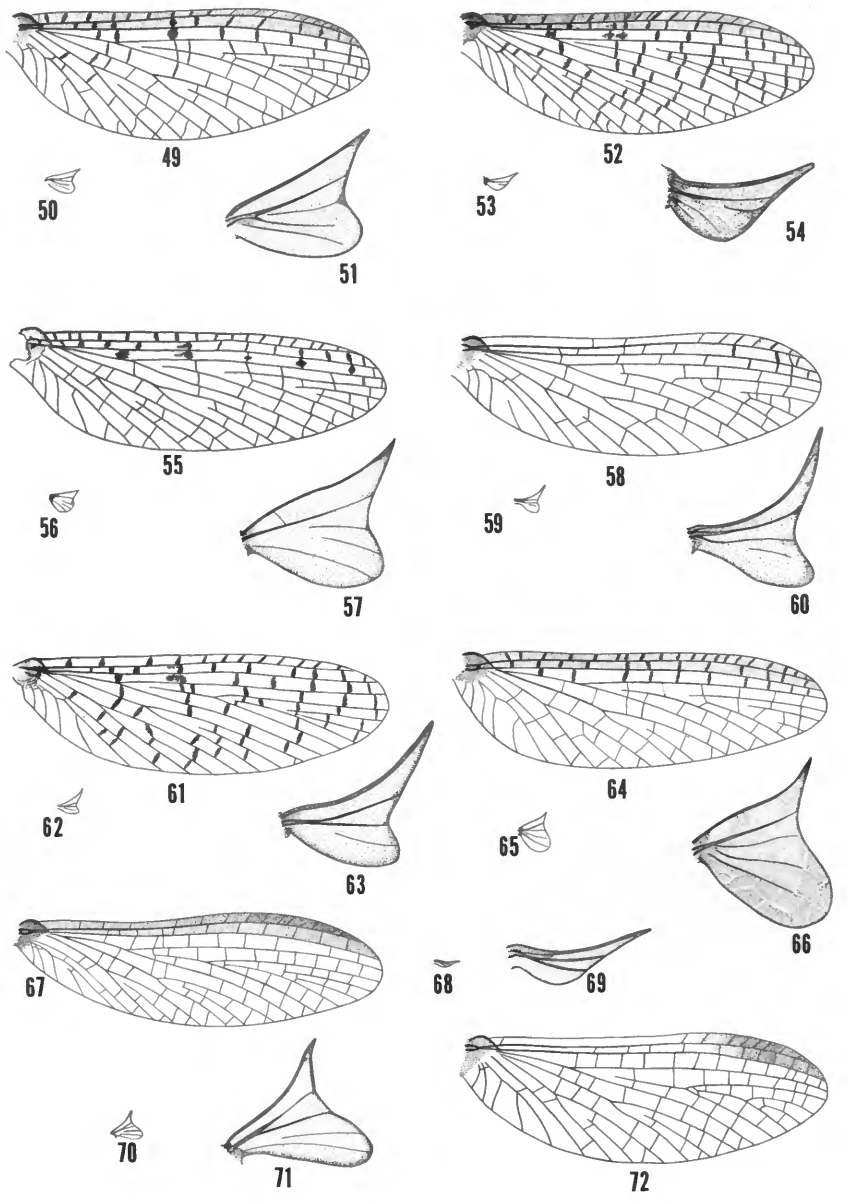
FIGURE 3.—*Hagenulus* species from Jamaica, dorsal view of mature female nymph.



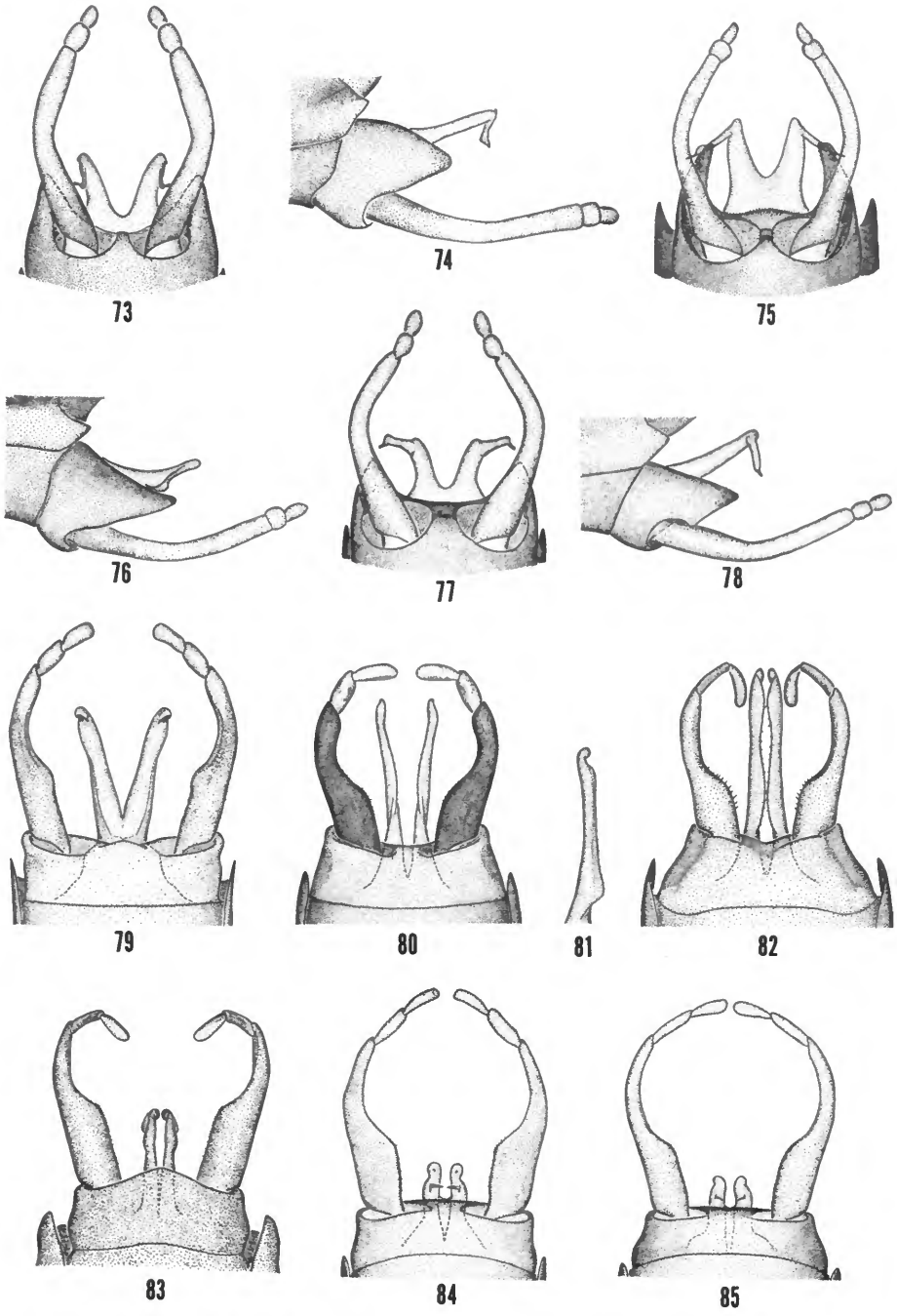
FIGURES 4–26.—Adult fore and hind wings. Schematic wings, showing abbreviations of venational terminology used in this paper: 4, fore wing; 5, hind wing. *Farrodes hyalinus*, new species: 6, fore wing; 7, hind wing; 8, hind wing enlarged. *Farrodes grenadae*, new species: 9, fore wing; 10, hind wing; 11, hind wing enlarged. *Farrodes bimaculatus*, new species: 12, fore wing; 13, hind wing; 14, hind wing enlarged. *Traverina cubensis*, new species, imago: 15, fore wing, ♂; 16, hind wing, ♂; 17, hind wing enlarged, ♂; 18, fore wing, ♀; 19, hind wing, ♀; 20, hind wing enlarged, ♀. *Careospina hespera*, new species, ♂ imago: 21, fore wing; 22, hind wing; 23, hind wing enlarged. *Careospina minuta*, new species, ♂ imago; 24, fore wing; 25, hind wing; 26, hind wing enlarged.



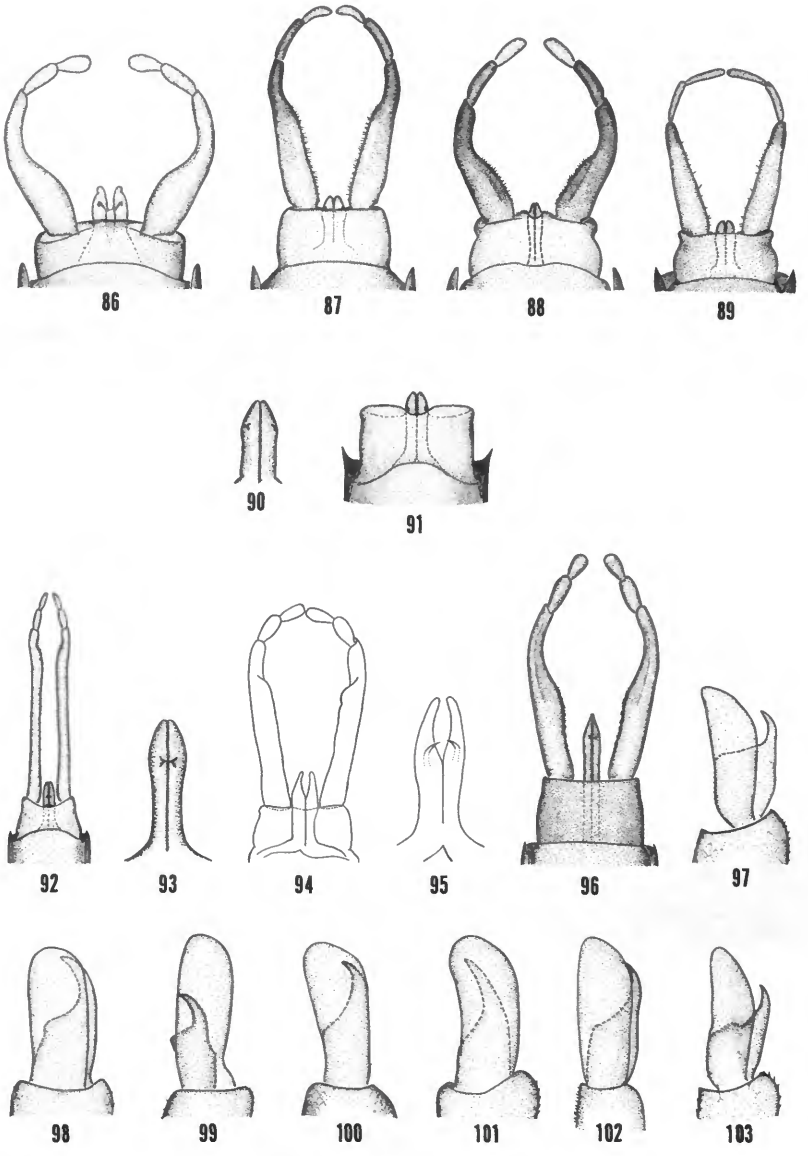
FIGURES 27–48.—Adult fore and hind wings. *Careospina annulata*, new species, ♂ imago: 27, fore wing; 28, hind wing; 29, hind wing enlarged. *Careospina* species, ♀ subimago: 30, fore wing; 31, hind wing; 32, hind wing enlarged. *Neohagenulus julio* Traver, imago: 33, fore wing, ♂; 34, hind wing, ♂; 35, hind wing enlarged, ♂; 36, fore wing, ♀; 37, hind wing, ♀; 38, hind wing enlarged, ♀. *Neohagenulus tinctus* Traver, ♂ imago: 39, hind wing; 40, hind wing enlarged. *Neohagenulus luteolus* Traver, ♂ imago: 41, hind wing; 42, hind wing enlarged. *Hagenulus caligatus* Eaton, imago: 43, fore wing, ♂; 44, hind wing, ♂; 45, hind wing enlarged, ♂; 46, fore wing, ♀; 47, hind wing, ♀; 48, hind wing enlarged, ♀.



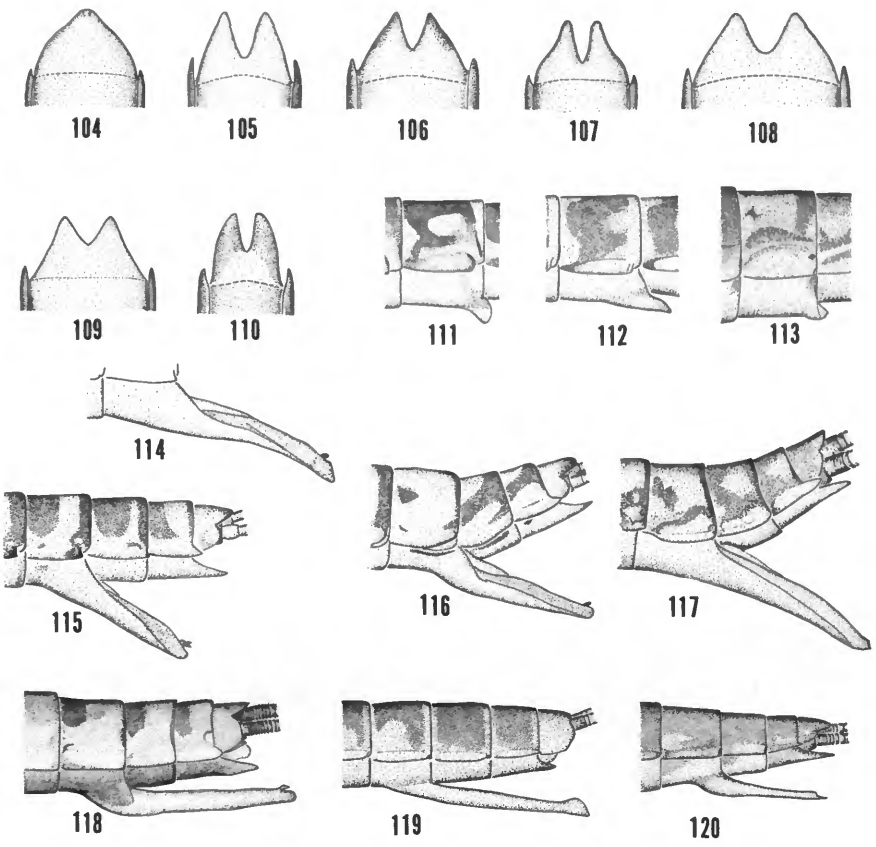
FIGURES 49–72.—Adult fore and hind wings. *Hagenulus morrisonae,* new species, imago: 49, fore wing, ♂; 50, hind wing, ♂; 51, hind wing enlarged, ♂; 52, fore wing, ♀; 53, hind wing, ♀; 54, hind wing enlarged, ♀. *Hagenulus eatoni* Banks, ♀ imago: 55, fore wing; 56, hind wing; 57, hind wing enlarged. *Hagenulus jamaicensis,* new species, imago: 58, fore wing, ♂; 59, hind wing, ♂; 60, hind wing enlarged, ♂; 61, fore wing, ♀; 62, hind wing, ♀; 63, hind wing enlarged, ♀. *Hagenulus rangelae,* new species, ♂ imago: 64, fore wing; 65, hind wing; 66, hind wing enlarged. *Borinquena (B.) carmencita* Traver: 67, fore wing; 68, hind wing; 69, hind wing enlarged. *Borinquena (B.) contradicens* Traver: 70, hind wing; 71, hind wing enlarged. *Borinquena (Australphlebia) traverae,* new species: 72, fore wing.



FIGURES 73–85.—Genitalia of male imago. *Farrodes hyalinus,* new species: 73, ventral view; 74, lateral view. *Farrodes grenadae,* new species: 75, ventral view; 76, lateral view. *Farrodes bimaculatus,* new species: 77, ventral view; 78, lateral view. *Traverina cubensis,* new species: 79, ventral view. *Careospina hespera,* new species: 80, ventral view; 81, lateral view of penes. *Careospina minuta,* new species: 82, ventral view. *Careospina annulata,* new species: 83, ventral view. *Neohagenulus julio* Traver: 84, ventral view. *Neohagenulus tinctus* Traver: 85, ventral view.



FIGURES 86–103.—Genitalia of male imago. *Neohagenulus luteolus* Traver: 86, ventral view. *Hagenulus caligatus* Eaton: 87, ventral view. *Hagenulus morrisonae,* new species: 88, ventral view. *Hagenulus jamaicensis,* new species: 89, ventral view; 90, ventral view of penes enlarged. *Hagenulus rangelae,* new species: 91, ventral view. *Borinquena (B.) carmencita* Traver: 92, ventral view; 93, ventral view of penes enlarged. *Borinquena (B.) contradicens* Traver (after Traver, 1938): 94, ventral view; 95, ventral view of penes enlarged. *Borinquena (Australphlebia) traverae,* new species: 96, ventral view. Claws of fore leg of male imago. 97, *Farrodes hyalinus,* new species; 98, *Traverina cubensis,* new species; 99, *Careospina hespera,* new species; 100, *Neohagenulus julio* Traver; 101, *Hagenulus caligatus* Eaton; 102, *Borinquena (B.) carmencita* Traver; 103, *Borinquena (Australphlebia) traverae,* new species.



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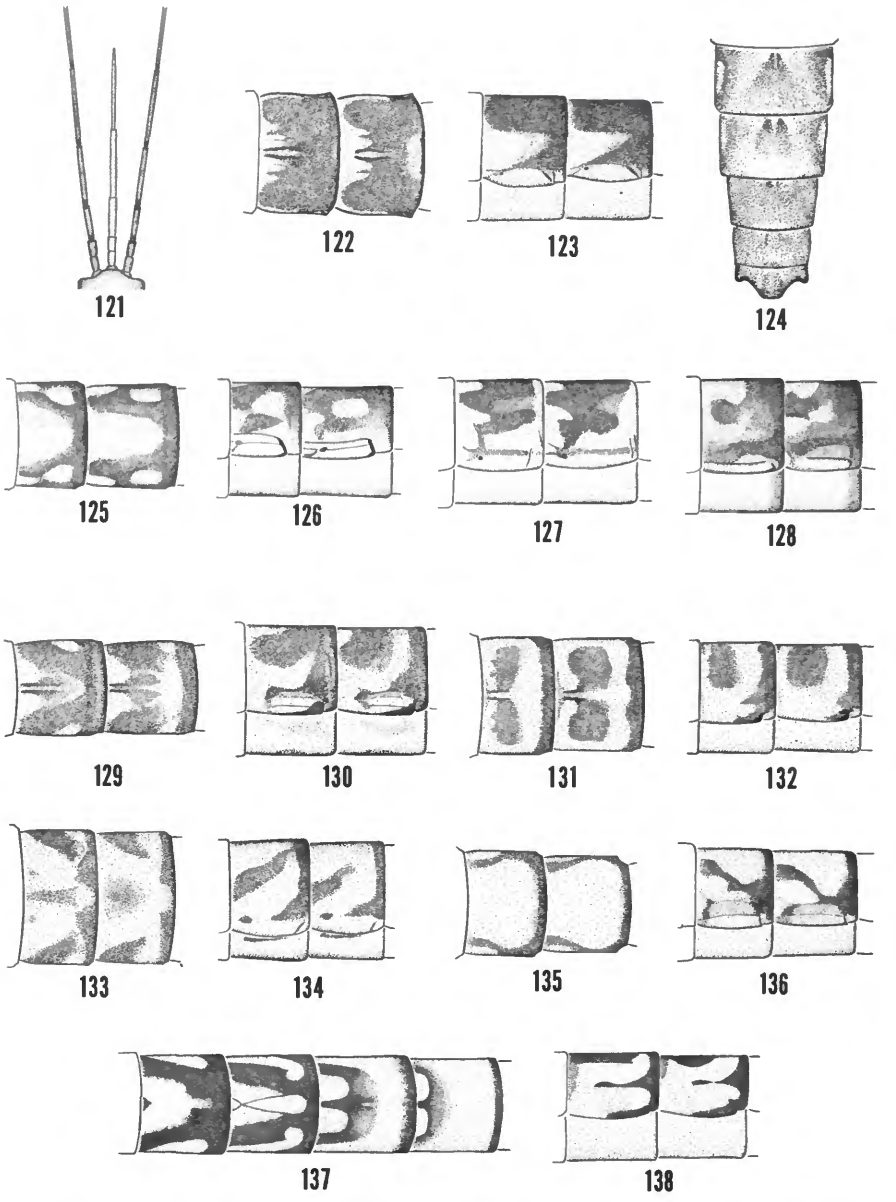

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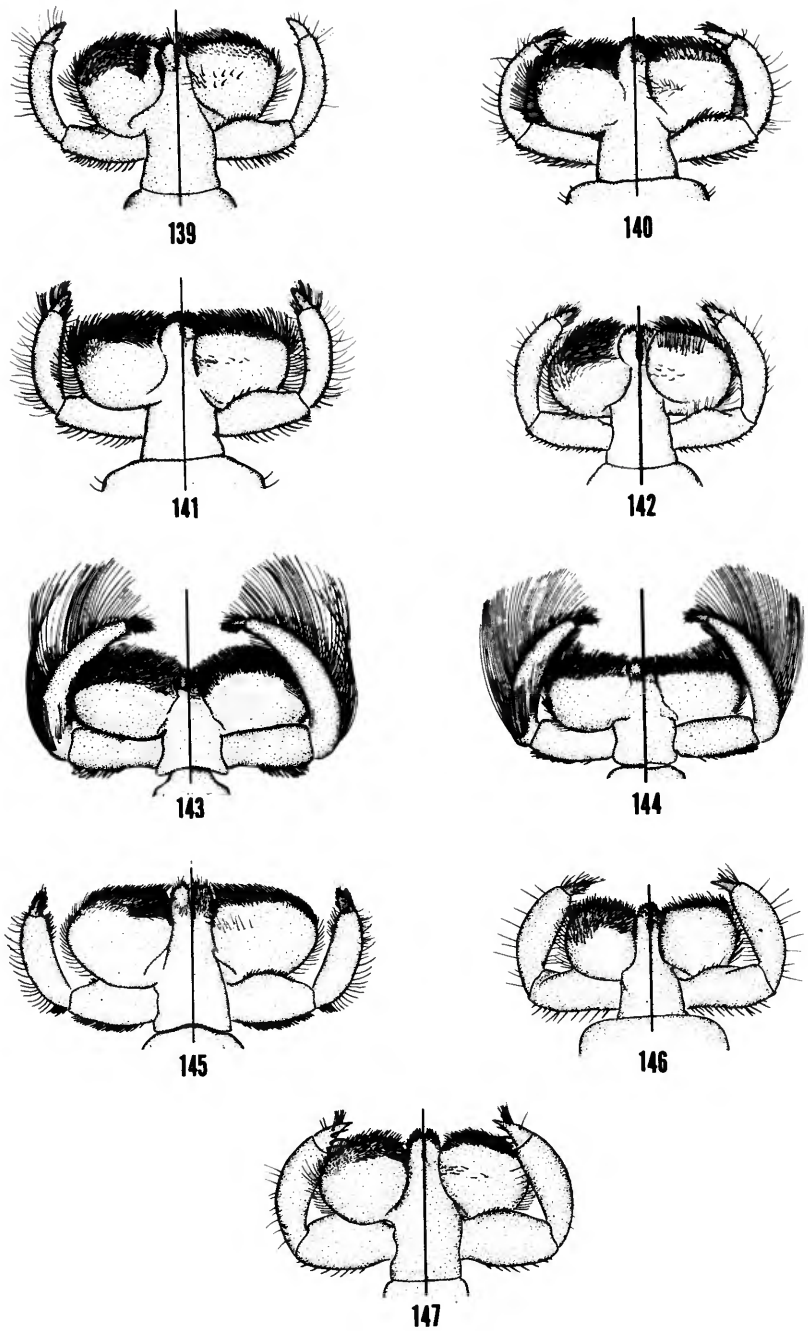

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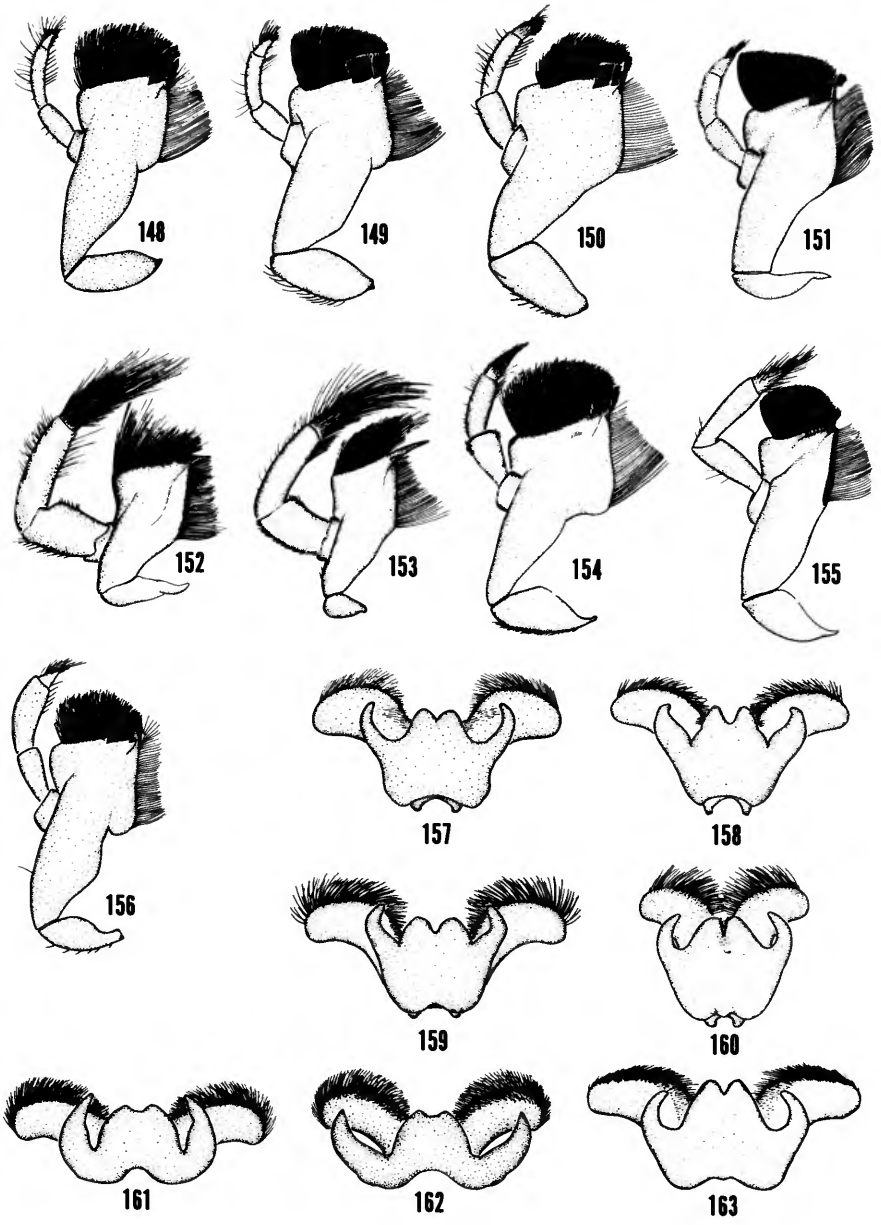

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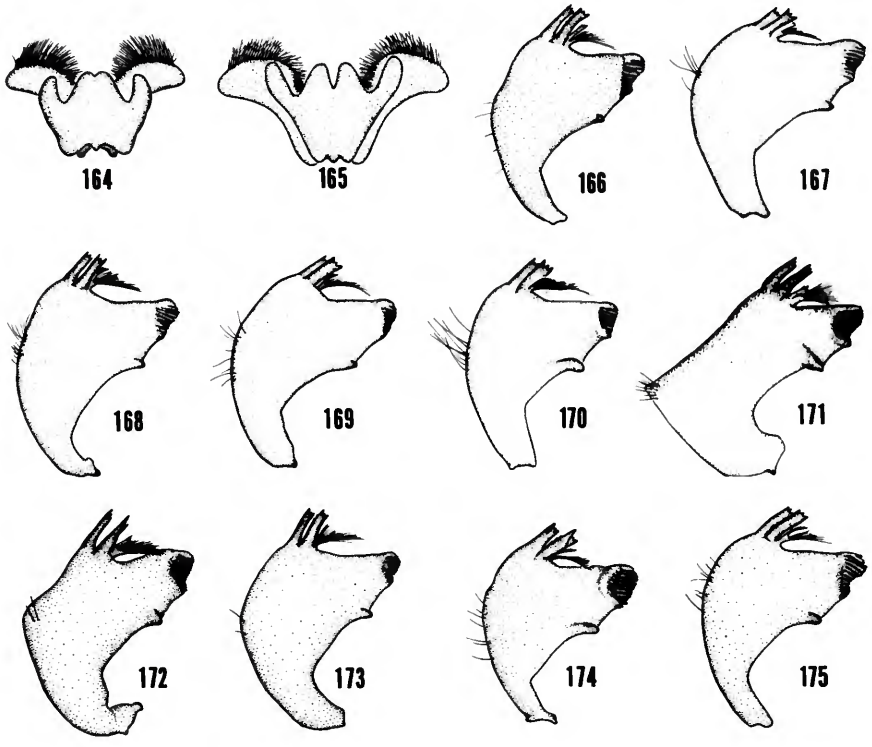

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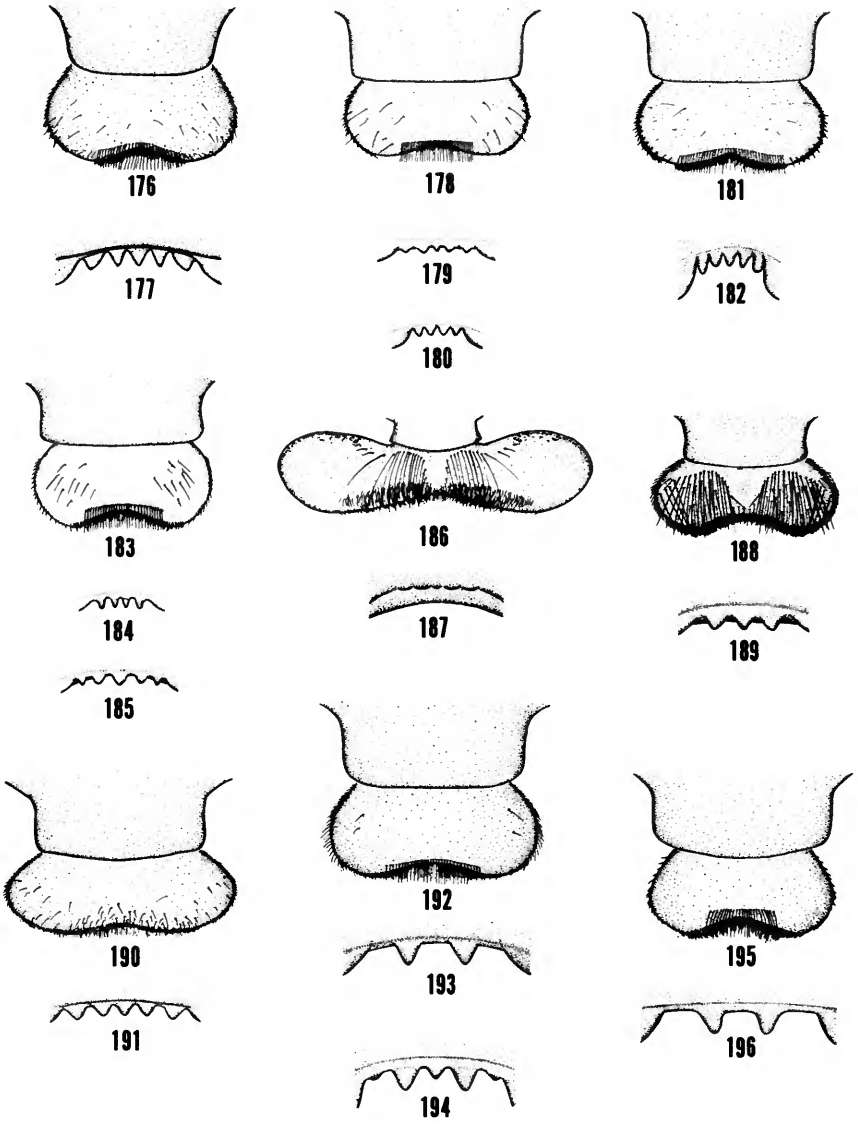

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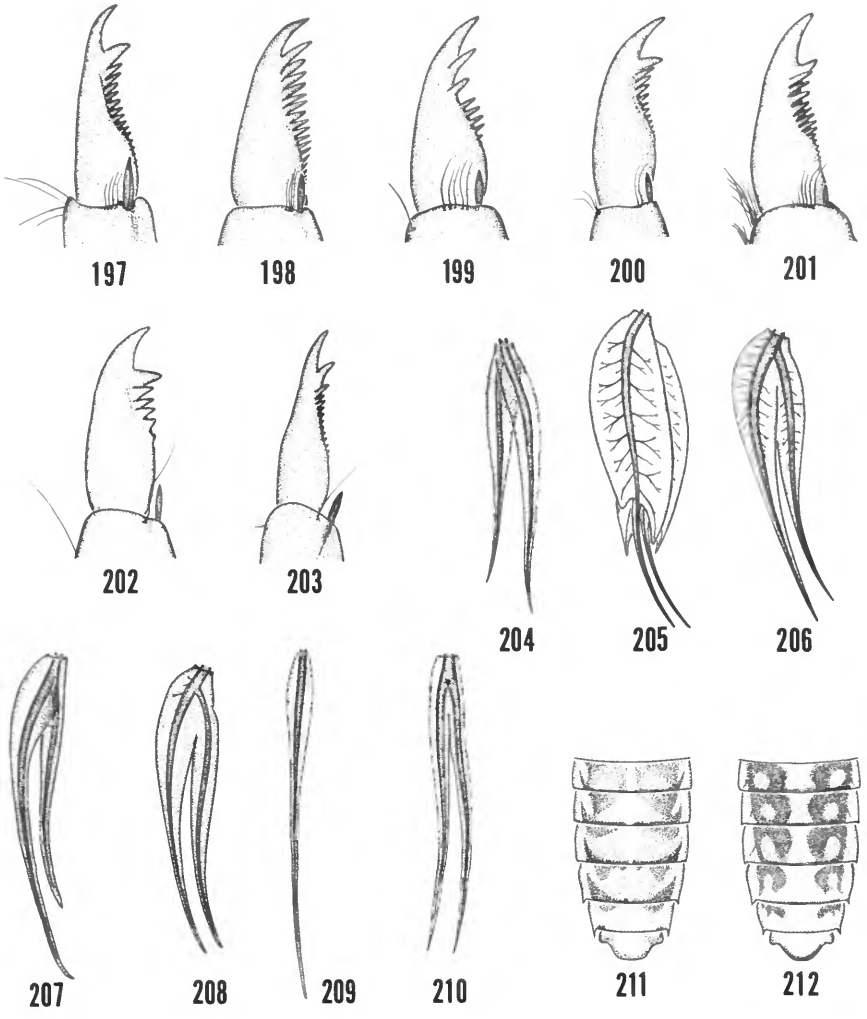

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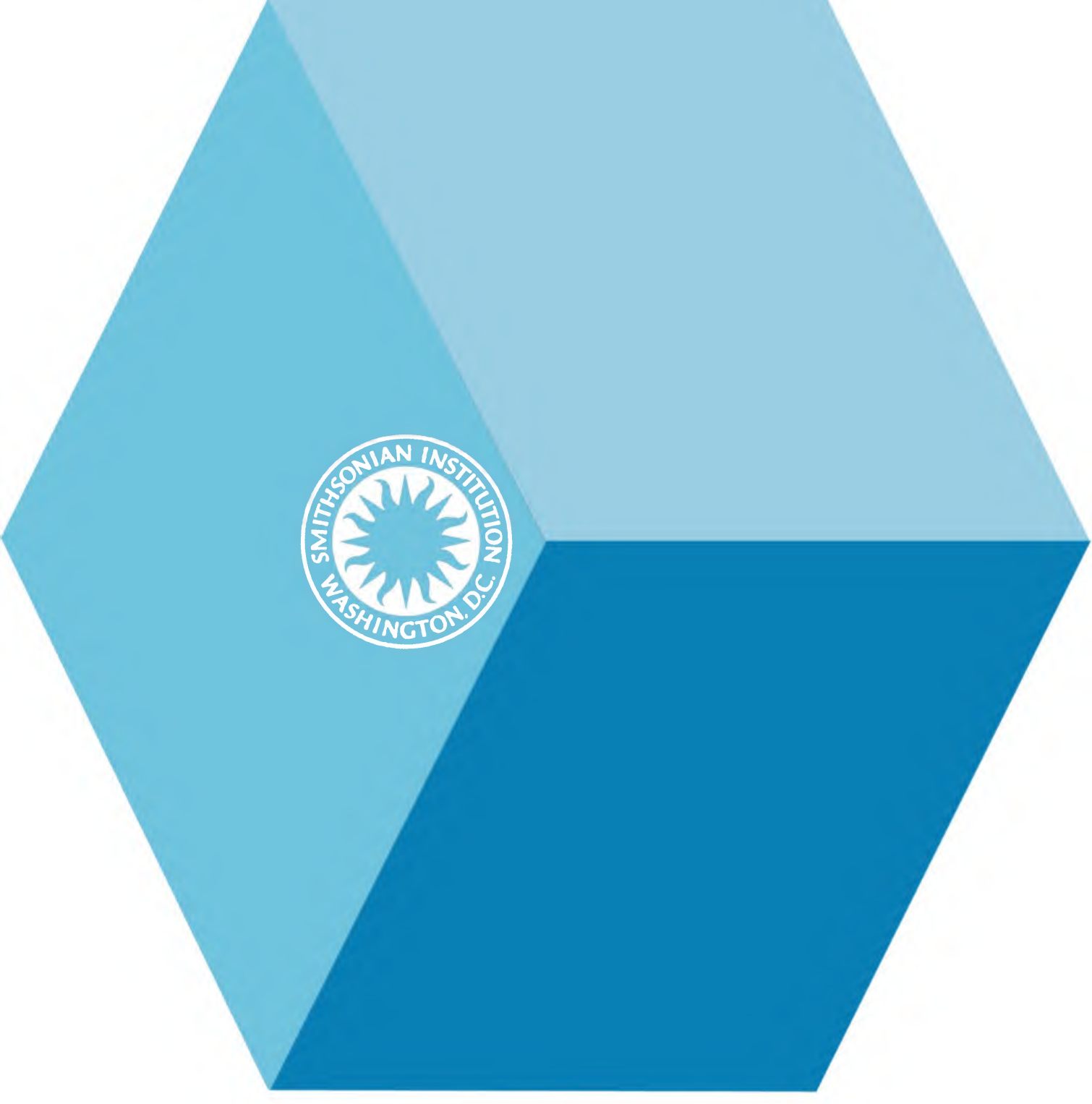
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