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A new genus of Heteromurini (Collembola: Entomobryidae) with dental base falcate macrochaetae, from India

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Abstract

A new monotypic genus of Heteromurinae from Chilika lake, Ganjam district of Odisha, India is described. *Falcomurus* gen. n. is similar to other genera of the subfamily, especially to *Heteromurus* Wankel, 1860 in presence of antennae with 5 segments, 8 + 8 eyes, Abd. I without macrochaetae. It differs from all other genera of Heteromurinae by the combination of: eyes 8 + 8, Ant. III and Ant. IV annulated, unguis with single paired basal inner teeth, dental base commonly with 1+1 falcate type macrochaetae. *Falcomurus chilikaensis* sp. n., the type species of the new genus is described. An identification key to the genera of Heteromurini is also provided.

Keywords: *Collembola, Heteromurini, new genus, new species, Chilika, India.*

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Introduction

Heteromurini Absolon & Ksenemann, 1942 is a tribe of entomobryids widely distributed in the world and highly diverse in the tropics, currently with about 127 described species (Bellinger *et al.*, 1996-2017).

Heteromurini species are distinguished from other tribes by the presence of strongly striated apically rounded or truncate scales on body and five antennal segments (Mari Mutt, 1980a), but other current classification suggests that some members of the tribe are devoid of scales (Soto-Adames *et al.*, 2008). However, Zhang *et al.* (2014) recently proposed a new classification for Heteromurini, suggesting these characteristics appeared independently from other Entomobryidae and therefore added *Dicranocentrus* Schött, 1893 and *Pseudodicranocentrus* Mari Mutt, 1981 (in:1981b) in Heteromurini (Zhang *et al.*, 2014; Zhang & Deharveng, 2015). *Heteromurus* Wankel, 1860 is the type genus of Heteromurini, with 17 described species widely distributed (Cipola *et al.*, 2016). Pantropical taxa *Alloscopus* Börner, 1906, *Heteromurtrella* Mari Mutt, 1979 (in: 1979b) and *Verhoeffiella* Absolon, 1900 restricted to Africa and Europe, are ambiguously considered as: generic levels of Heteromurini (Thibaud & Massoud 1973; Hopkin 1997; Soto-Adames *et al.*, 2008); or subgenera of *Heteromurus* (Mari Mutt, 1977, 1980a, b; Lučić *et al.*, 2007, 2008).

Heteromurini species are diagnosed by Ant. with 5 (Ant. I subdivided in Ia and Ib) or 6 segments (Ant. II also subdivided in IIa and IIb), Ant. III–IV annulated or not; eyes 0+0 to 3+3, 6+6 or 8+8; PLQ with 2+2 chaetae; PAO present or absent (more common); head dorsal macrochaetotaxy with or without mac in series postsutural (Ps) and postoccipital (Pa, Pm and Pp); body dorsal mac reduced (e.g. *Heteromurus* s. lat.) or relatively dense (e.g. *Dicranocentrus* and *Pseudodicranocentrus*); Abd. II–IV bothriotricha formula 2, 3, 2; Th. II to Abd. V with S-chaeta formula 1, 0| 1, 0, 1, 0, 0 (ms) and 2, 2| 1, 3, 3, - , 3(4); Abd. IV 1.2–1.5 times the length of Abd. III in the midline; trochanteral organ with at least 12 spine-like chaetae; dental spines present or absent; mucro bidentate with or without basal spine (Cipola *et al.*, 2016).

Heteromurini resembles other tribes of Entomobryidae as Orchesellini (Orchesellinae) and Mastigocerini (Heteromurininae) by Ant. with 5–6 segments, trochanteral organ with more than 15 chaetae, Th. II to Abd. III with S-chaeta (ms) formula 1, 0| 1, 0, 1 and mucro bidentate (Zhang & Deharveng, 2015). However the Heteromurini is distinguished from these tribes by presence of scales apically rounded or truncate on body, while in Mastigocerini scales are fusiform and in Orchesellini they are absent. Also, the chaetotaxy of tergal sensilla is 33- 3(4) in Abd. II–V of Heteromurini and Mastigocerini, while in Orchesellini the number is higher (Zhang & Deharveng, 2015).

Here a new genus and species of Heteromurini with 5 segmented antennae from Chilika Lagoon, India is described and illustrated, and an identification key to Heteromurini genera is provided.

Materials and Methods

The specimens were collected from the wet soil under the stones near the intertidal zone of the Chilika Lake, Odhisa, India, and preserved in 70% alcohol. Specimens were mounted under a cover slip in Hoyer's medium, and were studied under a Leica Digital Module (DM 2500) microscope; photographs were taken under a Leica Digital Module R (DMR) microscope using a mounted Leica DFC 295 digital Camera, and were enhanced with photoshop CS4 (Adobe Inc.). All specimens are deposited in the Apterygota section, Zoological Survey of India (ZSI), Kolkata.

Abbreviation

Ant- antennae; Abd- abdomen; Bot- bothritrichia; Mac- macrochaetae; PLQ-post labial quadrangle; PAO- post antennal organ; Th- thorax, ZSI = Zoological Survey of India, (Kolkata).

Results

Systematics

Family Entomobryidae Tomosvary, 1882

Subfamily Heteromurinae sensu Zhang & Deharveng, 2015

Tribus: Heteromurini Absolon & Ksenemann, 1942

Key to the world genera of Heteromurini

(modified from Cipola *et al.,* 2016)

1. Antennae with 6 segments, Ant II subdivided (IIa and IIb); unguis with two paired basal inner teeth, never wing like….2
- Antennae with 5 segments, Ant II not subdivided; unguis with two basal inner teeth or with two basal wing-like paired teeth……..3
2. Head with A1 and Ps2 mac; prelabral chaetae bifurcate; dens base commonly with 3 groups of circularly arranged compound spines; dental spines absent……... ……..…..***Pseudodicranocentrus* Mari Mutt**
- Head without A1 and Ps2 mac; prelabral chaetae not bifurcate; dens base without compound spines; dental spines rows present or absent…...***Dicranocentrus* Schött**
3. Ant. III not annulated……...…4
- Ant. III annulated……...…..6
4. Abd. I with at least 1+1 mac...……5
- Abd. I without mac....***Heteromurus* Wankel**
5. Posterior region of head without postoccipital mac; PAO present; dental spines always present……..….***Alloscopus* Borner**
- Posterior region of head with postoccipital mac; PAO absent; dental spines usually absent……...***Heteromurtrella* Mari Mutt**
6. Dens base with 1+1 falcate type macrochaetae; mucronal spine absent…… ……...***Falcomurus* gen. n**.
- Dens base without 1+1 falcate type macrochaetae; mucronal spine present…….. ……..……***Verhoeffiella* Absolon**

Description of new genus

***Falcomurus* gen. n. Mandal**

Type species: *Falcomurus chilikaensis* **sp. n**.

Diagnosis of genus:

Strongly striated apically rounded or truncate scales present on body, antennae, legs and furcula (Fig. 2). Ant. with 5 segments (Ant.I subdivided in Ia and Ib), Ant. III-IV annulated (Fig. 4); eyes 8+8; PAO absent; head dorsal macrochaetotaxy with mac in series postsutural (Ps2) and postoccipital (Fig. 6); body dorsal mac reduced; Abd. II-IV bothritrichia formula 3,3,2

(Fig. 7); unguis with single paired basal inner teeth; unguiculus broad, lanceolate type without tooth (Fig. 14); dental base with 1+1 falcate type macrochaetae (Fig. 16); dental spine absent; mucro bidendate without basal spine (Fig. 17).

Etymology

The genus was named after the falcate type of macrochaetae on dens-base and it is similar to *Heteromurus* in morphology.

Remarks

Falcomurus **gen. n**. is given generic status within the group of other *Heteromurus* - like genera because of a combination of characters. These are antennae 5 segmented, Ant. III-IV annulated, PAO absent, eyes 8+8, unguis with single paired basal inner teeth and dental base commonly with 1+1 falcate type macrochaetae. The last character is present only in this genus.

Table 1. Comparison of Heteromurini genera with 5 segmented antennae

Sl. No.	Genera	*Falcomurus* **gen.nov**.	*Heteromurus* Wankel, 1860	*Heteromurtrella* Mari Mutt,1979	*Alloscopus* Borner, 1906	*Verhoeffiella* Absolon, 1900
1	Ant. IV annulated	+	+	+ or –	+	+
2	Ant. III annulated	+	–	–	–	+
3	Number of eyes	8+8	0+0 to 3+3 or 8+8	0+0 to 2+2 or 6+6	0+0 to 3+3	0+0
4	Postantennal organ	–	–	–	+	–
5	Th II central mac	11+11 to 15+15	6+6 to 9+9	7+7 to 15+15	10+10 to 13+13	7+7 to 9+9
6	Th III central mac	9+9	4+4	2+2 to 8+8	6+6 or 7+7	4+4
7	Abd. I central mac	–	–	1+1 to 3+3	3	–
8	Abd. II central mac	4+4	0 +0 to 2+2	1+1	1+1	1+1
9	Abd. III central mac	3+3	0+0 to 2+2	1+1	1+1	1+1
10	Paired basal teeth in unguis	inner	inner	Wing-like	inner	inner
11	Outer tooth in unguiculi	–	+	+ or –	+ or –	+ or –
12	Smooth setae on manubrium	+	+ or –	+	+	+
13	Dens base with macrochaetae	1+1 falcate type macrochaetae	–	–	–	–
14	Spines on dens	–	–	+ or –	+	–
15	Mucronal spine	–	+or –	+ or –	+ or –	+

Symbols used to represent the morphological characteristics: Ant.- antennae; Abd.- abdomen; mac- macrochaetae; (+) present; (–) absent.

Falcomurus **gen. n**. is similar to *Heteromurus* by the presence of 8+8 eyes, Abd. I without macrochaetae and absence of dental spines. *Falcomurus* **gen. n**. can be separated from *Heteromurus* by presence of annulated Ant. III, 9+9 mac on Th. III, 4+4 mac on Abd. II, 3+3 mac on Abd. III and 5+5 mac on Abd. IV, unguis with single paired basal inner teeth and dental base with 1+1 falcate type macrochaetae.

Falcomurus **gen. n**. is also similar to *Verhoeffiella* in having Ant. III-IV annulated and absence of dental spines. However, *Falcomurus* **gen. n.** can be distinguished from *Verhoeffiella* by the presence of 8+8 eyes, dental base with 1+1 falcate type macrochaetae and absence of mucronal basal spine. The detailed difference of *Heteromurus* -like genera having Ant. with 5 segments is given in Table 1.

Description of a new species:

***Falcomurus chilikaensis* sp. n. Mandal**
(Figures 1-17)

urn:lsid:zoobank.org:act:F47C3CA2-EE16-4575-A4BB-FB6237C141CE

Type material:
Holotype: female on slide, India: Odhisa: Chilika lake near Sabbulia Village, Rambha Town, Ganjam district, Latitude 19°32´002. 2´´North and Longitude 85°06´04.44´´East, Altitude 11 meters, Salinity-17, date 13.ii.2017, Coll. K. Valarmathi, Registration No.2156/H14/ ZSI deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata).

Paratype: 1 female on slide, same data as Holotype (Registration No.2157/ H14/ZSI); Paratype: 1 female on slide, same data as Holotype (Registration No.2158 / H14/ZSI); Paratype: 1 female on slide (dissected), same data as Holotype (Registration No.2159/ H14/ZSI) and 15 specimens in ethyl alcohol, same data as Holotype (Registration No.2160 / H14/ZSI) deposited in the National Zoological Collection, Zoological Survey of India, (Kolkata).

Measurement: Body length up to 1.40 mm (excluding appendage). Habitus typical of Heteromurinae (Fig. 1)

Colour pattern: Background colour brownish – white due to body clothed with heavily striated scales. Ant. Ia and Ib, II, III, IV with dark-blue pigment. Eyes dark, a dark spot present between two eyes. All tibio-tarsi dark blue pigmented, light blue pigment present on Abd. VI. No other pigment present on the body.

Head: Eyes 8+8, G & H smaller than the rest (Fig. 3). PAO absent. Antennae 5 segmented and scaled (Fig.4). Antennal segment ratio as Ia : Ib : II: III: IV= 1: 3: 6: 5.5: 9.8 :11.6. Ant. I subdivided (Ia and Ib). Ant II not subdivided and annulated. Ant. III annulated, large number of ciliated setae and smooth setae present. Ant. IV annulated with ciliated setae, smooth setae and 2 apical bulbs. (Fig. 5). Head with large macrochaetae and heavily striated scales. Smooth setae also present on head. Sutural series 'S' with 6+6 macrochaetae, S0 absent. Postsutural & postoccipital shown as head dorsal chaetotaxy in Fig. 6. PLQ with smooth chaetae. Prelabral chaetae smooth, chaetotaxy, labial papillae and proximal chaetae shown as in Fig. 8. Differentiated seta of outer labial papilla as in Fig.9. Prelabral/labral formula 4/5, 5, 4, all smooth chaetae.
Thorax and legs: Ratio of segments of thorax II: III = 1: 1.2. Large numbers of mesothoracic collar macrochaetae. Dorsal chaetotaxy of Th. II to Th. III as in Fig. 7. Th. II chaetotaxy with 11+11 to 15+15 macrochaetae. Th. III with 9+9 macrochaetae. Thorax with heavily striated oval and truncate scales. All legs are scaled. Tibiotarsi with ciliated setae, smooth setae and few macrochaetae (Fig. 12). Unguis with single paired inner basal teeth. Unguiculus broad, lanceolate, without tooth (Fig.14). Tenent hair present on all legs, clavate type. Ventral tube anterior face with smooth setae, lateral faces with 18 long smooth setae (Fig. 10) and posterior face with 3 large macrochaetae (Fig. 11). Trochanteral organ with 16-18 spines like setae (Fig. 13).

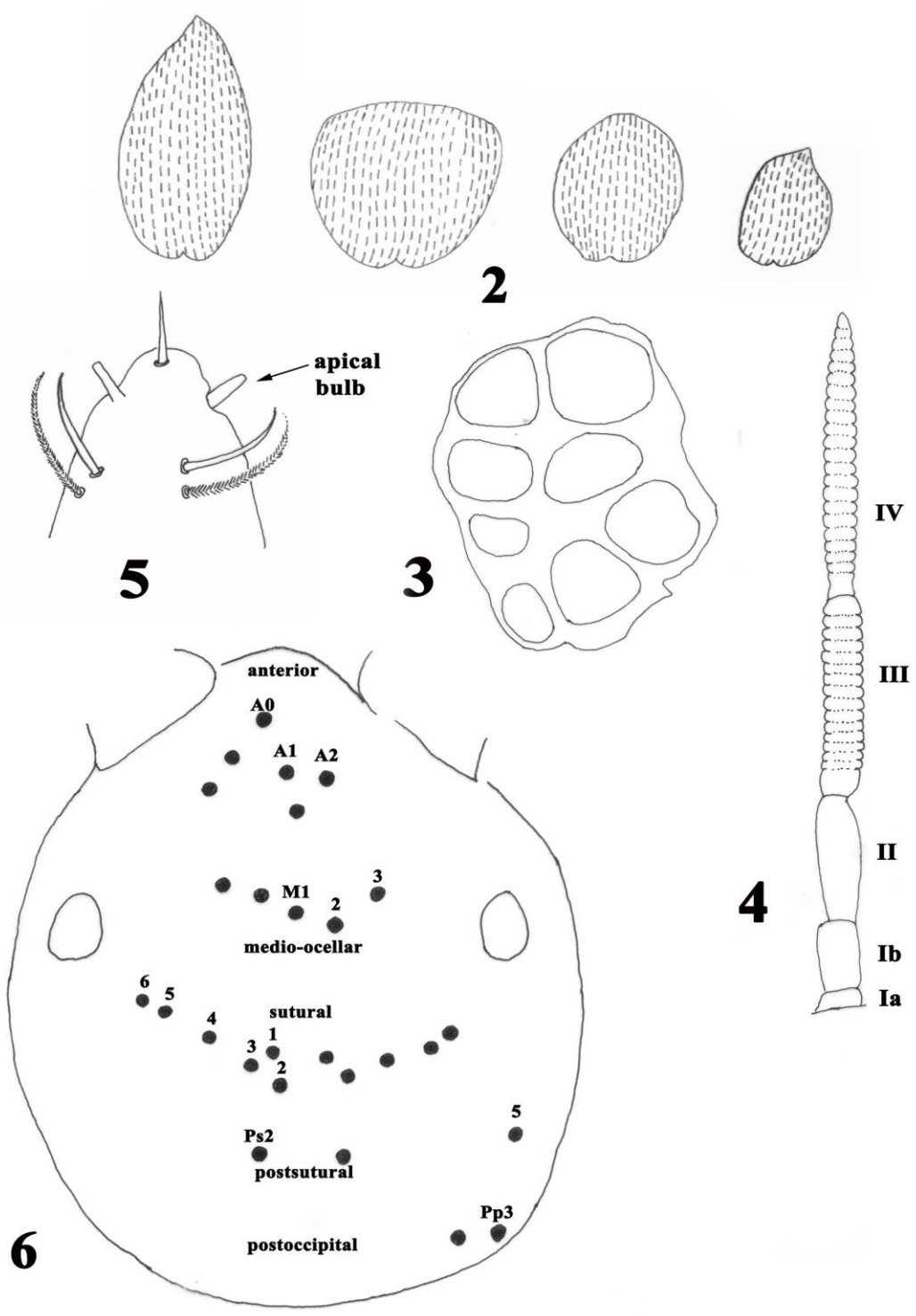
Abdomen: Ratio of segments of Abdomen I: II: III: IV: V: VI= 1: 1.4: 2.4: 3.6: 1.2: 0.5. Dorsal chaetotaxy of Abd. I to Abd. IV as in Fig. 7. Abd. I without macrochaetae. Abd. II with 4+4 macrochaetae and 3+3 bothritichia, Abd. III with 3+3 macrochaetae and 3+3 bothritichia, Abd. IV with 5+5 macrochaetae and 2+2 bothritrichia, Abd. V with 3+3 macrochaetae, 3 sensilla. Manubrium: dens: mucro = 1: 1.4 : 0.03. Dorsal face of manubrium with multiple rows of unilateral ciliated setae and few small smooth setae (Fig. 15). Ventral face of manubrium with scales only, no setae. Dens dorsally crenulate with unilateral setae, without scale; ventrally with large number of striated scales and setae. Base of dens with 1+1 falcate type machrochaetae (Figs. 16 and 16a). Detal spine absent. Percentage of uncrenulated dens is 11. Mucro bidentate without basal spine (Fig. 17).

Body chaetotaxy: Body clothed with mostly ciliated setae throughout head, thorax and abdomen. Cephalic portion clothed with large macrochaetae. Antennae clothed with scales and different types of ciliated setae and few smooth setae. Scales present on head, thorax, antennae, abdomen, legs and furcula. Scales are heavily striated and different type of shapes- elongate, oval and truncate (Fig. 2).

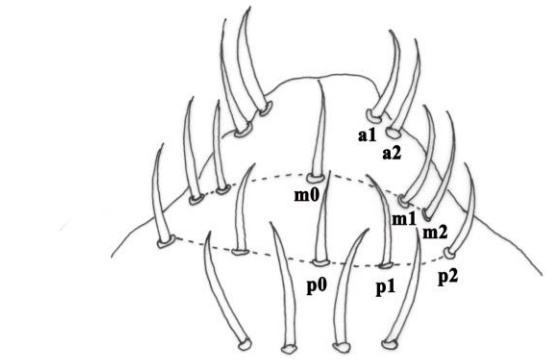
Remarks

The new species *Falcomurus chilikaensis* **sp. n**. possesses several unique characters compared to its closed taxon, *Heteromurus gigans* Mari Mutt & Stomp, 1980. The new species has Ant. III annulated, unguis with single paired basal inner teeth, dental base with 1+1 falcate type macrochaetae (absent in *H. gigans*). Apex of Ant. IV with two apical blunt setae (absent in *H. gigans*), labial triangle without scales (present in *H. gigans*), mucro without basal spine (present in *H. gigans*).

Fig. 1. *Falcomurus chilikaensis* **gen. n. sp. n.**, habitus (lateral view)



FIGURES 2-6. *Falcomurus chilikaensis* **gen. n. sp. n.: 2**, different shapes of scales; **3**, arrangement of eyes; **4**, antennae; **5**, Ant. V apex; **6**, head dorsal chaeatotaxy.



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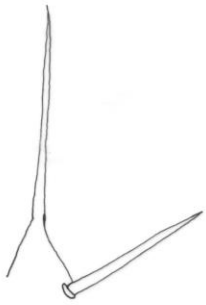

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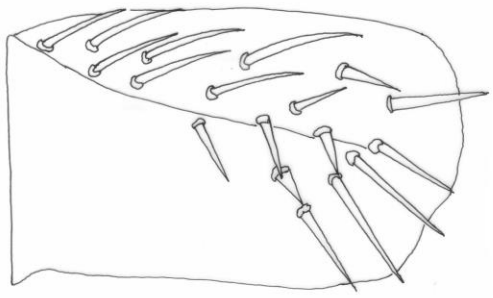

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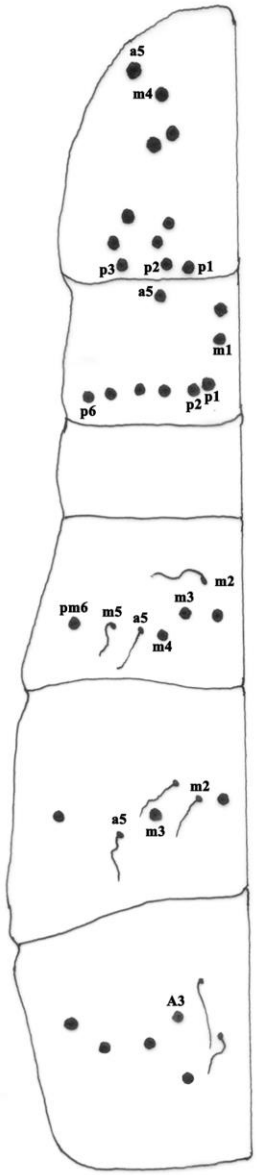

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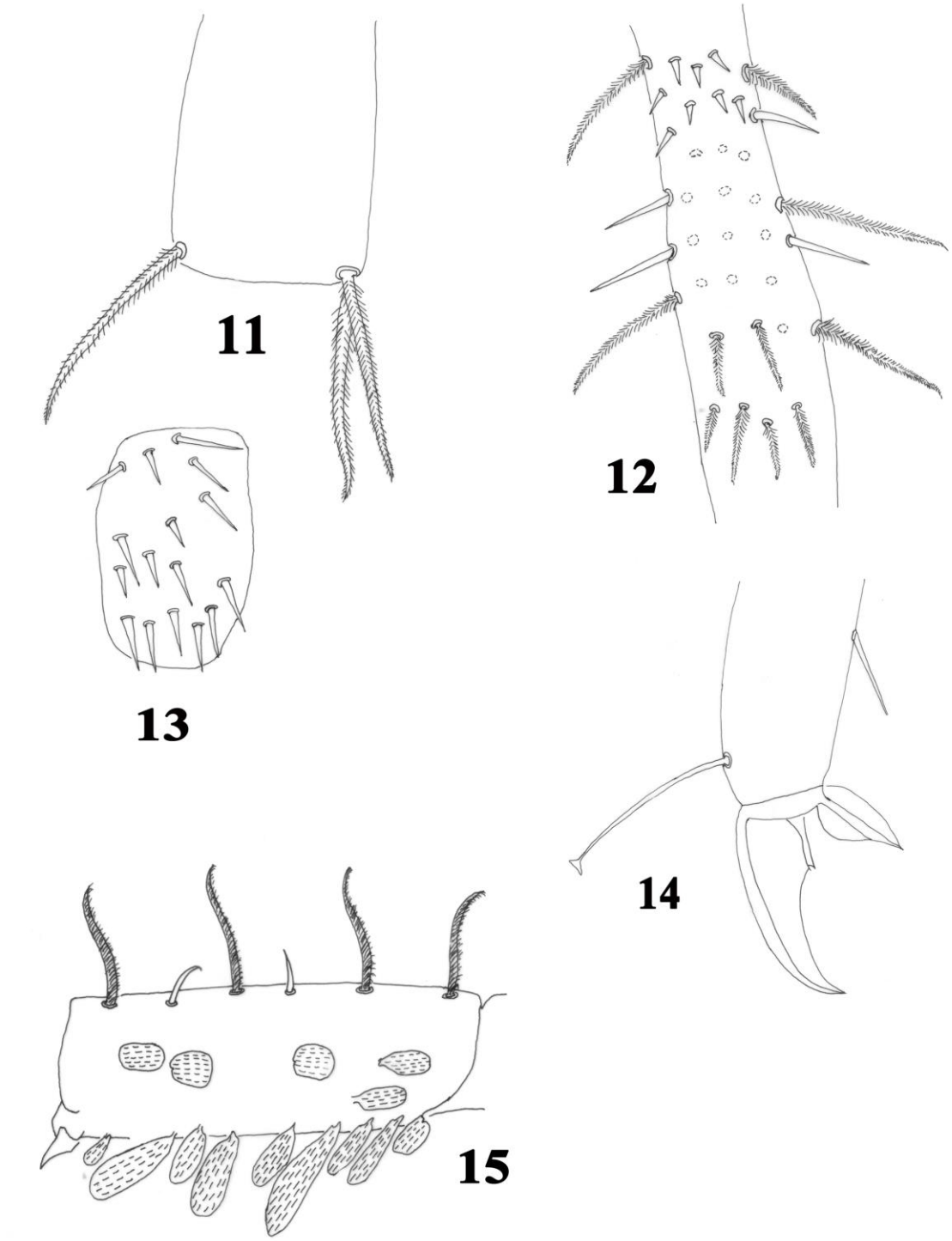
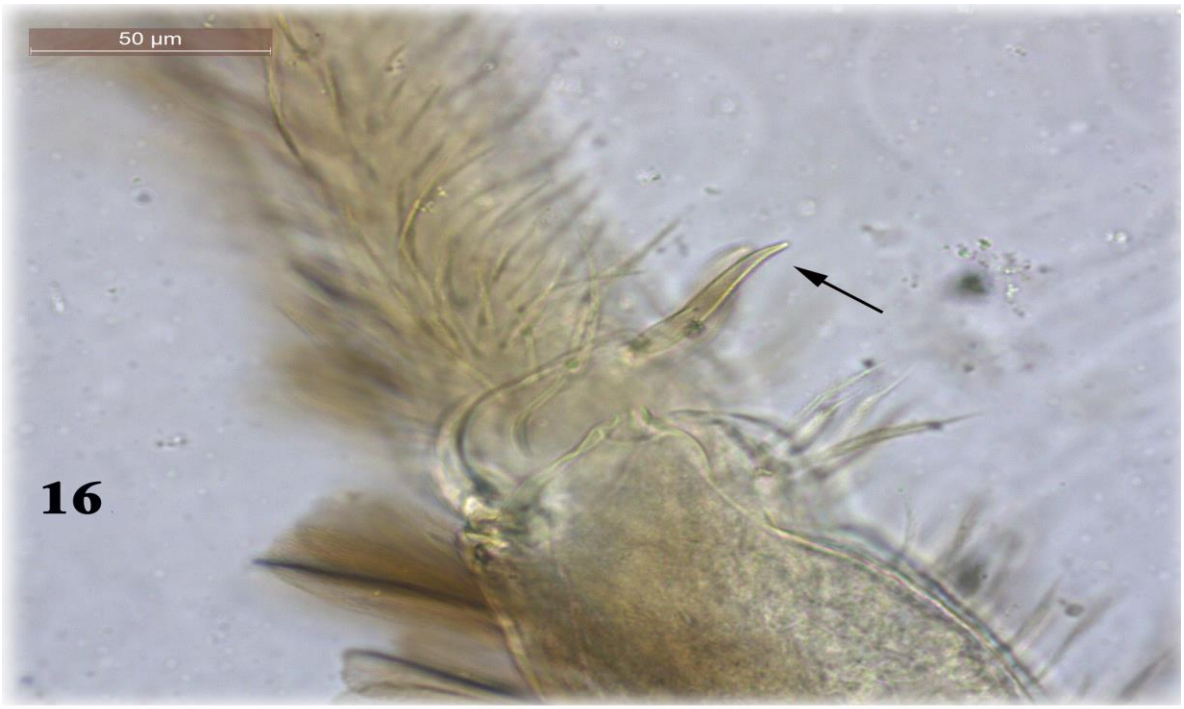
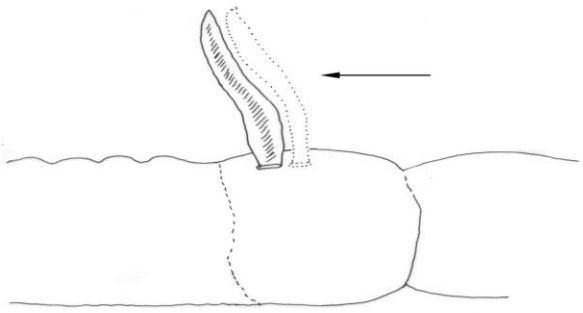
FIGURES 7-10. *Falcomurus chilikaensis* **gen. n. sp. n.: 7**, dorsal chaetotaxy of Th. II to Abd. IV; **8**, prelabral and labral chaetotaxy; **9**, outer labial papilla; **10**, Ventral tube (lateral face).

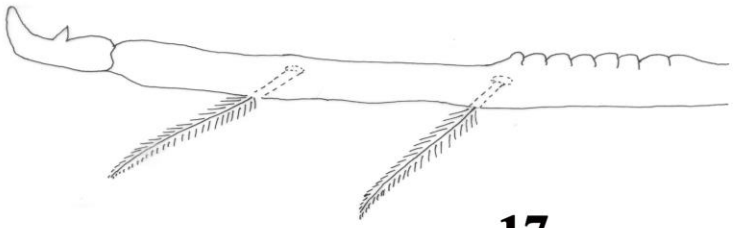


FIGURES 11–15. *Falcomurus chilikaensis* **gen. n. sp. n.: 11**, Ventral tube (posterior face); **12**, tibio-tarsi with setae; **13**, Trochanteral organ; **14**, empodial complex (unguis & unguiculus and tenent hair); **15**, manubrium with setae and scales.





16a



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FIGURES 16–17. *Falcomurus chilikaensis* **gen. n. sp. n.: 16** and **16a**, dens base with falcate macrochaetae; **17**, distal dens and mucro.

Etymology

The new species is named after the type locality, Chilika Lake, Odhisa, India.

Distribution

The new species was found in the Chilika Lake near Sabbulia village, Rambha town, Ganjam districts of Odhisa state, India. The area lies between 19°32´002.2´´ N latitude and 85°06´04.44´´E longitude. Altitude of the locality is 11 meters. The climate of the area is tropical.

Habitat

The specimens were found in the intertidal zone of the lake. It is an edaphic species. The specimens were collected from the wet soil under the stones near the intertidal zone of the Chilika Lake.

Discussion

According to Mari Mutt (1980a, b), Heteromurini species are characterized by the presence of dark scales, although species such as *Heteromutrella anae* (Cipola *et al.,* 2016) and *Alloscopus tetracanthus* (Yosii, 1959) bear hyaline scales. Therefore the coloration of scales should not be taken as a diagnostic character to the Heteromurini. In the other hand the sculpturing of the scales is a characteristic that can possibly be useful to determine the groups of Entomobryidae (Zhang *et al*. 2014). In *Heteromurtrella* the scales can be strongly striated with unaligned rows of stria; or moderately striated with aligned rows of stria (Cipola *et al.,* 2016). This condition is similarly seen in other genera of the tribe and should be investigated due to its potential as a diagnostic feature (Mari Mutt, 1976, 1979a; Zhang *et al*., 2014).

Although the relationship between Heteromurini genera is uncertain, in this context the dorsal chaetotaxy within the tribe create two distinct groups: *Dicranocentrus* and *Pseudodicranocentrus* with abundant macrochaetae and antennae with 6 segments; and *Heteromurus*, *Alloscopus*, *Heteromurtrella* and *Verhoeffiella* with reduction of macrochaetae and antennae with 5 segments (Mari Mutt, 1977, 1979a, b, 1980b, 1981).

Among this second group, *Heteromurus* and *Verhoeffiella* species are the most similar with each other by reduction on some mac as S0 and Pa2 in the head, Th. III with up to 4 mac, and Abd. I without mac (Mari Mutt, 1985). Both genera are currently distinguished especially by presence of annulations on Ant. III (absent in *Heteromurus*) and *Verhoeffiella* species as cave-dweller organisms (Mari Mutt, 1980a, b), although further characteristics presented in Table 1 can also help to correctly identify the genera.

The absence of head macrochaeta S0 was pointed as an exclusive characteristic of *Heteromurus* (Mari Mutt, 1980b) but it is also absent in some species of *Heteromurtrella*, such as *H. anae* sp. n. and *H. similis*. According to Cipola *et al.* (2016), Abd I macrochaetae distribution is the main characteristic to distinguish *Heteromurus* (absent) to *Heteromurtrella* (present). In the same sense the presence of dorsal spines in dens is not exclusive of *Alloscopus* as it is also present in *Heteromurtrella* as *H. echinata* and *H. tihuiensis*, so the presence of PAO and reduction of head postoccipital macrochaetae (Pa2, Pa3, Pm3 and Pp5) in *Alloscopus* is the main characteristic to distinguish it from other genera (Table 1).

Falcomurus **gen. n**. belongs to the second group with *Heteromurus*, *Alloscopus*, *Heteromurtrella* and *Verhoeffiella*, absence of head macrochaeta S0, reduction of macrochaetae and antennae with 5 segments.

Falcomurus **gen. n**. is similar to *Heteromurus* by the presence of 8+8 eyes, Abd. I without macrochaetae and absence of dental spines. It can be separated from *Heteromurus* by presence of annulated Ant. III, 9+9 mac on Th. III and 5+5 mac on Abd. IV, unguis with single paired basal inner teeth and dental base with 1+1 falcate type macrochaetae.

Falcomurus **gen. n**. is also similar to *Alloscopus* in having Ant. IV annulated, smooth setae on manubrium but it can be distinguished from *Alloscopus* by absence of PAO and dental spines.

Falcomurus **gen. n**. is also similar to *Heteromurtrella* in having PAO absent, Abd. V with 3 sensilla, dens generally without spines

but it can be easily separated from *Heteromurtrella* by presence of 8+8 eyes, annulated Ant. III, unguis with single paired basal inner teeth, dental base with 1+1 falcate type macrochaetae and mucro without basal spine.

Falcomurus **gen. n**. is also similar to *Verhoeffiella* in having Ant. III-IV annulated and absence of dental spines. However, *Falcomurus* **gen. n.** can be distinguished from *Verhoeffiella* by the presence of 8+8 eyes, dental base with 1+1 falcate type macrochaetae and absence of mucronal basal spine.

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