

**Life stages of four species of *Polypedilum* KIEFFER (Diptera Chironomidae) with a new species of the genus from the Darjeeling-Sikkim Himalayas of India**

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**Abstract**

Life stages of four species, *Polypedilum* (*Polypedilum*) *centisetum* n.sp., *Polypedilum* (*Pentapedilum*) *convexum* JOHANNSEN, *Polypedilum* (*Polypedilum*) *nudiceps* CHAUDHURI *et al.*, and *Polypedilum* (*Polypedilum*) *yapensis* TOKUNAGA have been described from India.

**Keywords:** Larva, pupa, imago, distribution, ecology.

**Introduction**

A well defined and probably the largest chironomid genus *Polypedilum* was obtained by KIEFFER (1913) with *Polypedilum emarginatum* KIEFFER, as its type species. ASHE (1981) discovered one earlier species, *Polypedilum pelostolum* KIEFFER (1912) which replaced the previous species designated by KIEFFER. The adults of the genus form a clearly distinct and easily recognizable group of species by the presence of deeply bifid pulvilli and eighth abdominal segment triangular, narrow at its basal region. The immatures, in comparison to the adults, belong to the easily distinguishable groups of chironomid midges. The genus is now divided into 6 subgenera, *Asheum* SUBLETTE & SUBLETTE, *Cerobregma* SÆTHER & SUNDAL, *Pentapedilum* KIEFFER, *Polypedilum* KIEFFER, *Tripodura* TOWNES & *Uresipedilum* SASA & KIKUCHI (SÆTHER & SUNDAL, 1999) and of which only *Pentapedilum* KIEFFER and *Polypedilum* KIEFFER have so far recorded from India.

The genus is known to be represented by 5 species belonging to subgenus *Pentapedilum* KIEFFER, 29 species to *Polypedilum* KIEFFER and 6 species to *Tripodura* TOWNES (CHAUDHURI *et al.*, 2001; VARDAL *et al.*, 2002). The larval and pupal stages were however, unreported from India until the present investigations. The paper describes the immature stages of four species of *Polypedilum* KIEFFER of which adults of three were recorded earlier.

### Material and Methods

Materials of this study were collected during our survey of the chironomid fauna from the Darjeeling-Sikkim Himalayas during 1995-99. The larva collected from water bodies of the study areas was kept in a field laboratory in order to rear the adult stage.

Morphological nomenclature follows SÆTHER (1980) with the additions and corrections given in SÆTHER (1990). Measurements of different parts of larva, pupa and adults are expressed in micrometers and the total length and wing length in millimeters (mm) and are stated as mean value followed by ranges with the number (n) in parentheses.

*Holotype* of new species and other specimens are retained with the collection of insects of the University of Burdwan. *Paratypes* along with the other specimens Type specimens have been deposited to the National Zoological Collections (NZC), Calcutta and will also be deposited to The Natural History Museum (BMNH), London and the United States National Museum (USNM), Washington D.C. in future.

**Abbreviations:** AR- Antennal ratio; BR- bristle ratio; BV- combined lengths of femur to basitarsus by combined length of tarsomeres II-V; CR- costal ratio; LR-leg ratio; SV- ratio of femur plus tibia to metatarsus; VR - venarum ratio.

### Description of the taxa

#### 1. *Polypedilum (Pentapedilum) convexum* JOHANNSEN, 1932

*Pentapedilum convexum* JOHANNSEN 1932: 540; TOKUNAGA, 1964: 596; CHAUDHURI & GUHA, 1987: 28; CHAUDHURI, HAZRA & ALFRED, 2001: 354.

#### Pupa

*Total length* of exuviae 3.92 (3.77-4.25, n=4). Margin of VI-VIII and caudolateral spur brown.

**Cephalothorax.** Cephalic tubercles absent, frontal setae (Fig. 1a) 37-44 long frontal warts absent; basal ring oval (Fig. 1b). 2 precorneals, 2 antepronotals.

**Abdomen** (Fig. 1c). Tergite I bare, tergites II - VI each with strong anterior row of spinules, II-VI with variably shaped sparse median and posterior shagreen, VII-VIII without any shagreen; sternites bare; tergite II with 38-44 caudal hooklets occupying 0.39-0.42 segment width; conjunctives III/IV-IV/V with irregular 4-6 rows of shagreen. Pedes spurii A present on segment IV. Pedes spurii B well developed on segments II and I. Anal spur (Fig. 1d) consisting of 2 small teeth on either side 1 large strong apical tooth and 2-3 spines. Segments II-IV each with 1L seta, V-VI each with 3-L setae and VII-VIII with 4 LS setae on each segment. Anal lobe (Fig. 1e) with 24-28 setae on each side.

**Material.** 1 male with pupa [reared], West Bengal, Mirik, 26.V.1996, Coll. N. HAZRA; 5 males with pupae [reared], Sikkim: Tadong, 06.IV.1996, Coll. N. HAZRA; 2 males with pupae [reared], West Bengal: Darjeeling, 04.IV.1996, Coll. N. HAZRA.

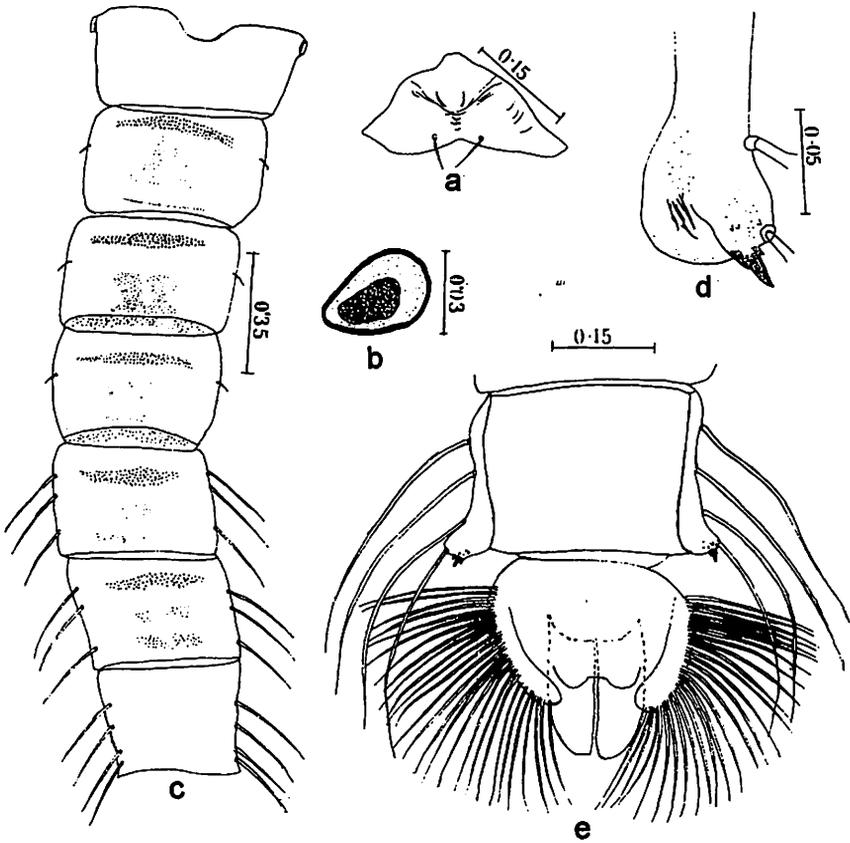


Fig. 1. *Polypedilum (Pentapedilum) convexum* JOHANNSEN, pupa; a: Frontal apotome; b: Basal ring; c: Tergites; d: Anal spur; e: Tergite VIII, anal lobe and genital sac.

**Distribution.** Bhutan, Micronesia, Sumatra and India.

**Remarks.** The species was described first by JOHANNSEN (1932) from Sumatra followed by TOKUNAGA (1964) from Micronesia and CHAUDHURI & GUHA (1987) from India. The materials studied during the present investigation conform fully to that of JOHANNSEN and TOKUNAGA except for a few minor morphometric variations like body length, AR, LR and thoracic chaetotaxy. The key features of the species are: **Male imago.** i) Frontal tubercles inconspicuous, ii) scutellum with 12 setae in transverse row, iii) wings hyaline with dense macrotrichia, iv) RM oblique and proximal to FCu, v) hypopygium with short and broad anal point bearing 6–8 setae on each basolateral margin, vi) gonostylus slender, slightly curved, vii) superior volsella short, slender, tapering with an apical notch having 1 long seta and an incurved sharp spine at its extremity and viii) inferior volsella elongate, digitiform with 1 long apical and 9–10 incurved subapical setae. **Pupa.** i) Basal ring oval, ii) tergites II–VI with sparsely arranged separate median and

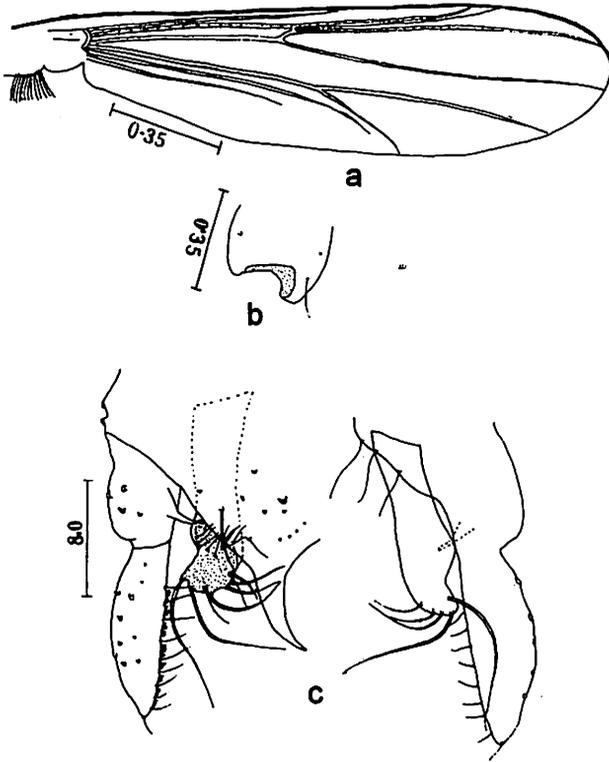


Fig. 2. *Polypedilum (Polypedilum) centisetum* n. sp., Adult male; a: Wing; b: Fore tibial scale; c: Hypopygium.

posterior shagreen, and each with only one L seta, iii) segments VII–VIII without any shagreen, iv) hookrow consisting of 38–44 hooklets, v) pedes spurii B present on segments I and II, vi) anal spur consisting of 1 strong and 2 small apical teeth and vii) anal lobe with 24–28 setae on each side.

## 2. *Polypedilum (Polypedilum) centisetum* n. sp.

### Adult male

**Total length** 2.81(2.81–2.83, n=4) **wing length** 1.55 (1.53–1.55, n=4). **Total length / wing length** 1.81; **wing length / length of profemur** 2.06.

**Head.** Eyes with 92–111 long dorso-medial extension; length of flagellomeres I–XIII 37, 40, 26, 26, 26, 26, 29, 29, 26, 26, 26, 26, 29, 160; AR 1.7 Temporal setae 6–8 (1–2 IV, 3–4 OV, 2 Po). Clypeus with 10–11 setae. Length of palpomeres: 52, 37, 96, 100, 129. CA 0.51; CP 1.34.

**Thorax.** Acrostichals 11–15 irregularly biserial, dorsocentrals 10–12 uniserial, prealars 4 uniserial; scutellum with a row of 12 large posterior setae and 7 small anterior irregular rows of setae.

**Wing** (Fig. 2a). VR 1.23, CR 0.97. Brachiolum with 1 seta; FCu far distal MCu; R with 18–20 setae, R<sub>1</sub> 12–14 and R<sub>4+5</sub> 21–23 setae; squama with 12–14 setae. Anal lobe undeveloped.

**Leg.** Fore tibial scale (Fig. 2b) oval without any spur, spurs of mid and hind tibia 53 and 58 long; width at the apices of fore tibia 48, mid tibia 74 and hind tibia 88.

Length and proportion of leg segments:

	Fe	Ti	ta <sub>1</sub>	ta <sub>2</sub>	ta <sub>3</sub>	ta <sub>4</sub>	ta <sub>5</sub>	LR	BV	SV	BR
P <sub>1</sub>	50	33	65	45	30	24	11	1.96	1.34	1.27	2.14
P <sub>2</sub>	53	45	26	16	11	6	4	0.57	3.35	4.66	3.62
P <sub>3</sub>	56	50	38	21	17	10	5	0.76	2.71	3.31	4.12

**Abdomen.** Tergites I–VIII with dense elongate setae.

**Hypopygium** (Fig. 2c). Anal point 55–66 moderately stout, apex slightly narrowed, curved extending beyond superior volsella; gonocoxite 81–92 long, superior volsella small, bare and inwardly curved, inferior volsella stout bearing 2 very long and 3–5 long setae at apex and a group of small setae near the centre; gonostylus 135–140 long, slender, stout, little pointed with 1 seta at apex and 8–9 curved setae on its inner margin; lateral sternapodeme 80–89 long, coxapodeme 37–42 long, phallapodeme 50–56 long. HR 0.60–0.65, HV 2.00–2.05.

### Pupa

Total length of exuvia 4.07(4.07–4.08, n=4); margin of segments VII–VIII and caudolateral spur brown.

**Cephalothorax.** Cephalic tubercle absent, frontal apotome (Fig. 3a) with 2 frontal setae of 38–39 long, frontal warts absent, basal ring more or less ovoid.

**Abdomen** (Fig. 3b). Tergite I bare, tergite II with few posterior shagreen above hook row, tergites III–VII with anterior band of spinules, II–VI with varied median shagreen, VII with 1 median and 2 posterior patches of shagreen, VIII with 2 patches of shagreen. Hook row consisting of 44–47 hooklets. Pedes spurii B on segments I–II and A on segment IV. Anal spur (Fig. 3c) with 1 strong apical and 3 minute lateral teeth. Segments II–IV with 3 L setae, V–VI with 3 LS setae and VII–VIII with 4 LS setae. Anal lobe (Fig. 3d) with 51–56 setae on each side.

**Material.** *Holotype* male with pupa [reared] (Type no. B.U.Ent. 235), Tadong: Sikkim, 06.IV.1996, Coll. N. Hazra. *Paratype* 1 male with pupa [reared], data same as *holotype*.

**Remarks.** The species has been named *Polypedilum (Polypedilum) centisetum* due to the presence of a patch of setae near the central part of inferior volsella of male hypopygium. The species bears similarity with *P. fuscum* FREEMAN (1954), *P. (P.) longicrus* KIEFFER with respect to gonostylus. Similarly, *P. (P.) albicarpus* TOKUNAGA and *P. (P.) yapensis* TOKUNAGA come closer to the present species in the small size of superior volsella and apex of fore tibial scale. The scutellar setae of *P. (P.) nudiceps* CHAUDHURI *et al.* (2001) and the new species appear to be alike in arrangement. The pupa of *P. (P.) pedestre* (MEIGEN) seems to be nearer

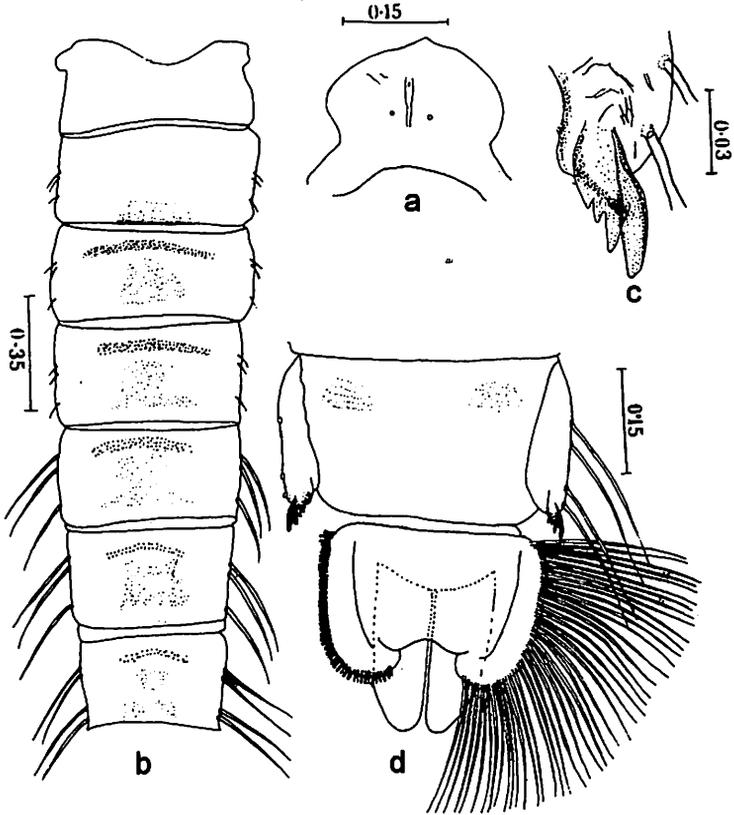


Fig. 3. *Polypedilum (Polypedilum) centisetum* n. sp., pupa; a: Frontal apotome; b: Tergites; c: Anal spur; d: Tergite VII, anal lobe and male genital sac.

to the species described here in the anal comb on segment VIII and fringe of setae on anal lobe. But the differences in structure and chaetotaxy of the adults and the pupae are so pronounced which speak in consideration of the species as a new member of *Polypedilum* from India. The diagnostic features of the species are as follows: **Male imago.** i) AR 1.7. ii) scutellum with 12 large and 7 small setae, iii) squama with 12–14 setae, iv) fore tibial scale apically blunt, v) superior volsella very small, bare and inwardly curved, vi) inferior volsella with 2 very long apical setae and a patch of small subapical setae and vii) anal point moderately stout, curved apex little narrowed. **Pupa.** i) Tergite II with few posterior shagreen, ii) tergites III–VII with anterior band of spinules, iii) VII with 1 median and 2 posterior patches of shagreen, iv) hookrow consisting of 44–47 hooklets, v) both pedes spurii A and B present, vi) anal spur consisting of 1 strong apical and 3 lateral teeth and vii) anal lobe with 51–56 setae on each side.

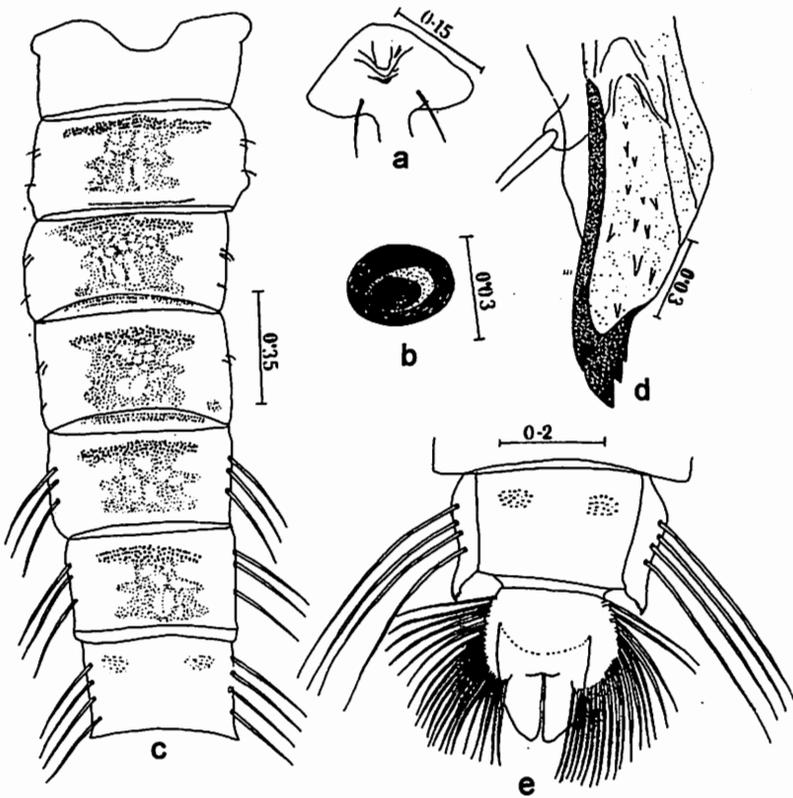


Fig. 4. *Polypedilum (Polypedilum) unispinum* nomen novum, pupa; a: Frontal apotome; b: Basal ring; c: Tergites; d: Anal spur; e: Tergite VIII, anal lobe and male genital sac.

### 3. *Polypedilum (Polypedilum) nudiceps* CHAUDHURI, GUHA & DAS GUPTA, 1981

*Polypedilum (Polypedilum) nudiceps* CHAUDHURI, GUHA & DAS GUPTA, 1981: 133; CHAUDHURI, HAZRA & ALFRED, 2001: 356.

#### Pupa

Total length exuviae 3.98 (3.62–4.25,  $n=4$ ), margins of segments V–VII and caudolateral spur brown.

**Cephalothorax.** Cephalic tubercle absent, frontal setae 44–60 long (Fig. 4a), frontal warts absent; basal ring (Fig. 4b) elliptical; 2 precorneals, 2 antepnotals.

**Abdomen** (Fig. 4c). Tergite I bare, tergites II–VI each with a strong anterior row of spinules, II–VI with variably shaped extensive shagreen; sternites bare. Tergite II with 46–72 caudal hooklets occupying 0.44–0.52 of segment width. Conjunctives III/IV–IV–V with irregular 2–3 rows of shagreen. Pedes spurii A

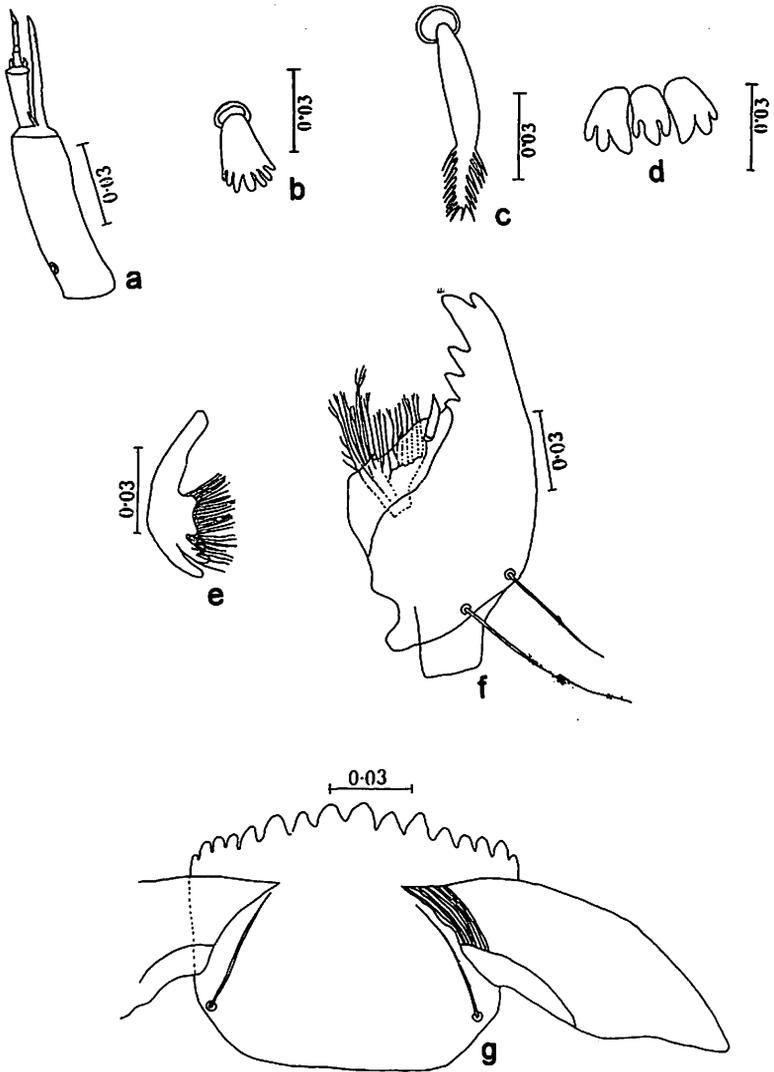


Fig. 5. *Polypedilum (Polypedilum) unispinum* nomen novum, larva; a: Antenna; b: SI of Labrum; c: SII of labrum; d: Pecten epipharyngis; e: Premandible; f: Mandible; g: Mentum.

present, pedes spurii B well developed on segments II and I. Anal spur (Fig. 4d) with 1 strong apical and 2 minute lateral teeth, and 3-4 spines. Segments II-IV with 3-L setae each, V-VI with 3 LS setae each, VII-VIII with 4 LS setae each. Anal lobe (Fig. 4e) with 15-28 setae on each side, dorsal seta absents.

#### Larva

**Antenna** (Fig. 5a). AR 1.26-1.29, length of antennal segments 44-52, 15-18,

6-8, 10-11, 3-4; segment III shorter than IV, distance of ring organ from the base 10-12; blade 32-37 long slightly extending beyond the segment IV, accessory blade 5-7 long.

**Labrum.** S I (Fig. 5b) broad, apically serrated, S II (Fig. 5c) plumose on both sides, each platelet of pecten epipharyngis (Fig. 5d) divided distally into 3 parts; premandible (Fig. 5e) 63-77 long with 2 apical and 1 inner teeth.

**Mandible** (Fig. 5f). 111-118 long with 1 dorsal tooth, 3 inner teeth, and seta subdentalis-18-24 long, weakly curved distad.

**Mentum** (Fig. 5g) with 4 median and 6 pairs of lateral teeth, outer median somewhat smaller than the first laterad; striae of ventromental plate fine and almost straight.

**Material.** *Holotype* male (Type no. B.U.Ent. 85), West Bengal: Darjeeling, 05.IX.1977, Coll. S. K. Das Gupta; 4 males and 1 female with larvae and pupae [reared], West Bengal: Darjeeling, 23.V.1996, Coll. N. HAZRA; 1 male and 1 female with larvae and pupae [reared], West Bengal: Lebong, 03.IX. 1996, Coll. N. HAZRA; 2 males with larvae and pupae [reared], Sikkim: Jorethang, 31.III.1996. Coll. N.HAZRA.

**Distribution.** Bhutan and India.

**Remarks.** CHAUDHURI *et al.* (1981) described the adult of the species as *Polypedilum nudiceps* from the hilly tracts of Darjeeling, West Bengal. The adults reared during the present investigation are similar to that described by CHAUDHURI *et al.* (1981) except of possession of one seta on the superior volsella which was probably overlooked during the previous study. The following combination of characters amply justifies its identity as a member of subgenus *Polypedilum* of the genus *Polypedilum* KIEFFER that is in use: **Male imago.** i) Haltere yellow and bare, ii) scutellum with 12 long and 6 small setae arranged in two oblique rows, iii) wings with dense microtrichia, iv) fore tibial scale abruptly pointed with 3-4 setae, v) tergites with broad bands and vi) hypopygium with long slender anal point, elongate, little inwardly bent gonostylus, slender, stout, inwardly curved superior volsella bearing 1 long preapical seta and elongate digitiform inferior volsella bearing 2 long straight apical and 6-7 subapical incurved setae. **Pupa.** i) Precoxae 2, anteprenotals 2, ii) tergites II-VI with extensive shagreen, iii) pedes spurii B present on segments I-II iv) hookrow consisting of 46-72 hooklets, v) anal spur with 1 strong and 2 lateral teeth and vi) anal lobe with 15-28 setae on each side. **Larva.** i) AR 1.26-1.29, ii) segment III shorter than IV, iii) apex of S I serrated, iv) apex of seta subdentalis weakly curved and iv) all mental teeth decreasing in size gradually.

#### 4. *Polypedilum (Polypedilum) yapensis* TOKUNAGA, 1964

*Polypedilum (Polypedilum) yapensis* TOKUNAGA, 1964: 595; HASHIMOTO *et al.* 1981: 25; CHAUDHURI & CHATTOPADHYAY, 1990: 164; CHAUDHURI, HAZRA & ALFRED, 2001: 357.

#### Pupa

**Total length** of exuviae 4.1(4.1-4.2, n-4), margin of all segments and caudolateral spur brown.

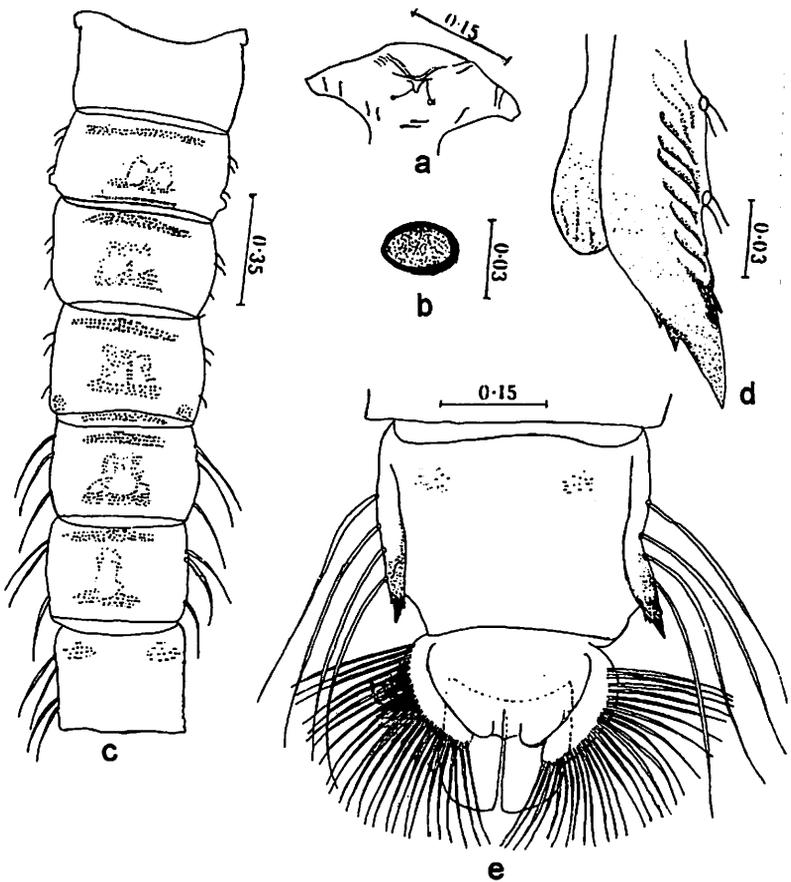


Fig. 6. *Polypedilum (Polypedilum) yapensis* TOKUNAGA, pupa; a: Frontal apotome; b: Basal ring; c: Tergites; d: Anal spur; e: Tergite VIII, anal lobe and male genital sac.

**Cephalothorax.** Frontal setae (Fig. 6a) 40 long; frontal wart absent; basal ring (Fig. 6b) oval; precorneals and anteprenotals 2 in nos.

**Abdomen** (Fig. 6c). Tergite I bare, tergites II–VI each with anterior band of spinules, II–VI with variably shaped sparse shagreen, VII–VIII (Figs 6c & e) with anteromedian patches of shagreen; tergite II with 25 caudal hooklets. Conjunctive IV–V with irregular 2–3 rows of spines. Pedes spurii A present on segments I–II and pedes spurii B on IV. Anal spur (Fig. 6d) with 1 large strong apical tooth and 2 smaller lateral teeth on inner side and 1 on outer side; segments II–IV with 3 L setae, V–VI with 3 LS setae and VII–VIII with 4 LS setae on each side. Anal lobe (Fig. 6e) with 26 setae on each side.

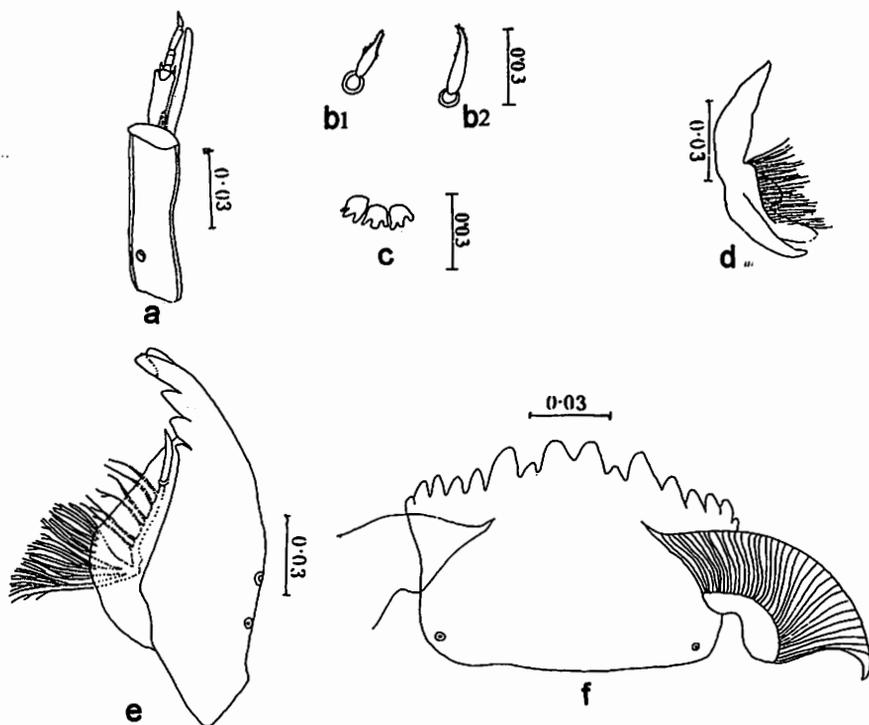


Fig. 7. *Polypedilum (Polypedilum) yapensis* TOKUNAGA, larva; a: Antenna; b<sub>1</sub>- b<sub>2</sub>: SI and SII of labrum; c: Pecten epipharyngis; d: Premandible; e: Mandible; f: Mentum.

**Larva [only head capsule retained]**

**Antenna** (Fig. 7a). AR 1.57, length of antennal segments 55, 18, 5, 8, 4; segment II shorter than IV, distance of ring organ from the base 10; length of blade 37 long not extending beyond the apex of flagellum, accessory blade 6.3 long; lauterborn organ 3 long.

**Labrum**. S I (Fig. 7b<sub>1</sub>) and S II (Fig. 7b<sub>2</sub>) plumose on both sides; each platelet of pecten epipharyngis (Fig. 7c) divided distally into 3 parts; premandible (Fig. 7d) 70 long with 2 apical and 1 inner teeth.

**Mandible** (Fig. 7e). 107 long, dorsal tooth prominent, 3 inner teeth; seta subdentalis 22 long, straight.

**Mentum** (Fig. 7f). 4 median and 6 pairs of lateral teeth, 2 tall, central median teeth, 2 short outer median teeth and a tall first lateral tooth followed by the remainder of short lateral teeth; striae of ventromental plate fine and curved.

**Material** 4 males, West Bengal: Howrah, 08.III.1987, Coll. S. Chattopadhyay; 2 males with larvae and pupae [reared], Darjeeling: West Bengal, 04.IX.1996, Coll. N. Hazra.

**Distribution**. Micronesia, Thailand and India: West Bengal.

**Remarks.** TOKUNAGA (1964) described the adults of *Polypedilum* (*Polypedilum*) *yapensis* from Micronesia, followed by HASHIMOTO *et al.* (1981) from Thailand, and CHAUDHURI & CHATTOPADHYAY (1990) from India. The specimens collected from the study area conform fully to the counterparts from Thailand and India. The specific characters, which differ from other members of the genus *Polypedilum* KIEFFER, are male *Imago*. i) Frontal tubercle well developed, ii) scutellum with 11 large and 5 small setae in two different rows, iii) fore tibial scale blunt apically, iv) squama with 10–11 setae, v) superior volsella with 2 basal setae, distal part slender, bare, tapered in and with single long seta in the middle, vi) inferior volsella almost straight with 9–10 setae besides a single long apical seta and vii) anal point slender ending before the tip of inferior volsella. *Pupa*. i) 2 precomeals and 2 anteprenotals, ii) basal ring oval, iii) shagreen on segments II–VI sparse, iv) caudal hooklets 25, v) pedes spurii A on segments I–II and B on segments IV, vi) anal spur with 1 strong apical and 3 smaller lateral teeth and vii) anal lobe with 26 setae on each side. *Larva*. i) AR 1.61, ii) antennal segment III shorter than IV, iii) S I and S II plumose, iv) seta subdentalis distally straight and v) teeth of mentum typical of genus.

### Ecology

Larvae of *Polypedilum* (*P.*) *nudiceps* and *Polypedilum* (*P.*) *yapensis* studied here are eurythermal in nature and were observed to prefer shallow, slow flowing water studded with soft organic enriched matters, aquatic macrophytes, soft woods, leaf axis (epixylous) often attached to domestic wastes like polythene packets and waste papers etc.

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### References

- ASHE P., 1981. - A taxonomic note on the genus *Polypedilum* Kieffer (Diptera: Chironomidae) with an earlier date for the genus and designation of a species. *Aquatic Insects*, 3: 57-59.
- CHAUDHURI P.K., GUHA D.K. & DAS GUPTA S.K., 1981. - Taxonomic studies of Chironomidae (Diptera: Chironomidae) from India. The genus *Polypedilum* KIEFFER. *Tijdschrift voor Entomologie*, 124: 111-147.
- CHAUDHURI P.K. & GUHA D.K., 1987. - A conspectus of chironomid midges (Diptera: Chironomidae) of India and Bhutan. *Entomologica Scandinavica Supplement*, 29: 23-33.

- CHAUDHURI P.K. & CHATTOPADHYAY S., 1990. - Chironomids of the rice paddy areas of West Bengal, India (Diptera: Chironomidae). *Tijdschrift voor Entomologie*, 133 (2): 149-196.
- CHAUDHURI P.K., HAZRA N. & ALFRED J.R.B., 2001. - A Checklist of Chironomid midges (Diptera: Chironomidae) of the Indian subcontinent. *Oriental Insects*, 35: 335 - 372.
- FREEMAN P., 1954. - Chironomidae (Diptera) from Western Cape Province II. *Proceedings of Royal entomological Society, London*, 23: 172 - 180.
- HASHIMOTO H., WONGSIRI T., WONGSIRI M., TIRAWAT C., LEWVANICH & YASUMATSU K., 1981. - Chironominae from the rice fields of Thailand, with description of 7 new species. Dept. Agric., Bangkok, Taxonomy Branch, Entomology and Zoology Division, *Technical Bulletin*, 7: 1 - 47.
- JOHANNSEN O.A. 1932. - Chironomidae of the Malayan subregion of the Dutch East Indies. *Archiv für Hydrobiologie Supplement*, 11: 503 - 552.
- KIEFFER J.J. 1912. - Tendipedidae (Dipt.) in Formosa - Ausbeute. *Supplementa entomologica*, 1: 27 - 43.
- KIEFFER J.J., 1913. - Nouveaux Chironomides (Tendipedides) d' Allemagne. *Bulletin de la Société d' Histoire naturelle de Metz.*, 3(4): 7 - 35.
- SÆTHER O.A. 1980. - Glossary of chironomid morphology, terminology (Diptera: Chironomidae). *Entomologica Scandinavica Supplement*, 14: 1-51.
- SÆTHER O.A. 1990. - A review of the genus *Limnophyes* Eaton from the Holarctic and Afrotropical regions (Diptera: Chironomidae). *Entomologica Scandinavica*, 35: 1 - 139.
- SÆTHER O.A. & SUNDAL A., 1999. - *Cerobregma*, a new subgenus of *Polypedilum* Kieffer, with a tentative phylogeny of subgenera and species groups within *Polypedilum* (Diptera: Chironomidae). *Journal of the Kansas Entomological Society*, 71(3): 315 - 382.
- TOKUNAGA M., 1964. - Insects of Micronesia (Diptera: Chironomidae). *Bernice P. Bishop Museum*, 12: 485 - 628.
- VARDAL H., ALFRED B. & SÆTHER O.A., 2002. - Afrotropical *Polypedilum* subgenus *Tripodura* with a review of the subgenus (Diptera: Chironomidae). *Zoologica Scripta*, 31: 331- 402.