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A new species of *Pronura* (Neanuridae: Paleonurini) from the Luquillo Mountains, Puerto Rico with a key to American poorly tuberculated Paleonurini

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Abstract

A new species of *Pronura* from the Luquillo Experimental Forest on Northeastern Puerto Rico is described and illustrated. *Pronura yunquensis* **sp. nov.** differs from other Neotropical *Pronura* in the absence of eyes and can be separated from other species of the genus by the presence of a head tubercle (De), the displacement of Di1 in Abd IV and the fused tubercles De+DL in Abd V. A key for identification to American species of *Paramanura, Pronura* and *Paleonura* is included.

Key words: Collembola, chaetotaxy, Greater Antilles, Luquillo Experimental Forest, subtropical forest, taxonomy

Introduction

The Caribbean fauna of Neanuridae is poorly known and in particular, few species have been reported for Puerto Rico (Ospina-Sánchez 2019) and Cuba (Díaz-Azpiazu *et al.* 1996). In a recent checklist of Collembola from Puerto Rico (Ospina-Sánchez *et al.* 2020), twenty-five species were reported including two species belonging to the Paleonurini tribe: *Paleonura borincana* Palacios-Vargas and Soto-Adames, 2017 and *Pronura yunquensis* **sp. nov.** The latter is described here.

The genus *Pronura* was created to accommodate *P. kilimanjarica* (Delamare Deboutteville, 1953) from Tanzania. To the date, 53 species are listed in this genus (Bellinger *et al.* 1996–2020). All of them are tropically distributed, mainly found in Africa and southeast Asia although a few others are known from Australia, southwestern Asia and South America (Palacios-Vargas *et al.* 2011). In South America, three species have been described: *P. amazonica* Cassagnau & Oliveira, 1990 from Brazil, *P. gaucheri* Palacios-Vargas *et al.*, 2011 from French Guayana and *P. paraguayana* Palacios-Vargas *et al.*, 2011 from Paraguay. The new species described below is the first record of the genus in Puerto Rico.

Materials and methods

The material used to describe the new *Pronura* species came from a survey of the Collembola inhabiting the Luquillo Experimental Forest (also known as El Yunque National Forest) in the Luquillo Mountains of Puerto Rico carried out in 2014 and 2015 in three forest types. Firstly the Tabonuco *(Dacryodes excelsa* Vahl) forest which occupies areas below 600 m. Secondly the mid-elevation, Palo colorado *(Cyrilla racemiflora* L.) forest which occurs in areas above the cloud condensation level from 600–900 m. Thirdly the elfin forest (*Tabebuia rigida* Urban), with stunted vegetation and waterlogged anoxic soils, which is located only on the highest peaks above 900 m (Gould *et al.* 2006). Those forests represent subtropical wet and subtropical rain forest life zones in Puerto Rico (Ewel & Whitmore 1973).

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Collembola were extracted using a Berlese-Tullgren funnel and stored in 95% ethanol. We identified 16 families (*sensu* Deharveng 2004 and Soto-Adames *et al.* 2008), 37 genera and 60 species, among them 15 species are new (Ospina-Sánchez 2019). Collected specimens were cleared using Nesbitt solution and fixed on slides using Mac André II solution (Mari Mutt 1979). To harden the solution, the slides were dried in a slide warmer at 45 to 50°C for seven days. Finally, each specimen was labelled with its collecting data. Specimens were examined with a Leica DM500 phase–contrast microscope. The drawings were made with the aid of a drawing tube. All the type material is kept at corresponding author's institution.

The terminology used in the text and Tables follows Palacios-Vargas & Soto-Adames 2017 (partly derived from Deharveng 1981, 1983) and D'Haese (2003). Ventral chaetotaxy follows Smolis (2008).

Abbreviations. Types of setae: M—long macroseta, me—mesoseta mi—microseta, ss—sensorial seta, S.g.d.—dorsal guard sensillum of Ant III, S.g.v.—ventral guard sensillum of Ant III. General morphology: Abd–abdominal segment, Ant—antennal segment, Th—thoracic segment. Setal groups and/or tubercles on head and tergites: Af—antenno–frontal, Cl—clypeal, De—dorso–external, Di—dorso–internal, DL—dorso–lateral, L–lateral; Oc—ocular, So—subocular. Setal groups of sternites: Ag—ante–genital, An—anal, Fu–furcal vestige; Ve—ventro–external, Vi–ventro–internal, VL—ventro–lateral, VT—ventral tube. Legs: Cx—coxa, Fe—femur, Scx2—subcoxa 2, Tr–trochanter, Tita—tibiotarsus. Ventral chaetotaxy of head: Vea—ventro–externo–anteriores, Vem—ventro–externo–mediales and Vep—ventro–extero–posteriores. Ventral chaetotaxy of abdomen IV. Vel—ventro–externo–laterales, Vec—ventro–externo–centrales and Vei—ventro–externo–internales. Ventral Ant III chaetotaxy: vi—ventro internal, ve—ventro central, ve—ventro external.

Taxonomy

Diagnosis of Genus *Pronura* Delamare Deboutteville, 1953

Individuals without pigment, with dorsal tubercles poorly developed or absent, usually without reticulations or tertiary granulations. Maxilla needle–like, mandible bi or tridentate, 2 + 2 unpigmented eyes, sometimes absent; sensilla on Ant. IV subequal. Posterior tergites not fused. Without additional sensorial setae on the lateral group of abdominal tergites. Di setae, at least Di1, shifted towards De on Abd. V. Tibiotarsi tenent hairs undifferentiated, unguis without teeth (Palacios-Vargas *et al.* 2011).

Pronura yunquensis sp. nov. Ospina-Sánchez, Palacios-Vargas and González

Figs.1–7, Tables 1A–C

Diagnosis of the species: This is the first Neotropical species without eyes and the combination of the following characters: head tubercles De, DL and O present, setae D and Ocp absent. Abd IV with Di1 shifted toward De. Abd V Di2 is close to the middle line and De+DL are fused with two thick macrosetae, one sensillum, one pointed macroseta, and one microseta.

Type material: ***Holotype:*** male on slide. ***Paratypes:*** 2 males, 1 female on slides. All type material kept at corresponding author's institution.

Type Locality: Puerto Rico, Fajardo, Pico del Este, 18° 16' 17"N, 65 °45' 40"W; 987 m a.s.l; *Tabebuia rigida* forest type, 19.ii.2015. Puerto Rico, Luquillo, Toro Trail 18° 16' 40"N, 65 °50' 53"W; 815 m a.s.l; *Cyrilla racemiflora* forest type, 19.ii.2015.

Other material: 1 immature on slide, Puerto Rico, Luquillo, Yunque Peak 18° 18' 37"N, 65 °47' 26"W 1045 m a.s.l.; *Tabebuia rigida* forest type, 4.xi.2014. 1 immature on slide, Puerto Rico, Fajardo, Pico del Este, 18° 16' 17"N, 65 °45' 40"W; 987 m a.s.l; *Tabebuia rigida* forest type, 4.xi.2014. C. M. Ospina–Sánchez Coll.

Description: Length adult n=4, 0,895 mm (0,769–1,02); immature n=2, 0,64 (0, 598–0,682) . Color in alcohol white. Granulation fine. Only dorso-lateral tubercles on Abd III, IV and V well developed. Body clothing comprising microsetae (less than 1µm); mesosetae (1–2µm); thick, hyaline macrosetae (3–5µm), and acuminate macrosetae (4–5µm), in addition to sensorial setae (3–4µm) (Fig.1)

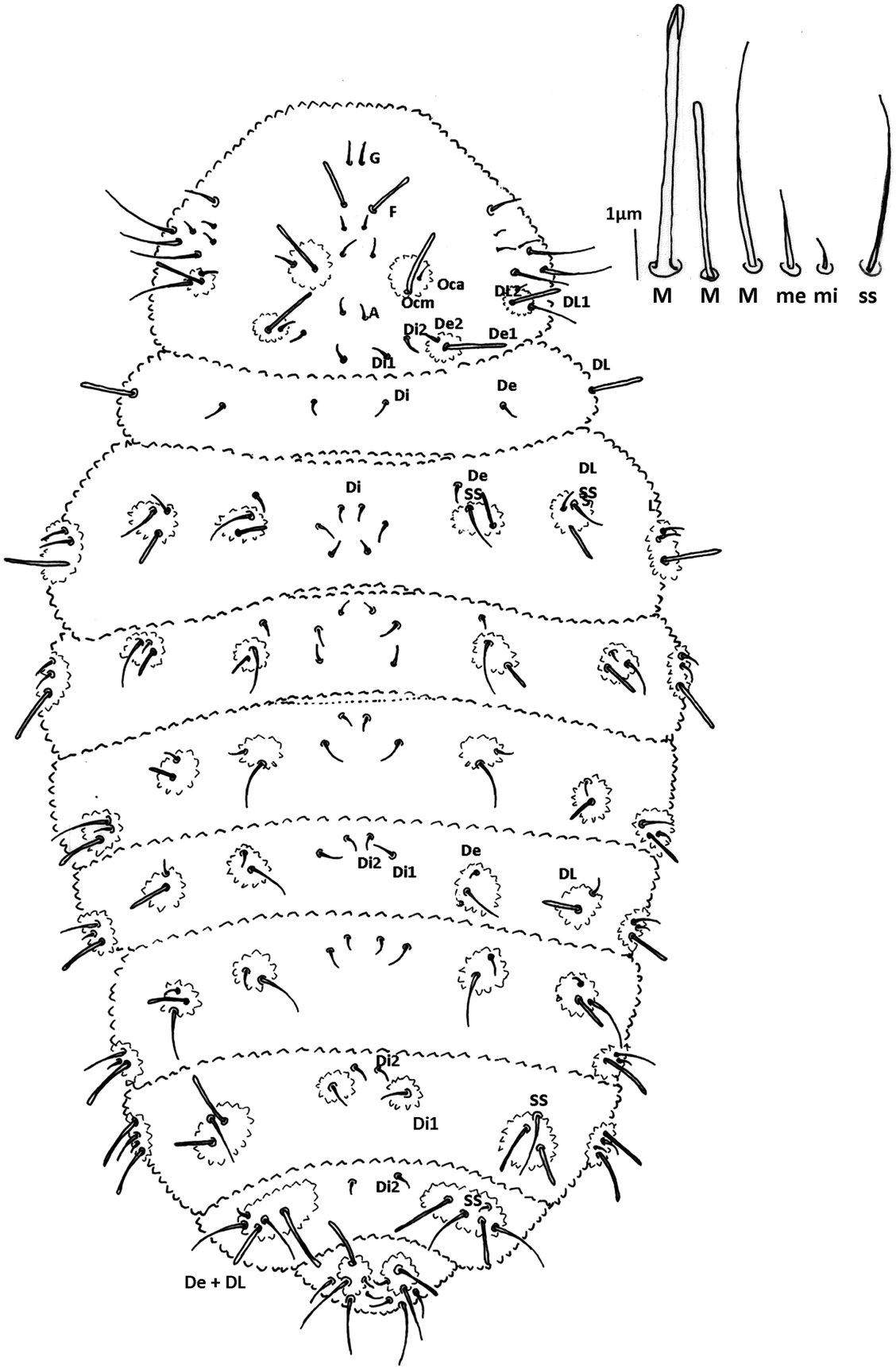

FIGURE 1. *Pronura yunquensis* **sp. nov**. Dorsal body chaetotaxy.

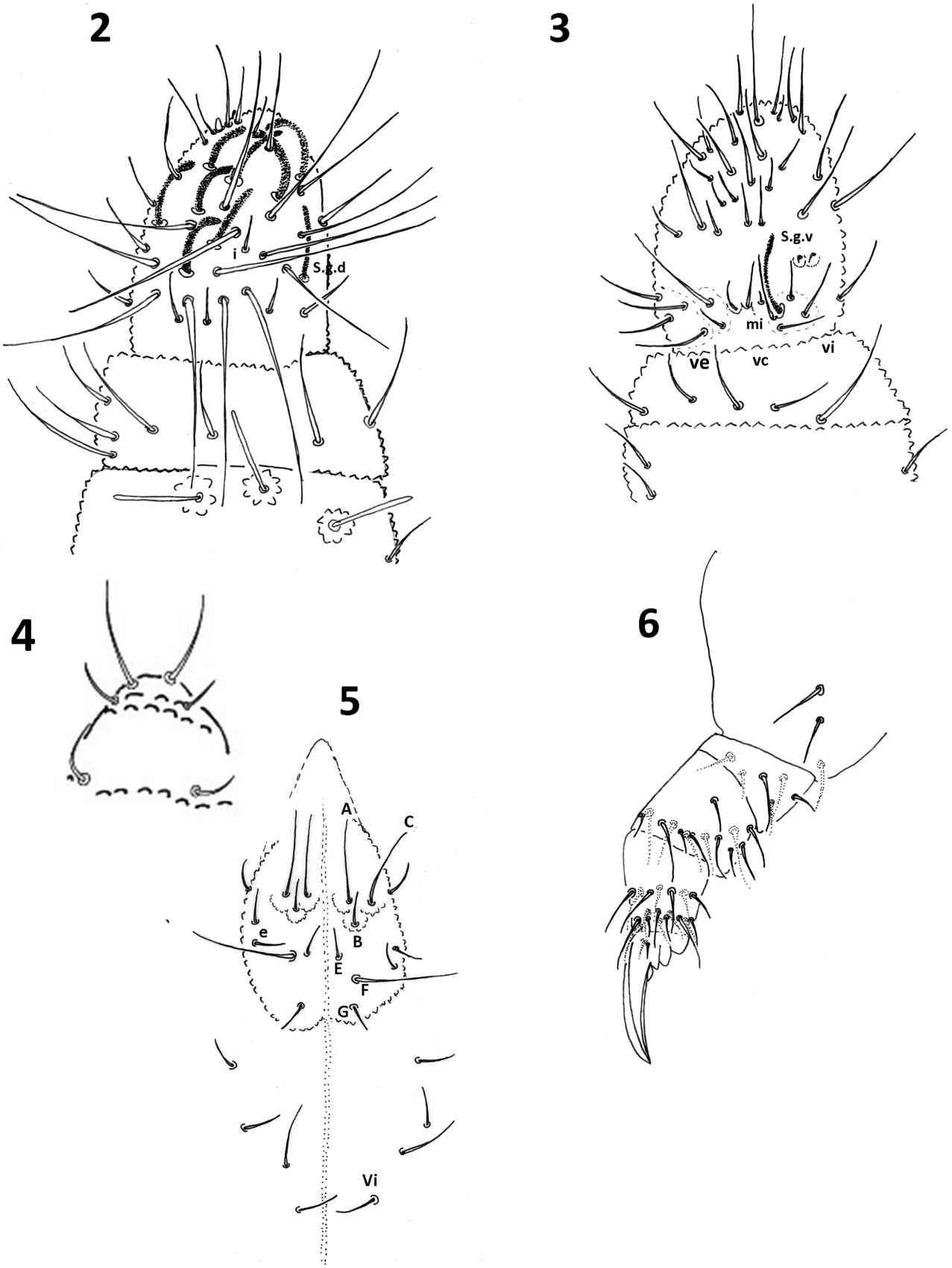

FIGURE 2–6. *Pronura yunquensis* **sp. nov**. 2 Antenna dorsal chaetotaxy; 3. Antenna ventral chaetotaxy; 4. Labrum; 5. Labium; 6. Leg I.

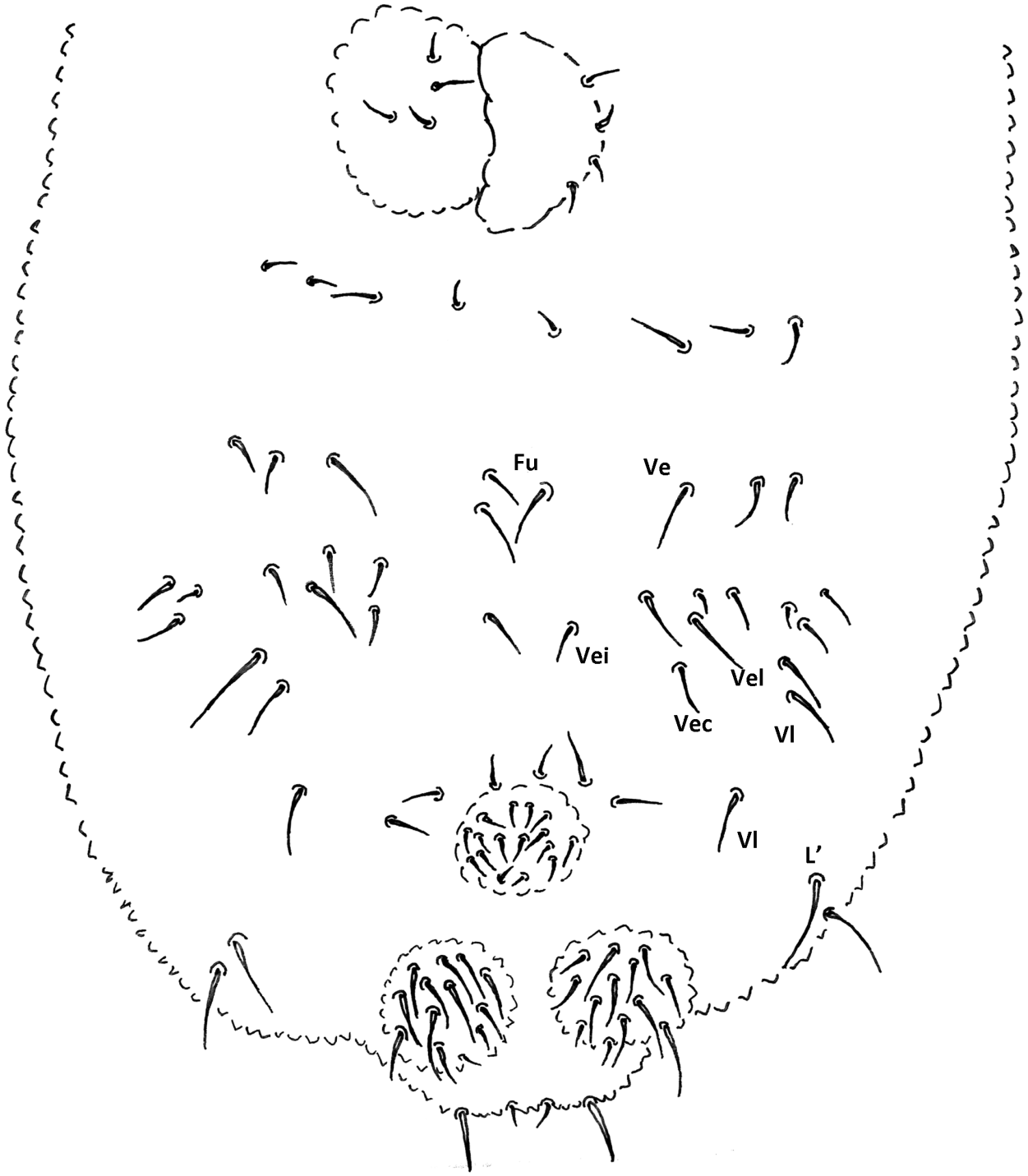

FIGURE 7. *Pronura yunquensis* **sp. nov**. Ventral abdominal chaetotaxy.

Head. Antenna shorter (ratio head: antenna: 1:0.47) than head diagonal. Ant III and IV fused dorsally, ventral separation well marked. Ant IV dorsally with eight subequal sensilla, twelve long and pointed setae, apical organ differentiated, subapical bulb absent (Fig. 2). Ant III dorsally with two globular sensilla in a cuticular fold and two guard sensilla. S.g.v. almost straight and subequal to S.g.d.; one ventral microsensillum (Fig. 3). Ant II with eleven setae. Ant. I with seven setae, including three macrosetae with blunt tips (Fig. 2).

Eyes absent. Head with three pairs of weakly delimited tubercles, and dorsal chaetotaxy as in Fig. 1 and Table 1A. Mandibles styletiform, maxillae with a hook shape. Labrum elongate, rounded apically; formula 0/2,4 (Fig. 4). Labium with-ten pairs of setae (Fig. 5). Four setae Vi on ventral side of head (Fig. 5), head ventral chaetotaxy in Table 1B.

Thoracic and abdominal dorsal chaetotaxy as in Fig. 1 and Table 1C. Abd VI unilobed, lacking tubercle. Setal numbers on legs as in Table 2. Unguis without inner teeth (Fig. 6).

Ventral tube with 4+4 setae. Furcal vestige with two regular setae and one microsetae. Ventral chaetotaxy as shown in Table 1C and Fig.7. Male genital plate with 3+3 pregenital, twelve circumgenital and four pairs of eugenital setae. Each lateral anal valve with eleven regular setae and two microsetae (Fig. 7).

Etymology: *yunquensis* is a reference of the locality were the species was found on mountain peaks at El Yunque National Forest in Puerto Rico.

TABLE 1. Complete chaetotaxy of *Pronura yunquensis* **sp. nov**. per semi–tergites.

A. Cephalic chaetotaxy—dorsal side.

Head setae group	Tubercles	Number of setae	Seta Type	Setae
Cl	–	1	M	F
	–	1	m	G
Af	–	2	me, m	AB
	–	1	m	C
Oc	±	1	M	Ocm
	±	1	mi	Oca
Di	–	2	m	Di1,Di2
De	+	1	M	De1
	+	1	mi	De2
DL	±	3	2M, mi	DL1, DL2
L+Sc[1]	–	7	4M, 3me	L1–4
Total	1	20		

B. Cephalic chaetotaxy—ventral side

	Number of setae
Vi	4
Vea	4
Vem	3
Vep	4
labium	7

C. Postcephalic, dorsal, ventral and leg chaetotaxy

	Thorax Dorsal					Legs			
	Di	De	DL	L	Scx2	Cx	Tr	Fe	Ti
Th. I	me	me	M	–		3	6	14	19
Th. II	2me	M,mi+ss	M,mi+ss	M,2me		6	6	12	19
Th. III	1mi,-2me	M,mi+ss	M,mi+ss	M,2me		8	6	10	18
	Abdomen Dorsal				Abdomen Ventral				
Abd. I	mi, me	mi+ss	me, mi	M,me, mi	VT:4+4				
Abd. II	mi, me	mi+ss	M, me	M,me, mi	Ve: 4				
Abd. III	mi, me	M+ss	M,me+ss	M, me, mi	Ve:3		Fu:3*		
Abd. IV	mi,me	2M+S		2M. 2mi	Vel:4	Vec:2	Vei: 1	Vl:4	
Abd. V	mi	3M+mi+S		M	Ag:3			Vl:1	L':2
Abd. VI		3M, me, 2mi			Ve: 11me+2mi				

*setae in Fu not paired.

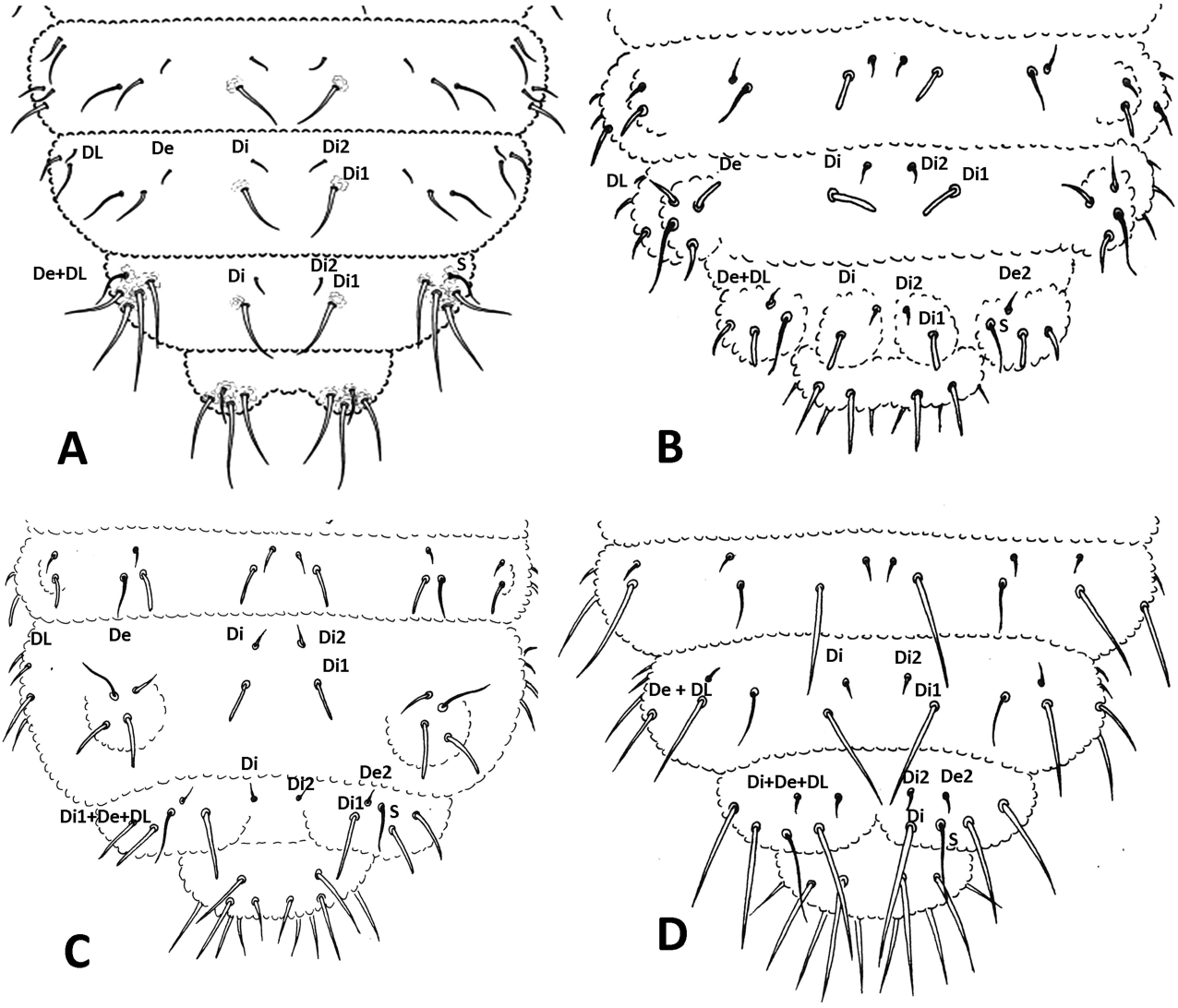

FIGURE 8. Dorsal abdominal chaetotaxy for some genera of Paleonurini, showing the position of setae in Abd IV and V. A. *Paleonura bilinskii* (Paśnik & Weiner, 2013), B. *Paleonura nuda,* C. *Paramanura najtae*, D. *Pronura amazonica* (Cassagnau & Oliveira, 1990).

Key for identification of American poorly tuberculated Paleonurini

1. Abd V with well–defined setal groups 2
- Abd V without well–defined setal groups . . . . . *Paramanura*
DL group on Abd IV is composed by 4 setae and 1 sensillum eg. *P. najtae* Cassagnau & Oliveira 1990 Venezuela
2. Setal group Di on Abd V is composed only of Di2 . . . . . *Pronura* ... 3
- Setal group of Di on Abd V is composed of seta Di and Di2. . . . . *Paleonura* ... 6
3. Only two ocular setae present Oca and Ocm 4
- Three ocular setae present, Oca, Ocm and Ocp . . . . . *P. paraguayana* Palacios-Vargas *et al.*, 2011 Paraguay
4. Af area on head with setae ABCD 5
- Af area on head with only setae A, B and C. . . . . *P. yunquensis* **sp. nov.** Puerto Rico
5. Setal group De in Abd I–III composed by one seta and one sensillum . . . . . *P. gaucheri* Palacios-Vargas *et al.*, 2011 French Guayana
- The group of setae De in Abd I–III is composed by two setae and one sensillum . . . . . *P. amazonica* Cassagnau & Oliveira, 1990 Brazil
6. Three ocular setae present 7
- Fewer than three ocular setae 8
7. Ventral tube with 4+4 setae . . . . . *P. petebellingeri* Palacios-Vargas & Benito, 2007 North America
- Ventral tube with 5+5 setae . . . . . *P. saproxylica* Smolis & Kadej, 2014 North America

8. Only one ocular seta present 9
- Two ocular setae present 10
9. Two eyes per side, De group on Abd IV with one sensillum . . . . . *P. carayoni* Massoud & Thibaud, 1987 Guadeloupe Island, Caribbean
- One eye per side or no eyes, De setal group De on Abd IV fused with DL, with two setae and one sensillum . . . . . *P. miniseta* Massaud & Thibaud, 1987 Guadeloupe Island, Caribbean
10. Setal group De on Abd I–II composed of one seta and one sensillum . . . . . *P. nuda* Cassagnau & Oliveira, 1990 Brasil
- Setal group De on Abd I–II composed of two setae and one sensillum 11
11. Setal group De + DL on Abd IV is composed of 5 setae and one sensillum . . . . . .*P. bilinskii* Pasnik & Weiner, 2013 Ecuador
- Setal group De + DL in Abd IV is composed of two or three setae and one sensillum 12
12. Body macrosetae modified 13
- Body macrosetae acuminated . . . . . *P. pescadorius* Palacios-Vargas & Gómez Anaya, 1995 Mexico
13. Body macrosetae capitate 14
- Body macrosetae barbulate . . . . . .*P. colimana* Palacios-Vargas & Gómez Anaya, 1995 Mexico
14. Setal group De on Abd IV is composed of only one sensillum . . . . . *P. borincana* Palacios-Vargas & Soto-Adames, 2017 Puerto Rico
- Setal group De on Abd IV is composed of one seta and one sensillum . . . . . *P. daniae* Palacios-Vargas & Díaz, 1992 Cuba

Discussion

In the new species the seta Di2 is in the middle line, while Di1 seems located in the single tubercle present in Abd V (Fig. 1). This situation is similar to *P. gaucheri* (Palacios-Vargas *et al.*, 2011) but Di1 is not located in the single tubercle on Abd V. *Pronura yunquesis* **sp. nov**. is the first neotropical species without eyes and the combination of the follow characters: head tubercles De, DL and O present, Abd IV with Di1 shifted toward De. On Abd V Di2 is close to the middle line and De+DL are fused with two thick macrosetae, one sensorial seta, one acuminate macrosetae, and one microsetae. *Pronura yunquensis* **sp. nov**. is similar to *P. gaucheri* but this latter species has four antennal-frontal setae (instead of 3) and 3 setae on De+DL (versus 2+ss) (Table 2). The principal differences with *P. paraguayana* are that this species has relatively long setae and the presence of five tubercles in the head: Cl, Af, Oc (2), De (2), DL + L +So and three ocular setae. More differences are from *P. paraguayana* is because it has most head and body setae clearly barbulate and more abundant cephalic chaetotaxy as on De of Abd. I–III and on De + DL of Abd. IV. This group of species of Paleonurini share the presence of two eyes per side and 2 setae on De tubercle of Th I. Other differences betweenneotropical members of *Paleonura, Paramanura* and *Pronura* are in Table 2. Most interesting is that *P. paraguayana* is the only with 3 ocular setae, while *P. carayoni* and *P. minisetae* only have 2 setae on antennal-frontal tubercle and one ocular seta.

TABLE 2. Comparative Table of South–American, Mexican and Caribbean species of *Paleonura*, *Paramanura* and *Pronura* head and body saeta.

Genera	Species	Head		Body			
		Af	Oc	De Th. II–III	De Abd. I–III	De+DL Abd IV	L Abd I–II
Paleonura	*bilinskii*	ABCD	Oca, Ocm	2+ss	2+ss	4+ss	3
	borincana	ABCD	Ocm, Ocp	2+ss	2+ss	0+ss	2
	carayoni	ABC-	Ocm	2+ss	2+ss	2+ss	2
	colimana	ABCD	Ocm, Ocp	2+ss	2+ss	5+ss	3
	daniae	BCDE	Oca, Ocm	2+ss	2+ss	1+ss	2
	minisetae	--CD-	Ocp	2+ss	1+ss	2+ss	2
	nuda	-B-D-	Oca, Ocm	2+ss	1+ss	3+ss	3
	pescadorius	ABCD	Ocm, Ocp	2+ss	2+ss	4+ss	3
Paramanura	*najtae*	ABD	Oca, Ocm	2+ss	1+ss	4+ss	2
Pronura	*amazonica*	ABCD	Oca, Ocm	2+ss	2+ss	3+ss	2
	gaucheri	ABCD	Oca, Ocm	2+ss	1+ss	3+ss	2
	paraguayana	ABD	Oca, Ocm, Ocp	3+ss	2+ss	4+ss	3
	yunquensis **sp. nov.**	ABC-	Oca, Ocm	2+ss	1+ss	2+ss	3

Among the members of the tribe Paleonurini, it is difficult to separate *Paleonura, Paramanura* and *Pronura* because of the lack of differentiation of the tubercles (Queiroz & Deharveng 2015). Many species in these genera have moved genera; Palacios-Vargas & Deharveng (2014) transferred two of them, *Paleonura friasica* Cassagnau & Oliveira, 1990 and *P. limnophila* Cassagnau & Rapoport, 1962 to *Australonura*, and the genus *Itanaura* was created by Queiroz and Deharveng (2015) to accommodate *P. brasiliensis* Arlé, 1959. Some species need to be revised in light of new characters to confirm their position (Palacios-Vargas & Soto-Adames 2017), or even to validate genera that are still not resolved (Cassagnau 1991). The position of setae Di in Abd V is a diagnostic character to separate such genera (Fig. 8). It would be advisable to carry out a robust phylogenetic analysis including at least two taxa of each genus of the tribe and all the species at least from America to validate or not generic status.

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