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A new invasive weed-feeding species of *Polypedilum* (*Pentapedilum*) Kieffer from South Africa (Diptera: Chironomidae, Chironominae)

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Abstract

Polypedilum (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n. is described and figured as male, female, pupa and larva based on material collected in the Eastern Cape Province in South Africa, imported into quarantine in Ireland and reared in the laboratory. The species feeds on the aquatic weed *Lagarosiphon major* (Ridl.) Moss ex Wager and is regarded as a promising candidate agent for biological control of this invasive weed.

Key words: Chironomidae, *Polypedilum*, *Pentapedilum*, new species, *Lagarosiphon major*, South Africa, Afrotropical region, alien invasive weed

Introduction

The African curly waterweed, *Lagarosiphon major* (Ridl.) Moss ex Wager (Hydrocharitaceae), has become invasive in freshwater habitats in Europe and elsewhere in the world such as New Zealand and infestation of this submersed plant induces changes to native macrophyte, invertebrate and fish communities (e.g. Howard-Williams & Davies 1988; Bickel & Closs 2008; Hussner 2012). A native of southern Africa, *L. major* is a potential target for biological control and biological studies on an undescribed *Polypedilum* species found to mine the plant's shoot tips in its native range have been conducted (Earle *et al.* 2013). A population of the midge was imported into quarantine in Ireland and reared in the laboratory. Below we describe the species based on males, females, pupae and larvae from this laboratory culture and place it in the subgenus *Pentapedilum* Kieffer, 1913.

Polypedilum Kieffer, 1912 is the most species rich genus of Chironomidae, with more than 440 described species worldwide. Nine subgenera are generally recognized, of which eight occur in the Afrotropical Region: *Cerobregma* Sæther *et* Sundal, 1999; *Kribionympha* Kieffer, 1921; *Pentapedilum*; *Probolum* Andersen *et* Sæther, 2010; *Tripedilum* Kieffer, 1921; *Tripodura* Townes, 1945; *Uresipedilum* Oyewo *et* Sæther, 1998 and *Polypedilum sensu stricto*; only *Asheum* Sublette *et* Sublette, 1983 has not been recorded from the region (see Sæther *et al*. 2010; Epler *et al.* 2013). A total of nearly 90 named *Polypedilum* species are currently recorded from the Afrotropical Region (Sæther & Sundal 1999; Vårdal *et al*. 2002; Oyewo & Sæther 2008; Sæther *et al*. 2010; Cranston 2014), of which 10 are assigned to subgenus *Pentapedilum*. A world revision of the subgenus was published by Oyewo and Sæther (2008). Later, Tang *et al.* (2014) have described the immature stages of *Pentapedilum nodosum* (Johannsen, 1932) and Pinho *et al.* (2015) have published a new species from Brazil.

Polypedilum larvae occur in virtually all standing and flowing waters with the exception of the high arctic and high mountains (Epler *et al.* 2013). Most species prefer sediments, but some are found on hard substrata and some feed on healthy tissues of water plants. A few species are also specialising in plant-held waters (phytotelmata) (e.g. Pinho *et al.* 2013). *Polypedilum* (*Po.*) *vanderplanki* Hinton, 1951 is known to inhabit temporal pools and can remain desiccated for years (e.g. Kikawada *et al.* 2005). A second inferred desiccation tolerant species, *P.* (*Po.*)

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ovahimba Cranston, 2014, has recently been described in all stages from rock-pools on the Waterberg Plateau, Namibia (Cranston 2014).

Material and methods

The field surveys and laboratory cultures are described in detail in Earle *et al.* (2013). The specimens examined were preserved in alcohol and later mounted on slides in Canada balsam following the procedure outlined by Sæther (1969). The general terminology follows Sæther (1980). The measurements are given as ranges, followed by the mean when more than three specimens were measured, followed by the number of specimens measured (n) in parenthesis.

The holotype and most paratypes are deposited in the Department of Natural History, University Museum of Bergen, Bergen, Norway (ZMBN). Other paratypes are deposited in the Albany Museum, Grahamstown, South Africa (AMGS); the National Museum of Ireland, Dublin, Ireland (NMID); and in the Zoologische Staatssammlung München, Munich, Germany (ZSM).

Polypedilum (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n.

(Figures 1–26)

Type material. Holotype male. **South Africa:** Eastern Cape Province, north of Cala, 31.41817ºS 27.7815ºE, 4.VI.2011, leg. J.-R. Baars & W. Earle; reared in laboratory in Ireland IX.2011 (ZMBN). Paratypes: 23 males, 10 females, 3 mature male pupae, 5 mature female pupae, 21 pupal exuviae, 11 fourth instar larvae, as holotype (AMGS, NMID, ZMBN, ZSM).

Etymology. From Latin *tuburcinatus* meaning eats greedily, referring to the species feeding on the aquatic weed *Lagarosiphon major* (Ridl.) Moss ex Wager.

Diagnostic characters. The male can be separated from other *Pentapedilum* species with the following combination of features: more than 100 setae in each of cells m_{1+2} and r_{4+5}, less than 6 setae in cell m basal of RM, fore tibial scale without spur, base of superior volsella with microtrichia and apical seta of the inferior volsella prominent, reaching apex of gonostylus by having an AR of about 0.8 and more than 10 setae on scutellum. The female can be separated from other known females with the following combination of features: unbanded abdomen, spherical seminal capsules and broadly triangular postgenital plate by having a ventrolateral lobe without brush. However, both sexes can easily be separated from all other described *Pentapedilum* species on the short fifth palpomere; in both sexes the ratio fifth palpomere / third palpomere is < 1.0, while in all other species this ratio is > 1.0. The pupa can be separated from other known pupae with the following combination of features: strong anterior band of spinules and median and posterior shagreen on tergite II, anterolateral spinules on tergite VII, conjunctive III/IV with spinules and pedes spurii B on segment II comparatively well developed by having about 100 µm long frontal setae and anterolateral patches of spinules on tergite VIII. The larva can be separated from other known larvae with the following combination of features: mandible with dorsal tooth, mentum with median teeth slightly longer than second lateral teeth, and third antennal segment slightly shorter than fourth as the combined length of third and fourth antennal segment is subequal to second segment by having minute Lauterborn organs.

Description. Male (n = 5). Total length 3.34–3.65, 3.53 mm. Wing length 1.77–2.04, 1.92 mm. Total length / wing length 1.78–1.91, 1.84. Wing length / length of profemur 1.84–2.02, 1.95.

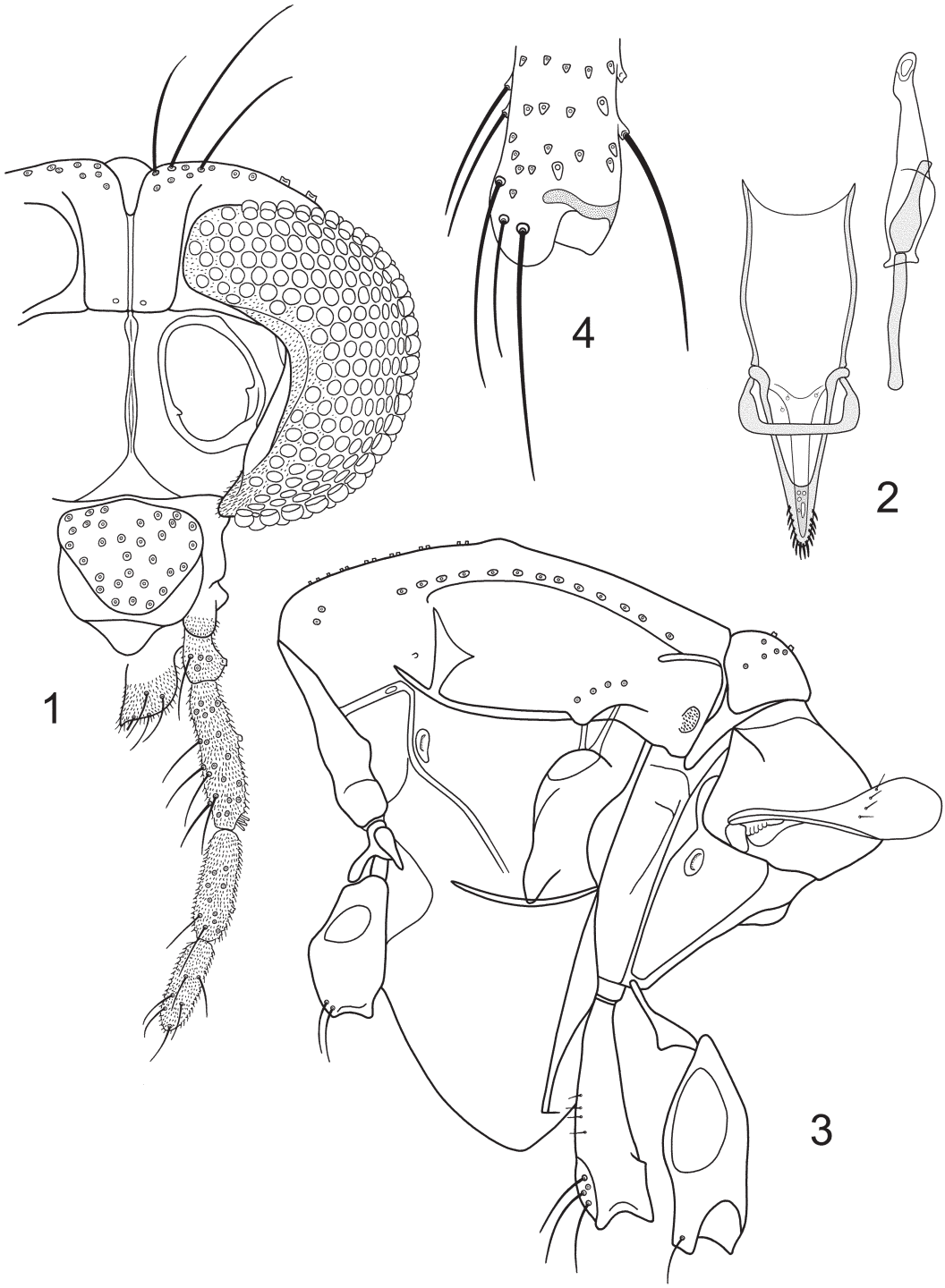
Coloration. In Canada balsam, head, thorax, legs and abdomen brown; wing membrane light brownish. According to Earle *et al.* (2013) live adults have light brown thorax and green abdomen.

Antenna. AR = 0.81–0.87, 0.84. Ultimate flagellomere 372–404, 389 µm long.

Head (Fig. 1). Temporal setae 10–15, 13 including 6–9, 8 inner verticals, partly biserial; 3–4, 4 outer verticals and 1–2, 2 postorbitals. Clypeus with 23–30, 25 setae. Tentorium, stipes and cibarial pump as in Figure 2. Tentorium 131–160, 149 µm long; 30–33, 31 µm wide at sieve pore. Stipes 137–141, 139 µm long. Palpomere lengths (in µm): 35–43, 39; 55–65, 62; 117–125, 120; 86–94, 91; 76–84, 80. Fifth palpomere / third palpomere 0.65–0.68, 0.67. Third palpomere with 3–6 lanceolate sensilla clavata apically; longest 13–19, 15 µm long.

Thorax (Fig. 3). With distinct tubercle in mid scutum. Acrostichals 11–14, 13, biserial; dorsocentrals 12–16, 14, of which 1–2, 2 separate, close to anterior margin of scutum; prealars 4–6, 5. Scutellum with 11–16, 13 setae, partly biserial.

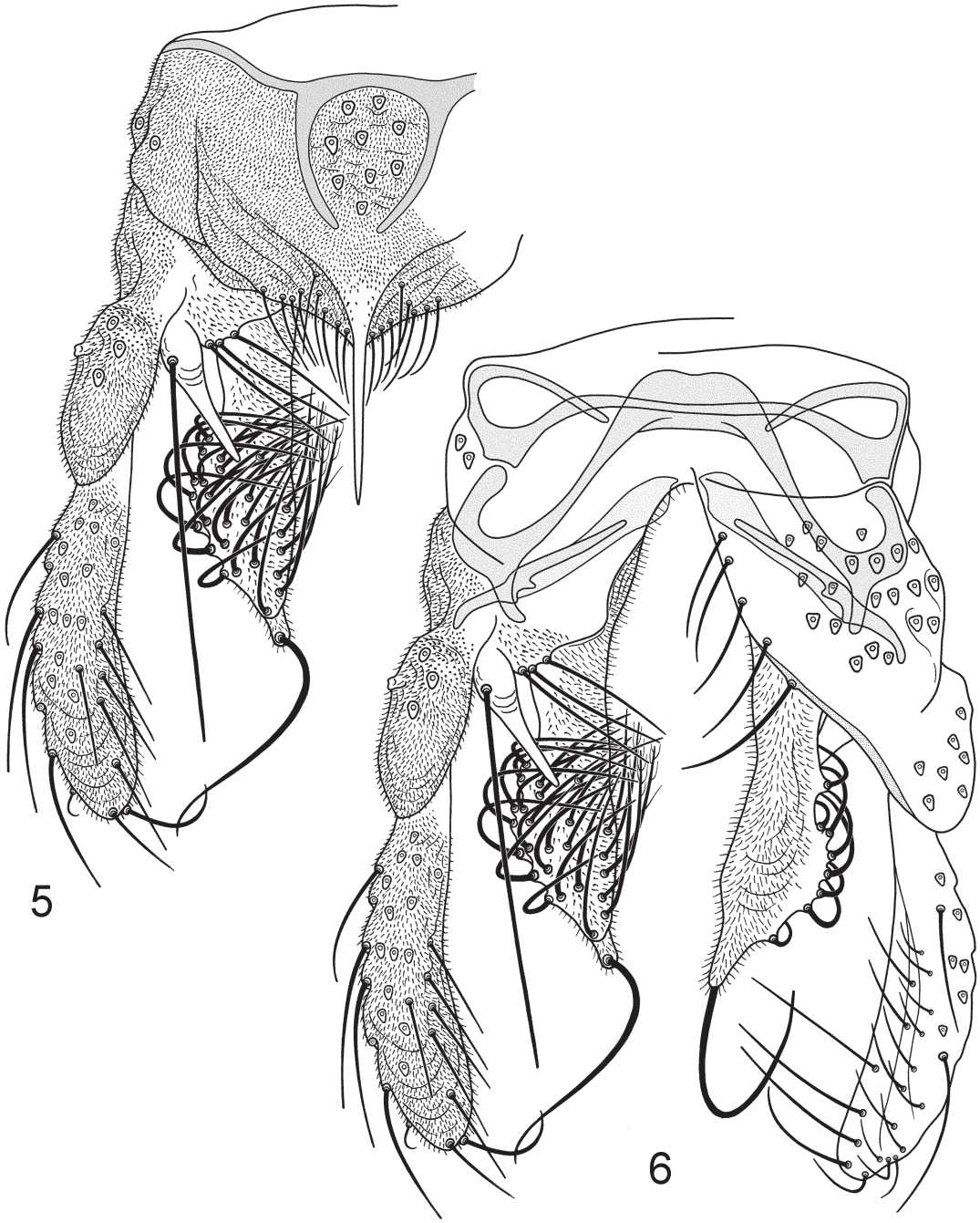
Wing (Fig. 7). Anal lobe moderately developed. VR 1.15–1.18, 1.17. Brachiolum with 2 seta; R with 24–28, 26; R_1 with 14–18, 16; R_{4+5} with 33–41, 38; SC with 8–11, 9; M with 1–3, 2; M_{1+2} with 53–59, 56; M_{3+4} with 21–24, 22; Cu with 30–39, 34; Cu_1 with 12–14, 13; PCu with 1–6, 2; An with 35–40, 38 setae. Cell r_{4+5} with 114–145, 130; cell m_{1+2} with 99–126, 113; cell m_{3+4} with 39–48, 43; cell m basal of RM with 2–5, 3; cells cu plus an with 86–126, 104 setae. Squama with 6–10, 8 setae.



FIGURES 1–4. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., male. 1. Head. 2. Tentorium, stipes and cibarial pump. 3. Thorax. 4. Scale of fore tibia.

Legs. Scale on fore tibia (Fig. 4) 28–39, 29 µm long; without apical spur. Spur of mid tibia 44–52, 49 µm long including comb; unspurred comb 19–23, 22 µm long. Spur on hind tibia 58–66, 61 µm long including comb;

unspurred comb 22–25, 24 µm long. Width at apex of fore tibia 55–61, 58 µm; of mid tibia 58–63, 61 µm; of hind tibia 65–72, 68 µm. Length and proportions of legs as in Table 1.



FIGURES 5–6. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., male. 5. Hypopygium, dorsal view. 6. Hypopygium with anal point and tergite IX removed, dorsal aspect to the left and ventral aspect to the right.

Hypopygium (Figs 5–6). Tergite IX with 9–11, 10 strong, median setae and 8–11, 10 setae to each side of base of anal point of which 3–6, 4 on the ventral side. Laterosternite IX with 5–6, 5 setae. Anal point 99–110, 104 µm long; 25–36, 29 µm wide at base, narrow, tapering to pointed apex. Transverse sternapodeme 51–59, 55 µm long; phallapodeme 110–134, 121 µm long. Gonocoxite 200–228, 210 µm long. Superior volsella (Fig. 12) 86–98, 91 µm long; base covered with microtrichia; with 3–4, 3 inner setae; projection straight, tapering towards apex, with 1 dorsolateral seta, 145–190, 160 µm long. Inferior volsella 158–170, 163 µm long; 31–37, 34 µm wide basally; 41–47, 44 µm wide medially; 8–10, 9 µm wide apically; with 1 strong apical seta and 21–26, 23 dorsal setae of which 3–5, 3 setae along inner margin with split apices. Gonostylus 164–172, 168 µm long; with 3–4, 4 long setae along inner margin. HR 0.96–1.39, 1.22. HV 2.06–2.33, 2.20.

TABLE 1. Lengths (in µm) and proportions of legs of *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., male (n = 5).

	fe	**ti**	**ta_1**	**ta_2**
p_1	923–1111, 992	605–735, 663	923–1201, 1038	637–760, 676
p_2	940–1087, 993	760–964, 871	335–507, 440	286–310, 292
p_3	989–1168, 1070	956–1038, 991	670–801, 712	368–433, 395
	ta_3	**ta_4**	**ta_5**	**LR**
p_1	474–556, 512	327–392, 355	147–180, 165	1.20–1.58, 1,49
p_2	229–253, 239	147–173, 157	74–90, 82	0.51–0.53, 0.52
p_3	319–376, 346	188–221, 208	98–106, 100	0.69–0.77, 0.72
	BV	**SV**		**BR**
p_1	1.55–1.62, 1.57	1.54–1.66, 1.60		2.15–2.47, 2.33
p_2	2.97–3.14, 3.06	4.03–4.17, 4.09		2.63–3.07, 2.86
p_3	2.62–2.69, 2.66	2.76–3.02, 2.90		3.11–3.38, 3.18

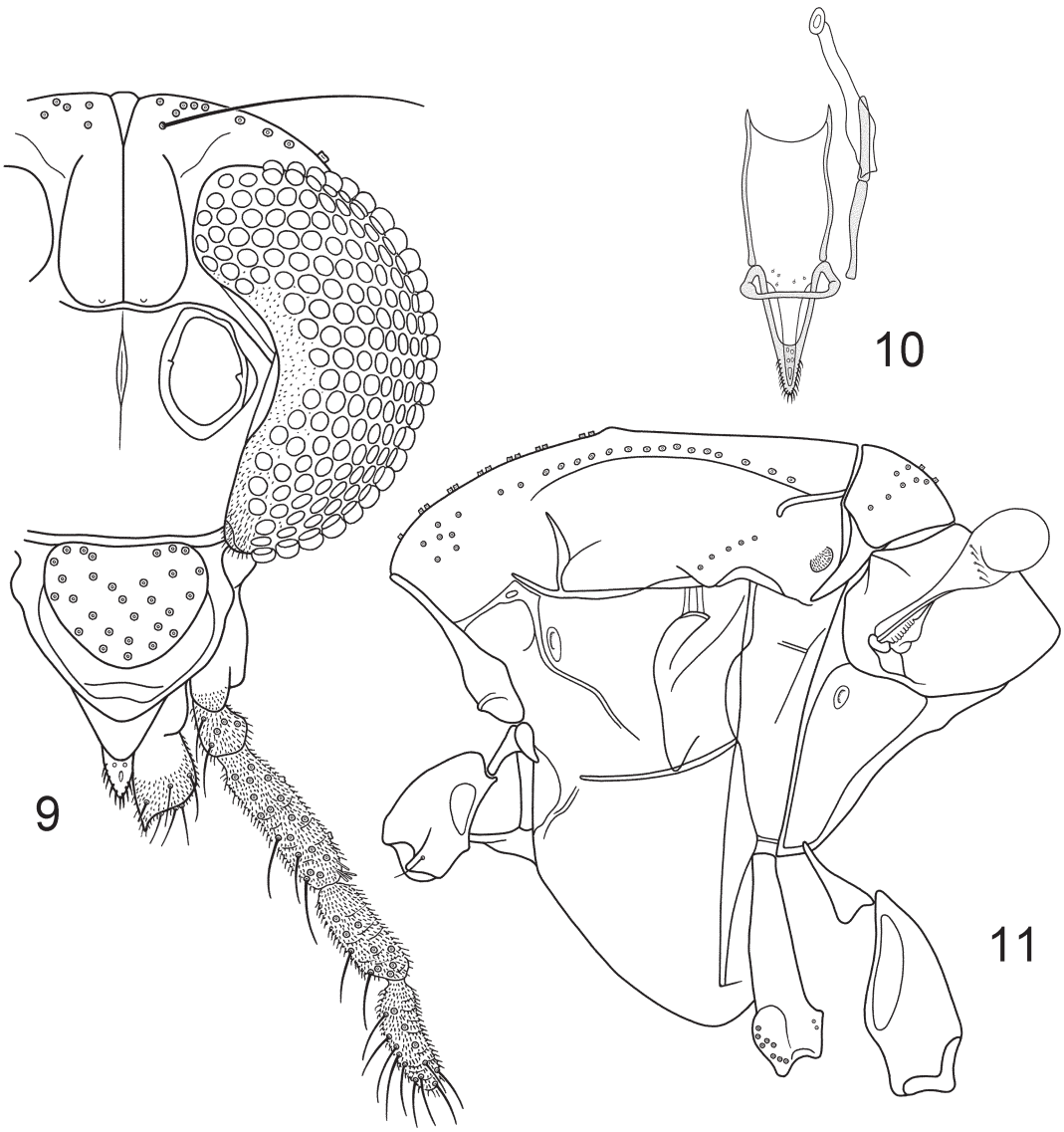
Female (n = 5). Total length 2.43–2.97, 2.64 mm. Wing length 1.79–2.00, 1.87 mm. Total length / wing length 1.36–1.48, 1.41. Wing length / length of profemur 2.19–2.29, 2.23.

Coloration. As in male.

Antenna. AR = 0.36–0.38, 0.37. Flagellomere lengths (in µm): 128–152, 144; 80–92, 86; 88–96, 91; 64–76, 69; 132–152, 142. Longest sensilla chaetica on ultimate flagellomere 25–35, 32 µm long.

Head (Fig. 9). Temporal setae 12–14, 13 including 5–7, 6 inner vericals; 4–5, 5 outer verticals and 1–2, 2 postorbitals. Clypeus with 30–42, 35 setae. Tentorium, stipes and cibarial pump as in Figure 10. Tentorium 150–162, 156 µm long; 16–25, 21 µm wide at sieve pore. Stipes 131–149, 142 µm long. Palpomere lengths (in µm): 30–40, 34; 41–57, 50; 98–121, 113; 79–104, 89; 80–94, 85. Fifth palpomere / third palpomere 0.75–0.82, 0.78. Third palpomere with 5–8, 7 lanceolate sensilla clavata apically; longest 11–15, 13 µm long.

FIGURES 7–8. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., wings. 7. Male. 8. Female. (Photos Linn K. Hagenlund).

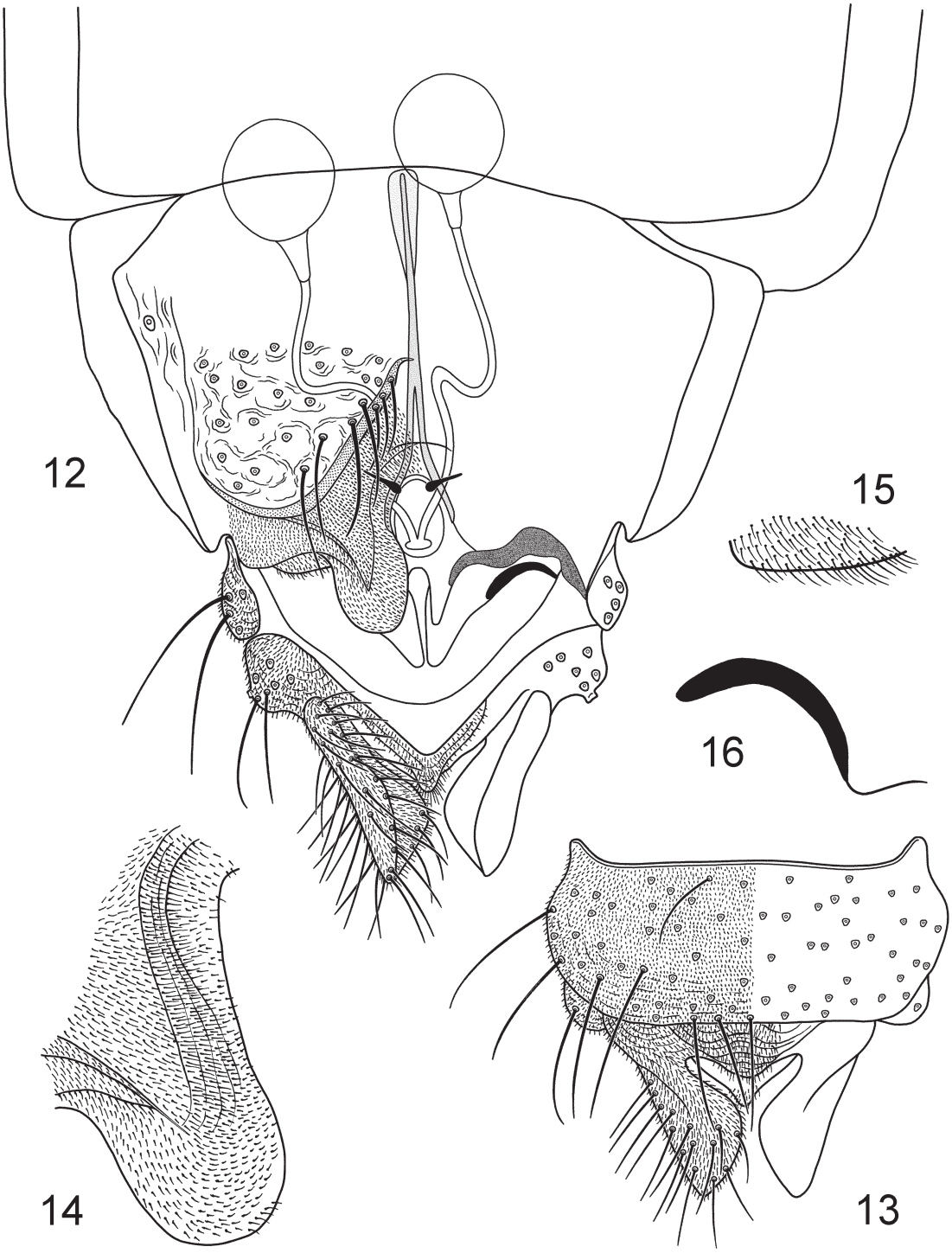


FIGURES 9–11. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., female. 9. Head. 10. Tentorium, stipes and cibarial pump. 11. Thorax.

Thorax (Fig. 11). With low, but distinct tubercle in mid scutum. Acrostichals 9–12, 11, partly biserial; dorsocentrals 17–22, 18 of which 3–6, 5 in separate cluster close to anterior margin of scutum; prealars 4–5, 5. Scutellum with 13–16, 14 setae, biserial.

Wing (Fig. 8). Anal lobe moderately developed. VR 1.16–1.21, 1.19. Brachiolum with 2 seta; R with 19–30, 23; R_1 with 16–22, 18; R_{4+5} with 37–49, 43; SC with 6–12, 9; M with 0–3, 2; M_{1+2} with 52–73, 62; M_{3+4} with 18–25, 20; Cu with 24–32, 30; Cu_1 with 12–14, 13; PCu with 2–4, 3; An with 31–47, 38 setae. Cell r_{4+5} with 108–152, 122; cell m_{1+2} with 68–178, 99; cell m_{3+4} with 12–55, 32; cell m basal of RM with 0–7, 4; cells cu plus an with 32–141, 77 setae. Squama with 5–8, 7 setae.

Legs. Scale on fore tibia 25–35, 29 µm long, without spur. Spur of mid tibia 40–52, 48 µm long including comb; unspurred comb 19–25, 23 µm long. Spur on hind tibia 48–59, 54 µm long including comb; unspurred comb 22–29, 25 µm long. Width at apex of fore tibia 52–61, 56 µm; of mid tibia 58–68, 62 µm; of hind tibia 62–72, 66. Length and proportions of legs as in Table 2.



FIGURES 12–16. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., female. 12. Genitalia, ventral view. 13. Tergite IX. 14. Dorsomesal lobe. 15. Ventrolateral lobe. 16. Apodeme lobe.

Genitalia (Figs 12–13). Gonocoxapodeme curved, ending on base of dorsomesal lobe. Sternite VIII with 21–35, 27 strong setae to each side. Gonocoxite IX with 4–6, 5 setae. Tergite IX (Fig. 14) with 62–79, 72 setae. Segment X with 6–9, 7 setae to each side. Cercus 91–116, 102 µm long. Seminal capsule spherical, 62–72, 67 µm long; not including 12–19, 14 µm long neck. Notum 144–173, 157 µm long. Dorsomesal lobe (Fig. 14) 97–108, 102 µm long from base of vagina to apex; 80–97, 90 µm wide. Ventrolateral lobe (Fig. 15) 23–35, 28 µm wide. Apodeme lobe as in Figure 16. Postgenital plate broadly triangular.

TABLE 2. Lengths (in µm) and proportions of legs of *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., female (n = 5).

	fe	ti	ta_1	ta_2
p_1	776–858, 835	523–621, 580	801–940, 863	515–605, 560
p_2	842–1021, 933	768–923, 843	359–441, 395	229–278, 253
p_3	940–1152, 1031	874–1021, 943	539–686, 611	327–384, 350
	ta_3	ta_4	ta_5	LR
p_1	384–441, 413	261–327, 291	123–147, 134	1.42–1.51, 1.48
p_2	188–221, 208	114–147, 136	49–65, 59	0.46–0.48, 0.47
p_3	286–327, 312	163–196, 178	65–82, 72	0.53–0.70, 0.65
	BV	SV		BR
p_1	1.61–1.65, 1.63	1.63–1.68, 1.65		2.14–2.57, 2.44
p_2	3.22–3.39, 3.32	4.35–4.67, 4.49		2.57–2.79, 2.66
p_3	2.69–3.10, 2.84	2.93–4.03, 3.25		3.13–3.53, 3.41

Pupa (n = 5). Total length 4.29–4.86, 4.55 mm.

Coloration. In Canada balsam exuviae with pale brown cephalothorax, margins of wing sheath golden brown, lateral margins of abdominal segments VI–VII and caudolateral spur brown. According to Earle *et al.* (2013) live pupae have black thorax and green abdomen.

Cephalothorax (Fig. 17). Frontal apotome as in Figure 18. Cephalic tubercles absent. Frontal setae 92–102, 97 µm long. Wing sheath 1.34–1.44, 1.39 mm long.

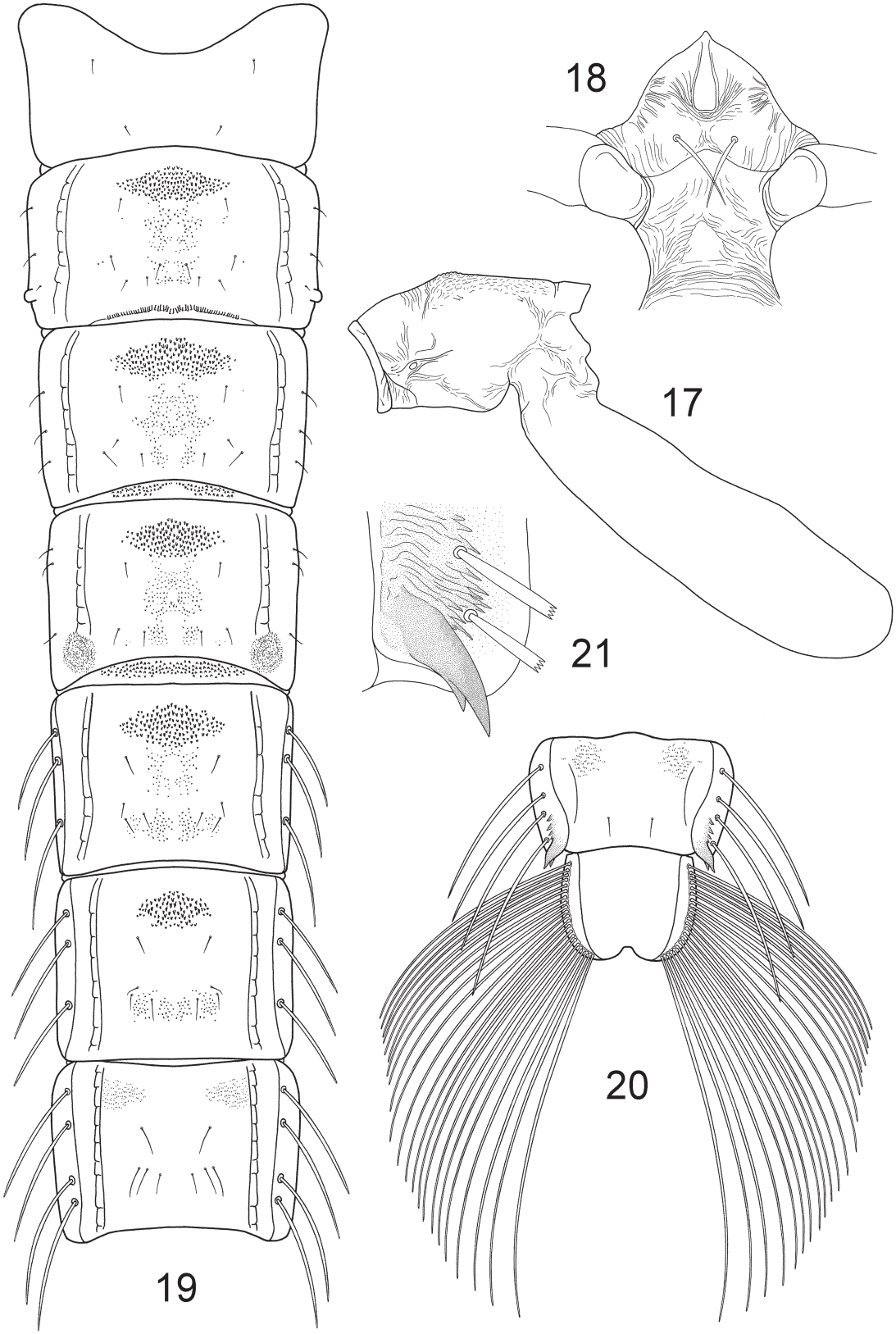
Abdomen (Figs 19–20). Tergite I bare; tergites II–VI each with 6–7 rows of prominent spinules in anterior band; tergites II–V each with medial anterior to posterior patches of fine shagreen; tergite VI with posterior band of fine spinules; tergites VII–VIII with anterolateral patches of fine spinules. Tergite II with 58–79, 66 caudal hooklets in single row. Spinules on conjunctive III/IV in 3 rows, nearly interrupted medially; on conjunctive IV/V in 4–5 rows. Pedes spurii A well developed on segment IV. Pedes spurii B well developed posterior on segment II. Caudolateral spur (Fig. 21) 72–92, 81 µm long; with 1 strong apical tooth or tooth bi- to trifid. Segment I without lateral setae, segments II–IV each with 3 hair-like lateral setae; segments V–VI each with 3 taeniae; segments VII–VIII each with 4 taeniae. Anal lobe fringe with 21–25, 23 taeniae. Length of genital sac overreach 140–152 (2) µm.

Larva (n = 7–10, unless otherwise stated). Total length 4.43–6.26, 5.07 mm. Head capsule 0.49–0.60, 0.54 mm long. Postmentum 237–261, 253 µm long.

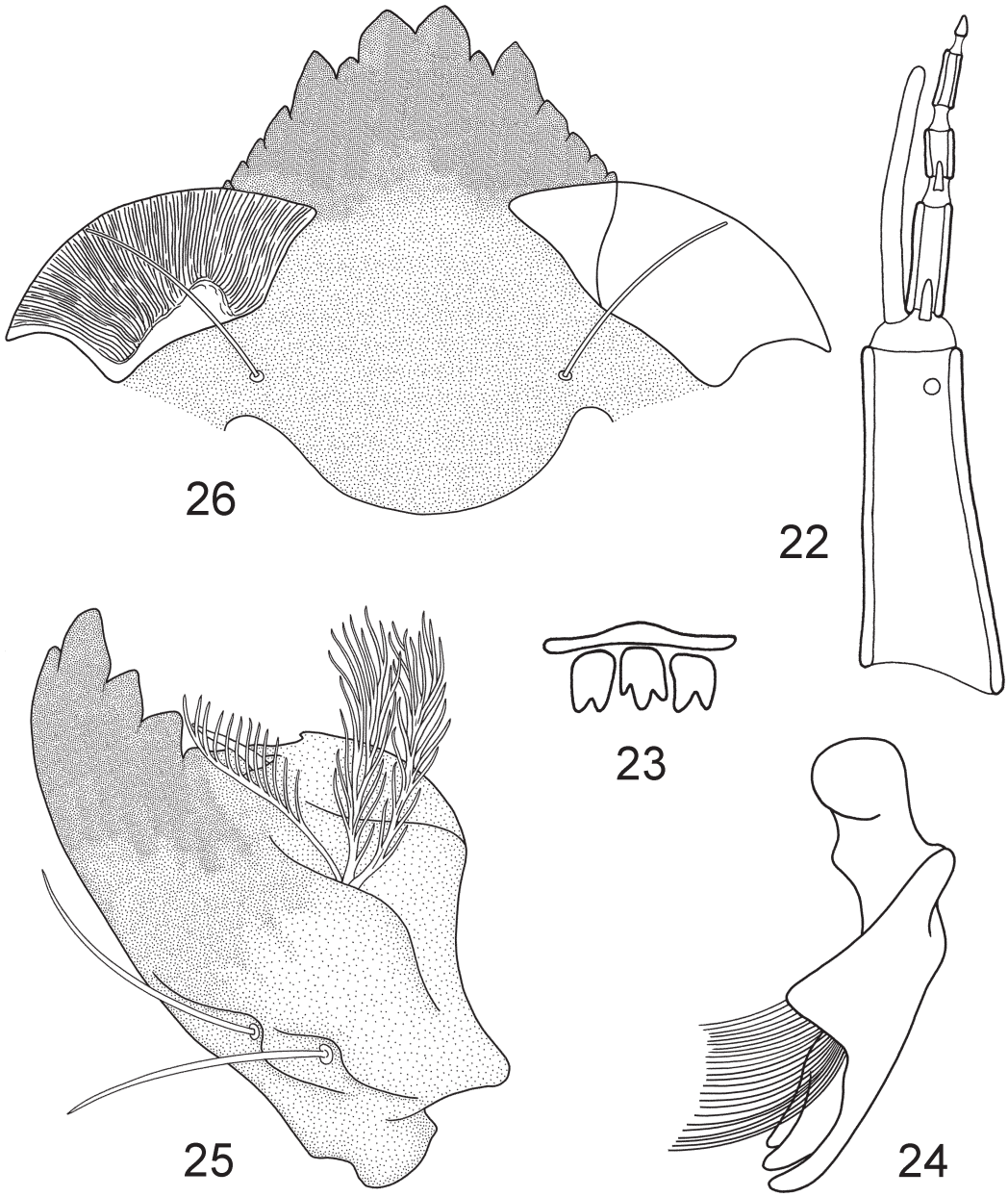
Coloration. Head capsule brown with teeth of mentum and mandible dark brown, postoccipital margin blackish brown.

Head. AR 1.19–1.36, 1.23. Antenna as in Figure 22; antennal segment lengths (in µm): 48–52, 51; 17–21, 18; 7–8, 7; 10–12, 11; 5–6, 6. Basal antennal segment 17–18, 17 µm wide; ring organ 10–12 (2) µm from base; blade at apex of 1st segment 32–39 (3) µm long; apical style of 2nd segment 11–15 (2) µm long; Lauteborn organs minute. Pecten epipharyngis (Fig. 23) consisting of 3 platelets, each with 2–3 unequal teeth. Premandible (Fig 24) 90–101, 95 µm long, bi- to trifid, with prominent mandibular brush. Mandible (Fig. 25) 146–166, 155 µm long, with 1 apical, 1 dorsal and 3 inner teeth; seta subdentalis 18–22, 20 (5) µm long, slender and straight; setae interna prominent. Mentum (Fig. 26) 113–127, 120 µm wide, with 7 pairs of teeth; pair of median teeth 25–29, 27 µm wide, second lateral tooth as large as median tooth, first lateral tooth smaller, third to sixth lateral teeth decrease progressively to a minute seventh tooth. Ventromental plate 90–102, 96 µm wide; distance between plates 48–55, 51 µm; median apices of plates pointing towards each other. Ratio of ventromental plate / mentum 0.75–0.83, 0.79. Setae submenti 44–55, 49 µm long.

Abdomen. Procercus 14–23, 18 µm long; 27–33, 30 µm wide; with 8–9, 8 anal setae 480–560, 511 µm long. Supraanal setae 336–360, 349 µm long. Ratio of supraanal setae / anal setae 0.62–0.70, 0.67 (6). Posterior parapods 133–159, 144 µm long. Anal tubules 82–148, 104 (5) µm long; 43–49, 45 (5) µm wide at base.



FIGURES 17–21. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., pupa. 17. Thorax. 18. Frontal apotome. 19. Abdominal segments I–VII. 20. Abdominal segments VIII–IX. 21. Caudolateral spur.



FIGURES 22–26. *Polypedilum* (*Pentapedilum*) *tuburcinatum* Andersen *et* Bello González sp. n., larva. 22. Antenna. 23. Pecten epipharyngis. 24. Premandible. 25. Mandible. 26. Mentum.

Remarks

The male of *P.* (*Pe.*) *tuburcinatum* n. sp. is similar to *P.* (*Pe.*) *camposense* Oyewo *et* Sæther, 2008 from Brazil in having wings with just over 100 setae in each of cells m_{1+2} and r_{4+5}, few setae in cell m basal of RM, fore tibial scale without spur, base of superior volsella with microtrichia, apical seta of the inferior volsella prominent reaching apex of gonostylus, tergite IX with about 10 median setae and the anal point narrow, gradually tapering to nearly parallel-sided. However, the two species are easily separated as the new species has an AR of about 0.8 while the AR in *P.* (*Pe.*) *camposense* is 1.35. Further, *P.* (*Pe.*) *camposense* has only 5 setae on scutellum, while the new species has more than 10 setae in partly double row; the apical portion of the superior volsella appears to be more curved with a much shorter dorsolateral setae than in the new species; and the inferior volsella apparently lacks setae with split apices.

Unfortunately the female and immatures of *P.* (*Pe.*) *camposense* are not known. In the key to the females of *Polypedilum* subgenus *Pentapedilum* (Oyewo & Sæther 2008) the female of *P.* (*Pe.*) *tuburcinatum* n. sp. will key to *P.* (*Pe.*) *chutteri* Harrison, 2001 from South Africa as the abdomen is not banded, the seminal capsule is spherical and the postgenital plate is broadly triangular. However, the two species can easily be separated as *P.* (*Pe.*) *chutteri* has a brush-like ventrolateral lobe, while the ventrolateral lobe in the new species lacks a brush. Further, the ratio fifth palpomere / third palpomere is about 0.78 in the female of the new species, while it is 1.22 in the female of *P.* (*Pe.*) *chutteri*.

In the key to the pupae of *Polypedilum* subgenus *Pentapedilum* (Oyewo & Sæther 2008) the pupa of the new species will key to couplet 9 as tergite II has median and posterior shagreen, conjunctive III/IV with spinules and tergite VII has anterolateral spinules, but not further as tergite VIII also has anterolateral spinules.

In the key to the larvae of *Polypedilum* subgenus *Pentapedilum* (Oyewo & Sæther 2008) the larva will key to couplet 7 as the mandible has a dorsal tooth, the median teeth of mentum is slightly longer than second lateral teeth and third antennal segment is slightly shorter than fourth segment, but no further as the combined length of third and fourth antennal segment is subequal to second segment and Lauterborn organs are minute.

Biology

The larvae of *P.* (*Pe.*) *tuburcinatum* n. sp. feed on actively growing shoots of the submerged aquatic plant *Lagarosiphon major*. After emerging from a gelatinous egg mass larvae disperse in the water column and settle on plant material. Early larval stages seek out and enter the meristematic tissue in the crown of shoots feeding on the developing leaves and stems. Feeding damage typically stops shoot growth promoting the development of side shoots (Earle *et al.* 2013), which are equally suitable to the larvae. The larva may move between shoots to complete development and the later instars tunnel a few centimeters and pupate within the stem. The adult female typically deposits one or two egg masses into the water within 2–3 days of emerging. The life cycle takes approximately 30 to 50 days from egg to adult, at water temperatures of ~21ºC (Earle *et al*. 2013). In the introduced range *L. major* spreads and competes with native macrophytes only through vegetative growth and requires repeated mechanical control to prevent the formation of large monocultures (Caffrey *et al.* 2011). By feeding on the new shoots the chironomid has the potential as a candidate biocontrol agent (see Baars 2011) to reduce the growth rate and architecture of *L. major* if it was to be found safe for a field release in Europe.

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