

# CHIGGERS OF THE GENUS *PSEUDOSCHOENGASTIA* (ACARINA: TROMBICULIDAE) FROM COSTA RICA

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ABSTRACT: Chigger larvae of thirteen species of the genus *Pseudoschoengastia* are described and reported from mammals of Costa Rica. Nine species are new and the other four are recorded from this country for the first time. The subgenus *Pseudoschoengastia* Lipovsky contains ten species: *P. bulbifera* Brennan, *P. intermedia* sp. n., *P. montana* sp. n., and *P. peromysci* sp. n. belonging to the *Bulbifera* Complex of the *Hungerfordi* Group; *P. zona* Brennan, *P. hoguei* sp. n., *P. hooperi* sp. n., and *P. rheomys* sp. n. of the *Farneri* Group; *P. abditiva* Brennan and *P. finitima* Brennan and Yunker in the *Anomala* and *Aeci* Groups respectively. The second subgenus, *Walchioides* Vercammen-Grandjean, has three new species: *P. costaricensis*, *P. guanacastensis* and *P. verdensis*.

These chiggers were found on fifteen species of rodents: *Heteromys desmarestianus*, *Liomys salvini*, *Oryzomys* (five species), *Ototylomys phyllotis*, *Peromyscus nudipes*, *Rheomys hartmanni*, *Rheomys underwoodi*, *Scotinomys teguina*, *Sigmodon hispidus*, *Zygodontomys microtinus* and *Proechimys semispinosus*; and on one opossum *Philander opossum*.

Species of *Pseudoschoengastia* are recorded from 24 localities. The life zones, biotic provinces and biotic districts of Costa Rica are discussed and mapped. Three species are limited to the Guanacaste Biotic District of the Pacific México-Nicaragua Biotic Province and two species are known from the Golfo Dulce Biotic District of the Pacific Costa Rica-Panamá Biotic Province, both along the Pacific versant. Two species occur in the Caribbean Costa Rica Biotic District of the Caribbean Costa Rica-Panamá Biotic Province, also of the Tropical Lowlands. Nine species occur in the Tropical Highlands or Costa Rica-Panamá Highlands Biotic Province, which is divided into the Costa Rica Highlands Biotic District in the north with six species and the southern Panamá Highlands Biotic District, also with six species of *Pseudoschoengastia*.

The larval stage of each species is described and illustrated, and notes are given on the ecology, including a complete host list. A key is included to the larvae of the twenty species of *Pseudoschoengastia* known from Central and South America.

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collect mammals and their ectoparasites and to observe the various habitats in Costa Rica for a period of six months.

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#### INTRODUCTION

Chiggers of the genus *Pseudoschoengastia* Lipovsky belong to the subfamily Trombiculinae, family Trombiculidae. As larvae, they possess six legs and parasitize small mammals, especially rodents. Both the taxonomy and classification have been based on the larvae, the only stage easily obtained. The nymphs and adults are free-living and have not been taken in Costa Rica.

From January, 1962, to December, 1964, more than 500 rodents from Costa Rica were examined and chiggers were recovered from approximately 291 specimens. Of those with chiggers, 112 hosts (nearly 39 percent) had one or more species of *Pseudoschoengastia*. These larvae were recovered from the ears of 16 host species, including one opossum and 15 kinds of rodents belonging to three families: Heteromyidae, Cricetidae, and Echimyidae.

Examination of 548 larvae revealed 13 species of *Pseudoschoengastia*, nine of which are new; ten species in the subgenus *Pseudoschoengastia* Lipovsky, and three species in the subgenus *Walchioides* Vercammen-Grandjean.

#### DESCRIPTION OF COSTA RICA

Costa Rica is a small Central American Republic with numerous volcanoes, high mountains, plateaus and coastal plains providing diverse habitats for many kinds of plants and animals. Physiographically Costa Rica consists



of Pacific and Atlantic lowlands almost completely separated by central highlands, which follow roughly a northwest to southeast orientation.

The Pacific lowland is widest at the Nicoyan Peninsula in Guanacaste Province, and after narrowing near mid-country, widens again in the region of Golfo Dulce and the Osa Peninsula. The Atlantic lowland extends almost entirely across the northern border but narrows to less than 50 kilometers at the Panamanian border.

The elevation near the Nicaraguan border is no greater than 100 meters; however, just to the south is the Cordillera de Guanacaste with elevations over 1000 meters. This range consists of a series of volcanoes called the Cordillera Volcánica, and at the southern end is the east-west range, the Cordillera Central. Here the lowest elevation is 1500 meters, but between Volcán Irazú and Volcán Turrialba the lowest elevation is 2150 meters. To the south, the Cordillera Central forms the central plateau, or Meseta Central, which separates the northern and southern highlands. South of this plateau is the Dota Region, the lower northern portion of the Cordillera de Talamanca, which for one hundred and sixty kilometers forms the major northwest-southeast axis with elevations above 2150 meters.

The following numbered localities for *Pseudoschoengastia* are plotted in Figs. 1 and 2 and are listed consecutively from northwest to southeast:

GUANACASTE PROVINCE: 1. 5-8.3 km N Liberia; 2. Liberia; 3. 1.4 km S and 7.3 km S Liberia; 4. 3 km S Playa del Coco; 5. 5 km NW Tilarán. PUNTARENAS PROVINCE: 6. Monteverde, 1380 m. HEREDIA PROVINCE: 7. 2.9 km S Puerto Viejo; 8. El Angel Falls. ALAJUELA PROVINCE: 9. Volcán Poás, 2493 m, and Río Poasito, Poasitos, 2000 m. CARTAGO PROVINCE: 10. Río Claro, 600 m, 27.5 km N San José on San Jerónimo Rd. LIMON PROVINCE: 11. Finca "La Lola." CARTAGO PROVINCE: 12. Turrialba, IICA, 600 m; 13. Tapanti, Río Quiri, 1220 m. SAN JOSE PROVINCE: 14. Río Damitos, 14 km N Quepos; 15. 11.3 km S La Georgina, 2500 m; 16. 15-20.8 km N San Isidro del General, 1495-1600 m. PUNTARENAS PROVINCE: 17. Finca "Los Helechales," 12-15 km E Potrero Grande, 1040 m; 18. Finca de Señor Treno, 8 km E Potrero Grande, 660 m; 19. 1.7 km W Palmar Norte; 20. Río Coronado, 20 km N Puerto Cortez; 21. 7.3 km S Palmar Sur; 22. Rincón de Osa, 50 m; 23. 8.3 km W Rincón, Camp Seattle, 100 m; 24. vicinity of Villa Neily.

#### LIFE ZONES

The five life zones and the forest formations in the Tropical Life Zone, as discussed and mapped by Slud (1964), are listed below.

- I. Tropical Life Zone.
  - A. Tropical Dry Forest Formation
  - B. Moist Forest Formation
  - C. Tropical Wet Forest Formation
- II. Subtropical Life Zone.



- III. Submontane Life Zone.
- IV. Montane Life Zone.
- V. Subalpine Life Zone.

The map (Fig. 2) follows Slud except that the Tropical Wet and Moist Forest Formations are combined and the Subalpine Life Zone is not shown. This latter Life Zone is surrounded by the Montane Life Zone and occurs on two mountain tops where no *Pseudoschoengastia* are found.

#### BIOTIC PROVINCES AND BIOTIC DISTRICTS

Many authors have stated that Costa Rica can be divided into areas based on the distribution of plants and animals and on the environmental factors. Goodwin (1946), in discussing mammalian distributions, did not delineate distinct provinces but mentioned five regions. Taylor (1951) suggested essentially the same patterns of distribution based upon the herpetofauna. Slud (1964) proposed, but did not map, four distinct avifaunal zones based on the geography, climate, geologic history, and the distribution of birds.

Although he stated that there were differences in the compositions of bird species between the two major mountain areas, he found it convenient to keep them together as a single avifaunal zone. Slud utilized plant data adapted from Holdridge (1959) to give more definite boundaries to his avifaunal zones. West (1964) listed four "natural regions" that seem to correspond to the avifaunal zones of Slud. Ryan (1963) utilized the distribution of mammals to define the biotic provinces of Central America. He divided Costa Rica into two provinces, the Puntarenas-Chiriquí Biotic Province of the Pacific slope and the Guatuso-Talamancan Biotic Province of the Caribbean slope, separated by the central highlands. Ryan did not believe that the highlands should be a separate biotic province, and both the northern dry and southern wet forests of the Pacific slope were placed into one province. This arrangement does not seem as appropriate for Costa Rica as that of Stuart (1964), who mapped and named the biotic provinces of Central America, including four biotic provinces within Costa Rica, based upon the flora and the known vertebrate and invertebrate faunas. These biotic provinces are comparable to the avifaunal

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Figure 1. Map of Costa Rica showing Biotic Provinces and Districts, political provinces and all localities for *Pseudoschoengastia*. Localities 1-24 are listed in the text.

A. Tropical lowlands

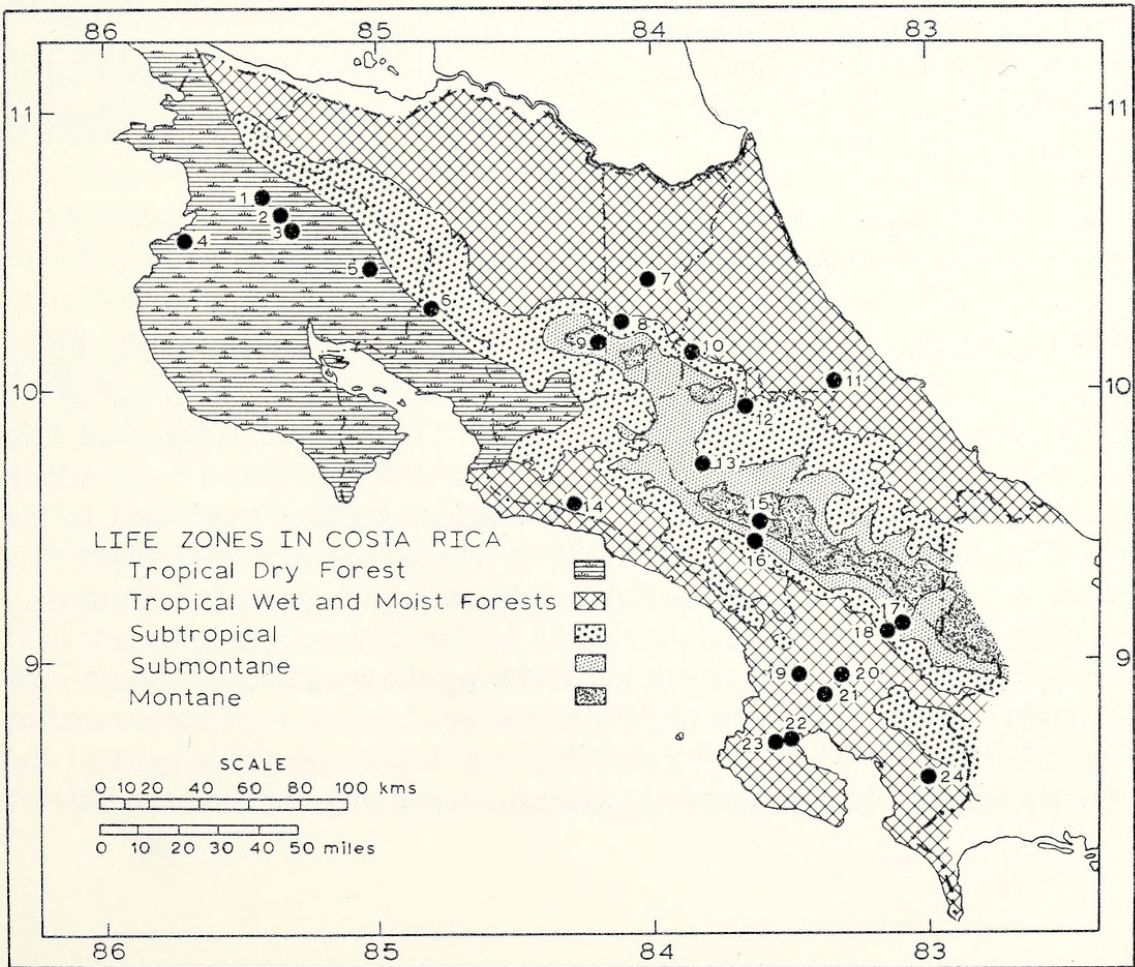
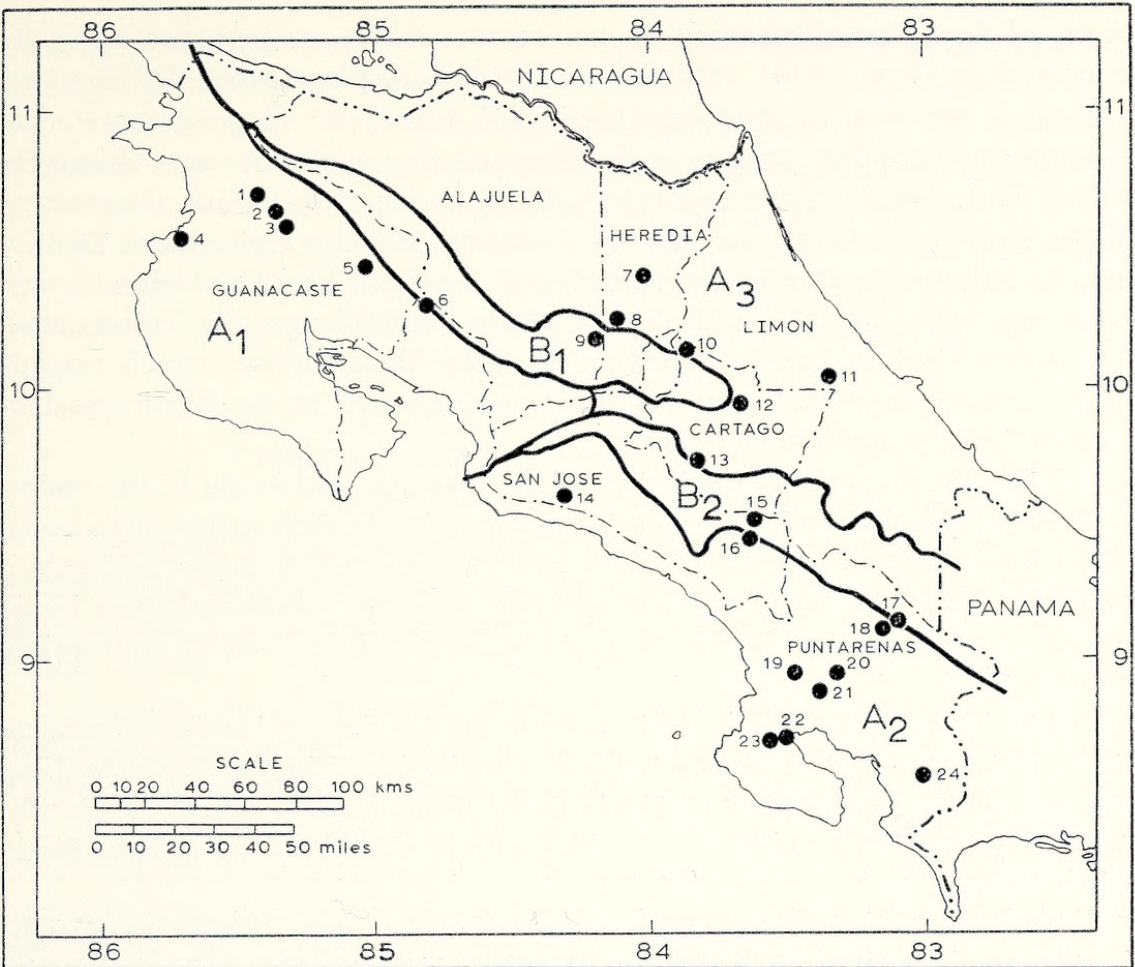
- A1. Guanacaste Biotic District of the Pacific México-Nicaragua Biotic Province.
- A2. Golfo Dulce Biotic District of the Pacific Costa Rica-Panamá Biotic Province.
- A3. Caribbean Costa Rica Biotic District of the Caribbean Costa Rica-Panamá Biotic Province.

B. Tropical highlands (Costa Rica-Panamá Highlands Biotic Province)

- B1. Costa Rica Highlands Biotic District.
- B2. Panamá Highlands Biotic District.

Figure 2. Life Zones in Costa Rica and localities for *Pseudoschoengastia*.







zones of Slud. For zoogeographic patterns the biotic provinces, as originally conceived by Dice (1943), represent a more realistic picture than do life zones.

In a recent paper, Savage (1966:723) listed and mapped the Recent Central American Herpetofaunas. Four separate herpetofaunas were shown for Costa Rica. His Nicaraguan herpetofauna corresponds to our Guanacaste Biotic District, the Golfo Dulcean is the same as the Golfo Dulce Biotic District and the Isthmian has the same distribution as the Costa Rica Caribbean. Savage considered the tropical highlands as a single herpetofauna, the Talamancan. The entire Central American Region is called Mesoamerica, which extends northward to the Nearctic in México and southward to the Neotropical of eastern Panamá and South America.

The following biotic provinces and districts are used to aid in the understanding of the distribution of *Pseudoschoengastia* and their mammalian hosts. The names assigned to the four biotic provinces presented below, and shown in Fig. 1, follow Stuart (1964). In addition, we have subdivided these biotic provinces of Costa Rica into biotic districts, and each is given an appropriate name.

The Tropical Lowlands (A) consists of the Pacific Mexico-Nicaragua Biotic Province and its Guanacaste Biotic District (A1); the Pacific Costa Rica-Panamá Biotic Province and its Golfo Dulce Biotic District (A2); the Caribbean Costa Rica-Panamá Biotic Province with its Caribbean Costa Rica Biotic District (A3).

The Tropical Highlands (B) is composed of the Costa Rica-Panamá Highlands Biotic Province subdivided into the Costa Rica Highlands Biotic District (B1) and the Panama Highlands Biotic District (B2).

Rainfall data presented under each biotic province and district were taken from the official records of the Ministerio de Agricultura y Ganadería, Sección Climatología, for 1961.

#### PACIFIC MEXICO-NICARAGUA BIOTIC PROVINCE GUANACASTE BIOTIC DISTRICT

The Pacific México-Nicaragua Biotic Province, as represented in Costa Rica, is called the Guanacaste Biotic District. It covers the northern half of the Pacific slopes of Costa Rica and includes the Tropical and Subtropical Life Zones. It is the southern part of a relatively arid Pacific Coast forest which extends intermittently from the state of Sinaloa, México, southward to the mouth of the Gulf of Nicoya (Slud, 1964). The Guanacaste Biotic District is named for the large political province which is the major part of the district.

The average annual rainfall in 1961 for ten stations was less than 2000 mm and most of this was concentrated during the months of June through November with over 50 mm of rainfall recorded for each of these months. Taylor (1951) stated that the rainfall is confined for the most part to the summer months (May to August), while the remaining months have little or



no rainfall and the winds during this dry season contribute to further moisture loss for this already dry area.

Although many areas with better soil have been cleared and burned, it originally supported subhumid to moist forest associations with tall stands of deciduous forest composed of relatively few species (Slud, 1964).

The mammals (Goodwin, 1946) and birds (Slud, 1964) of this region are primarily northern in origin. Three new chigger species, *Pseudoschoengastia hoguei*, *P. costaricensis* and *P. guanacastensis*, occur only in this biotic district.

#### PACIFIC COSTA RICA-PANAMA BIOTIC PROVINCE GOLFO DULCE BIOTIC DISTRICT

That part of the Pacific Costa Rica-Panamá Biotic Province in Costa Rica includes the Pacific versant from the southern tip of the Nicoyan Peninsula into Panamá. The Tropical and parts of the Subtropical Life Zones are included in this district.

In 1961, the average rainfall of ten stations was in excess of 3500 mm, with one station recording more than 7200 mm. All months except January (85 mm) and February (36 mm) had rainfall in excess of 100 mm.

The forest association is composed predominantly of tall evergreen species typical of the tropical humid to wet rainforest. On good undisturbed soils, approximately 100 species of trees make up this three or four story tropical rain forest. The canopy is almost closed and the crowns of the scattered emergents project above it. The forest floor has only a small amount of litter and the easy passage through this forest reveals buttressed trunks of the larger trees, stilt roots of the smaller trees, and the presence of many lianas, as mentioned by Allen (1956).

Slud (1964) stated that many birds of this region can tolerate the humid conditions on both the eastern and western slopes, although the many endemics found here and the absence of Caribbean species attest to a distinct avifauna.

Two species of *Pseudoschoengastia* occur in this district. *Pseudoschoengastia bulbifera* has been taken at seven of the eight localities, and *P. zona* is known from one locality.

#### CARIBBEAN COSTA RICA-PANAMA BIOTIC PROVINCE CARIBBEAN COSTA RICA BIOTIC DISTRICT

This district extends along the entire length of the eastern slope, and includes the Tropical and Subtropical Life Zones.

The average annual rainfall in 1961 at ten stations was in excess of 3400 mm. Yearly rainfall in excess of 7200 mm has been recorded in the extreme northeastern corner. The average recorded rainfall for each month in 1961 was in excess of 100 mm. There was less rainfall in January (102 mm) and February (170 mm) and a second relatively "dry spell" occurred from Septem-



ber to November, as each month had less than 300 mm of rainfall.

The evergreen floral composition of this biotic district has extremely moist to wet forest associations similar to those found in the Golfo Dulce Biotic District. The lower slopes near sea level are covered by extensive tracts of palm swamps that are almost impassable because of numerous water courses and a year-round high water table. Large tracts of this land in Costa Rica and Panamá have been cleared to grow bananas, cacao and sugar cane. Many typical species of trees in the Golfo Dulce Biotic District are also found here. Slud (1960, 1964) listed the species of trees.

Goodwin (1946) stated that the mammals of the Caribbean are closely related to forms in adjacent Panamá, and Slud (1964) noted that affinities of the Caribbean species of birds are with species of Panamá and South America.

Of the two species of *Pseudoschoengastia* taken in this district, *P. bulbifera* were taken from all localities and *P. finitima* from only one site.

#### COSTA RICA-PANAMA HIGHLANDS BIOTIC PROVINCE

This biotic province of the Tropical Highlands in Costa Rica consists of two distinct areas which are separated into the northern Costa Rica Highlands and the southern Panamá Highlands Biotic District. Seven of the nine species of *Pseudoschoengastia* from this province have not been taken elsewhere, but only *P. montana* sp. n. is known from both districts.

#### COSTA RICA HIGHLANDS BIOTIC DISTRICT

This biotic district, with many endemic species of mammals (Goodwin, 1946), consists of the northern mountains and Cordillera Central, including the Montane, Submontane and parts of the Subtropical Life Zones.

The average annual rainfall in 1961 for ten stations was in excess of 2600 mm. The rainfall pattern was similar to that of the adjacent Guanacaste Biotic District, although the rainfall was heavier and the pattern showed sharper peaks.

Slud (1964) stated that the evergreen trees of the subtropical forest often form a dense canopy but are not of value as timber and are poorly known. The montane moist to very humid forest formations are dominated by many species of oaks that are often bathed in clouds. Many of these temperate mountain areas have been cleared to raise fruits, vegetables, and cattle.

Goodwin (1946) believes that many mammals of this district have affinities with species of the Mexican Central Plateau.

Six species of *Pseudoschoengastia* are reported; one new species (*P. montana*) is known only from these two highland districts, and three new species (*P. hooperi*, *P. peromysci*, and *P. verdensis*) were taken in this district.

#### PANAMA HIGHLANDS BIOTIC DISTRICT

This district is south of the central plateau and includes the mountains of



the north-central Dota Region of Costa Rica and the high Talamanca Cordillera. These mountains terminate with Cerro Pittier in the Chiriquí region of Panamá bordered by the arid savannas of northwestern Panamá. Subtropical to Subalpine Life Zones occur in this biotic district.

The average rainfall for eight stations was in excess of 2300 mm and had a pattern similar to that of the Costa Rica Highlands. The Panamá Highlands has fewer human inhabitants, and rainfall records probably are from the drier areas.

The moist to wet forest formations of this region are dominated by species of oaks and a subalpine wet páramo above the tree line on Cerro de la Muerte and Cerro Chirripó, which according to Slud (1964) has an affinity with the páramos of the Andes.

Most species of mammals (Goodwin, 1946) and birds (Slud, 1964) are related to forms of Panamá and South America.

Six species of *Pseudoschoengastia* have been taken here, of which three (*P. abditiva*, *P. intermedia* sp. n., and *P. rheomys* sp. n.) were not obtained elsewhere in Costa Rica.

TABLE 1

The distribution of *Pseudoschoengastia* in Costa Rica, based on the occurrence of the species in each biotic district. Numbers in each column refer to the number of localities for each species.

| Species  | BIOTIC DISTRICTS |    |    |    |    |
|--|------------------|----|----|----|----|
|  | A1               | A2 | A3 | B1 | B2 |
| Total localities with<br><i>Pseudoschoengastia</i>   | 5                | 8  | 6  | 2  | 3  |
| 1. <i>P. bulbifera</i> Brennan                       | —                | 7  | 6  | 1  | 2  |
| 2. <i>P. intermedia</i> sp. n.                       | —                | —  | —  | —  | 1  |
| 3. <i>P. montana</i> sp. n.                          | —                | —  | —  | 1  | 2  |
| 4. <i>P. peromysci</i> sp. n.                        | —                | —  | —  | 1  | —  |
| 5. <i>P. zona</i> Brennan                            | —                | 1  | —  | 1  | 2  |
| 6. <i>P. hoguei</i> sp. n.                           | 3                | —  | —  | —  | —  |
| 7. <i>P. rheomys</i> sp. n.                          | —                | —  | —  | —  | 1  |
| 8. <i>P. hooperi</i> sp. n.                          | —                | —  | —  | 1  | —  |
| 9. <i>P. abditiva</i> Brennan                        | —                | —  | —  | —  | 1  |
| 10. <i>P. finitima</i> Brennan & Yunker              | —                | —  | 1  | —  | —  |
| 11. <i>P. guanacastensis</i> sp. n.                  | 3                | —  | —  | —  | —  |
| 12. <i>P. costaricensis</i> sp. n.                   | 3                | —  | —  | —  | —  |
| 13. <i>P. verdensis</i> sp. n.                       | —                | —  | —  | 1  | —  |
| Number of species in each<br>district (or districts) | 3                | 2  | 2  | 6  | 6  |
|  |                  | 3  |    | 9  |    |
| Number limited to biotic district<br>(in Costa Rica) | 3                | 0  | 1  | 3  | 3  |
|  |                  |    |    | 1  |    |



## MATERIALS AND METHODS

From 1962 through 1964 approximately 3,500 mammals from Costa Rica were examined for ectoparasites. Most of these were bats, but 505 were rodents. They were taken primarily in Sherman live traps, rat and museum special kill traps using baits of rolled oats, bananas and peanut butter.

Each specimen was sealed in a separate cloth or plastic bag until it was examined for ectoparasites with the aid of a stereoscopic microscope. The ectoparasites were preserved in 75 per cent ethyl alcohol and each kind of parasite and its location on the host usually were listed in the field notes. The mammals were prepared as wet specimens in formalin or as dry study skins and have been deposited in the Los Angeles County Museum of Natural History (LACM).

Representatives of the larval chiggers were mounted in polyvinyl alcohol-lactophenol (PVA-LP). These larvae were studied with the aid of a phase-contrast microscope, and all drawings, made with the aid of a drawing tube by the senior author, were based on the type series and other specimens from Costa Rica.

Specimens designated with an O- were taken by members of the LACM field parties and those specimens with the designation "RML" belong to the Rocky Mountain Laboratory, Hamilton, Montana. Unless otherwise noted, the chiggers have been deposited in the Acarina collection, LACM.

The holotype and at least one paratype of each new species has been retained in the LACM collection. When available, paratypes will be deposited in the following collections: Chigger Research Collection, California State College, Long Beach; Rocky Mountain Laboratory, Hamilton, Montana; The University of Kansas; The George Williams Hooper Foundation, University of California Medical Center, San Francisco; United States National Museum; Institute of Acarology, Ohio State University; Bishop Museum, Honolulu, Hawaii; Dr. Anita Hoffmann, Mexico, D.F., and other appropriate institutions and individuals.

## ACCOUNTS OF THE SPECIES

The terminology for the larva usually follows that of Wharton *et al.* (1951), supplemented by the terms from Newell (1957). All measurements are in microns. Unless otherwise noted, the description and illustrations of each new species are based upon the holotype. Paratypes from Panamá and referred specimens from Costa Rica were utilized to characterize those species already named. The term "group" is utilized to bring together similar species below the subgeneric level. Any subgroup of several more nearly similar and presumably related species is called a complex.

Genus **Pseudoschoengastia** Lipovsky, 1951

*Type-species: Pseudoschoengastia hungerfordi* Lipovsky, 1951.

*Vanidicus* Brennan and Jones, 1961 (type species, *Vanidicus tricosus*),  
*new synonymy.*



*Pseudoschoengastia* was proposed by Lipovsky (1951) to include two new species, *P. hungerfordi* and *P. farneri*, and *Ascoschoengastia diazi* (Hoffmann 1948). Two additional species, *Ascoschoengastia anomala* and *A. pedregalensis*, were described from México by Hoffmann (1951), and Brennan (1952) named *P. guatemalensis* from Guatemala and *P. occidentalis* from California. Seventeen additional species of *Pseudoschoengastia* have been described from southwestern United States and from México southward to Panamá (Brennan and Jones, 1959; Brennan, 1960; Hoffmann, 1960; Brennan, 1965; Brennan and Yunker, 1966). Fauran (1960) described *Pseudoschoengastia myoprocatae* from French Guiana, the only species of this genus known from South America.

Brennan and Jones (1961) described a new genus and species, *Vanidicus tricosus*, from Panamá, and indicated a close relationship to *Pseudoschoengastia*. The absence of differentiation in characters and the close similarity to *P. abditiva* Brennan has prompted us to synonymize *Vanidicus* with the genus *Pseudoschoengastia*.

*Walchioides* Vercammen-Grandjean (1960) was proposed originally as a subgenus of the Asiatic genus *Susa* Audy. Although the type-species, *Walchia gouldi* Hoffmann from México, is unique in lacking the AM scutal seta, it closely resembles several species of *Pseudoschoengastia*, and therefore we consider *Walchioides* a subgenus of *Pseudoschoengastia*. We are placing all species of *Pseudoschoengastia* with the PL setae on the scutal plate in the subgenus *Walchioides*.

Twenty-seven species of *Pseudoschoengastia* have been described: four from the United States; 13 from México and Guatemala; nine from Panamá; one from northern South America. The nine additional species from Costa Rica described below brings the total number to 36.

Larval *Pseudoschoengastia* are parasitic on small rodents, lagomorphs, insectivores and other small terrestrial mammals.

*Referred species:* Thirty-six species, arranged below in two subgenera: *Pseudoschoengastia* (26 species) and *Walchioides* (10 species).

*Diagnosis:* *Pseudoschoengastia* differs from all other genera in the subfamily Trombiculinae by having the following combination of larval characters: scutum small; sensilla clavate to capitate; palpotibial claw trifurcate; palpal tarsus with five branched setae; body with many setae, usually with two or more pairs of humeral setae and one or more pairs of lateral humeral and lateral sternal setae between coxae II and III; leg I with stout subterminala (dorsal eupathid) and parasubterminala (companion seta); basifemur and telofemur III completely or partially fused (showing line of previous articulation), with two or more internal bars; tibiala III present; leg III without mastisetae. Closely resembling the genera *Euschoengastoides* Loomis and *Cordiseta* Hoffmann; but differing from *Euschoengastoides* in having subterminala and parasubterminala I (usually absent in *Euschoengastoides*); lateral humeral and lateral sternal setae between coxae II and III (absent in *Euschoengas-*



*toides*); long slender vestigiala on leg I (short dagger-shaped vestigiala in *Euschoengastoides*); femora II and III fused (not fused in *Euschoengastoides*); differing from *Cordiseta* in lacking large foliate dorsal body setae.

*Description*: Larval characters as in diagnosis, plus: scutum with postero-lateral setae on or off the scutal plate; expanded sensilla with setules large to extremely small; cheliceral blade with a terminal tricuspid cap (some with a serrated medial margin), and with or without a dorsomedial tooth; palpal tarsus without subterminala (eupathid); body small, ellipsoidal and somewhat constricted when engorged; eyes 2/2 (rarely absent), usually on a plate; anus at level of 4th and 5th rows of ventral body setae; postanal setae resembling dorsal setae; all legs terminating in two lateral claws and median clawlike empodium, without tenent hairs (onychotriches); cheliceral bases, capitular sternum, scutum and all leg segments punctate. Galeala usually nude, rarely with one to four fine branches.

*Comments*: There is some confusion in the names of the lateral body setae which are present between and near coxae II and III of *Pseudoschoengastia*. Lipovsky (1951) and Brennan (1952) followed Hoffmann (1948) and referred to these setae as dorsal and ventral humerals. However, these lateral setae are of two distinct morphological types: 1) a humeral seta, and 2) a sternal seta. Because of the position between coxae II and III, the ventralmost humerals will be called lateral humeral setae, and the sternals will be considered lateral sternal setae.

The leg segmentation of this genus should be considered as 7-6-6, with the fusion of the basifemur and telofemur on legs II and III. Most species of *Pseudoschoengastia* were examined, and in some species a definite line of fusion was seen. Loomis (1956:1419) reported that a femoral suture could be discerned in *P. hungerfordi* but seemed to be entirely absent or indistinct in *P. farneri*. The degree of fusion was determined by the thickness and number of heavily sclerotized rings within the femur. When completely fused, there were fewer, less distinct bars. The condition of fusion seemed to be consistent within each species, but varied among different species.

The leg index is the sum of one measured length for each of the legs I, II and III.

*Taxonomic remarks*: *Cordiseta* is another New World genus that shares many characteristics with *Pseudoschoengastia*. These similarities include five branched setae on the palpal tarsus, expanded sensilla, multiple lateral humerals and sternals, and reduced (7-6-6) leg segmentation. The many characteristics shared by *Cordiseta* and *Pseudoschoengastia* indicate a close relationship. They are not closely similar to *Ascoschoengastia*, *Laurentella*, or other Old World genera.

#### Subgenus ***Pseudoschoengastia*** Lipovsky, 1951

*Referred Species*: Twenty-six species placed into four groups: Hunger-



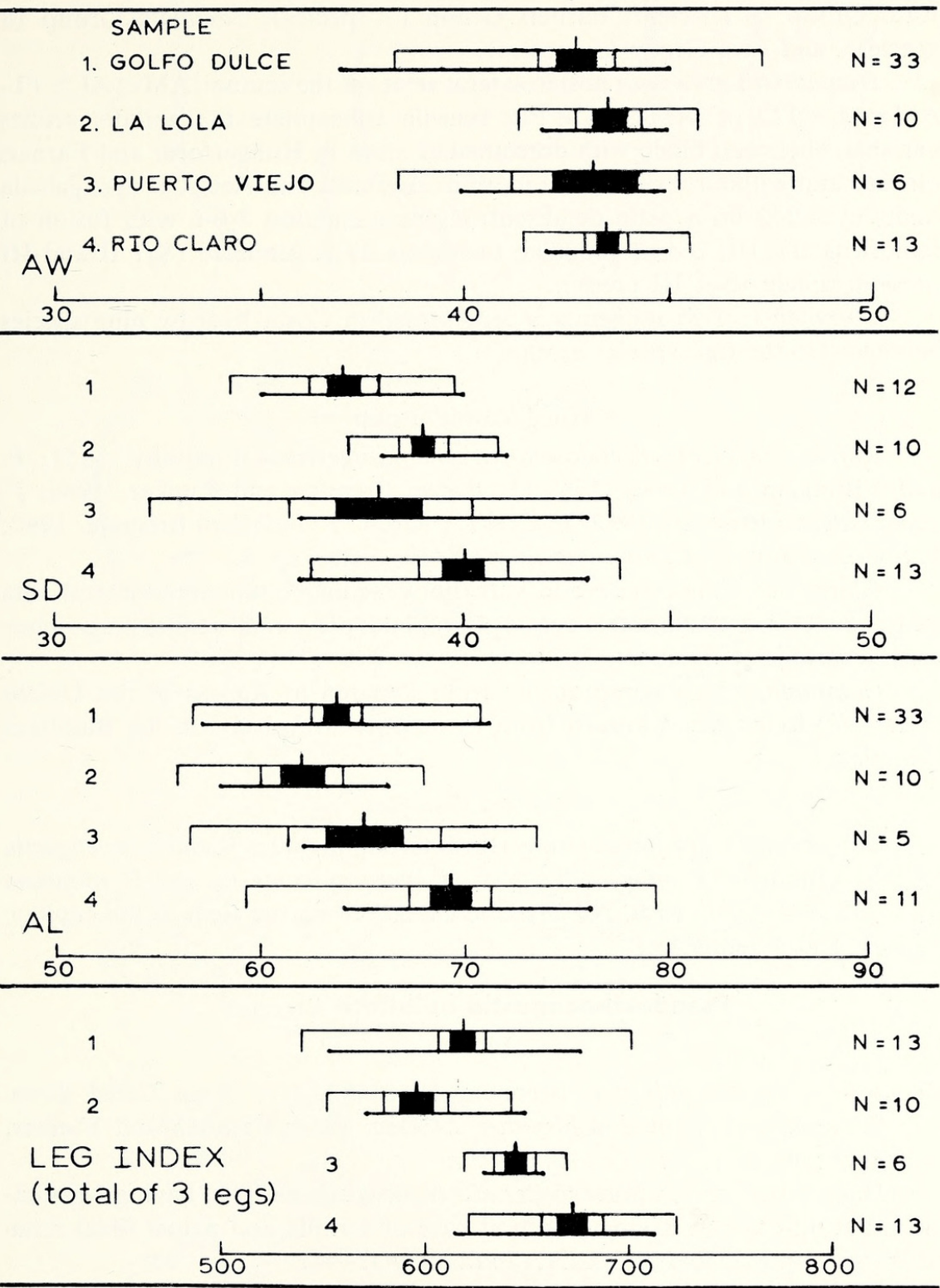


Figure 3. Modified Dice-Leraas diagrams of selected measurements of *Pseudoschoengastia bulbifera* from four different populations: 1. Golfo Dulce Biotic District; 2. Finca "La Lola"; 3. Puerto Viejo de Serapiquí; 4. Río Claro. Measurements, top to bottom, are: AW, anterior width of scutum; SD, scutal depth; AL, length of antero-lateral scutal seta; leg index, total length of three legs. N = size of sample.

In each diagram the lower line indicates the total variation of the sample (N); the shaded area one standard error, the adjacent bar twice the standard error on each side of the mean; and the upper line is two standard deviations on each side of the mean.



fordi Group (8 species), Farneri Group (7 species), Anomala Group (8 species), and Aeci Group (3 species).

*Diagnosis:* Larva with posterolateral setae off the scutum;  $AM < AL > PL$ ,  $AM = AL < PL$  or  $AM > AL < PL$ ; sensilla subcapitate to capitate, setules variable; cheliceral blade with dorsomedial tooth in Hungerfordi and Farneri Groups and without dorsomedial tooth in Anomala and Aeci Groups; galeala nude; eyes 2/2 on a plate or absent; leg segmentation 7-6-6 with fusion of femora II and III; 2 or 3 genualae (solenidia 3) I, genualae ( $S_3$ ) II and III present; tibiala ( $S_3$ ) III present.

*Comments:* This subgenus is represented in Costa Rica by nine species belonging to the four species groups.

### Hungerfordi Group

*Referred species:* *Pseudoschoengastia hungerfordi* Lipovsky, 1951; *P. audyi* Brennan and Jones, 1959; *P. dasypi* Brennan and Yunker, 1966; *P. guatemalensis* Brennan, 1952. In COSTA RICA: *P. bulbifera* Brennan, 1960; *P. intermedia* sp. n.; *P. montana* sp. n.; *P. peromysci* sp. n.

*Diagnosis:* Cheliceral blade with dorsomedial tooth; anterolateral seta longer than other scutal setae; eyes 2/2 on plate; only small setules on postero-ventral surface of sensilla.

*Comments:* This group occurs from Panamá to Kansas in the United States. All four species known from Costa Rica are placed in the Bulbifera Complex.

### Bulbifera Complex

This complex within the Hungerfordi Group includes *Pseudoschoengastia bulbifera* Brennan, *P. intermedia* sp. n., *P. peromysci* sp. n., and *P. montana* sp. n., all from Costa Rica. All have the basal bulb on the stem of the capitate sensilla, and 3 genualae I.

### ***Pseudoschoengastia bulbifera* Brennan**

Fig. 4

*Pseudoschoengastia bulbifera* Brennan, 1960:483, type from Canal Zone, Panamá, host *Sigmodon hispidus*, 24 Dec. 1954; Brennan and Yunker, 1966:245

*Diagnosis:* Larva, similar to *Pseudoschoengastia audyi* in having 3 genualae I, but differing in having a bulb at base of sensilla and palpal tibial setae BBB (without bulb and setae NNN in *P. audyi*).

*Description* (based on 29 larvae from Costa Rica): Body partially engorged, 189 by 284, color in life probably yellow; eyes 2/2, anterior slightly larger, color in life probably red, ocular plate present.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-8-10-8-6 + 20, total 62; dorsal humeral setae 38, 38, lateral humeral seta 32, seta of first posthumeral row 37, posterior dorsal seta measuring 39.



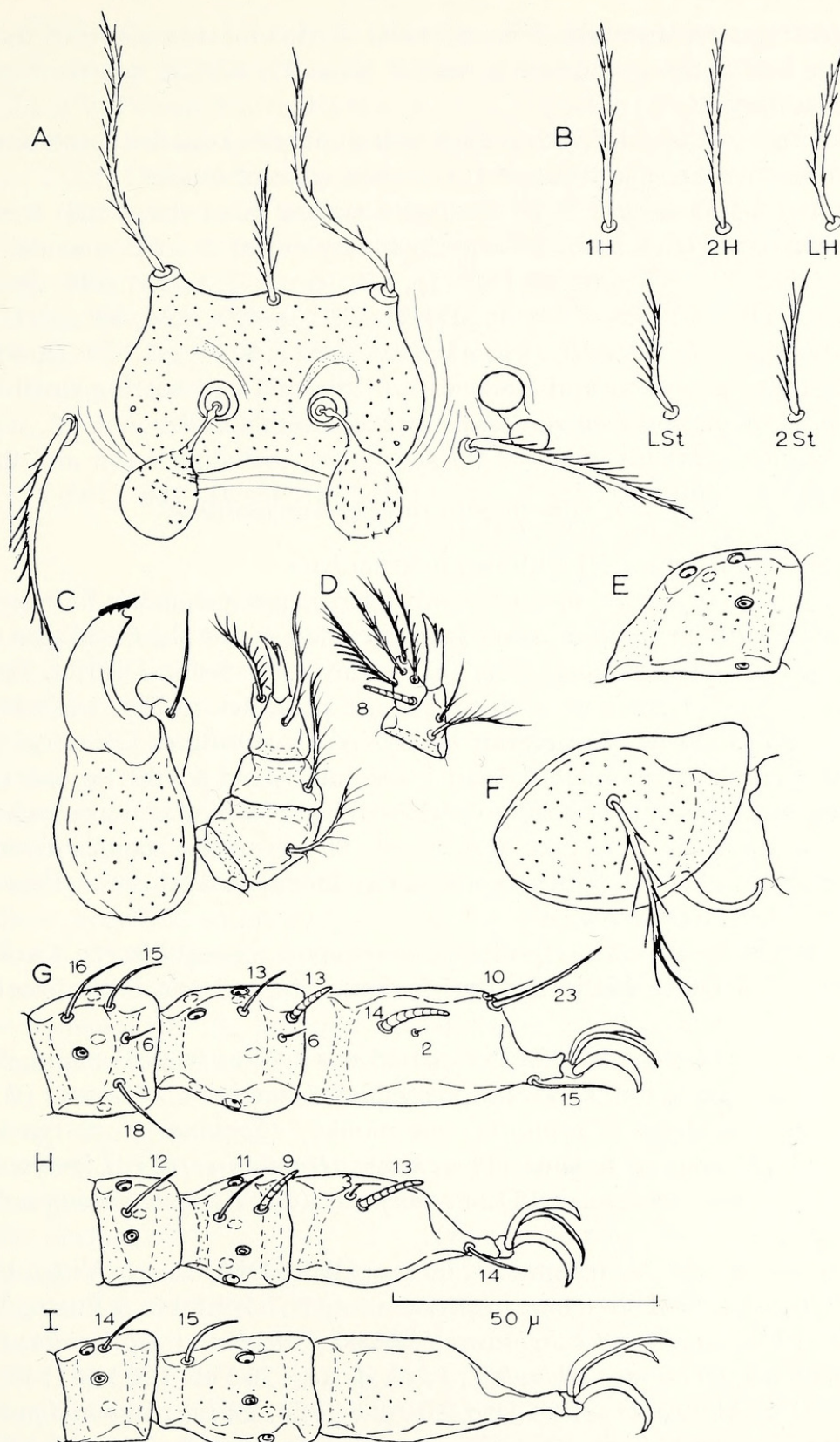


Figure 4. *Pseudoschoengastia bulbifera* Brennan. A. Scutum and eyes. B. Representative body setae: 1H—first dorsal humeral seta; 2H—second dorsal humeral seta; LH—lateral humeral seta; LSt—lateral sternal seta; 2St—second sternal seta. C. Dorsal aspect of gnathosoma showing chelicera, cheliceral base, and palpus. D. Ventral aspect of palpal tibia and tarsus. E. Femur III. F. Coxa III. G. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. H. Leg II; as above. I. Leg III; as above.



Ventral setal formula 2-2 (sternals)-2 (lateral sternals)-6-6-8-4-2-2, total 34; first, second, and lateral sternal setae 29, 27, 28, posterior ventral seta measuring 21.

Scutum: rectangular with posterolateral margins rounded, posteromedial margin concave. Sensilla subcapitate with two types of setules.

Scutal measurements of 29 specimens (unless otherwise noted) from the Caribbean Costa Rica Biotic District including mean,  $\pm 2$  SE, and the range (in parentheses): AW,  $43 \pm 1$  (40-45); SB,  $16 \pm 1$  (13-19); ASB,  $26 \pm 0.5$  (24-28); PSB,  $14 \pm 0.5$  (11-16); SD,  $39 \pm 1$  (36-43); AM,  $32 \pm 2$  (26-38, 23); AL,  $66 \pm 2$  (58-76, 26); PL,  $47 \pm 1$  (44-52); S,  $31 \pm 1$  (29-32, 8).

Gnathosoma: cheliceral blade with a tricuspid cap bearing small serrations and a tooth on the dorsomedial surface. Galeala nude.

Leg measurements of above 29 specimens, including mean and the extremes (in parentheses): leg I, 233 (199-256); leg II, 188 (165-213); leg III, 225 (201-253); leg index, 641 (573-713).

Legs: femur of leg III with two internal bars.

*Comments:* Selected measurements of *Pseudoschoengastia bulbifera* are presented from four samples: three from localities within the Caribbean Costa Rica Biotic District, and one from the Golfo Dulce Biotic District. Four of thirteen measurements from each sample are presented in Fig. 3 as modified Dice-Leraas diagrams: 1) anterior width (AW) of scutum, 2) scutal depth (SD), 3) length of anterolateral scutal seta (AL), and 4) the leg index. The variation of each sample broadly overlaps those of all other samples and no significant statistical difference was noted. However, the sample from Río Claro seemed to have slightly longer legs (leg index) and AL setae, than those from the other three areas.

*Ecological notes:* This species is widespread throughout the Caribbean and the Golfo Dulce Biotic Districts in both Tropical and Subtropical Life Zones.

Brennan and Yunker (1966) reported this species from Panamá off one lizard (*Sceloporus*), four species of marsupials (*Didelphis*, *Marmosa* (2) and *Philander*), one shrew (*Cryptotis*), one monkey (*Saguinas*), one bat (*Stur-nira*), and 17 kinds of rodents (*Proechimys*, *Heteromys* (2), *Liomys*, *Hop-lomys*, *Sigmodon*, *Oryzomys* (5), *Peromyscus* (2), *Reithrodontomys*, *Scoti-nomys*, *Zygodontomys* and *Nectomys*).

*Specimens examined:* Total 172 larvae: HEREDIA: Puerto Viejo, 154 m, 14 and 16 Aug. 1963, *Oryzomys caliginosus* (3); 7.5-9.5 km S Puerto Viejo, 15 Aug. 1964, *Oryzomys caliginosus* (2) and *Proechimys semispinosus* (1); El Angel Falls, *Oryzomys albigularis* (= *O. devius*), 6 Feb. 1963 (4); 18 Aug. 1964 (12). CARTAGO: Río Claro, 30 June 1964, *Peromyscus nudipes* (8); Turrialba, 600 m, 22 Sept. 1964, *Oryzomys caliginosus* (7); Tapanti, 1200 m, 3 July 1964, *Peromyscus nudipes* (1). LIMON: finca "La Lola," 23-24 July 1964, *Oryzomys caliginosus* (23). SAN JOSE: 20.8 km N San Isidro del General, 15 July 1963, *Oryzomys albigularis* (= *O. devius*) (9). PUNTA-



RENAS: Río Damitas, 11 Jan. 1963, *Proechimys semispinosus* (1); Río Coronado, 20 km N Puerto Cortez, 7 March 1963, *Proechimys semispinosus* (3); 1.7 km W Palmar Norte, 10 March 1963, *Sigmodon hispidus* (4); 7.3 km S Palmar Sur, 11 Aug. 1963, *Sigmodon hispidus* (9); finca "Los Helechales," 1040 m, 2 Oct. 1964, *Oryzomys alfaroi* (1); and 840 m, 11 Oct. 1964, *Zygodontomys microtinus* (= *Z. cherriei*) (46); 8 km E Potrero Grande, finca de Señor Treno, 660 m, 10 Oct. 1964, *Oryzomys caliginosus* (5); Rincón de Osa, *Oryzomys caliginosus*, 27 June 1963 (3); 3 July 1963 (1), 9-11 July 1964 (10); Camp Seattle, 13 Aug. 1962, *Oryzomys fulvescens* (8); 2.5-6.1 km N Villa Neily, 9-11 Aug. 1963, *Oryzomys fulvescens* (2), *Oryzomys caliginosus* (1), *Proechimys semispinosus* (2), and *Philander opposum* (1). PANAMA: Chiriquí, 31 Jan. and 12 Feb. 1960, *Peromyscus nudipes* (2, RML 35919, 35926).

***Pseudoschoengastia intermedia* sp. n.**

Fig. 5

*Types*: Larvae, holotype and 8 paratopotypes from 20.8 km N San Isidro del General, 1600 m, San José Province, host *Oryzomys albigularis*, field no. 0-2102, collected 15 July 1963 by R. S. Casebeer, H. Coulombe, A. G. Hollister, A. Starrett and C. L. Hogue.

*Diagnosis*: Larva differing from other members of Bulbifera Complex in at least one of the following combinations of characters: teeth on cheliceral cap; palpal setal formula B/B/NNB; 3 internal bars within femur III; and less than 70 dorsal body setae.

*Description of holotype*: Body partially engorged, 143 by 208, color in life yellow; eyes 2/2, anterior larger, ocular plate inconspicuous.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-8-10-8-8-8 + 12, total 64; dorsal humeral setae 43, 45, lateral humeral seta 40, seta of first posthumeral row 36, posterior dorsal seta measuring 36.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-10-12-4-2, total 34; first, second and lateral sternal setae 43, 33, 45, posterior ventral seta measuring 17.

Scutum: slightly wider than deep rectangle with posterolateral margins rounded, posteromedial margin concave. Sensilla capitate with few barbs on posterior surface.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE, range and total number of specimens measured: AW, 44 ( $43 \pm 1$ , 40-47, 9); SB, 15 ( $15 \pm 1$ , 12-19, 9); ASB, 26 ( $27 \pm 1$ , 26-28, 6); PSB, 15 ( $14 \pm 1$ , 13-17, 6); SD, 41 ( $42 \pm 1$ , 41-44, 6); AM, 40 ( $39 \pm 2$ , 36-43, 8); AL, 76 ( $74 \pm 3$ , 66-78, 9); PL, 50 ( $50 \pm 1$ , 45-52, 9); S, 31 ( $33 \pm 1$ , 31-34, 5).

Gnathosoma: cheliceral blade with small teeth on medial surface of cap. Galeala nude.

Leg measurements of holotype and 5 paratopotypes, including mean and the extremes (in parentheses): leg I, 266 (256-279); leg II, 218 (205-227);



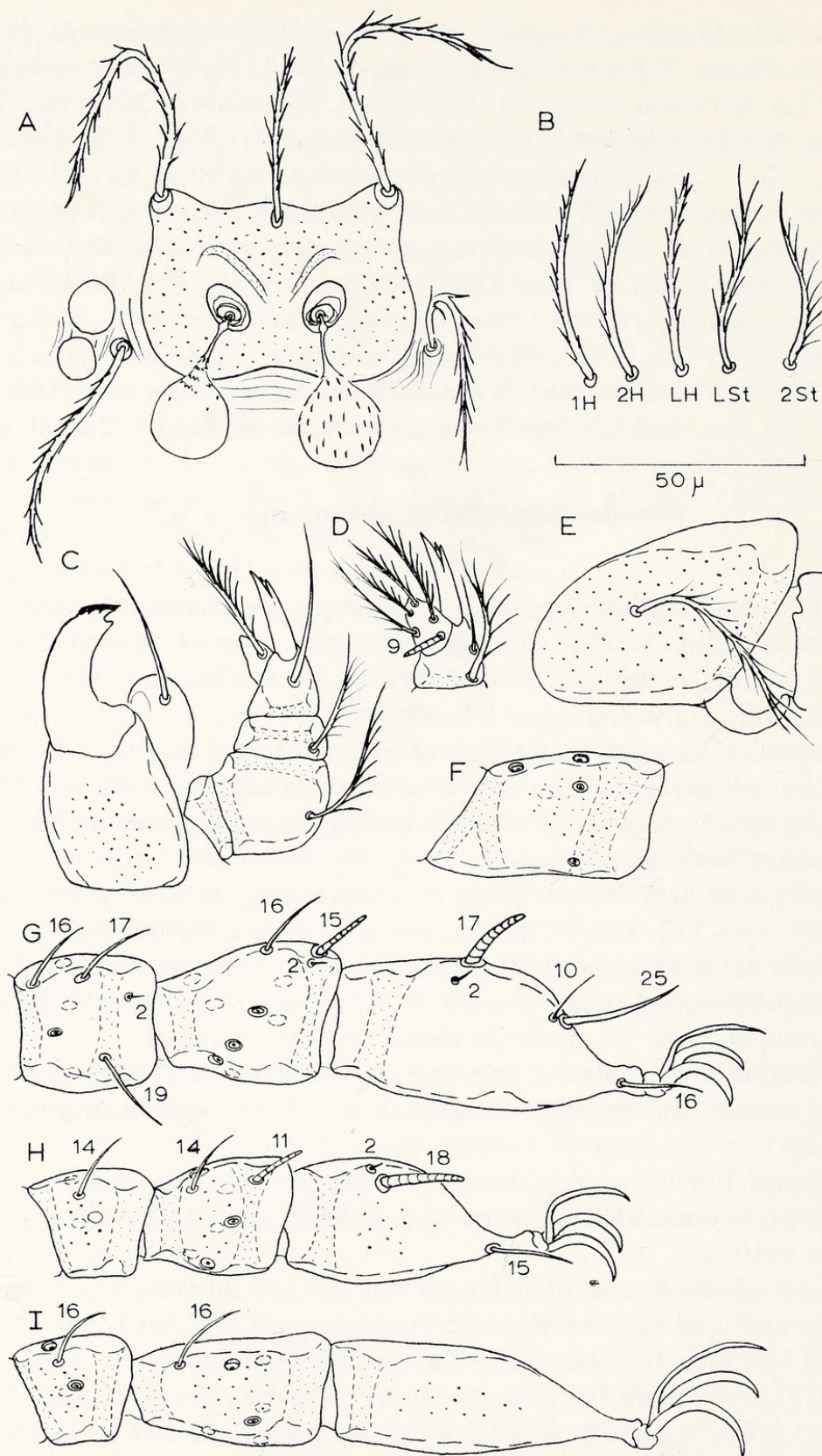


Figure 5. *Pseudoschoengastia intermedia* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Femur III. G. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. H. Leg II. I. Leg III.



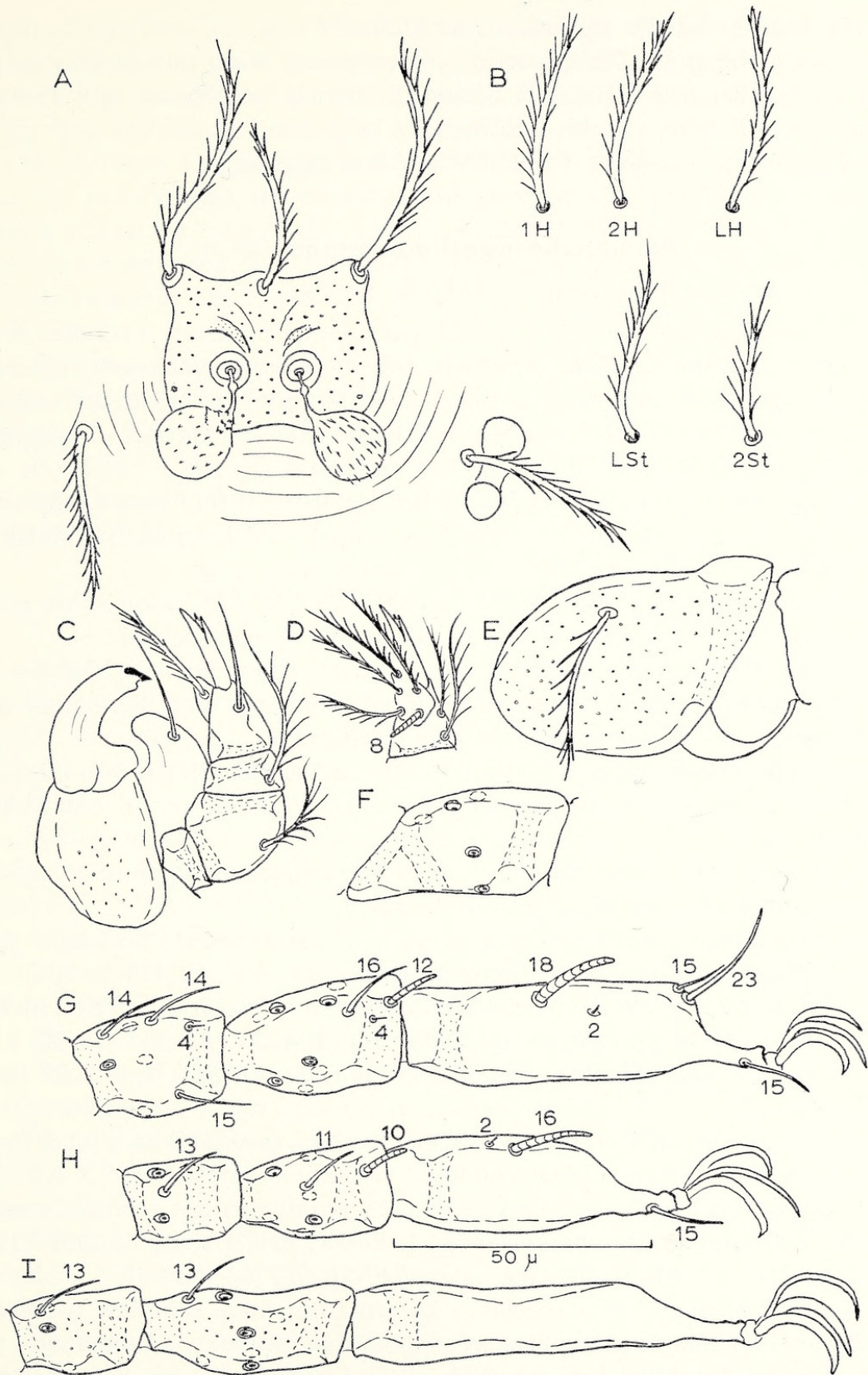


Figure 6. *Pseudoschoengastia montana* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Femur III. G. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. H. Leg II. I. Leg III.



leg III, 262 (237-278); leg index, 749 (709-779).

*Ecological notes:* This species is known only from one locality at the edge of the Panamá Highlands Biotic District. It was found with *Pseudoschoengastia bulbifera* at this locality.

*Specimens examined:* Total of 9 larvae of type series.

***Pseudoschoengastia montana* sp. n.**

Fig. 6

*Types:* Larvae, holotype and 23 paratopotypes: from 11.3 km S La Georgina, 2500 m San José Province, host *Oryzomys albigularis*, holotype and 22 paratypes from field no. 0-2112, taken 16 July 1963 by R. S. Casebeer, H. Coulombe, A. G. Hollister, C. L. Hogue and A. Starrett, 1 paratype (0-1150), taken 20 Nov. 1962 by R. S. Casebeer.

*Diagnosis:* Larva differing from other members of Bulbifera Complex in the following combinations of characters: palpal setal formula B/B/NBB, 3 bars within femur III, and fewer than 70 dorsal body setae.

*Description of holotype:* Body engorged, 284 by 473, color in life probably yellow; eyes 2/2, anterior larger, ocular plate inconspicuous.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-8-10-8-6 $\pm$ 16, total 58; dorsal humeral setae 38, 38, lateral humeral seta 38, seta of first posthumeral row 28, posterior dorsal seta measuring 37.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-6-6-6-4-2, total 30; first, second and lateral sternal setae 36, 31, 34, posterior ventral seta measuring 22.

Scutum: rectangular with posterolateral margin rounded, sensilla capitate with several rows of barbs on posterior surface.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE, range and total number of specimens measured: AW, 32 (35  $\pm$  1, 30-38, 24); SB, 10 (12  $\pm$  1, 9-16, 24); ASB, 22 (24  $\pm$  1, 20-27, 23); PSB, 14 (13  $\pm$  1, 11-16, 22); SD, 36 (36  $\pm$  .5, 33-41, 22); AM, 33 (32  $\pm$  1, 28-35, 21); AL, 47 (49  $\pm$  1, 45-52, 22); PL, 37 (35  $\pm$  1, 31-40, 23); S, 26 (25  $\pm$  1, 24-26, 6).

Gnathosoma: cheliceral blade without teeth on cap and with a small tooth on dorsomedial surface. Galeala nude.

Leg measurements of holotype and 23 paratopotypes, including mean and the extremes (in parentheses): leg I, 248 (236-270); leg II, 211 (199-227); leg III, 255 (241-280); leg index, 717 (672-778).

*Ecological notes:* This species is known from three samples: two from the Panamá Highlands Biotic District in the Submontane Life Zone and at the edge of the Subtropical Life Zone in a wet forest formation along a small stream bed; and the third sample of two larvae is from Volcán Poás in the Costa Rica Highlands Biotic District.

*Taxonomic remarks:* The three series of larvae from "Los Helechales,"



south of La Georgina, and Volcán Poás are closely similar in most characteristics. However, it was noted that the legs and tarsalae I and II were shorter in the "Los Helechales" sample. Tarsala I (11-13) and tarsala II (12-14) from "Los Helechales" measured shorter than tarsala I (16-20) and tarsala II (14-16) from La Georgina and Volcán Poás. The leg measurements, means and (in parentheses) the extremes are presented for the "Los Helechales" sample (22 larvae): Leg I, 211 (195-218); leg II, 174 (161-180); leg III, 207 (199-218); leg index, 591 (560-625). Leg measurements of two larvae from Volcán Poás are: Leg I, 238, 235; leg II, 213, 205; leg III, 256, 237; leg index 707, 677.

*Specimens examined*: Total 48 larvae: ALAJUELA: Volcán Poás, 2493 m, 24 March 1963, *Peromyscus nudipes* (2). SAN JOSE: 11.3 km S La Georgina, 2500 m, *Oryzomys albigularis* (= *O. devius*), 20 Nov. 1962 (1), 16 July 1963 (23). PUNTARENAS: Finca "Los Helechales," 15 km E Potrero Grande, 1040 m, 2 Oct. 1964, *Oryzomys alfaroi* (7), *Oryzomys bombycinus* (15).

***Pseudoschoengastia peromysci* sp. n.**

Fig. 7

*Types*: Larvae, holotype and one paratopotype: from Monteverde, 1380 m, Puntarenas Province, host *Peromyscus nudipes*, holotype from field no. 0-2831, obtained 14 May 1964 by C. A. McLaughlin, F. S. Truxal and J. M. Savage; and paratopotype from 0-2809-10, taken 13 May 1964 by same collectors.

*Diagnosis*: Larva differing from other members of Bulbifera Complex in having a palpal setal formula of B/B/NNB; ASB, 30-32 (24-28 in *P. bulbifera*); 3 bars within fused femur III; more than 80 dorsal body setae; legs long; and scutum small.

*Description of holotype*: Body unengorged, 151 by 246, color in life yellow; eyes 2/2, equal, ocular plate present, color in life probably red.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-6-10-8-6 + 50, total 90; dorsal humeral setae 49, 52, lateral humeral seta 50, seta of first posthumeral row 43, posterior dorsal seta measuring 43.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-8-10-8 + 6, total 38; first absent, second and lateral sternal setae 47, 57, posterior ventral seta measuring 26.

Scutum: rectangular, as deep as wide with posterolateral margins rounded, posteromedial margin concave, sensilla capitate with 2 types of setules.

Scutal measurements of holotype and single paratopotype (in parentheses): AW, 36 (38); SB, 14 (14); ASB, 30 (32); PSB, 16 (16); SD, 36 (38); AM, 47 (42); AL, 76 (79); PL, 57 (52); S, 31.

Gnathosoma: cheliceral blade with tricuspid cap and small tooth on the dorsomedial surface. Galeala nude.



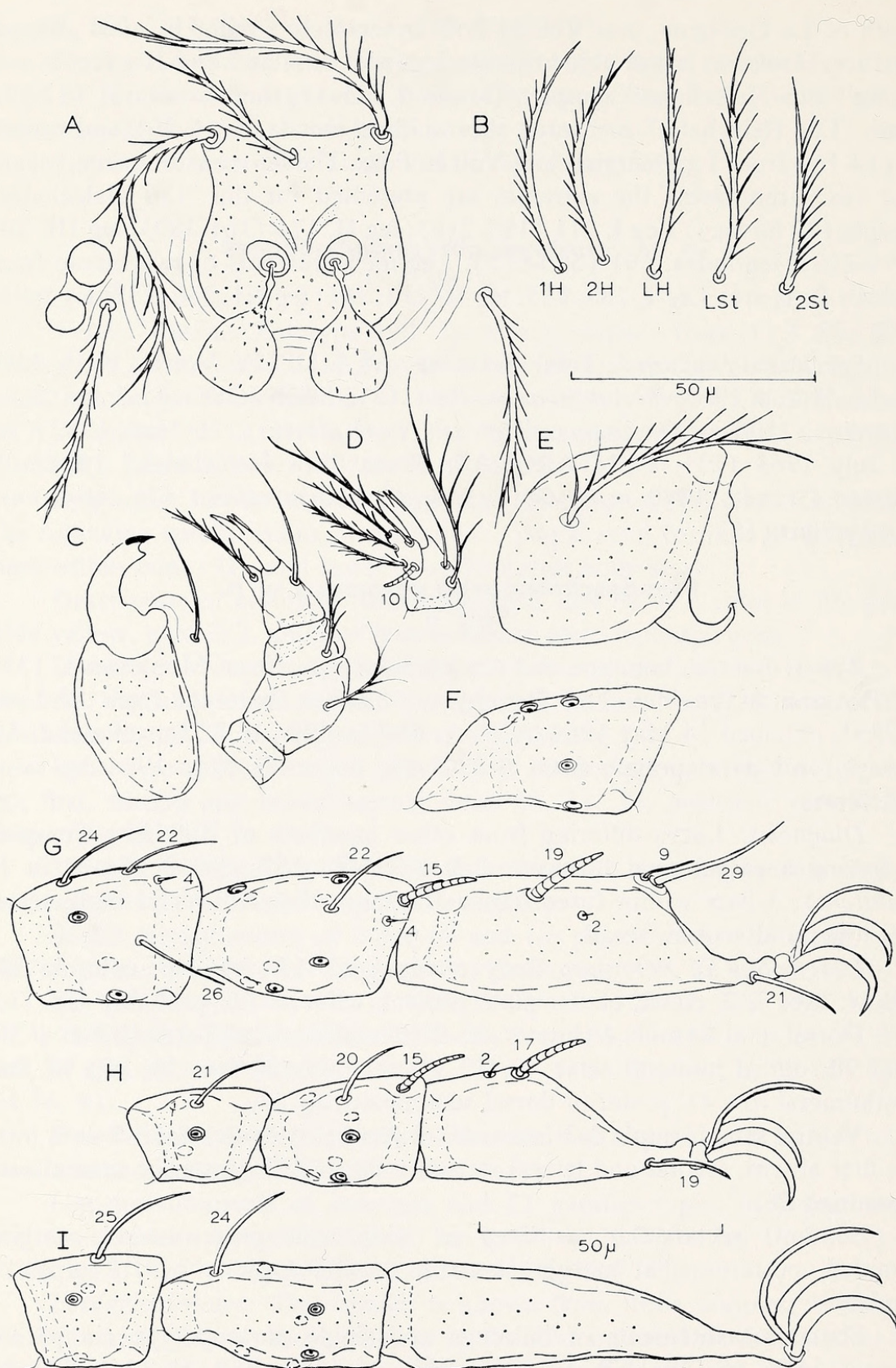


Figure 7. *Pseudoschoengastia peromysci* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Femur III. G. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. H. Leg II. I. Leg III.



Leg measurements of holotype and paratopotype: leg I, 360, 350; leg II, 289, 284; leg III, 341, 322; leg index, 990, 956.

*Ecological notes:* This species, as well as *P. bulbifera* and *P. zona*, was taken off a series of *Peromyscus nudipes* from the Costa Rica Highlands Biotic District.

*Taxonomic remarks:* *P. peromysci* has the longest legs and the smallest scutum of any species in the *Bulbifera* Complex.

*Specimens examined:* Total of 2 larvae of type series.

#### Farneri Group

*Referred species:* *Pseudoschoengastia farneri* Lipovsky, 1951; *P. hypopsia* Brennan and Jones, 1959; *P. scitula* Brennan and Jones, 1959. In COSTA RICA: *P. hoguei* sp. n.; *P. hooperi* sp. n.; *P. rheomys* sp. n.; and *P. zona* Brennan, 1960.

*Diagnosis:* Palpal femoral seta shorter than nude genual seta; cheliceral blade with tricuspid cap (no teeth) and a dorsomedial tooth;  $AL < AM < PL$  or  $AM < AL < PL$ ; eyes 2/2 on a plate; 2 pairs of dorsal humerals and 1 pair of lateral humerals; 1 pair of lateral sternal setae.

*Comments:* This group occurs from Kansas to Panamá. Three new species of the group are described from Costa Rica. In Costa Rica and Panamá, members of this group have few or no branches on the palpal setae, and the palpal femoral seta is branched only in *Pseudoschoengastia zona* and *P. hoguei* sp. n. This characteristic also obtains for *P. abditiva* of the *Anomala* Group.

#### ***Pseudoschoengastia zona* Brennan**

Fig. 8

*Pseudoschoengastia zona* Brennan, 1960:490, type from Canal Zone, Curundu, Panamá, host *Liomys adspersus*, 8 July 1954; Brennan and Yunker, 1966:248.

*Diagnosis:* Larva similar to *Pseudoschoengastia scitula* of southern México in having palpal setal formula of B/N/NNN, but differing from it in having AM seta shorter than AL seta.

*Description* (4 referred specimens from Panama and 7 larvae from Costa Rica): Body partially engorged, 133 by 189, color in life probably red, ocular plate present.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-6-10-12-12-12-8-6 + 14, total 86; dorsal humeral setae 29, 29, lateral humeral seta 30, seta of first posthumeral row 22, posterior dorsal seta measuring 26.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-8-10-8-4-4-2, total 36; first, second and lateral sternal setae 30, 24, 27, posterior ventral setae measuring 19.

Scutum: Rectangular with rear margin concave, sensilla capitate with setules of two types.

Scutal measurements including mean and range of 2 paratypes and 2



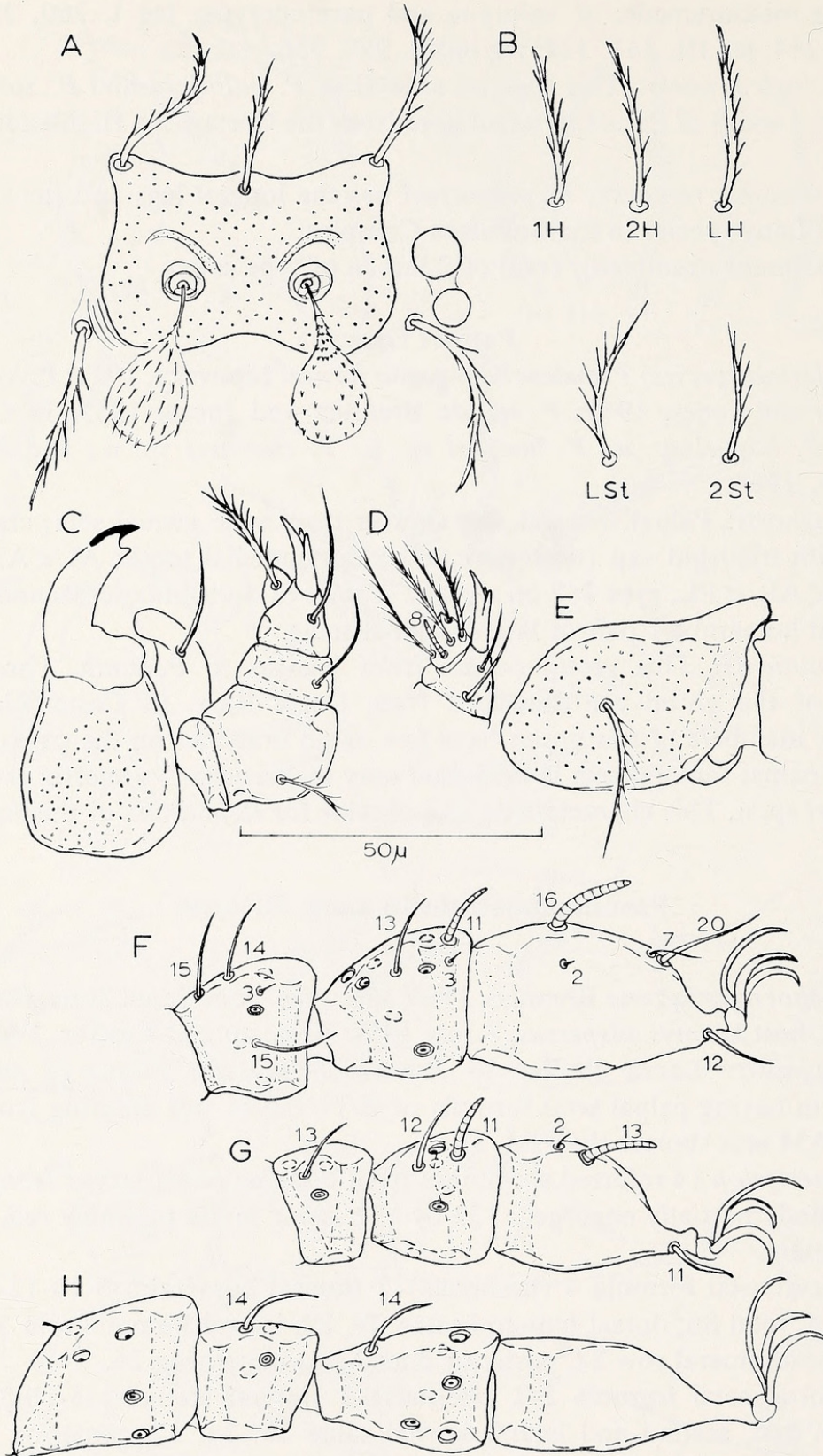


Figure 8. *Pseudoschoengastia zona* Brennan. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



referred specimens from Panamá and (in parentheses) the mean  $\pm$  2 SE, and the range of 7 specimens from Costa Rica: AW, 52, 47-56 ( $46 \pm 1$ , 44-47); SB, 28, 26-30 ( $24 \pm 2$ , 21-27); ASB, 23, 21-25 ( $23 \pm 1$ , 21-25); PSB, 16, 14-18 ( $13 \pm 2$ , 11-16); SD, 39, 35-42 ( $36 \pm 1$ , 34-38); AM, 27, 24-30 ( $25 \pm 1$ , 24-26); AL, 28, 27-30 ( $28 \pm 3$ , 23-35); PL, 37, 35-38 ( $35 \pm 2$ , 32-38); S, 30, 30-31 ( $30 \pm 1$ , 28-32).

Gnathosoma: cheliceral blade with a tricuspid cap and dorsomedial tooth. Galeala nude.

Leg measurements of 2 paratypes and 2 referred specimens from Panamá, including means and extremes and (in parentheses) 7 specimens from Costa Rica: leg I, 203, 189-215 (200, 184-218); leg II, 168, 165-170 (160, 151-170); leg III, 204, 194-213 (197, 184-213); leg index, 569, 543-589 (557, 519-601).

*Ecological notes:* The range of this species extends from Golfo Dulce Biotic District to lower elevations of the Panamá-Costa Rica Highlands Biotic Province but it was not taken in the Guanacaste and Caribbean Costa Rica Biotic Districts. In Costa Rica it was taken from *Oryzomys*, *Zygodontomys*, *Proechimys* and *Peromyscus*, all of which are new host records. In Panamá it was obtained from five genera, *Heteromys*, *Liomys*, *Oryzomys*, *Sigmodon*, and *Tylomys* (Brennan and Yunker, 1966.)

*Specimens examined:* Total 11 larvae: SAN JOSE: 20.8 km N San Isidro del General, 15 July 1963, *Oryzomys albigularis* (= *O. devius*) (3). PUNTARENAS: Monteverde, 1380 m, 13 May 1964, *Peromyscus nudipes* (2); 12 km E Potrero Grande, finca "Los Helechales," 1040 m, 11 Oct. 1964, *Zygodontomys microtinus* (= *Z. cherriei*) (1); Rincón de Osa, 14 July 1964, *Proechimys semispinosus* (1). PANAMA: Canal Zone, National Forest, 20 April 1955, *Sigmodon hispidus* (paratype, RML 35239); Canal Zone, Summit Gardens, 21 Sept. 1954, *Liomys adspersus* (RML 35267, paratype); Canal Zone, Nuevo Emperador, 7 Aug. 1961, *Liomys adspersus* (2, RML 43336, 43338).

### ***Pseudoschoengastia hoguei* sp. n.**

Fig. 9

*Types:* Larvae, holotype and 53 paratypes: holotype and 40 paratopotypes from 7.5 km S Liberia, Guanacaste Province, host *Liomys salvini*, field no. 0-3290, taken 8 Aug. 1964 by C. L. Hogue, R. C. Stephens and J. C. Geest; 8 paratypes, 5 km NW Tilarán, *Liomys salvini* (0-438), 28 July 1962 by F. S. Truxal, C. A. McLaughlin, R. S. Casebeer, A. A. Schoenherr; and 5 paratypes, 3 km S Playa del Coco, *Liomys salvini* (0-328 to 339), 23 July 1962, same collectors.

*Diagnosis:* Larva resembling *Pseudoschoengastia zona* and *P. abditiva* in having palpal setal formula of B/N/NNN, but differing from them in having 2 (rather than 3) genualae I and tarsalae I and II being subequal (tarsala I longer than II in *P. zona*), and in having shorter scutal and body setae.



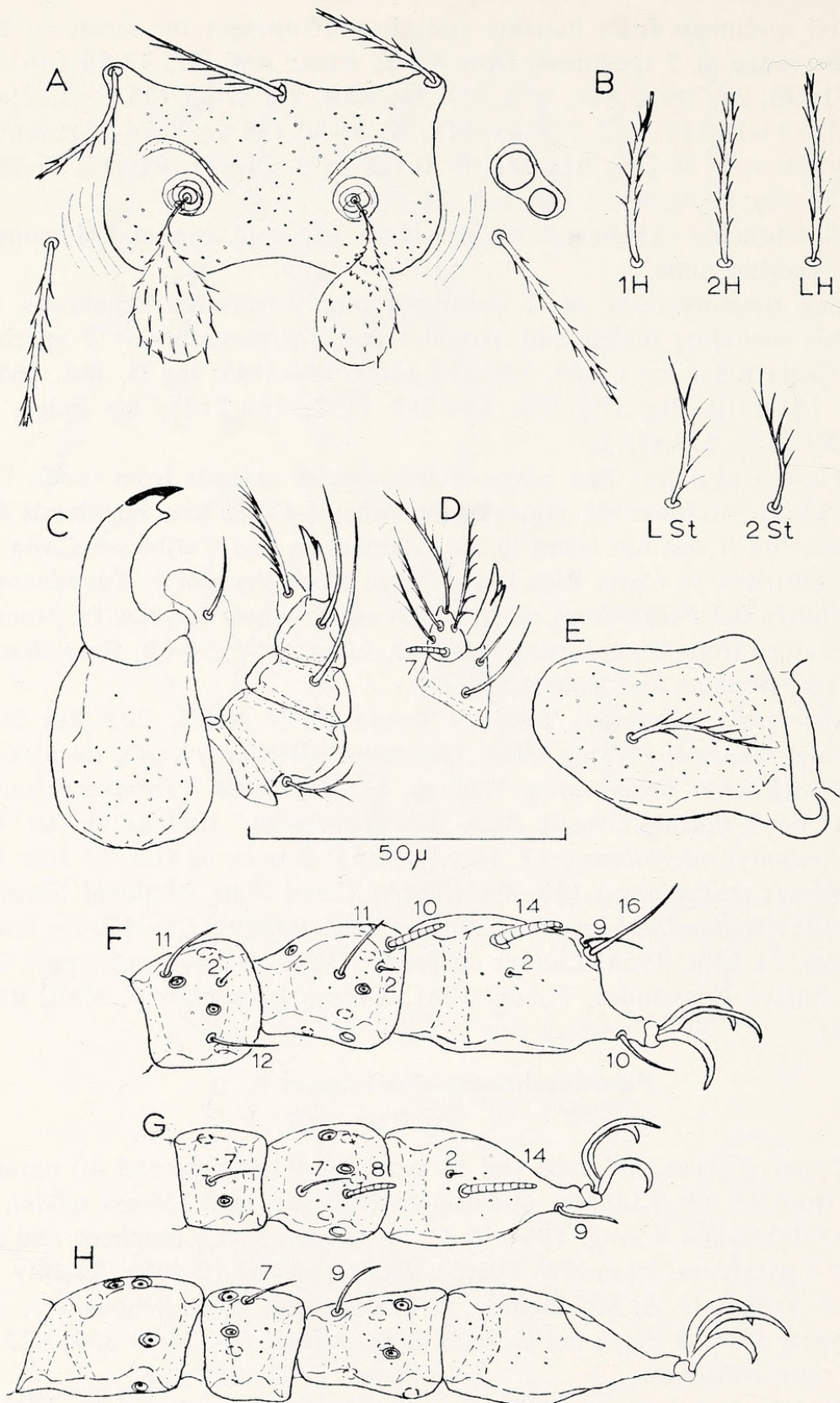


Figure 9. *Pseudoschoengastia hoguei* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



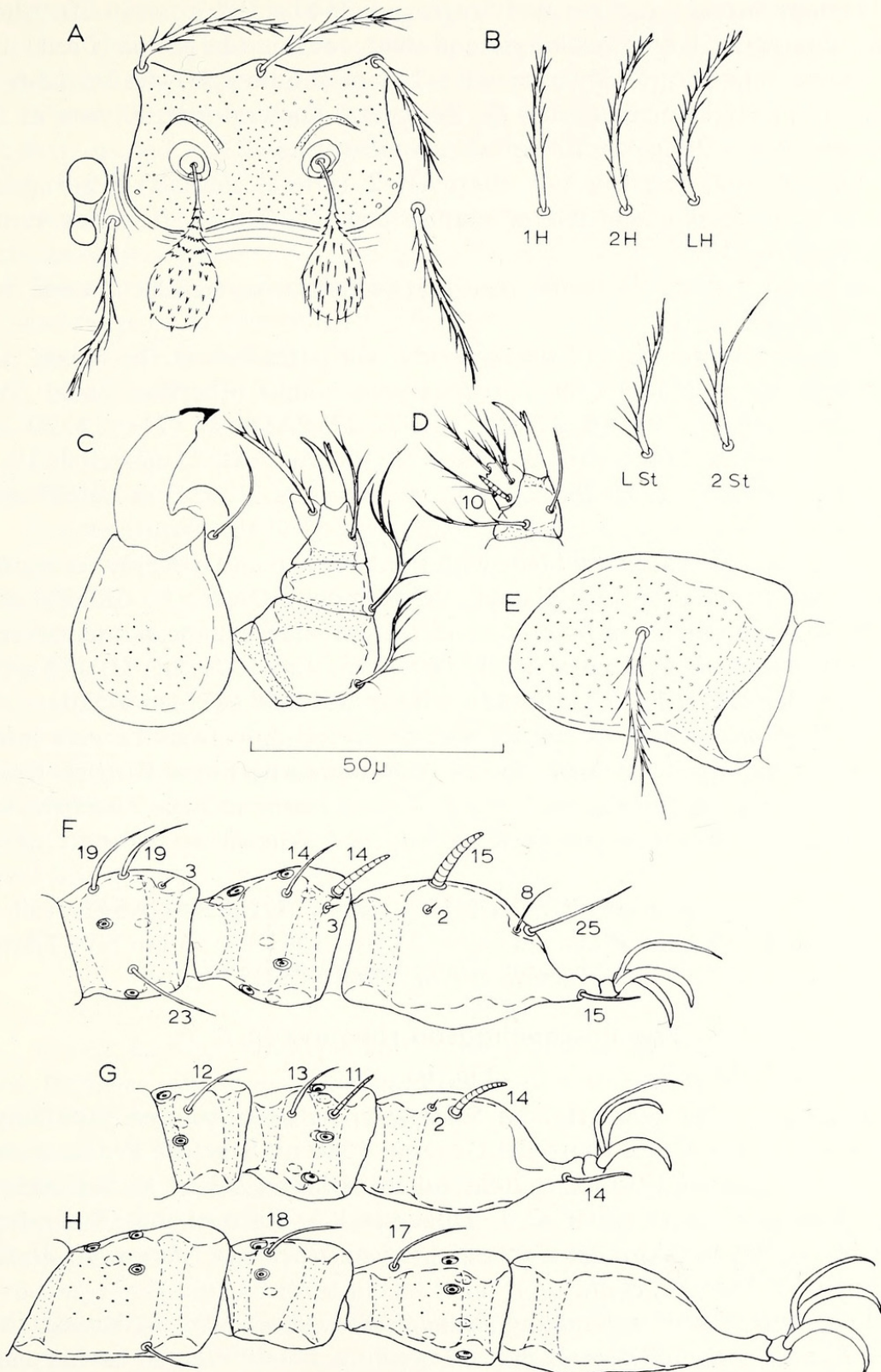


Figure 10. *Pseudoschoengastia rheomys* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



*Description of holotype:* Body engorged, 284 by 199, color in life yellow; eyes 2/2, anterior larger, ocular plate present, color in life probably red.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-12-6-12-6-12-6, total 64; dorsal humeral setae 29, 28, lateral humeral seta 30, seta of first posthumeral row 20, posterior dorsal seta measuring 22.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-8-9-8 + 26, total 57; first, second and lateral sternal setae 22, 21, 25, posterior ventral seta measuring 17.

Scutum: rectangular with rear margin concave, sensilla clavate with many barbules.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE, and range of holotype and 20 paratypes, unless otherwise noted: AW, 48 ( $49 \pm 1$ , 46-52, 20); SB, 27 ( $26 \pm 1$ , 22-27); ASB, 22 ( $21 \pm 1$ , 20-24); PSB, 14 ( $12 \pm 1$ , 10-16); SD, 36 ( $34 \pm 1$ , 30-37); AM, 21 ( $23 \pm 1$ , 19-27, 19); AL, 25 ( $24 \pm 1$ , 21-26, 20); PL, 30 ( $31 \pm 1$ , 27-35); S, 29 ( $29 \pm 1$ , 27-32, 11).

Gnathosoma: cheliceral blade with tricuspid cap and a deeply emarginate tooth on dorsomedial surface. Palpal setal formula B/N/NNN. Galeala nude.

Leg measurements of holotype and (in parentheses) mean and extremes of holotype and 19 paratypes: leg I, 180 (175, 156-189); leg II, 133 (139, 123-152); leg III, 161 (167, 156-183); leg index, 474 (477, 440-520).

*Ecological notes:* This species was recovered only from *Liomys salvini* captured in the dry forest formation of the Guanacaste Biotic District. Unlike the similar *Pseudoschoengastia zona*, *P. hoguei* seems to have a narrow host preference. All larvae were taken in July and August at the start of the rainy season.

*Specimens examined:* Total of 137 larvae: GUANACASTE (all off *Liomys salvini*); 3 km S Playa del Coco, 23 July 1963 (5); 5 km NW Tilarán, 28 July 1962 (8); 7.5 km S Liberia, 8 Aug. 1964 (124).

### ***Pseudoschoengastia rheomys* sp. n.**

Fig. 10

*Types:* Larvae, holotype and 55 paratypes: holotype and 9 paratypes from 18 km N San Isidro del General, 1580 m, San José Province, host *Rheomys hartmanni*, field no. 0-2098, taken 14 July 1963 by R. S. Casebeer, H. Coulombe, A. G. Hollister, C. L. Hogue and A. Starrett; and 46 paratypes from 15 km N San Isidro del General, 1495 m, *Rheomys hartmanni*, 21 July 1962 by E. T. Hooper, *et al.*

*Diagnosis:* Larva resembling *Pseudoschoengastia zona* in having short palpal femoral seta, and densely punctate scutum, but differing in having palpal genual and tibial setae branched.

*Description of holotype:* Body partially engorged, 265 by 180, color in life yellow; eyes 2/2, anterior larger, ocular plate present, color in life probably red.



Dorsal setal formula 4 (humeral)-2 (lateral humeral)-4-10-10-8-8-8-6, total 60; dorsal humeral setae 40, 36, lateral humeral seta 37, seta of first posthumeral row 31, posterior dorsal seta measuring 35.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-6-6  $\pm$  14, total 32; first, second and lateral sternal setae 38, 32, 36, posterior ventral seta measuring 21.

Scutum: rectangular with rear margin concave, sensilla clavate with barbules of two types.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE, and range of 21 specimens unless otherwise noted: AW, 49 (47  $\pm$  1, 43-52); SB, 27 (27  $\pm$  1, 24-31, 19); ASB, 24 (24  $\pm$  1, 22-27, 20); PSB, 15 (14  $\pm$  1, 12-17); AM, 34 (36,  $\pm$  2, 29-39, 14); AL, 42 (38  $\pm$  2, 30-44, 16); PL, 41 (42  $\pm$  1, 39-45); S, 33 (33  $\pm$  3, 30-35, 7).

Gnathosoma: cheliceral blade with tricuspid cap and small tooth on dorsomedial surface. Palpal setal formula B/B/BNB. Galeala nude.

Leg measurements of holotype and paratypes, including means, extremes and (in parentheses) the number of specimens: leg I, 259, 246-272 (7); leg II, 209, 199-218 (8); leg III, 265, 256-279 (7); leg index, 728, 701-749 (5).

*Ecological notes:* This chigger is known from the Panamá Highlands Biotic District. The host, a water mouse of the genus *Rheomys*, inhabits small jungle streams and the hind feet are fimbriated and slightly webbed, suggesting that it may spend a good deal of time in the water (Hall and Kelson, 1959). These chiggers were taken from deep within the external auditory meatus of the ears of all six *Rheomys hartmanni* examined. Examination of three *Oryzomys*, three *Peromyscus*, and a *Scotinomys* trapped in the same area failed to reveal this species.

*Specimens examined:* Total of 56 larvae of type series.

### ***Pseudoschoengastia hooperi* sp. n.**

Fig. 11

*Types:* Larvae, holotype and 9 paratypes from Río Poasito, Volcán Poás Highway, 2000 m, Alajuela Province, host *Rheomys underwoodi*, 7 April 1966 from field numbers JHB 447 and 448 and 0-3751, taken by J. H. Brown and A. Starrett.

*Diagnosis:* Larva resembling *Pseudoschoengastia zona* and *P. rheomys* in having a short palpal femoral seta, and similar densely punctate scutum, but differing from *P. zona* in having palpal genual seta branched and from *P. rheomys* in having all three palpal tibial setae nude.

*Description of holotype:* Body partially engorged, 180 by 265; color in preservative yellow; eyes 2/2, anterior larger, ocular plate present, color probably red.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-8-8-9-8-8-14-14+66, total 143; dorsal humeral setae 55, 49, lateral humeral seta 45, seta of first posthumeral row 31, posterior dorsal seta measuring 47.



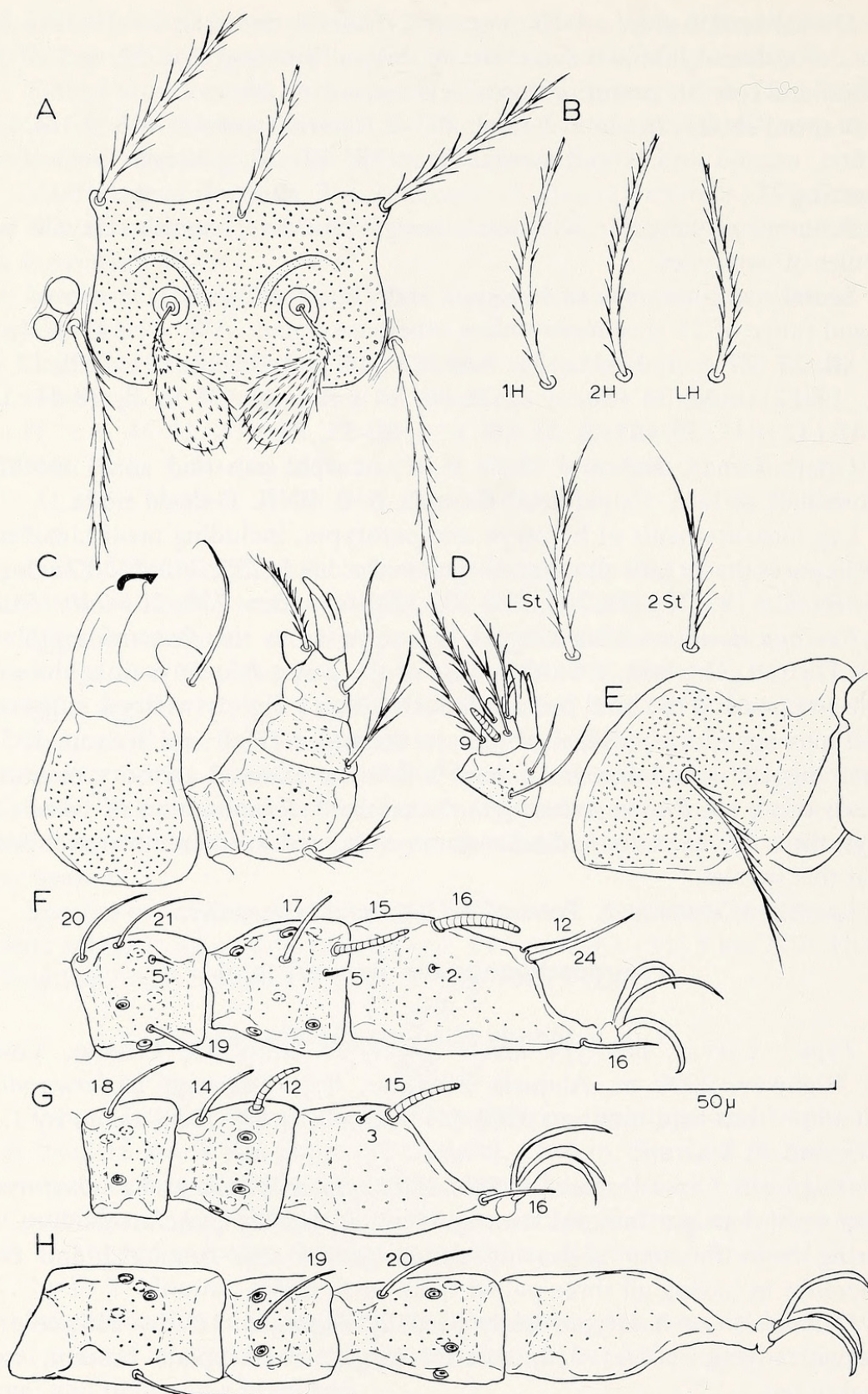


Figure 11. *Pseudoschoengastia hooperi* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



Ventral setal formula 2-2 (sternals)-2 (laterals sternals)-10-10-6+4, total 30; first, second and lateral sternal setae 43, 32, 38, posterior ventral seta measuring 25.

Scutum: rectangular with rear margin slightly concave, sensilla clavate with barbules of two types.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE, and range of 10 in type series unless otherwise noted: AW, 56 ( $56 \pm 2$ , 52-61); SB, 25 ( $27 \pm 2$ , 23-29); ASB, 27 ( $27 \pm 1$ , 26-30); PSB, 16 ( $16 \pm 1$ , 15-17); AM, 45 ( $45 \pm 1$ , 44-46, 3); AL 49 ( $47 \pm 2$ , 44-49, 6); PL, 57 ( $54 \pm 2$ , 47-59); S, 36 ( $36 \pm 1$ , 35-37, 7).

Gnathosoma: cheliceral blade with tricuspid cap and small dorsomedial tooth. Palpal setal formula B/B/NNN. Galeala nude.

Leg measurements of holotype and paratopotypes, including mean and extremes, and (in parentheses) the number of specimens: leg I, 237, 246, 237-251, (9); leg II, 204, 203, 199-210 (7); leg III, 251, 268, 251-279 (5); leg index 720, 718, 692-737 (5).

*Remarks:* *Pseudoschoengastia hooperi* resembles and seems to be closely related to *P. rheomys*, also recovered from water mice of the genus *Rheomys*. The species *P. hooperi* is known only from the type locality in the Costa Rica Highlands Biotic District.

*Specimens examined:* Total of 10 larvae of type series.

#### Anomala Group

*Referred species:* *Pseudoschoengastia anomala* (Hoffmann, 1951); *P. brennani* Hoffmann, 1960; *P. diazi* (Hoffmann, 1948); *P. extrinseca* Brennan, 1960; *P. occidentalis* Brennan, 1957; *P. pedregalensis* (Hoffmann, 1951); *P. tricola* (Brennan and Jones, 1961). In COSTA RICA: *P. abditiva* Brennan, 1960.

*Diagnosis:* Species having palpal setae of approximately equal lengths, cheliceral blade with small tricuspid cap and without dorsomedial tooth,  $AL < AM < PL$ , sensilla expanded to subcapitate with setules of one length, eyes 2/2 on a plate, 1-2 pairs of dorsal humerals, 1 pair of lateral humerals, 1-3 pairs of lateral sternal setae (except *P. tricola*); leg segmentation 7-6-6 but with line of articulation usually visible.

*Comments:* This group of species ranges from California (*P. occidentalis*) to Panamá (*P. tricola*). *Pseudoschoengastia tricola* and *P. abditiva* closely resemble each other in most characteristics. *Pseudoschoengastia abditiva* is the only species of this group known from Costa Rica.

#### ***Pseudoschoengastia abditiva* Brennan**

Fig. 12

*Pseudoschoengastia abditiva* Brennan, 1960: 482, type from Cerro Azul, Panamá, host *Oryzomys capito*, 8 Feb. 1956.

*Diagnosis:* Larva similar to *Pseudoschoengastia zona* in having a palpal



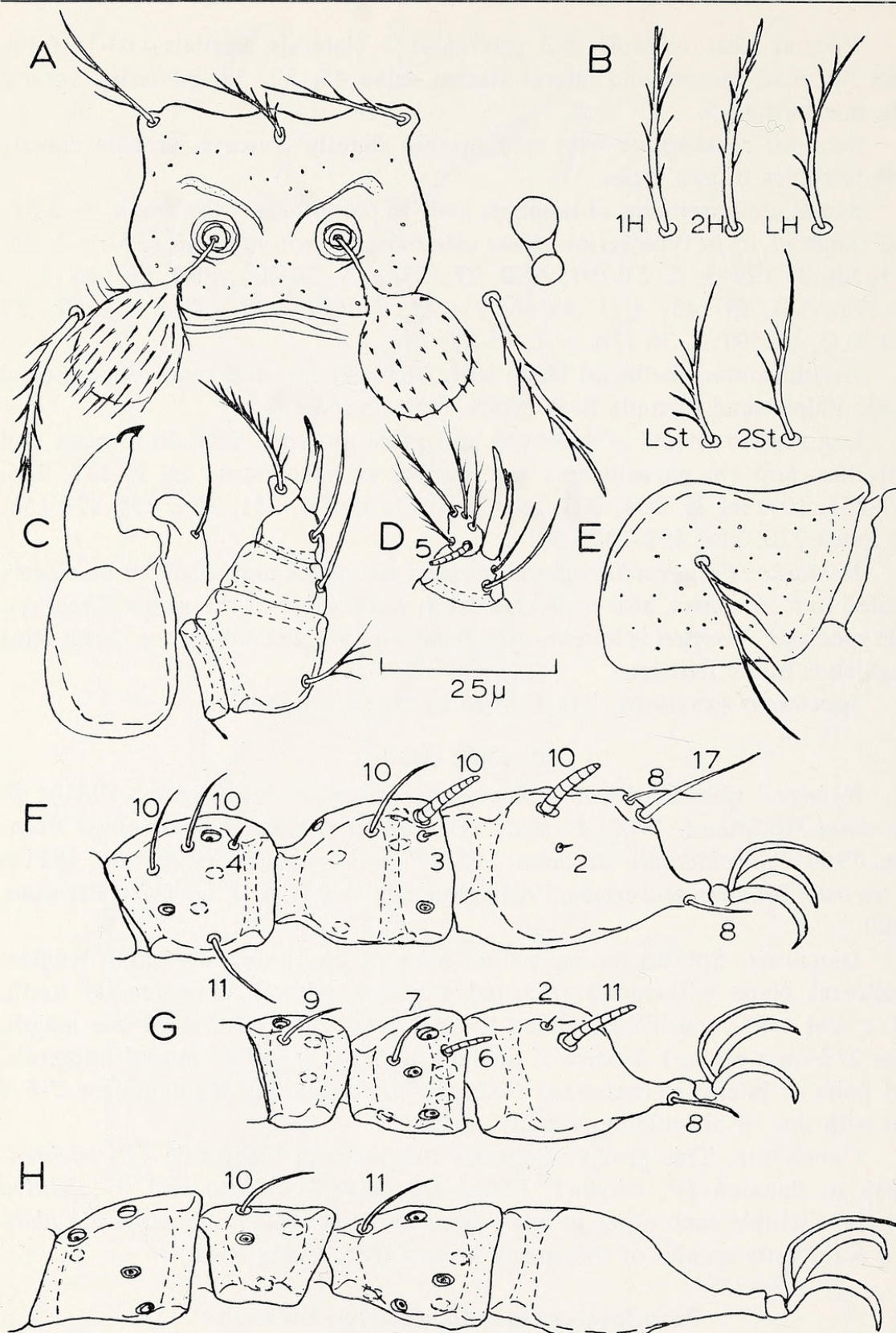


Figure 12. *Pseudoschoengastia abditiva* Brennan. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



setal formula of B/N/NNN, but differing from it in having narrow SB, 13-18 (21-30 in *P. zona*), and lacking dorsomedial tooth on cheliceral blade.

*Description* (paratype and 14 larvae from Costa Rica): Body partially engorged, 180 by 256, color in life probably yellow; eyes 2/2, anterior larger, color in life probably red, ocular plate present.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-6-10-10-10-8-4-2 + 12, total 68; dorsal humeral setae 29, 27, lateral humeral seta 26, seta of first posthumeral row 21, posterior dorsal seta measuring 24.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-8-4-4-4-2-2, total 30; first, second and lateral sternal setae 31, 25, 21 and posterior ventral seta measuring 16.

Scutum: roughly square with rear margin concave, sensilla capitate with two types of setules.

Scutal measurements of one paratype from Panamá and (in parentheses) the mean,  $\pm$  2 SE and range of 14 specimens, unless otherwise noted: AW, 33 ( $31 \pm 1$ , 29-34); SB, 18 ( $15 \pm 1$ , 13-17); ASB, 19 ( $19 \pm 1$ , 17-21); PSB, 17 ( $11 \pm 1$ , 9-12); SD, 36 ( $29 \pm 1$ , 27-32); AM, 24, ( $20 \pm 1$ , 19-24, 12); AL, 22 ( $22 \pm 1$ , 19-23); PL, 32, ( $31 \pm 1$ , 29-33); S, 27 ( $28 \pm 1$ , 26-29, 7).

Gnathosoma: cheliceral blade with tricuspid cap; cheliceral base and capitular sternum sparsely punctate. Palpal setal formula B/N/NNN; palpotibial claw with 3 prongs deeply cleft. Galeala nude.

Leg measurements of paratype and (in parentheses) means and extremes of 14 specimens from Costa Rica: leg I, 170 (163, 156-170); leg II, 147 (133, 128-139); leg III, 170 (159, 149-168); leg index, 487 (453, 436-477).

*Specimens examined*: Total of 16 larvae; PUNTARENAS: 15 km E Potrero Grande, finca "Los Helechales," 1040 m, 2 Oct. 1964, *Oryzomys alfaroi* (5), *Oryzomys bombycinus* (10). PANAMA: Cerro Azul, 8 Feb. 1956, *Oryzomys capito* (= *O. talamancae*) (paratype, RML 35338).

### Aeci Group

*Referred species*: *Pseudoschoengastia aeci* Brennan, 1965, and *P. myoproctae* Fauran, 1960. In COSTA RICA: *P. finitima* Brennan and Yunker, 1966.

*Diagnosis*: Species having cheliceral blade with large elongate tricuspid cap and without dorsomedial tooth;  $AL < AM < PL$ ; scutum only moderately punctate (densely punctate in other groups); eyes 2/2 on a plate, or absent.

### ***Pseudoschoengastia finitima* Brennan and Yunker**

Fig. 13

*Pseudoschoengastia finitima* Brennan and Yunker, 1966: 246, type from Piña, Canal Zone, Panamá, host *Heteromys desmarestianus*, 7 Dec. 1960.

*Diagnosis*: Larva similar to *Pseudoschoengastia hypopsia*, *P. myoproctae* and *P. aeci* in having 2 genualae I, but differing from *P. hypopsia* and *P. myo-*



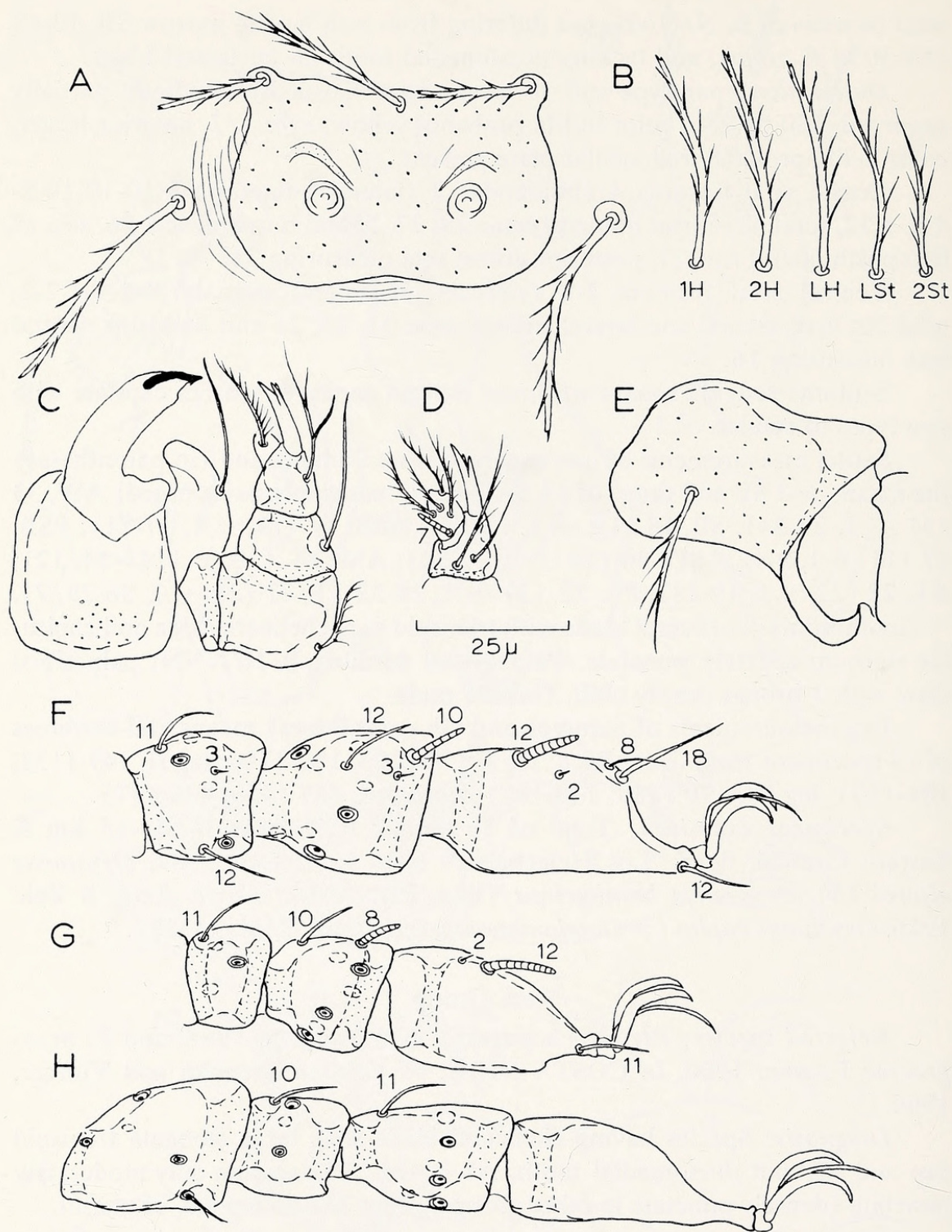


Figure 13. *Pseudoschoengastia finitima* Brennan and Yunker. A. Scutum. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



*proctae* in having genualae II and III, and from *P. aeci* by lacking eyes (eyes 2/2 on a plate in *P. aeci*).

*Description*: (2 paratypes from Panamá and 6 larvae from Costa Rica). Body partially engorged, 189 by 360, color in life probably yellow; no eyes.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-6-8-10-2 + 30, total 62; dorsal humeral setae 34, 33, lateral humeral seta 32, seta of first posthumeral row 25, posterior dorsal seta measuring 27.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-10-8-8-4-2-2, total 40; first, second and lateral sternal setae 27, 24, 26, posterior ventral seta measuring 24.

Scutum: rectangular with rear margin concave.

Scutal measurements of holotype (Brennan and Yunker, 1966), 2 paratypes and (in parentheses) the mean,  $\pm$  2 SE and range of 6 specimens from Costa Rica: AW, 47, 45, 45 ( $42 \pm 1$ , 40-43); SB, 25, 27, 27 ( $22 \pm 1$ , 20-23); ASB, 21, 21, 23 ( $21 \pm 1$ , 19-22); PSB, 10, 12, 12 ( $13 \pm 1$ , 12-15); SD, 31, 33, 35 ( $34 \pm 2$ , 31-37); AM, 33, 33, 33 ( $32 \pm 1$ , 31-33, 4); AL, 24, 25, 27 ( $19 \pm 1$ , 18-20); PL, 42, 43, 43 ( $38 \pm 1$ , 37-40). Sensilla unknown.

Gnathosoma: cheliceral blade with a tricuspid cap and long ventromedial projection. Cheliceral base and capitular sternum sparsely punctate. Palpal setal formula B/N/BNB. Galeala nude.

Leg measurements of 2 paratypes and the means and extremes of 6 specimens from Costa Rica (in parentheses): leg I, 208, 213, (185, 170-204); leg II, 180, 183 (158, 150-170); leg III, 203, 199 (172, 161-184); leg index, 591, 595, (513, 481-543).

*Specimens examined*: Total of 8 larvae: HEREDIA: 2.9 km S Puerto Viejo de Serapiquí, 89 m, 17 Aug. 1964, *Heteromys desmarestianus* (6); PANAMA, Canal Zone, Piña, 7 Dec. 1960, *Heteromys desmarestianus* (RML 40112, 2 paratypes).

Subgenus **Walchioides** Vercammen-Grandjean, 1960

*Type species*: *Walchia gouldi* Hoffmann, 1954.

*Referred species*: Ten species: *Pseudoschoengastia gouldi* (Hoffmann), *P. hoffmannae* Brennan, 1960; *P. intrinseca* Brennan, 1960; *P. inevicta* Brennan, 1960; *P. whartoni* Brennan, 1960; *P. apista* Brennan and Yunker, 1966; and *P. mermeriza* Brennan and Yunker, 1966. In COSTA RICA: *P. guana-castensis* sp. n.; *P. costaricensis* sp. n.; and *P. verdensis* sp. n.

*Diagnosis*: Larva with posterolateral setae on scutum;  $AM > AL < PL$ ; sensilla clavate to subcapitate, all setules prominent; cheliceral blade without dorsomedial tooth; eyes 2/2 on a plate; leg segmentation 7-6-6 but with line of articulation usually visible; 1 or 2 genualae I, genualae II and III present or absent, tibiala III present.

*Taxonomic remarks*: Originally *Walchioides* was proposed by Vercammen-Grandjean (1960) as a subgenus of *Susa*, a genus of southeast Asia, to which it does not belong. Although the type species, *Walchia gouldi* Hoff-



mann, from Chiapas, México, lacks the AM scutal seta, it resembles the other species of *Walchioides* in virtually all of the other characteristics.

*Comments:* This subgenus is represented in Costa Rica by three new species, two from the Guanacaste Biotic District and one from the adjacent Costa Rica Highlands Biotic District.

***Pseudoschoengastia guanacastensis* sp. n.**

Fig. 14

*Types:* Larvae, holotype and 12 paratypes: holotype and 2 paratopotypes from 8.3 km N Liberia, 144 m, Guanacaste Province, host *Liomys salvini*, field no. 0-3226, collected 3 Aug. 1964 by C. L. Hogue, R. C. Stephens and J. C. Geest; 2 paratopotypes from *Liomys salvini* (0-3228), 3 Aug. 1964; 3 paratypes from 7.3 km N Liberia, *Ototylomys phyllotis* (0-3220), 2 Aug. 1964; 2 paratypes from 5 km N Liberia, *Ototylomys phyllotis* (0-3232), 4 Aug. 1964; and 3 paratypes from 7.5 km S Liberia, 8 Aug. 1964, *Liomys salvini* (0-3291, 0-3294, 0-3295).

*Diagnosis:* Larva similar to *Pseudoschoengastia inevitica* in having 2 genualae I and genualae II and III, but differing from it in having narrower SB (13-18) and fewer (25) posterior ventral body setae (50 in *P. inevitica*).

*Description of holotype:* Body partially engorged, 143 by 218, color in life yellow; eyes 2/2, anterior larger, ocular plate present, color in life probably red.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-6-8-10-12-12-12 + 6, total 72; dorsal humeral setae 27, 25, lateral humeral seta 26, posterior dorsal seta measuring 19.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal) 19-8-8, total 31; first, second and lateral sternal setae 22, 21, 24, posterior ventral seta measuring 13.

Scutum: elongate rectangular with sinuous posterior margin (medial portion concave), twice as wide as broad. Sensilla subcapitate.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE and range of 11 specimens unless otherwise noted: AW, 37 (38  $\pm$  1, 36-40); PW, 48, (51  $\pm$  1, 47-54); SB, 15 (16  $\pm$  1, 13-18); ASB, 19 (18  $\pm$  1, 17-21); PSB, 9 (9  $\pm$  0.5, 8-10); AP, 22 (22  $\pm$  1, 20-24); AM, 26 (26  $\pm$  1, 24-28, 6); AL 16 (16  $\pm$  1, 15-17); PL, 27 (26  $\pm$  1, 24-27); S, 27 (1).

Gnathosoma: cheliceral blade with tricuspid cap; cheliceral base and capitular sternum punctate. Galeala nude or with one branch. Palpal setal formula B/B/BNB.

Legs (specialized setae): leg 1 with 2 genualae; genualae II and III present.

Leg measurements of holotype and (in parentheses) the means and extremes of holotype and 10 paratypes: leg I, 180 (178, 166-189); leg II, 148 (141, 133-148); leg III, 171 (167, 159-175); leg index, 499 (482, 463-502).



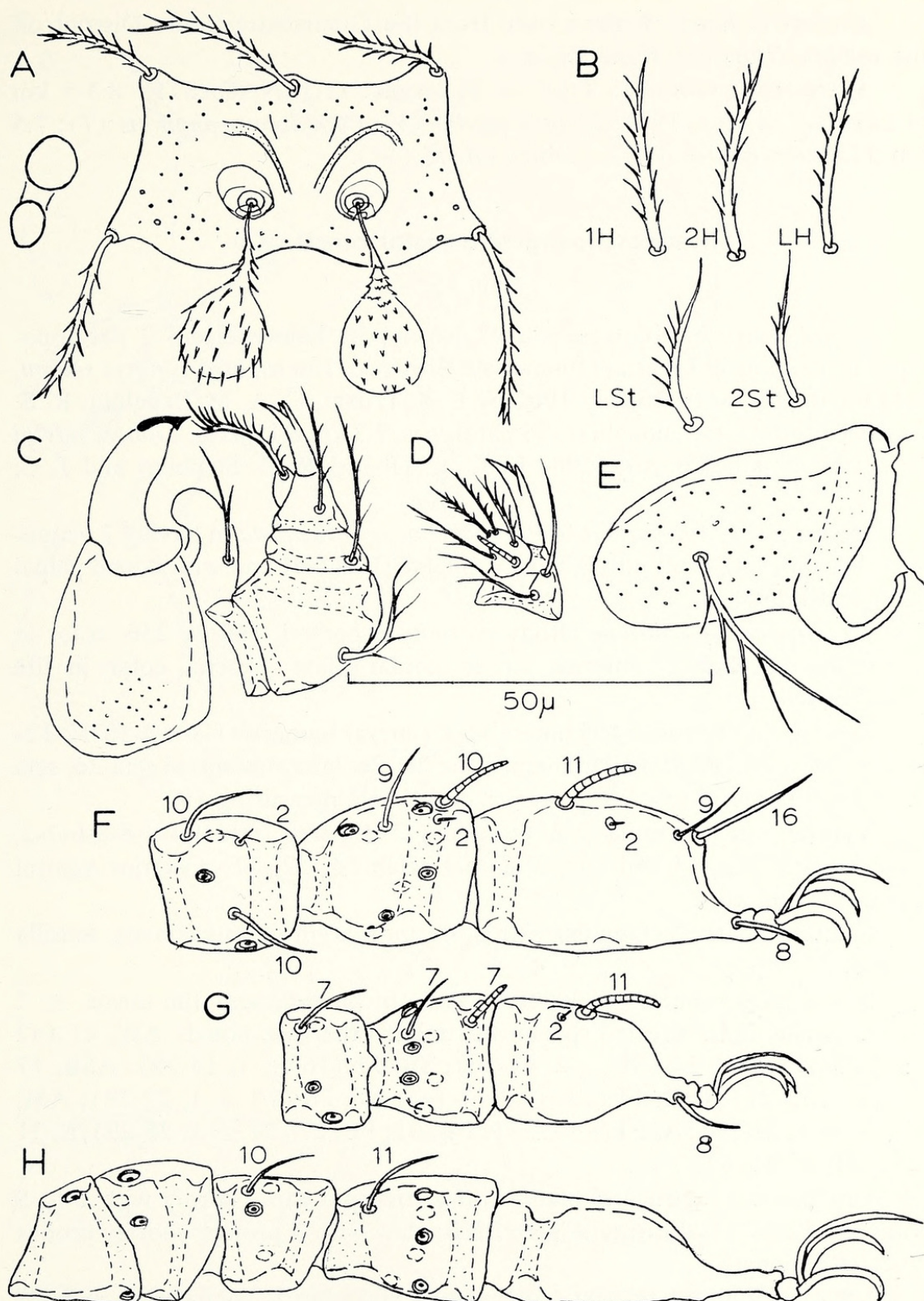


Figure 14. *Pseudoschoengastia guanacastensis* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



*Ecological notes:* Known only from the Guanacaste Biotic District off the rodents *Ototylomys* and *Liomys*.

*Specimens examined:* Total of 26 larvae: GUANACASTE: 8.3-5 km N Liberia, 3-4 Aug. 1964, *Liomys salvini* (5), *Ototylomys phyllotis* (7); 7.5 km S Liberia, 8 Aug. 1964, *Liomys salvini* (14).

***Pseudoschoengastia costaricensis* sp. n.**

Fig. 15

*Types:* Larvae, holotype and 43 paratypes: holotype and 7 paratopotypes from 2 km W Liberia, Guanacaste Province, 144 m, host *Liomys salvini*, field no. 0-415, taken 26 July 1962 by F. S. Truxal, C. A. McLaughlin, R. S. Casebeer and A. A. Schoenherr; 25 paratypes, 7.3 km S Liberia, *Liomys salvini* (0-3292), obtained 8 Aug. 1964 by C. L. Hogue, R. C. Stephens and J. C. Geest.

*Diagnosis:* Larva similar to *Pseudoschoengastia apista* in having 2 genualae I, but differing from it in lacking genualae II and III and with dorsal palpal tibial seta branched.

*Description of holotype:* Body partially engorged, 160 by 256, color in life yellow; eyes 2/2, anterior larger, ocular plate present, color in life probably red.

Dorsal setal formula 4 (humeral)-2 (lateral humeral)-8-8-4-10-12-12-10-8 + 24, total 102; dorsal humeral setae 26, 26, lateral humeral seta 26, seta of first posthumeral row 20, posterior dorsal seta measuring 19.

Ventral setal formula 2-2 (sternal)-2 (lateral sternal)-4-8-8-6-2-2, total 30; first, second and lateral sternal setae 24, 22, 27, posterior ventral seta measuring 16.

Scutum: nearly rectangular with posterior margin slightly convex, sensilla clavate.

Scutal measurements of holotype and (in parentheses) the mean,  $\pm$  2 SE and range of 10 selected specimens, unless otherwise noted: AW, 41 ( $42 \pm 1$ , 37-45); PW, 54 ( $51 \pm 2$ , 47-56); SB, 17 ( $16 \pm 1$ , 14-19); ASB, 17 ( $19 \pm 1$ , 17-21); PSB, 14 ( $13 \pm 1$ , 11-14); AP, 26 ( $25 \pm 1$ , 22-28); AM, 27 ( $25 \pm 1$ , 22-27); AL, 17 ( $17 \pm 1$ , 14-20); PL, 27 ( $27 \pm 1$ , 25-29); S, 31 ( $29 \pm 1$ , 26-31, 6).

Gnathosoma: cheliceral blade with a tricuspid cap. Galeala with 1 to 5 branches. Palpal setal formula B/B/BNB; claw with 3 prongs, shorter prongs subequal in length.

Legs (specialized setae): leg I with 2 genualae I; genualae II and III absent.

Leg measurements of holotype, means and (in parentheses) extremes of holotype and 12 paratypes: leg I, 187, 183 (166-212); leg II, 139, 146 (128-174); leg III, 167, 171 (161-189); leg index, 493, 509 (466-575).



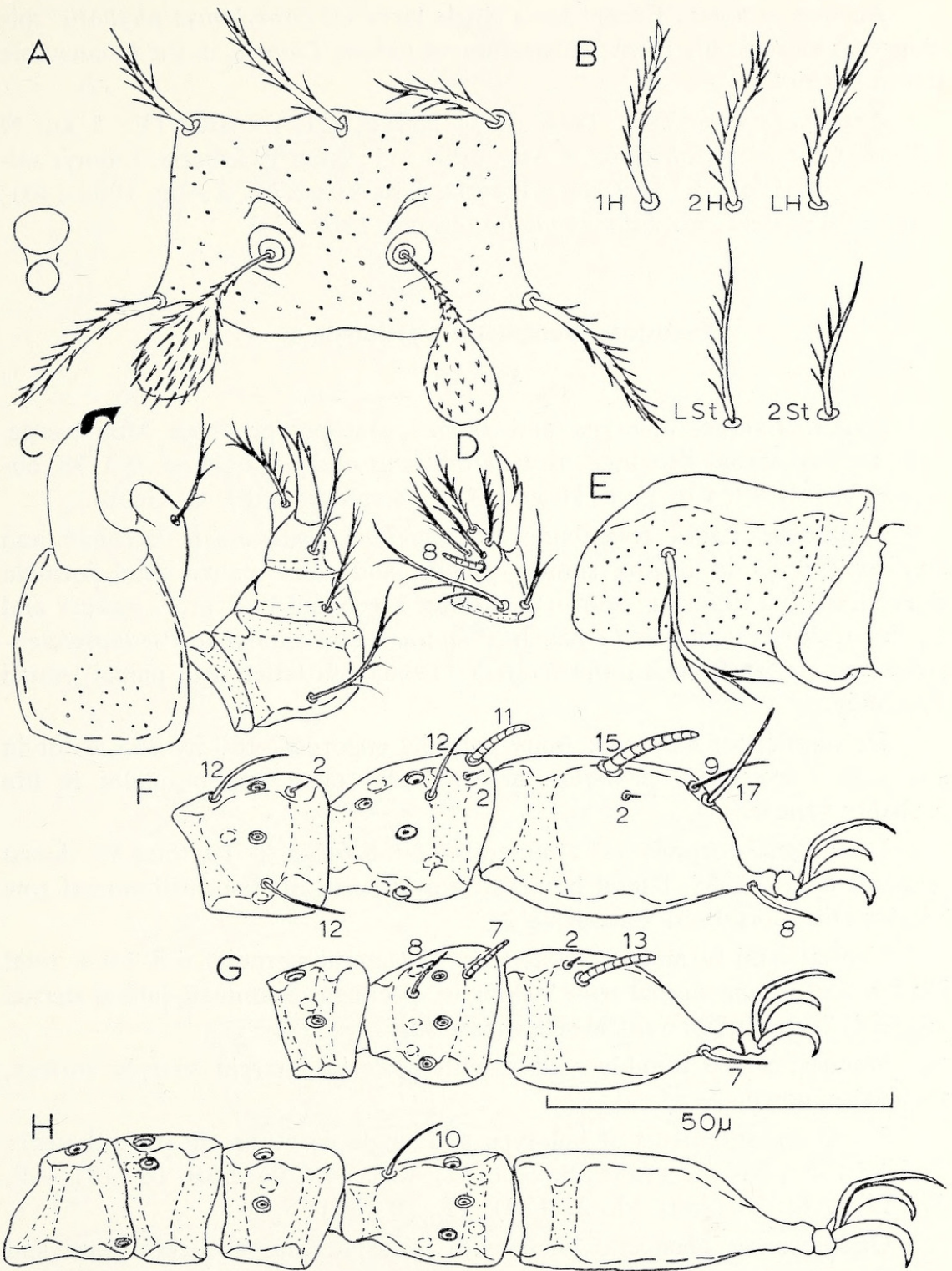


Figure 15. *Pseudoschoengastia costaricensis* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



*Ecological notes:* Except for a single larva off *Ototylomys phyllotis*, this chigger is known only from the heteromyid rodent, *Liomys*, in the Guanacaste Biotic District.

*Specimens examined:* Total of 51 larvae: GUANACASTE: 5 km N Liberia, *Ototylomys phyllotis*, 4 Aug. 1964 (1); 2 km W Liberia, *Liomys salvini*, 26 July 1962 (8); 7.3 km S Liberia, *Liomys salvini*, 8 Aug. 1964 (40); 3 km S Playa del Coco, *Liomys salvini*, 23 July 1962 (2).

***Pseudoschoengastia verdensis* sp. n.**

Fig. 16

*Types:* Larvae, holotype and single paratopotype from Monteverde, 1380 m, Puntarenas Province, host *Peromyscus nudipes*, field no. 0-3178, obtained 24 July 1964 by C. L. Hogue, R. C. Stephens and J. C. Geest.

*Diagnosis:* Larva resembling *Pseudoschoengastia apista* Brennan and Yunker (1966) in having similar scutum and same palpal setal formula B/B/NNB, but differing from it in having 1 genuala I (2 in *P. apista*) and 2 pairs of dorsal humerals (1 pair in *P. apista*); also similar to *Pseudoschoengastia mermeriza* Brennan and Yunker (1966) but latter with palpal genual seta nude.

*Description of holotype:* Body partially engorged, 180 by 265, color in life yellow; eyes 2/2, posterior larger, ocular plate present, color in life probably yellow.

Dorsal setal formula 3-3 (humeral)-4-6-6-6-6-6  $\pm$  10, total 50; dorsal humeral setae 40, 38, lateral humeral seta 26, seta of first posthumeral row 28, posterior dorsal seta measuring 24.

Ventral setal formula 2-2 (sternals)-2 (lateral sternals)-6-8-2-4-4, total 28; first and second sternal setae lacking in specimens examined, lateral sternal setae 28, 26, posterior ventral seta measuring 14.

Scutum: shape roughly square with posterior margin sharply convex, sensilla unknown.

Scutal measurements of holotype and single paratype (in parentheses): AW, 38 (38); PW, 52 (54); SB, 20 (18); ASB, 24 (20); PSB, 16 (18); AP, 25 (25); AM, 28 (29); AL, 22 (20); PL, 29 (33); S, —.

Gnathosoma: cheliceral blade with tricuspid cap; cheliceral base and capitular sternum punctate. Galeala nude. Palpal setal formula B/B/NNB.

Legs (specialized setae as follows): leg I with 1 genuala; genualae II and III absent.

Leg measurements of holotype and single paratype: leg I, 180, 180; leg II, 151, 153; leg III, 175, 173; leg index 506, 506.

*Specimens examined:* Total of 2 larvae of type series.



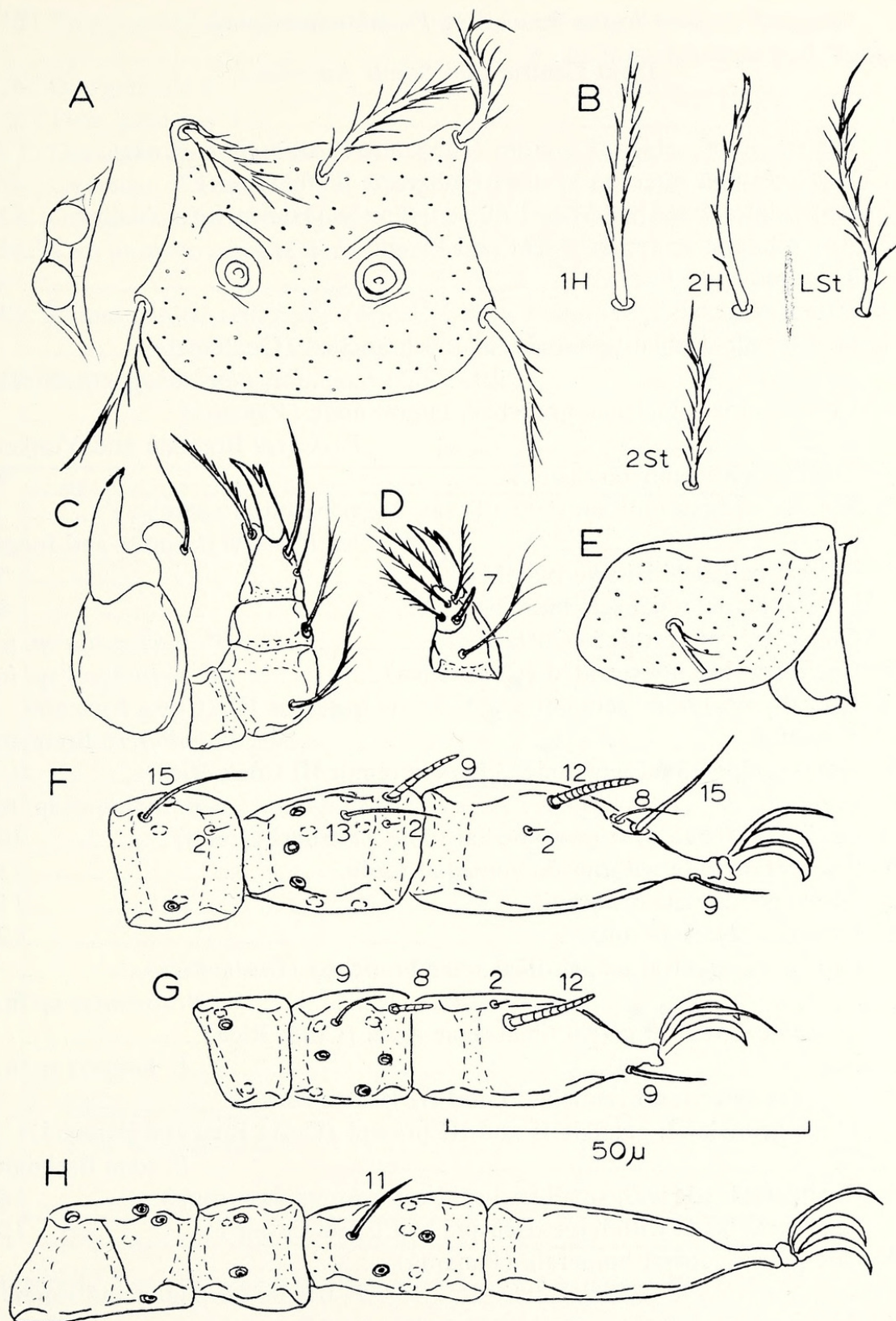


Figure 16. *Pseudoschoengastia verdensis* sp. n. A. Scutum and eyes. B. Representative body setae. C. Dorsal aspect of gnathosoma. D. Ventral aspect of palpal tibia and tarsus. E. Coxa III. F. Leg I; genu, tibia and tarsus with nude setae and bases of branched setae on genu and tibia. G. Leg II. H. Leg III; fused femur with internal bars.



Key to the Species of *Pseudoschoengastia*

from Central and South America.

1. Posterolateral setae off scutum (subgenus *Pseudoschoengastia*)..... 2
- 1.<sup>1</sup> Posterolateral setae on scutum (subgenus *Walchioides*).....16
2. Anterolateral seta > AM and PL scutal setae (Hungerfordi Group)..... 3
- 2.<sup>1</sup> Anterolateral seta = or < AM and PL scutal setae..... 9
3. Two genualae I..... 4
- 3.<sup>1</sup> Three genualae I..... 5
- 4.<sup>1</sup> Dorsal palpal tibial seta nude, lateral branched (Guatemala).....  
.....*P. guatemalensis* Brennan
- 4.<sup>1</sup> Dorsal palpal tibial seta branched, lateral nude (Panamá).....  
.....*P. dasypi* Brennan and Yunker
5. Sensilla with bulb on stem..... 6
- 5.<sup>1</sup> Sensilla without bulb on stem (Texas, Mexico and Guatemala).....  
.....*P. audyi* Brennan and Jones
6. Lateral palpal tibial seta nude..... 7
- 6.<sup>1</sup> Lateral palpal tibial seta branched..... 8
7. Cheliceral cap serrated (Costa Rica).....*P. intermedia* sp. n.
- 7.<sup>1</sup> Cheliceral cap not serrated (Costa Rica).....*P. peromysci* sp. n.
8. Dorsal palpal tibial seta branched, 2 bars in femur III (Costa Rica and Panamá).....*P. bulbifera* Brennan
- 8.<sup>1</sup> Dorsal palpal tibial seta nude, 3 bars in femur III Costa Rica).....  
.....*P. montana* sp. n.
9. Cheliceral blade with dorsomedial tooth (Farneri Group).....10
- 9.<sup>1</sup> Cheliceral blade without dorsomedial tooth.....13
10. Palpal genual seta branched.....11
- 10.<sup>1</sup> Palpal genual seta nude.....12
11. Dorsal and ventral palpal tibial setae branched (Costa Rica).....  
.....*P. rheomys* sp. n.
- 11.<sup>1</sup> Dorsal and ventral palpal tibial setae nude (Costa Rica).....  
.....*P. hooperi* sp. n.
12. Two genualae I, no genualae II and III (Costa Rica).....
- 12.<sup>1</sup> Three genualae I, genuala II and III present (Costa Rica and Panamá).....  
.....*P. zona* Brennan
13. Cheliceral blade with small tricuspid cap (Anomala Group).....14
- 13.<sup>1</sup> Cheliceral blade with large tricuspid cap (Aeci Group).....15
14. One pair of dorsal humerals (Panamá).....  
.....*P. tricola* (Brennan and Jones)
- 14.<sup>1</sup> Two pairs of dorsal humerals (Costa Rica and Panamá).....  
.....*P. abditiva* Brennan
15. One pair of dorsal humerals, eyes present (French Guiana).....  
.....*P. myoproctae* Fauran



- 15.<sup>1</sup> Two pairs of dorsal humerals, eyes absent (Costa Rica and Panamá)....  
.....*P. finitima* Brennan and Yunker
16. One genuala I.....19
- 16.<sup>1</sup> Two genualae I.....17
17. Genualae II and III present.....18
- 17.<sup>1</sup> Genualae II and III about (Costa Rica).....*P. costaricensis* sp. n.
18. One pair of dorsal humerals (Panamá).....*P. apista* Brennan and Yunker
- 18.<sup>1</sup> Two or more pairs of dorsal humerals (Costa Rica).....  
.....*P. guanacastensis* sp. n.
19. Palpal genual seta nude (Panamá, Canal Zone).....  
.....*P. mermeriza* Brennan and Yunker
- 19.<sup>1</sup> Palpal genual seta branched (Costa Rica).....*P. verdensis* sp. n.

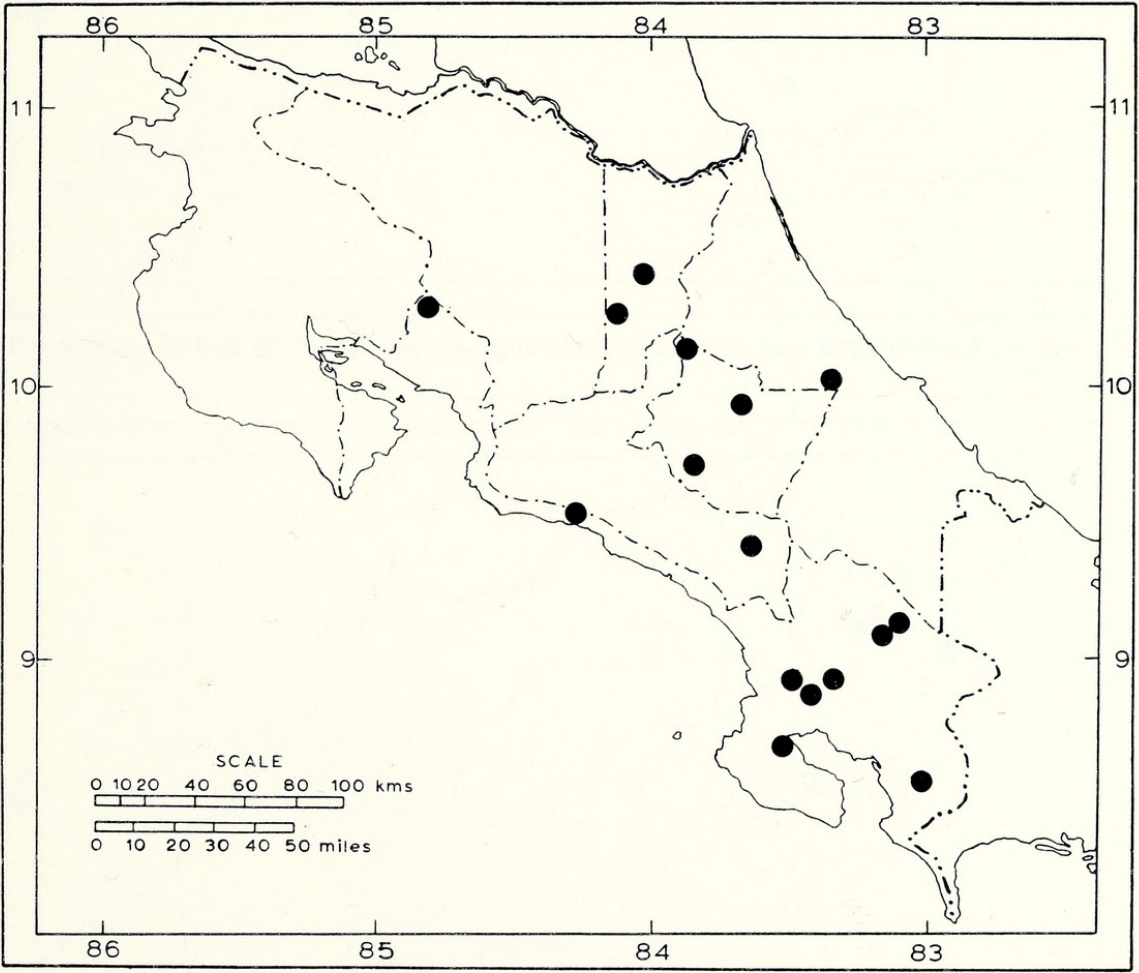


Figure 17. Locality records for *Pseudoschoengastia bulbifera*, ●.



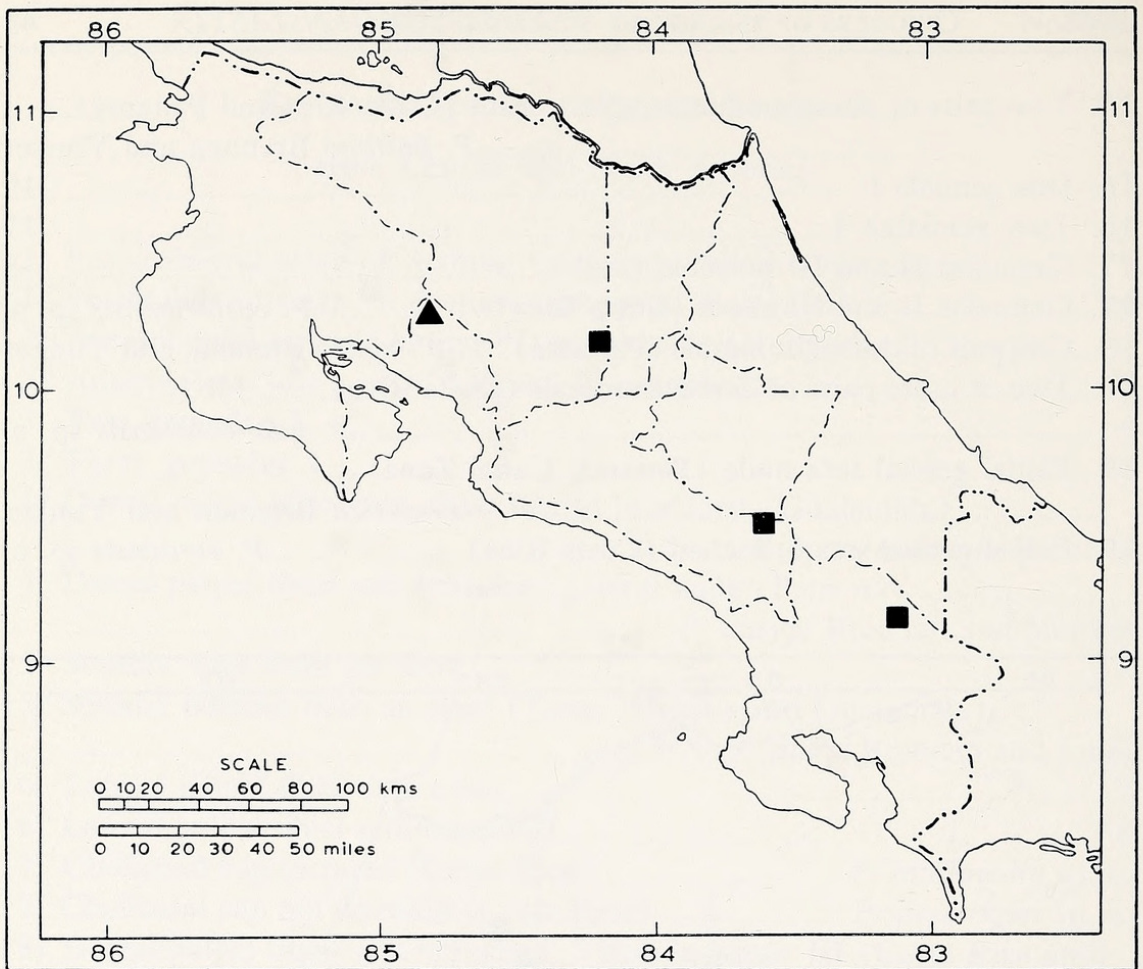


Figure 18. Locality records for *Pseudoschoengastia montana*, ■ and *P. peromysci*, ▲.

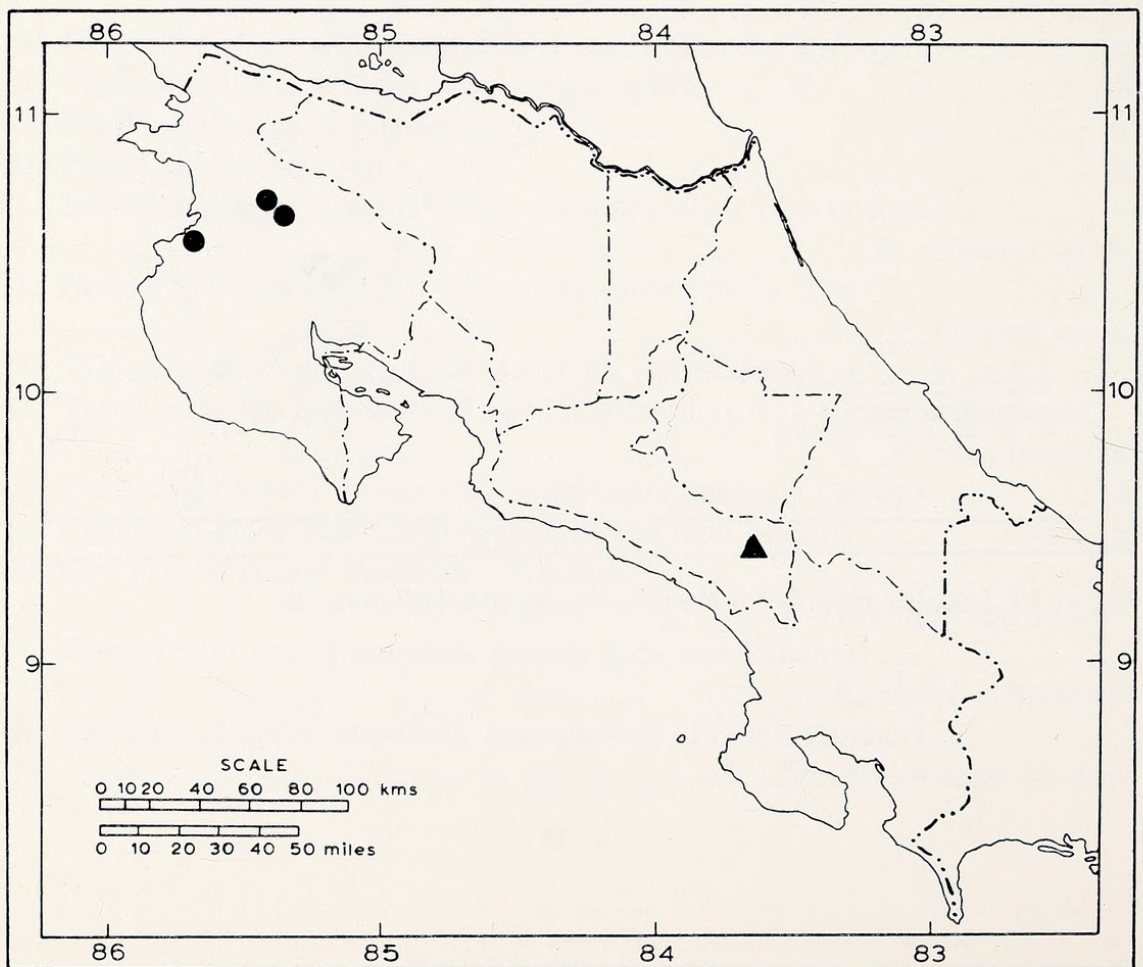


Figure 19. Locality records for *Pseudoschoengastia costaricensis*, ● and *P. intermedia*, ▲.



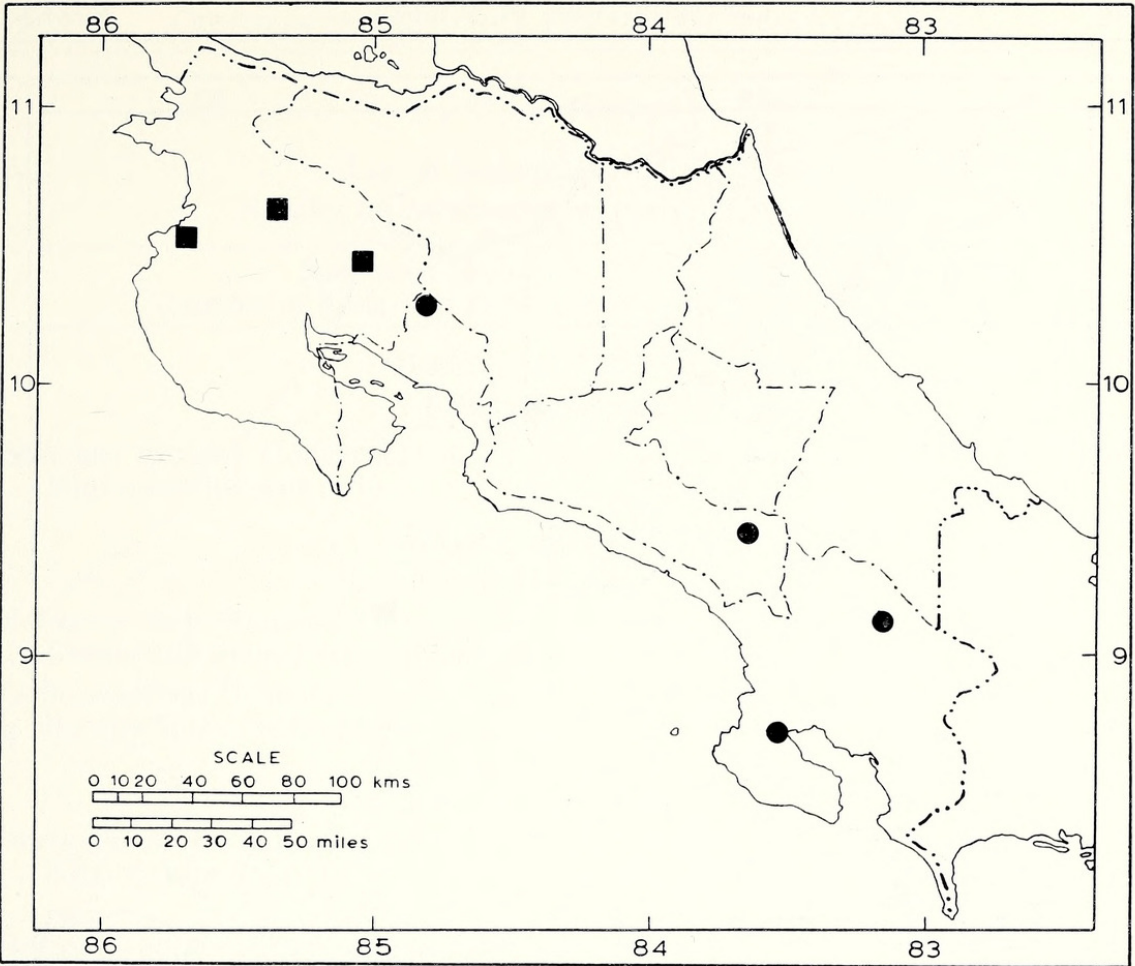


Figure 20. Locality records for *Pseudoschoengastia hoguei*, ■ and *P. zona*, ●.

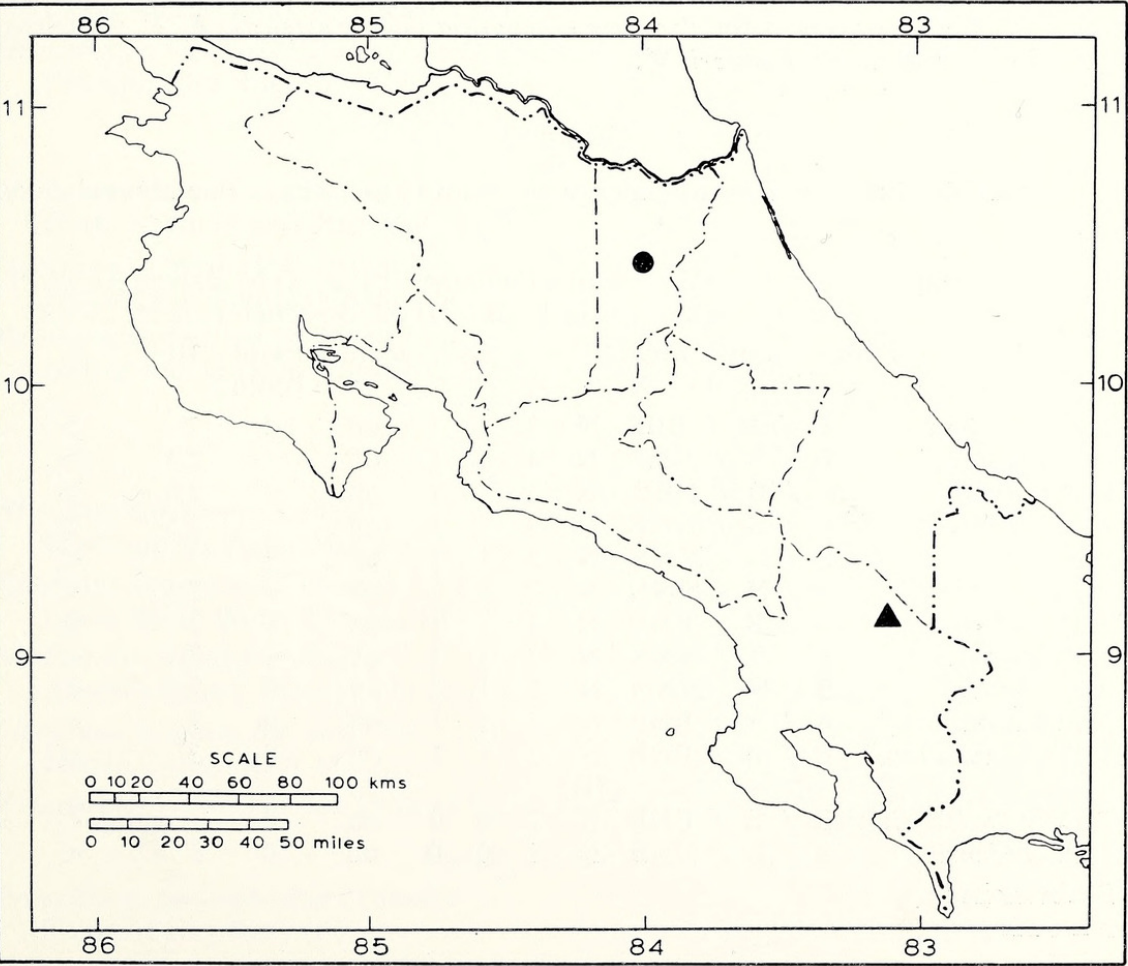


Figure 21. Locality records for *Pseudoschoengastia finitima*, ● and *P. abditiva*, ▲.



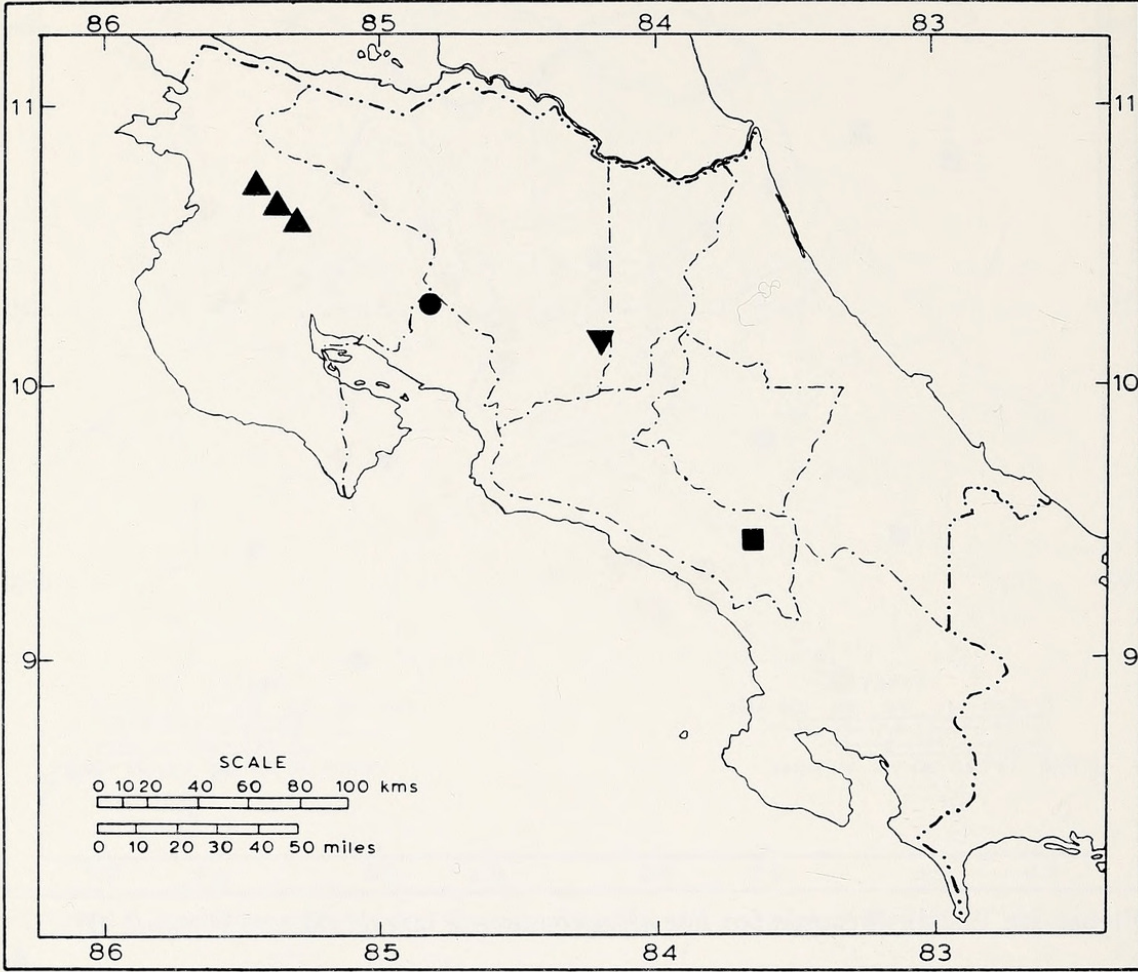


Figure 22. Locality records for *Pseudoschoengastia guanacastensis*, ▲, *P. verdensis*, ●, *P. rheomys*, ■ and *P. hooperi*, ▼.

TABLE 2

Larval characters of *Pseudoschoengastia* from Costa Rica. (For abbreviations see text.)

| <i>Pseudoschoengastia</i>    | Palpal tarsal<br>setal formula     | Gal-<br>eala I | Genu-<br>II | Genu-<br>III | PL's<br>off/on | D-M<br>Chel- | Bars in<br>Femur | AL vs PL<br>>=< |
|------------------------------|------------------------------------|----------------|-------------|--------------|----------------|--------------|------------------|-----------------|
|                              | femur / genu / tibia<br>*<br>D-L-V |                |             |              | scutum         | iceral       | III<br>Tooth     |                 |
| 1. <i>P. bulbifera</i>       | B / B / BBB                        | N              | 3           | 1 / 1        | off            | +            | 2                | >               |
| 2. <i>P. intermedia</i>      | B / B / NNB                        | N              | 3           | 1 / 1        | off            | +            | 2.5              | >               |
| 3. <i>P. montana</i>         | B / B / NBB                        | N              | 3           | 1 / 1        | off            | +            | 2.5              | >               |
| 4. <i>P. peromysci</i>       | B / B / NNB                        | N              | 3           | 1 / 1        | off            | +            | 2.5              | >               |
| 5. <i>P. zona</i>            | B / N / NNN                        | N              | 3           | 1 / 1        | off            | +            | 2                | <               |
| 6. <i>P. hoguei</i>          | B / N / NNN                        | N              | 2           | 1 / 1        | off            | +            | 2.5              | <               |
| 7. <i>P. rheomys</i>         | B / B / BNB                        | N              | 3           | 1 / 1        | off            | +            | 2                | =               |
| 8. <i>P. hooperi</i>         | B / B / NNN                        | N              | 3           | 1 / 1        | off            | +            | 2                | <               |
| 9. <i>P. abditiva</i>        | B / N / NNN                        | N              | 3           | 1 / 1        | off            | 0            | 2                | <               |
| 10. <i>P. finitima</i>       | B / N / BNB                        | N              | 2           | 1 / 1        | off            | 0            | 2                | <               |
| 11. <i>P. guanacastensis</i> | B / B / BNB                        | N              | 2           | 1 / 1        | on             | 0            | 3                | <               |
| (1B)                         |                                    |                |             |              |                |              |                  |                 |
| 12. <i>P. costaricensis</i>  | B / B / BNB                        | B              | 2           | 0 / 0        | on             | 0            | 3                | <               |
| 13. <i>P. verdensis</i>      | B / B / NNB                        | N              | 1           | 0 / 0        | on             | 0            | 3                | <               |

\*B=branched  
N=nude



TABLE 3

List of Mammalian Hosts for  
Species of *Pseudoschoengastia* in Costa Rica

| Species of Mammals*<br>(number of hosts with <i>Pseudoschoengastia</i> ) | Chiggers                 |
|--|--------------------------|
| <b>ORDER MARSUPIALA</b>  |                          |
| Family Didelphidae   |                          |
| <i>Philander opossum</i> (Linnaeus) . . . . .                            | <i>P. bulbifera</i>      |
| (Four-eyed Opossum) (1)  | <i>P. zona</i>           |
| <b>ORDER RODENTIA</b>  |                          |
| Family Heteromyidae  |                          |
| <i>Heteromys desmarestianus</i> Gray . . . . .                           | <i>P. bulbifera</i>      |
| (Desmarest's Spiny Pocket Mouse) (2)                                     | <i>P. finitima</i>       |
| <i>Liomys salvini</i> (Thomas) . . . . .                                 | <i>P. hoguei</i>         |
| (Salvin's Spiny Pocket Mouse) (30)                                       | <i>P. guanacastensis</i> |
|  | <i>P. costaricensis</i>  |
| Family Cricetidae  |                          |
| <i>Oryzomys alfaroi</i> (Allen) . . . . .                                | <i>P. abditiva</i>       |
| (Alfaro's Rice Rat) (1)  | <i>P. bulbifera</i>      |
|  | <i>P. montana</i>        |
| <i>Oryzomys bombycinus</i> Goldman . . . . .                             | <i>P. abditiva</i>       |
| (Silky Rice Rat) (2)   | <i>P. montana</i>        |
| <i>Oryzomys caliginosus</i> (Tomes) . . . . .                            | <i>P. bulbifera</i>      |
| (Costa Rican Dusky Rice Rat) (24)  | <i>P. zona</i>           |
| <i>Oryzomys albigularis</i> (Tomes) (= <i>O. devius</i> ) . . . . .      | <i>P. bulbifera</i>      |
| (Chiriqui Rice Rat) (7)  | <i>P. intermedia</i>     |
|  | <i>P. montana</i>        |
|  | <i>P. zona</i>           |
| <i>Oryzomys fulvescens</i> (Saussure) . . . . .                          | <i>P. bulbifera</i>      |
| (Costa Rican Pygmy Rice Rat) (1)   |                          |
| <i>Otodylomys phyllotis</i> Merriam . . . . .                            | <i>P. guanacastensis</i> |
| (Nicaraguan Climbing Rat) (2)  | <i>P. costaricensis</i>  |
| <i>Peromyscus nudipes</i> (Allen) . . . . .                              | <i>P. bulbifera</i>      |
| (Naked-footed Deer Mouse) (12)   | <i>P. montana</i>        |
|  | <i>P. peromyscus</i>     |
|  | <i>P. zona</i>           |
|  | <i>P. verdensis</i>      |
| <i>Rheomys hartmanni</i> Enders . . . . .                                | <i>P. rheomys</i>        |
| (Panamanian Water Mouse) (6)   |                          |
| <i>Rheomys underwoodi</i> Thomas . . . . .                               | <i>P. hooperi</i>        |
| (Costa Rican Water Mouse) (3)  |                          |
| <i>Scotinomys teguina</i> (Alston) . . . . .                             | <i>P. bulbifera</i>      |
| (Alston's Brown Mouse) (1)   |                          |
| <i>Sigmodon hispidus</i> Say and Ord . . . . .                           | <i>P. bulbifera</i>      |
| (Hispid Cotton Rat) (5)  | <i>P. zona</i>           |
| <i>Zygodontomys microtinus</i> Thomas (= <i>Z. cherriei</i> ) . . . . .  | <i>P. bulbifera</i>      |
| Family Echimyidae  |                          |
| <i>Proechimys semispinosus</i> (Tomes) . . . . .                         | <i>P. bulbifera</i>      |
| (Tomes' Spiny Rat) (5)   | <i>P. zona</i>           |

\*The specific names in this list follow Handley (1966), with previously used names in parentheses.



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