

PUERTO RICAN SPECIES OF PARONELLIDAE (INSECTA: COLLEMBOLA)

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ABSTRACT

The species of Paronellidae known from Puerto Rico are described and/or distinguished from their closest relatives. Currently known from the island are: *Dicranocentruga jataca* Wray 1953, *D. geminata* n. sp., *D. luquillensis* n. sp., *D. subterranea* n. sp., *D. riopedrensis* n. sp., *Microparonella incerta* n. sp., *Campylothorax sabanus* Wray 1953, *Salina wolcottii* Folsom 1927 and *S. tristani* Denis 1931. *Salina wolcottii* has not been collected in Puerto Rico in recent years; it is suggested that this species may have been displaced by the introduced *S. tristani*.

RESUMEN

Las especies de Paronellidae conocidas de Puerto Rico son descritas y/o diferenciadas de sus parientes más cercanos. Actualmente se conocen de la Isla las siguientes especies: *Dicranocentruga jataca* Wray 1953, *D. geminata* n. sp., *D. luquillensis* n. sp., *D. subterranea* n. sp., *D. riopedrensis* n. sp., *Microparonella incerta* n. sp., *Campylothorax sabanus* Wray 1953, *Salina wolcottii* Folsom 1927 and *S. tristani* Denis 1931. *Salina wolcottii* no ha sido colectada en Puerto Rico en años recientes; se sugiere que dicha especie ha sido desplazada por la especie introducida *S. tristani*.

INTRODUCTION

Paronellids are among the most visible and characteristic components of the collembolan fauna of tropical countries. Their fairly large size and abundance in the superficial layers of forest leaf litter makes them easy to encounter by even the most casual student of soil arthropods. Also, species of the genus *Salina* are frequently found on many types of plants and can be easily collected by beating vegetation.

This paper describes the Paronellidae gathered during a series of extensive collecting trips made in 1973, 1974, 1981 and 1982. The collection is supplemented by specimens collected during occasional trips made in recent years. All the common species are probably included in this contribution but additional species, especially of

Dicranocentruga, may be discovered by more thorough collecting in the Caribbean National Forest and in the many caves present in the island.

All the material studied for this paper remains in my collection. Unless otherwise stated, the specimens studied were collected by myself from leaf litter samples. Morphological abbreviations such as Ant. 2, Th. 2, Abd. 2, etc. stand for second antennal segment, second thoracic segment, etc.

Genus *Dicranocentruga* Wray 1953

Wray proposed this taxon for a Puerto Rican species similar to *Trichorypha* Schött 1893 except for its short antennae, unarmed unguiculus and lack of a scalelike lobe at the apex of the dens (the author failed to notice or did not agree that since 1923 *Trichorypha* has been considered a synonym of *Paronella*

Schott 1893). Palacios-Vargas et al. (1985) discussed the relationship between *Paronella*, *Dicranocentruga* and *Troglopedetes*. Absolon 1907, and decided that *Dicranocentruga* should be treated as a synonym of *Troglopedetes*, a genus which according to them differs from *Paronella* only in the number of eyes (8 + 8 in *Paronella* vs. 6 + 6 or less in *Troglopedetes*).

Yosii (1985) reserved *Troglopedetes* for a group of eyeless European cave species with subdivided fourth antennal segment, and Najt (in litt.) suggests that *Paronella* be reserved for the type species, *P. fusca* from Cameroon—the only *Paronella* with manubrial spines. These actions leave without generic placement many of the species previously kept in *Paronella* and *Troglopedetes*.

Pending a modern revision of the genera related to *Paronella*, I propose to keep the Puerto Rican *Paronella*-like species in *Dicranocentruga*. This genus may eventually be proven valid or it may fall as a synonym of one of several genera: *Trichorypha* Schött 1893, *Microparonella* Carpenter 1916, *Trogolaphysa* Mills 1938, or *Trogonella* Delamare 1945. The five species retained in *Dicranocentruga* possess head and body macrochaetae, a character that separates them from the American *Troglopedetes* treated by Palacios-Vargas et al. (1985).

The Puerto Rican species of *Dicranocentruga* are all very closely related; indeed I have literally spent days pondering whether several of them should instead be considered as forms of one variable species. In the following section, *D. jataca* is described in detail and brief diagnoses are given for the other species.

Dicranocentruga jataca Wray (Figs. 1-10, 11, 17, 18, 21, 22)

Dicranocentruga jataca Wray 1953: 143 Fig. 1 A-H (Puerto Rico).

Troglopedetes jataca – Palacios-Vargas et al. 1985: 28-30, Fig. 12 A-C (comb., descr. notes from topotypes).

Troglopedetes jatacus – Mari Mutt & Bellingier 1987: in press (mention).

Length to 2.0 mm. Background color white. Violet pigment on antennae, anterior portion of head, margins of thoracic segments, coxae, and posterior two-thirds of Abd. 4 (Fig. 11). Some specimens almost uniformly pigmented (cf. Fig. 12); others with pigment restricted to eyepatch and antennae. Live specimens shiny metallic violet-black due to refraction from scale cover. Ant. 4 annulated; apical region with a small sensilla in a depression and nearby a large slightly curved sensilla (Fig. 6).

Specimens with fused (regenerated) Ant. 3-4 generally possess 2 curved sensillae. Head macrochaetotaxy: A0, A2, M1, M2, S, Po, P (Fig. 1). Eyes 6 + 6. Interocular chaetotaxy (Fig. 5) of 1 outer seta, 2 setae between eyes C and E, and 1 seta near posterior margin of eye F. Prelabral setae ciliated, labral setae smooth. Setae of second labral row thicker and 1/3 to 1/2 longer than setae of third row. Labral intrusion narrow, V-shaped. Center of labral margin with 2 microchaetae. Labial chaetotaxy: a1-a5, M1M2r (reduced) EL1L2. Differentiated seta of outer labial papilla (Fig. 3) not reaching, to slightly surpassing apex of papilla. Maxillary lobe with 2 sublobal setae. Setae of maxillary palp similar in length and shape (Fig. 21). Venter of head with many scales and few ciliated setae. Body macrochaetotaxy as in Fig. 2. Th. 2 with 6 subequal macrochaetae (all insertions have equal diameter — Fig. 10). Detailed chaetotaxy of Abd. 2, Abd. 3 and distribution of differentiated setae near anterior bothriotricha of Abd. 4 as in Figs. 7-9. Abdomen with 2,3,3 bothriotricha. Trochanteral organ with up to 25 setae. Unguis with 2 basal outer teeth, an inner pair of large teeth and 1-2 unpaired inner teeth (Figs. 17-20). Unguiculus lanceolate, with one outer lamella serrated. Tenent hair weakly or conspicuously clavate. Collophore without scales but with 3 + 3 apical anterior macrochaetae and many slender, long, finely ciliated setae. Tenaculum with 1 long seta. Dorsum of manubrium without scales and smooth setae. Dens with inner row of up to 21 smooth spines and outer row of up to 22 ciliated spinelike setae; the latter (Fig. 22) progressively become setiform towards mucro. Mucro (Fig. 4) with 4 teeth. Length of mucro/width of dens at apex = 2.2.

Diagnosis. *Dicranocentruga jataca* (or *D. geminata* n. sp.) may be identical to *Paronella carpenteri* Denis 1925 (French Guyana, Costa Rica), which in turn may be synonymous with *P. hirtipes* Handschin 1924 (Brazil). *Paronella carpenteri* differs from *P. hirtipes* in possessing two rows of dental spines (one in Handschin's species). However, the outer dental row is ciliated in *D. jataca* and Handschin may not have regarded such "spines" as spines but as ciliated setae (this possibility is apparent in his description). A detailed study of chaetotaxy and other characters is needed before the taxonomic status of *P. hirtipes*, *P. carpenteri* and *D. jataca* can be settled finally.

Comments. I have found several popula-

tions in which all the specimens have one of two types of claws. In the most frequent type the tenent hair is conspicuously clavate, the ungues are quadridentate, and there is a considerable distance between the inner pair of unguis teeth and the first unpaired tooth (Fig. 17). In the second type the tenent hair is very weakly clavate (appearing lanceolate in lateral view), the ungues are tridentate, and the unpaired unguis tooth originates close to the basal pair of teeth (Fig. 18).

Material Examined. Quebradillas, Guajataba, Rd. 2 km 106.8, 11.I.1977, neotype (herein designated), 1 specimen on slide and 1 in alcohol. As preceding but collected on 9.III.1974, 2 specimens on slides and 1 in alcohol. Aibonito, Rd. 725, km 5.9, 7.I.1982, 3 on slides and 2 in alcohol. Arecibo, Rd. 682, entrance to Cambalache State Forest, 19.IV.1981, 5 on slides and 23 in alcohol, Cayey, Rd. 7741 km 1.8, 18.IV.1974. As preceding but km 2.3, 13.VI.1981, 3 on slides and 17 in alcohol. As preceding but km 4.6, 18.IV.1974, 3 on slides and 3 in alcohol. Cayey-Salinas Rd. (no. 14), km 70.3, 13.VI.1961, S. Medina Gaud, 4 on slides and 29 in alcohol. As preceding but collected by me in km 67.6, 18.IV.1974. Guayama, Rd. 179 km 3.7, 18.IV.1974, 3 on slides and 2 in alcohol. Luquillo, Caribbean National Forest (El Yunque), in front of the University of Puerto Rico house, 7.III.1987, F. Soto-Adames, 4 on slides and 7 in alcohol. **Manatí**, Rd. 149 km 4.2, 29.X.1976, 2 on slides and 3 in alcohol. Mayagüez, 11 de Agosto 224, backyard of author's home, 10.XII.1976, 1 on slide. Mayagüez, Rd. 349 km 1.4 XI.1977, F. Moll, 4 on slides and 2 in alcohol. As preceding but collected by me 25. VII. I 1984, 2 on slides and 10 in alcohol. As preceding but km 4.0, 8.VI.1974, 4 on slides. As preceding but 13.XII.1976, 1 on slide and 4 in alcohol. Morovis, Rd. 155 km 46.2, 1 on slide. **Río Piedras**, Agricultural Experiment Station, 20.II.1987, 1 on slide. Utuado, **Río Abajo** State Forest, near old camping grounds, 19.IV.1981, 5 on slides and 26 in alcohol. As preceding but collected on 17.XII.1986, 6 on slides and 16 in alcohol. Utuado, Rd. 111 km 12.4, Indian Ceremonial Center, 19.IV.1981, 3 on slides and 8 in alcohol.

Dicranocentrua geminata new species
(Figs. 19, 20)

This species is identical to *D. jataca* except

for two characters: absence of head macrochaeta M2 and the presence of a microchaeta internally to the area between eyes E and F (arrow in Fig. 5). These differences have been verified for all the specimens mounted on slides listed under both species. *Dicranocentrua jataca* and *D. geminata* have been found together only in two localities—one in Mayagüez and the other in Cayey.

Comments. The two types of claw morphology found in *D. jataca* are also present between populations of *D. geminata* (cf. Fig. 20). In addition, specimens from three locations (including the type locality) have a third type of claw complex consisting of clavate tenent hairs and quadridentate ungues, with the proximal unpaired tooth inserted close to the basal pair of teeth and the distal unpaired tooth inserted far from the former (Fig. 19).

Material Examined. Maricao, Rd. 120 km 13.9, nr. stone watch tower, 5.I.1977, holotype and 2 paratypes on slides plus 16 paratypes in alcohol. As preceding but collected on 24.I.1960 by H. E. Haas, 2 specimens on slides. Maricao, Rd. 120 km 13.6, vacation center, 5.I.1977, 2 on slides and 2 in alcohol. Ad juntas, Castañer, coffee farm, 24.IX.1958, S. Medina Gaud, 2 on slides. Aguadilla, Rd. 2 km. 129.8, 21.XII.1976, 2 specimens on slides and 3 in alcohol. Cayey, Rd. 7741 km 2.3, 13.VI.1981, 2 on slides. Cayey, Carite State Forest, Rd. 184 km 26.6, 13.VI.1981, 4 on slides and 8 in alcohol. Cayey, Carite State Forest, 14-15.XII.1986, F. Soto-Adames, 3 on slides and 13 in alcohol. Las Marías, Rd. 407 km 4.0, 11.XII.1976, 2 on slides and 10 in alcohol. Mayagüez, Rd. 349 km 4.0, 8.VI.1974, 1 on slide. As preceding but collected in km 5.9, 13.XII.1976, 2 on slides. San Sebastian, Rd. 111 km 14.5, b 9.III.1974, 3 on slides. San Sebastian, Rd. 119 km 33.7, 21.III.1981, 1 on slide and 1 in alcohol. Villalba, Toro Negro State Forest, Rd. 143 km 32.1, 6.XII.1981, 3 on slides and 13 in alcohol.

Dicranocentrua luquillensis new species
(Figs. 12, 15, 29)

This species differs from *D. jataca* as follows: head macrochaetae M2 and S absent, outermost posterior macrochaeta of Th. 2 much smaller than other macrochaetae (Fig. 29), unguis with 1 very small inner unpaired tooth inserted very close to the basal

paired teeth (Fig. 15), tenent hair short, slender and acuminate, outer unguicular lamellae not serrated.

Comments. A leaf litter sample taken just meters away from the type locality yielded only *D. jataca*. Specimens of *D. jataca* from this locality can be distinguished from *D. luquillensis* by their coloration (cf. Figs. 11, 12).

Material Examined. Luquillo, Caribbean National Forest (El Yunque), behind the University of Puerto Rico house, 7.III.1987, F. Soto-Adames, holotype and 5 paratypes on slides plus 14 paratypes in alcohol.

Dicranocentruga subterranean new species
(Figs. 14, 16)

This species differs from *D. jataca* as follows: head macrochaetae M1, M2 and S absent, labral microchaetae absent, outer unguicular lamella not serrated, mucro with external tooth placed closer to subapical tooth (cf. Figs. 4, 16). Specimens of *D. subterranea* reach 2.5 mm in length and possess up to 31 spines on both the inner and outer dental rows. The structure of the claws is illustrated in Fig. 14.

Material Examined. Aguas Buenas, Cave 14, 250 m, V.1973, S. Peck, holotype and 3 paratypes on slides, 6 paratypes in alcohol. Aguas Buenas, petroglyph cave, nr. Hoyo, 250 m, 15.V.1974, S. Peck, 3 on slides. and 2 in alcohol.

Dicranocentruga riopedrensis new species
(Figs. 23-29)

This species differs from *D. jataca* as follows: head macrochaeta M 1 inserted closer to A2 (cf. Figs. 1, 23), smaller curved sensilla near apex of Ant. 4 (cf. Figs. 6, 28), interocular chaetotaxy with 2 setae internal to the area between eyes E and F (Fig. 24), outermost posterior macrochaeta of Th. 2 much smaller than other macrochaetae (Fig. 29), Abd. 4 with a macrochaeta above the pseudopore (Fig. 25), outer unguicular teeth inserted distally (Fig. 26), unguiculus with more conspicuous outer serrations, mucro elongated (length/width of dens at apex = 2.9) and with 2 denticles on either side of the basal tooth (Fig. 27). The largest specimen measured 1.5 mm.

Diagnosis. This species may be identical to *Paronella separata* Denis 1933 (Costa Rica).

Both share the same position of the inner and outer unguicular teeth and the presence of distinct serrations on one unguicular lamella. The mucro of Denis' species is also elongated but apparently more so (length of mucro/width of dens at apex = 3.5 vs. 2.9 in *D. riopedrensis*). Also, Denis did not figure the 2 mucronal denticles found in *D. riopedrensis*. The teeth are very small and may have been overlooked.

Comments. One specimen has on one side of the head a small supplementary ciliated seta internal to labial seta M1. The denticles on both sides of the basal mucronal tooth (Fig. 27) were seen clearly in one mucro of one specimen. In two specimens the basal denticle is clearly visible but the apical was not observed. In another specimen the distal denticle is visible but the basal one can not be seen. The outer unguicular teeth are always distal but vary slightly in position (Fig. 26—arrows).

The type of *Dicranocentruga riopedrensis* is adjacent to the Botanical Garden of the University of Puerto Rico. In view of the many exotic plants in the area, the possibility exists that *D. jataca* is an introduced species.

Material Examined. Rio Piedras. Agricultural Experiment Station, 29.XII.1976, holotype and 1 paratype on slide. As preceding but 20.II.1987, 2 paratypes on slides and 3 in alcohol.

Dicranocentruga sp. (Fig. 13)

Two specimens with a striking color pattern (Fig. 13) were found in a population of *D. jataca* collected in 1981. Aside from coloration, the specimens are identical to *D. geminata* (not to *D. jataca*). A special collecting trip was made in December of 1986 but no additional specimens were found.

Material Examined. Utuado, Rio Abajo State Forest, near old camping grounds, 19.IV.1981, 2 specimens on slides.

Genus *Microparonella* Carpenter 1916

This genus, proposed for two species from the Seychelles Islands, differed from *Paronella* Schött 1893 in the small size of the specimens (1 mm), their relatively short antennae and their general habitus like that of the Entomobryinae. Perhaps due to the somewhat subjective nature of these characters,

several authors (e.g. Salmon 1964, Gapud 1971) have considered *Microparonella* as a synonym of *Paronella*.

Yosii (1981) redescribed the genus based on specimens of *M. annulicornis* (Oudemans) collected in Sabah. He gave as possible diagnostic characters the absence of macrochaetae on the body and the presence of truncate unguiculi, although the type species has lanceolate unguiculi and its chaetotaxy is unknown.

The new species described below has the appearance of a *Microparonella*, both in its original sense and in that of Yosii. The species is small, with rather short antennae and a general habitus much like that of a *Lepidocyrtus*. Like the type species of *Microparonella*, the Puerto Rican species has lanceolate unguiculi but its mucro is elongated and has three teeth instead of being short and with five teeth as in the Seychelles species.

The Puerto Rican species differs from *Microparonella* sensu Yosii in the presence of lanceolate unguiculi, head and body macrochaetae, an elongate mucro, labral papillae with denticles instead of being smooth and rounded, and probably also "in the presence of a large papilla on the apex of the fourth antennal segment. Like *Microparonella* sensu Yosii, the Puerto Rican species has 2,3,2 abdominal bothriotricha and hyaline scales.

Microparonella incerta new species
(Figs. 30-45)

Length to 1.3 mm. Body with distinct color pattern (Fig. 30); specimens from Aguadilla and Mayagüez lack lateral band of Abd. 4. Head and body covered with hyaline scales which are absent in all antennal segments and legs. Antennae about 2.8x longer than head. Ant. 4 with a large apical papilla set in a deep depression (Fig. 39). Eyes 8 + 8. Head macrochaetotaxy and interocular chaetotaxy as in Figs. 33, 42. Chaetotaxy of labrum as in Fig. 41. Labral papillae with minute distal denticles (Fig. 40). Labial chaetotaxy follows formula al-a5, M1M2rEL1L2; seta r small and ciliated (Fig. 36). Subapical seta of maxillary palp longer than apical seta, both setae very lightly ciliated (Fig. 37). Differentiated seta of outer labial papilla long and slender (Fig. 35). Body macrochaetotaxy as in Fig. 34; abdomen with 2,3,2 bothriotricha. Detailed chaetotaxy of Abd. 2 and Abd. 3, and distribution of setae associated with bothriotricha of Abd. 4 as in Fig. 43-

45. Femoral organ absent. Structure of claws as in Fig. 38; opposite seta to tenent hair Icing. Manubrium slightly longer than dens and without smooth setae or scales dorsally. Dentes without dorsal crenulations and usually not forming a distinct angle with the manubrium. Each dens with 2 parallel longitudinal rows of spines (Fig. 31). Mucro fairly elongated, with 3 teeth (Fig. 32).

Diagnosis. The color pattern and shape of the mucro readily distinguish this species from all other Neotropical paronellids. In coloration it resembles the Asian species *Microparonella annulicornis* (Oudemans) but many morphological characters distinguish the two forms.

Comments. At first sight, *M. incerta* is easily confused with a *Lepidocyrtus*, not only because of its habitus but because its dens does not usually form a distinct angle with the manubrium. Only after specimens are mounted on slides do the length of the manubrium, absence of dental crenulations and shape of the mucro reveal that the species is a paronellid. The remarkable similarity of the chaetotaxy with that of *Lepidocyrtus*, the similar hyaline scales and the presence of an eversible papilla on the fourth antennal segment fuel the idea that the Paronellidae is a polyphyletic taxon.

Material Examined. Guanica State Forest, 10.VI.1981, holotype and 9 paratypes on slides, 15 paratypes in alcohol, Aguadilla, Rd. 647, IV.1985, J. Roig, 1 specimen on slide and 15 in alcohol. Coamo-Aibonito Rd. (no. 14), km 44.1, beating grasses, II.1982, 1 on slide. Mayagüez, Rd. 349 km 1.4, 22.XII.1980, 1 on slide.

Genus *Campylothorax* Schött 1893

Dicranocentropa Wray 1953: 144. Mitra 1975: 17, synonymy.

Campylothorax sabanus (Wray)
(Figs. 46-52, 56, 58-60)

Dicranocentroides (*Dicranocentropa*) *sabana* Wray 1953: 144-145, Fig. 11-P.

Campylothorax sabana. Mitra 1975: 17, comb. Mitra & Dallai 1980: 297-307. Figs: 32-44, 45C; redescription.

Campylothorax sabanus. Mari Mutt 1982: 32, mention. Mari Mutt 1986:76, presence on grasses. Rosselló et al. 1986: 118, ingestion of fungal spores.

In their revision of *Campylothorax*, Mitra and Dallai (1980) presented a detailed description of *C. sabanus*. However, their observations contain errors in the chaetotaxy (verified by examining many specimens, including some from the same localities as the material studied by Mitra and Dallai) and do not describe some characters that could be important in the taxonomy of the genus. The following notes complement the aforementioned description.

Prelabral setae very finely ciliated. Setae of first and second labral rows extremely finely ciliated, setae of third row smooth. Labral papillae absent. Inner margin of labrum with 4 rounded protuberances, outer pair about 0.5x diameter of inner pair. Apical seta of maxillary palp much longer than subapical seta (Fig. 47). Maxillary lobe with 2 sublobal hairs. Labial chaetotaxy as in Fig. 52; L2 very small. Differentiated seta of outer labial papilla set in a huge mound that points inwardly (Fig. 51). Head chaetotaxy as in Fig. 50; DO, P1 and P3 (Mitra and Dallai 1980: 302, Fig. 34) absent. Four interocular setae present, arranged in opposite direction to that illustrated by Mitra and Dallai. Abd. 2 (Fig. 59) with 2 macrochaetae. Chaetotaxy of Abd. 3 and distribution of setae associated with bothriotricha of Abd. 4 as in Figs. 58, 60. Abd. 4 (Fig. 56) with an anterior triangle of macrochaetae and a posterior group of 6 macrochaetae (the seventh seta illustrated by Mitra and Dallai could correspond to the pseudopore). Unguis externally with 2 basal teeth and internally with 2 paired teeth and 1-2 unpaired teeth. A distinct protuberance (illustrated by Mitra and Dallai) present between inner paired teeth and first unpaired tooth. One outer unguicular lamella finely serrated. Smooth seta opposite tenent hair of metathoracic legs absent. Dental spines ciliated; proximally on dens clearly spiniform but towards mucro gradually transforming into large ciliated setae.

As indicated by Mitra and Dallai, the fourth abdominal segment has a characteristic anterior dorsal patch that resembles two closely apposed letter Ms (MM). In typical specimens (Fig. 46) the patch is very distinct but in pale individuals it can be very reduced. In very dark specimens (Fig. 49) the patch originates longitudinal bands that merge with the dorsal middle and posterior pigment of the segment.

Diagnosis. *Campylothorax sabanus* is very similar to *C. cubanus* Gruia 1983. Most of

the differences discussed by Gruia are based on incorrect observations reported by Mitra and Dallai. Once these are corrected, the only difference remaining is the coloration. *Campylothorax cubanus* is darker (but very dark specimens of *C. sabanus* resemble the habitus drawing presented by Gruia) and it lacks the MM-shaped patch on the fourth abdominal segment.

Comments. This is the first species of Entomobryidae sensu lato that, to my knowledge, lacks the smooth seta opposite the tenent hair of the metathoracic legs.

Material Examined. Maricao, Rd. 27, 120 m. el., 28.VIII.1951, J. Maldonado Capriles, 1 paralectotype in alcohol. Ad juntas, Castañer, litter of coffee trees, 24.IX.1958, S. Medina Gaud, 1 on slide and 5 in alcohol. Aguadilla, Rd. 2 km 129.8, 21.XII.1976, 1 in alcohol. Aibonito, Rd. 725 km 5.9, 7.I.1982, 8 in alcohol. Añasco, Rd. 108 km 9.8, 22.XII.1976, 2 in alcohol. Arecibo, Cambalache State Forest, Rd. 682, 19.IV.1981, 5 on slides and 8 in alcohol. Cayey, Rd. 7741 km 4.6, 18.IV.1974, 1 on slide and 15 in alcohol. Cayey, Rd. 15 km 22.4, 18.IV.1974, 2 on slides and 9 in alcohol. As preceding but km 20.2, 13.VI.1981, 6 in alcohol. Cayey-Salinas Rd., km 70.3, 13.VI.1961, S. Medina Gaud, 3 on slides and 38 in alcohol. As preceding but km 67.6, 18.IV.1974, 2 in alcohol. As preceding but km 74.6, 1 8.IV.1974, 4 in alcohol. Guayama, Rd. 179 km 3.7, 18.IV.1974, 5 on slides and 52 in alcohol. Quebradillas, Guajataca, Rd. 2 km 106.8, 9.III.1974, 5 on slides and 27 in alcohol. As preceding but 2.I.1977, 1 in alcohol. Quebradillas, Lake Guajataca, Rd. 119 at tower, 9.III.1974, 3 on slides. Las Marías, Rd. 106 km 15.1, 27.X.1973, 2 on slides. Las Marías, Rd. 407 km 4.0, 11.XII.1986, 16 in alcohol. Manatí, Rd. 149 km 4.2, 29.XII.1976, 3 on slides and 49 in alcohol. Maricao, road to fish hatchery, 0.5 km from town, 27.X.1973, 5 on slides and 7 in alcohol. Maricao, vocational center, Rd. 120 km 13.9, 5.I.1977, 2 in alcohol. Maricao, near stone tower, Rd. 120 km 13.9, 5.I.1977, 5 in alcohol. Mayagüez, Rd. 108 km 9.8, 4.I.1974, 3 on slides. Mayagüez, Rd. 349 km 1.4, 25.VII.1984, 5 specimens on slides and 11 in alcohol. As preceding but XI.1977, F. Moll, 1 in alcohol. As preceding but km 4.0, 8.VI.1974, 2 on slides and 49 in alcohol. As preceding but 13.XII.1976, 8 in alcohol. As preceding but km 5.9, 13.XII.1976, 4 in alcohol. As pre-

ceding but km 6.1, 17.VI.1981, 20 in alcohol. Morovis, Rd. 155 km 21.8, 21.III.1974, 22 in alcohol. Río Grande, El Verde, Rd. 186 kms 19.3 and 21.4, 30.XII.1973, 4 on slides. Río Piedras, Agricultural Experiment Station, 29.XII.1976, 5 in alcohol, As preceding but 20.II.1987, 8 in alcohol. San Sebastian, Rd. 111 km 14.5, 9.III.1974, 4 on slides and 4 in alcohol. San Sebastian, Rd. 119 km 33.7, 21.III.1981, 47 in alcohol. Utuado, Río Abajo State Forest, camping area, 19.IV.1981, 18 in alcohol. Utuado, Rd. 111 km 12.4, Indian Ceremonial Center, 19.IV.1981, 11 in alcohol. Villalba, Toro Negro State Forest, Rd. 143 km 32.1, 6.XII.1981, 6 in alcohol.

Genus *Salina* MacGillivray 1894

Salina wolcotti Folsom 1927 (Fig. 57)

Salina wolcotti Folsom 1927: 11-12, Figs. 61-67; Puerto Rico. Wolcott 1921: 10-11, biol. notes. Wolcott 1933: 241-242, biol. notes. Wolcott 1936: 21-22, biol. notes. Fennah 1947: 64, Fig. 49B; occurrence on sugarcane in the Virgin Islands. Wolcott 1950: 33, biol. notes. Box & Guagliumi 1953: ? occurrence on sugarcane in Venezuela; recorded as sp. nr. *wolcotti*. Wray 1959:68, record for Florida and Costa Rica, Guagliumi 1962: 450-452, Fig. 143; occurrence on sugarcane in Venezuela. Martin & Gregory 1962: 297, possible role in pollination of *Piper nigrum* in Puerto Rico. Metcalfe 1964: 24, occurrence on sugarcane in Jamaica; recorded as sp. nr. *wolcotti*.

Salina wolcotti was described from numerous specimens collected at five localities in Puerto Rico. The considerable distances between these localities, the different climates in each one, and the various substrates on which specimens were collected, suggests that *Salina wolcotti* was common and widespread in the island. This was seemingly the case during the first decades of this century, when F. S. Earle (cited by Wolcott 1950) found specimens "literally by the million in every cane field in Porto Rico."

When I started collecting Puerto Rican Collembola in 1973, specimens of *Salina* were found literally everywhere — in dry locations at sea level, on wet areas in the highest mountains, on the host plants mentioned by Wolcott and on many others including every species of grass, and even in buildings. However, none of these specimens pos-

sessed the elongated bidentate mucrones of *S. wolcotti* (Fig. 57). Instead, they had the short quadridentate mucrones of *S. tristani* (Fig. 54), a species described from Costa Rica.

The last specimens collected in Puerto Rico of a *Salina* with bidentate mucrones were found in 1974 in forest leaf litter from Las Marías. One very deteriorated individual remains in my collection. Some colleagues have suggested that *S. wolcotti* was decimated by the heavy use of DDT and other chlorinated insecticides applied to sugarcane in the 1950's. However, the species should have survived on the many other host plants in which it had been found. A more plausible explanation may be that the species was competitively displaced by the latecomer *S. tristani*.

The extreme deterioration of the specimens present in my collection makes it impossible to add any details to the original description of *S. wolcotti*.

Diagnosis. *Salina wolcotti* may be identical to the Costa Rican *S. bidentata* Handschin, whose description appeared simultaneously with that of Folsom's species. *Salina wolcotti* is also related to the Cuban species *S. ventricolor* Gruia 1983. Gruia's species has shorter antennae, two unpaired inner unguis teeth, and its mucro bears a small subapical denticle.

Denis (1931) and Gruia (1983) give as a diagnostic character of *S. wolcotti* the absence of a pigmented eye patch. However, the eyepatch of Folsom's species is normal for the genus. Under low magnification in alcohol, the patch appears as eight isolated black circles, each corresponding to an ocellus (this is clearly illustrated by Gruia's figure VII-2 and perhaps a bit too clearly by Folsom's figure 61). In specimens mounted on slides the eyepatch looks like that of other entomobryids — with pigment present between the individual ocelli.

Material Examined. Quebradillas, on cotton, 5.IX.1935, L. C. Fife, 3 specimens on slides. Las Marías, Rd. 119, V.1973, 1 on slide.

Salina tristani Denis (Figs. 53-55)

Salina tristani Denis 1931: 149, Figs. 167-173; Costa Rica. Denis 1933: 261; Costa Rica, descr. notes. Marcuzzi 1966: 428, record from Venezuela. Christiansen 1971: 47, Figs. 1, 2; uncertain ident. of Mexican fossils. Mari Mutt 1982: 32, record from Puerto Rico. Mari Mutt 1986: 76, presence on grasses. Rosseló et al. 1986: 118,

ingestion of fungal spores.

Length to 1.8 mm. Live specimens yellow or green, with scarce blue pigment on sides of thorax, lateral intersegmental areas of anterior abdominal segments, area between bases of antennae, apex of first three antennal segments, and legs (Fig. 53). Antennae mostly golden brown. Venter of head and body with abundant dark blue pigment forming numerous irregular spots. Specimens in alcohol gradually lose yellow background pigment and become white. Antennae 1.1-1.5x length of head and body combined. Macrochaetotaxy of Th. 2 to Abd. 1 as in Fig. 55. Mucro as in Fig. 54. All other morphological characters are identical to those of *S. dedoris* Mari Mutt 1987 and *S. hermana* Mari Mutt 1987.

Diagnosis. *Salina tristani* belongs to a group of Neotropical species with short quadridentate mucrones. The other members of the group are *S. panamae* Jacquemart 1982 and the Colombian species *S. dedoris* and *S. hermana* described by me in 1987.

Salina tristani differs from the Colombian species by its coloration and the presence of an extra macrochaeta on the second and third thoracic segments (Fig. 55). *Salina tristani* differs from *S. panamae* in the number of unpaired inner unguis teeth (1 in *S. panamae* vs. 2 in *S. tristani*)—a difference which is frequently given little importance. The head chaetotaxy and the chaetotaxy of the second through the fourth abdominal segments are identical in both species. The thoracic chaetotaxy is very different but this may reflect inaccurate observation by Jacquemart. At least the presence of a bothriothrix on the first abdominal segment is highly suspect.

Comments. The legend for figure 55 explains the variation observed in the chaetotaxy of Th. 2 to Abd. 1. Except for two cases, the variations were always symmetrical. The different lengths of the microchaetae may cause confusion in distinguishing them from macrochaetae.

Material Examined. Aguada, Rd. 148, grounds of Coloso sugar mill, on sugarcane leaves, 21.XII.1976, 16 in alcohol. Aguadilla, Borinquen Beach, Ramey, litter far from the shore, 23.XII.1976, 11 in alcohol. Bayamón, Santa Monica housing project, on leaves of banana plants, 9.I.1977, 15 in alcohol. Cayey, Rd. 184 km 26.6, Carite State Forest, beating grasses and other plants, 13.VI.1981, 7 in alcohol. Cayey, Rd. 7741 km 2.3, beating vegetation, 13.VI.1981, 4

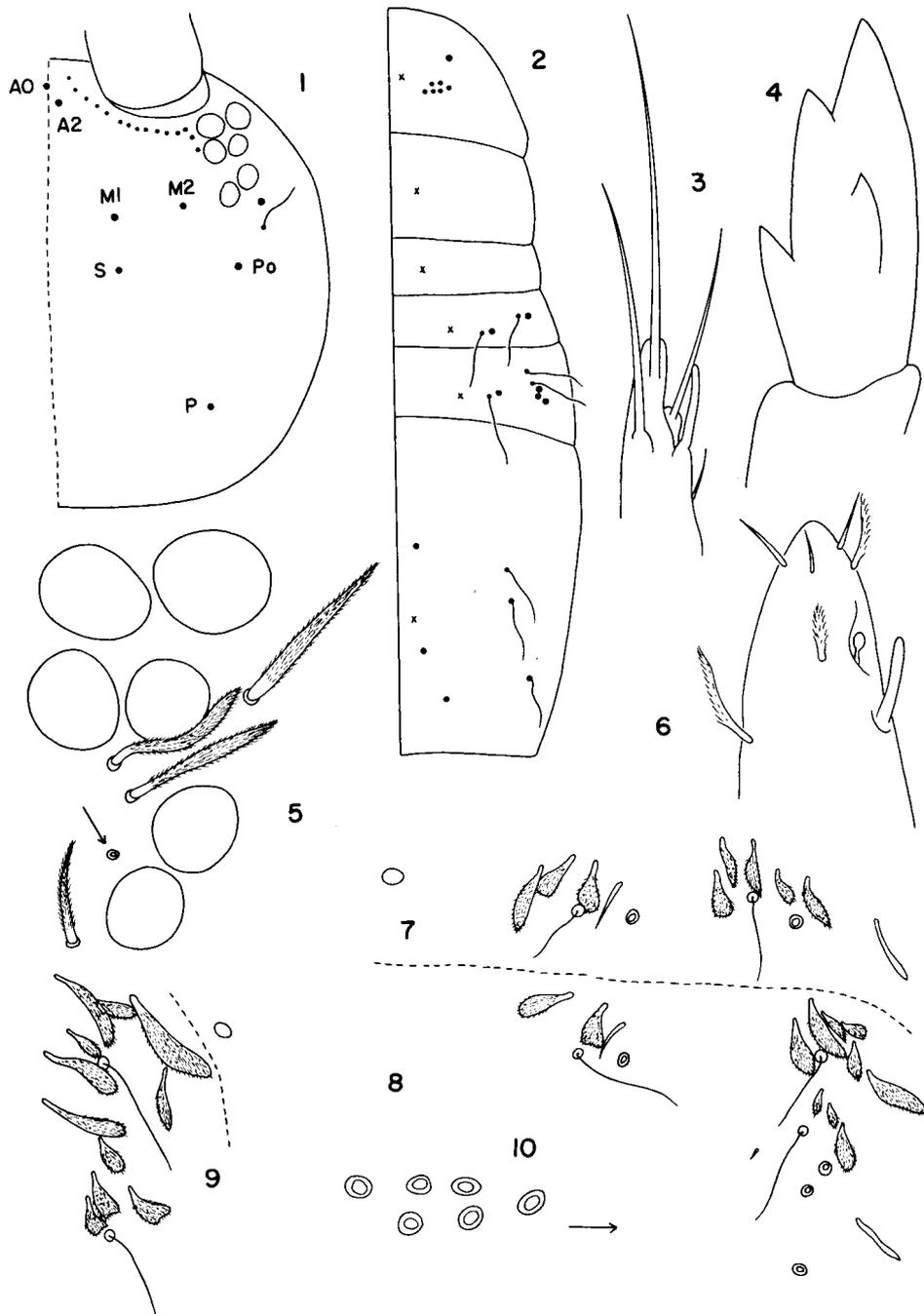
in alcohol. Coamo, Rd. 546, Baños de Coamo, dry leaf litter, 7.I.1982, 4 in alcohol. Coamo-Aibonito Rd. (14), km 44.1, beating grasses, 7.I.1982, 3 in alcohol. Guanica, Rd. 333 km 0.5, sugarcane litter, 7.II.1974, 1 specimen on slide and 23 in alcohol. As preceding but km 1.4, beating grasses at the edge of a sugarcane field, 10.IV.1981, 1 on slide. Guayama, Rd. 179 km 3.7, wet leaf litter, 18.IV.1974, 1 on slide. Hormigueros, Rd. 14 km 2.3, west of Vane Hermoso housing development, beating sugarcane and grasses, 26.XII.1976, 16 in alcohol. Isabela, Agricultural Experiment Station, sticky traps on soybeans var. Williams, 3.VI.1975, M. E. Irwin and E. M. Paschal, 2 on slides. Las Marías, Rd. 106 km 16.6, leaf litter, II.1976, 2 on slides. Mayagüez, Rd. 2 near Igualdad sugar mill, on sugarcane leaves and litter, 4.III.1987, 3 on slides and 14 in alcohol. Mayagüez, University of Puerto Rico campus, beating grasses at various locations, 14.II.1984, 10 specimens on slides. Mayagüez, UPR campus, in front of the Entomology Laboratory, lawn grass, II.1973, 1 on slide. As preceding but in nido de gungulén (*Tillandsia usneoides*), 7.VIII.1981, 14 in alcohol. Mayagüez, Rd. 108 km 9.8, leaf litter, 4.I.1974, 1 on slide. As preceding but beating banana leaves and grasses, 22.XII.1976, 14 in alcohol. Mayagüez, Rd. 349 km 6.5, beating vegetation, 18.II.1977, 15 in alcohol. Quebradillas, Rd. 119 near tower at Lake Guajataca, beating vegetation, 9.III.1974, 1 on slide. Río Grande, El Verde, Rd. 186 km 17.7, litter of pigeon pea pods, 30.XII.1973, 2 on slides. Río Piedras, Agricultural Experiment Station, beating grasses, 29.XII.1976, 16 in alcohol. Salinas, Rd. 180 km 0.9, beating grasses, 16.XII.1976, 10 in alcohol. San German, Rd. 114 km 14.5, beating grasses and sugarcane, 5.I.1977, 26 in alcohol. San Sebastian, Rd. 111 km 14.5, leaf litter, 9.III.1974, 1 on slide. Utuado, Rio Abajo State Forest, Rd. 621 camping area, beating vegetation, 19.IV.1981, 1 on slide and 8 in alcohol. Utuado, Rd. 111 km 12.4, Indian Ceremonial Center, beating vegetation, 19.IV.1981, 6 in alcohol. Villalba, Rd. 143 km 32.0, Toro Negro State Forest, beating vegetation, 6.XII.1981, 8 in alcohol.

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FIGURES 1-10. —*Dicranocentruga jataca*. 1. Head macrochaetotaxy. 2. Body macrochaetotaxy, pseudo-pores (x) and botriotricha. 3. Outer labial papilla. 4. Mucro. 5. Eyes and interocular setae; arrow signals the insertion of a seta present in *D. geminata* but absent in *D. jataca*. 6. Apex of Ant. 4. 7. Chaetotaxy of Abd. 2. 8. Chaetotaxy of Abd. 3. 9. Setae associated with anterior botriotricha of Abd. 4. 10. Posterior macrochaetae of Th. 2; arrow points to outer part of segment.

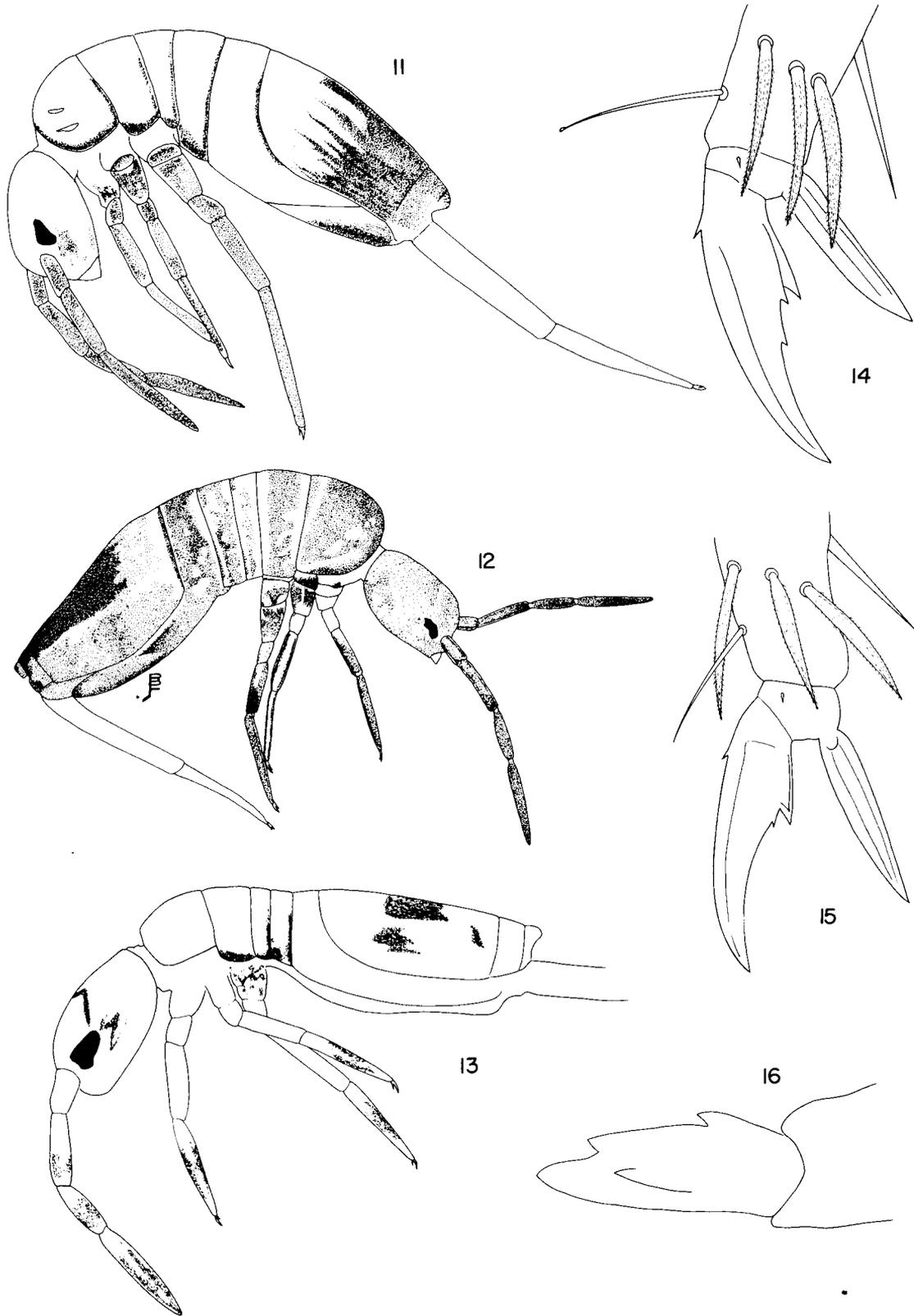
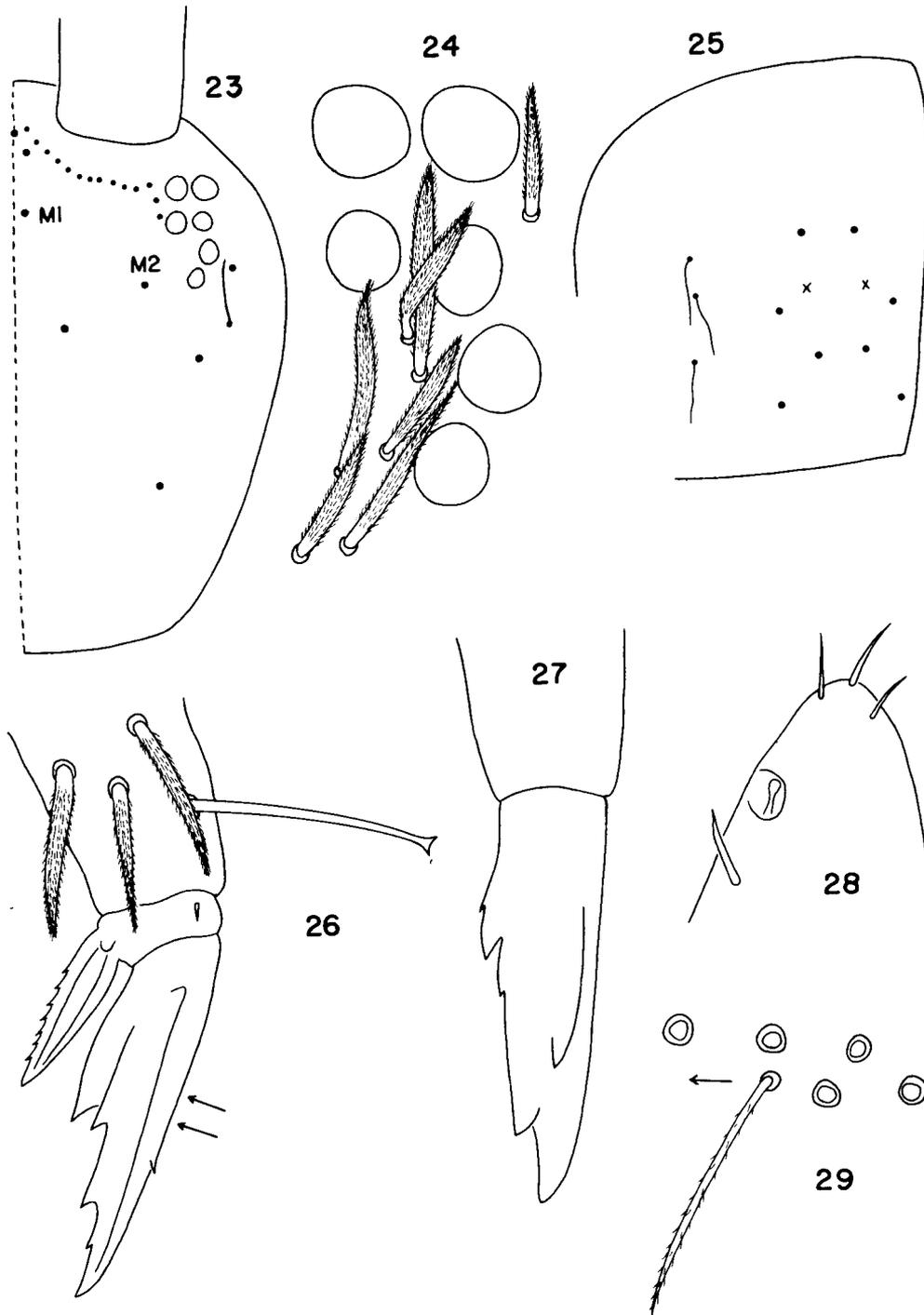
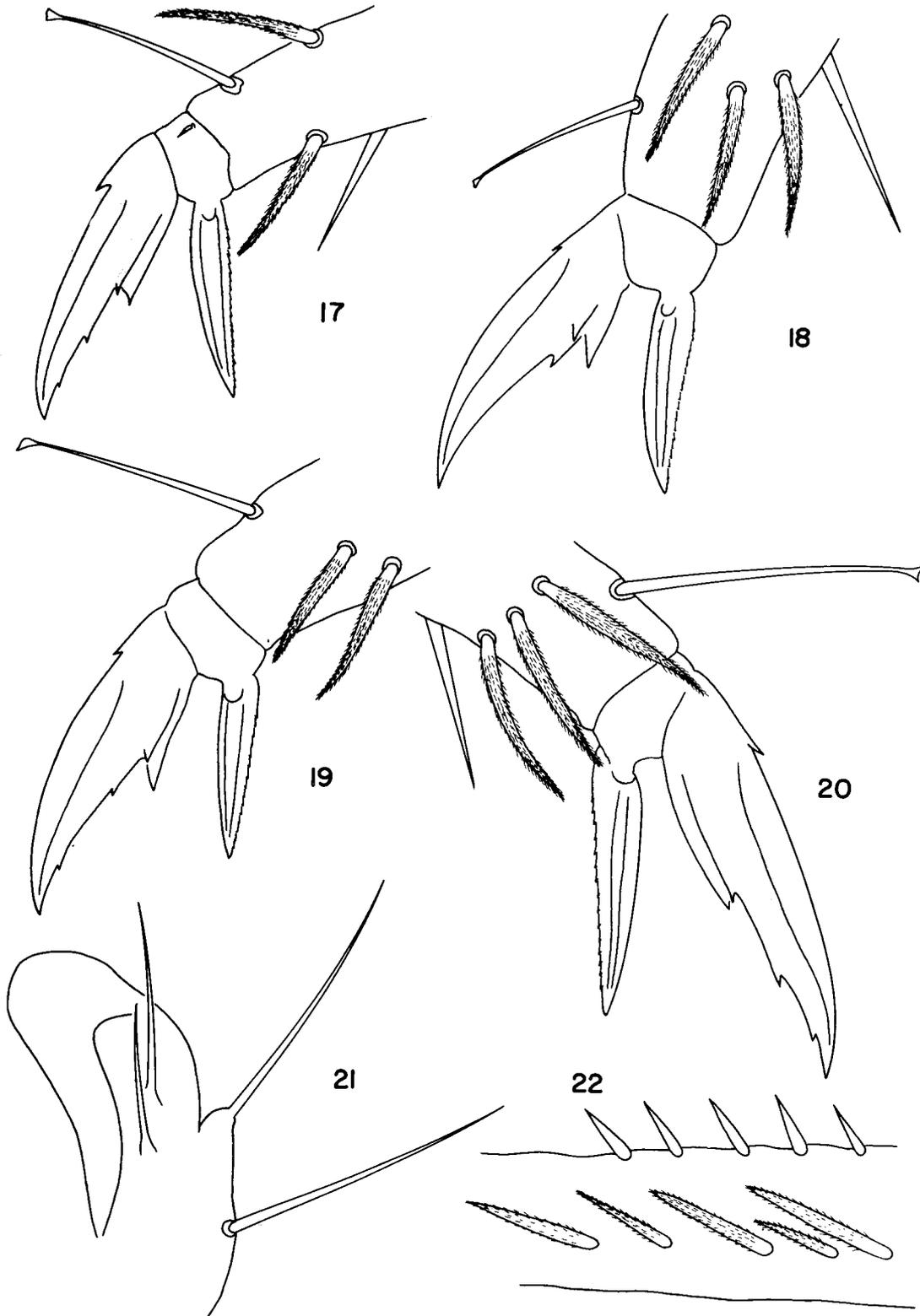


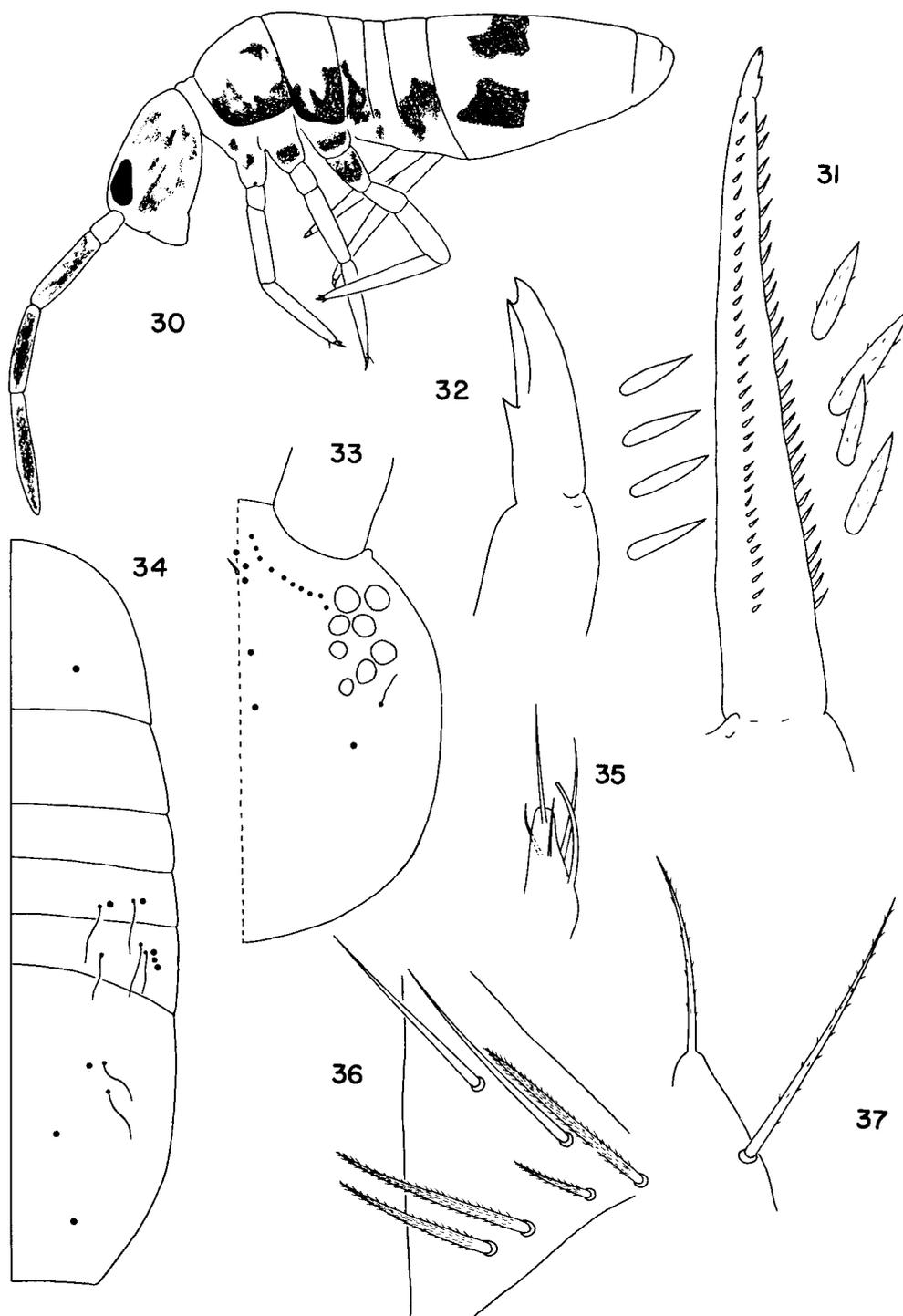
FIGURE 11. —*Dicranocentruga jataca*. Figs. 12, 15. *D. luquillensis*. Figs. 14, 16. *D. subterranea*. Fig. 13. *Dicranocentruga* sp. 11-13. Coloration. 14-15. Metathoracic claws. 16. Mucro.



FIGURES 23-29. —*Dicranocentrua riopedrensis*. 23. Head macrochaetotaxy. 24. Eyes and interocular setae. 25. Abd. 4. macrochaetotaxy, pseudopores (x) and botriotricha. 26. Metathoracic claws; arrows point to alternative positions of outer teeth. 27. Mucro. 28. Apex of Ant. 4. 29. Posterior macrochaetae of Th. 2; arrow points to outer part of segment.



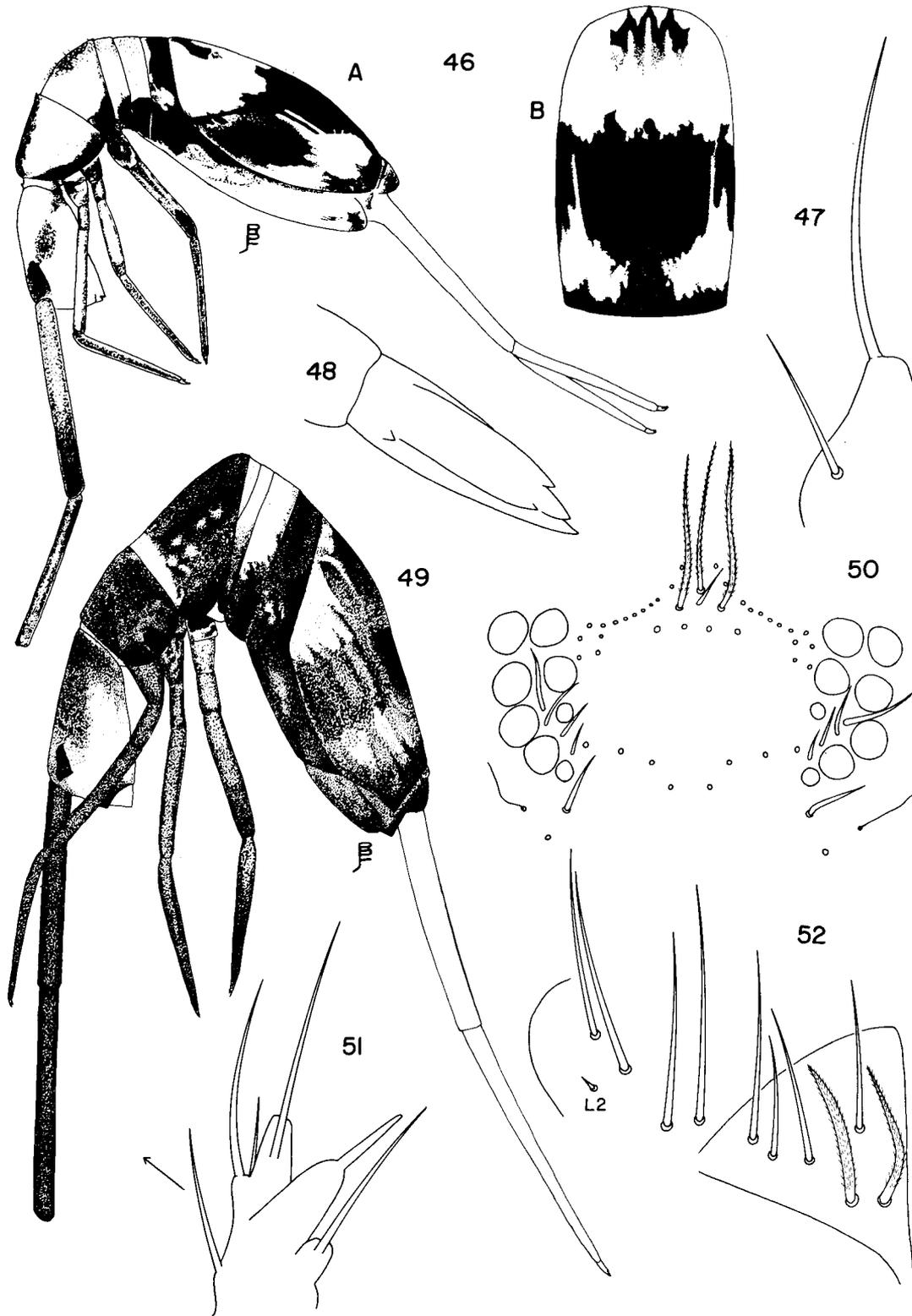
FIGURES 17-19, 21, 22. *Dicranocentruga jataca*. Fig. 20. *D. geminata* 17-20. Metathoracic claws. 21. Maxillary palp. 22. Section of dens.



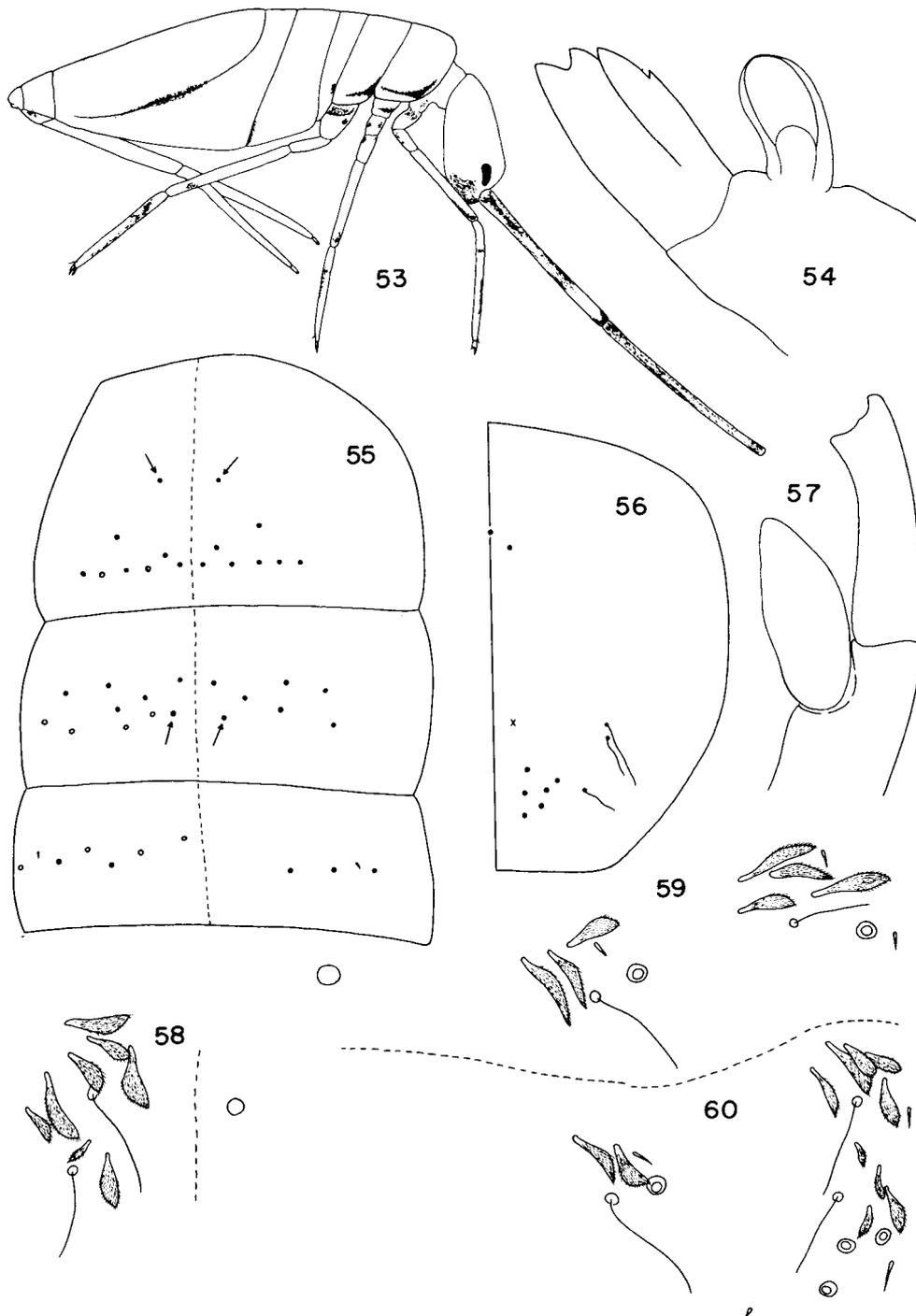
FIGURES 30-37. —*Microparonella incerta*. 30. Coloration. 31. Dorsolateral view of dens with details of dental spines. 32. Mucro. 33. Head macrochaetotaxy. 34. Body macrochaetotaxy. 35. Outer labial papilla. 36. Labial base (setae a3-a5, L1 and L2 not illustrated) 37. Maxillary palp.



FIGURES 38-45. - *Microparonella incerta*. 38. Metathoracic claws. 39. Apex of Ant. 4. 40. Labral papillae. 41. Labrum. 42. Eyes and interocular setae. 43. Chaetotaxy of Abd. 2. 44. Chaetotaxy of Abd. 3. 45. Setae associated with bothriotrachea of Abd. 4.



FIGURES 46-52. —*Campylothorax sabanus*. 46a. Coloration of typical specimen. 46b. Dorsal view of Abd. 4 of same specimen. 47. Maxillary palp. 48. Mucro. 49. Coloration of dark specimen. 50. Head macrochaetotaxy. 51. Outer labial papilla; arrow points to outer part of head. 52. Labial chaetotaxy.



FIGURES 53-55. —*Salina tristani*. Figs. 56, 58-60. *Campylothorax sabanus*. 57. *Salina wolcottii*. 53. Coloration. 54. Mucro. 55. Macrochaetotaxy of Th. 3 to Abd. 1; right side illustrates usual arrangement of setae, left side illustrates variable setae (circles); arrows point to setae absent in *S. dedoris* and *S. hermana*. 56. Abd. 4 macrochaetotaxy, pseudopores (x) and bothriotricha. 57. Mucro. 58. Setae associated with anterior bothriotricha of Abd. 4. 59. Chaetotaxy of Abd. 2. 60. Chaetotaxy of Abd. 3.