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Two new species of collembola *Sinella jaldaparaensis* (Entomobryidae) and *Cyphoderopsis gorumaraensis* (Paronellidae) from India

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Abstract

Two new species of Collembola from two different protected areas of West Bengal, India is described here: *Sinella jaldaparaensis* sp. nov. And *Cyphoderopsis gorumaraensis* sp. nov. *Sinella jaldaparaensis* sp. nov., is described, illustrated, and diagnosed; it is phenetically close congener of *Sinella siva* (Imms, 1912) and *Cyphoderopsis gorumaraensis* sp. nov. Is phenetically close congener of *Cyphoderopsis sexocellata* Yosii, 1966. Key to both the species from India is given.

Keywords: Collembola, Ommatidia, Sinella, Cyphoderopsis, India

Introduction

The collembolans commonly called "springtails" are small, entograthous, wingless hexapods possessing a spring-like forked jumping organ, the furcula underneath the fourth abdominal segment. They are minute in size (less than 6 mm in length); antennae primarily with 4 segments. The presence of antennae and absence of cerci distinguish them from the other entognathous hexapods. Mandal has published an updated checklist of collembola from India consisting of 342 species under 113 genera grouped in 20 families ^[1]. After that, Mandal ^[2]. Mandal *et al.* ^[3] Mandal & Arbea ^[4]. Added another five more species of collembola from India. Here, two genus of collembola, Sinella and Cyphoderopsis of the families Entomobryidae and Paronellidae were found. The genus Sinella is characterized by 4segmented antennae without apical bulb, reduced eye number (0-6 each side), pigment reduced or absent, polymacrochaetotic chaetotaxy, absence of dental spines and scales, and bidentate mucro. Deharveng^[5]. Chen & Christiansen^[6]. And Zhang et al.^[7-9] Zhang^[10]. Made significant contributions to its modern taxonomy. To date, genus Sinella represented 86 species from the world ^[11]. And a total of 3 species of *Sinella* have been recorded from India ^[1]. Genus Cyphoderopsis was established by Carpenter in 1917 for C. kempi Carpenter, 1917, a type species from Assam, India. Jantarit et al. ^[12]. Made great contribution to its modern taxonomy. At present 14 species of Cyphoderopsis described worldwide [11] and 4 species of *Cyphoderopsis* were known from India^[1]. The present contribution is added another two more species of collembolan fauna of India.

Material and methods

The present study is based on collection made by the first author during October, 2015 and August, 2016 from Duars region of Northern West Bengal as a part of Annual Programme of Research work of Apterygota section of Zoological Survey of India, Kolkata. The collembolan specimens were collected from two different protected areas of West Bengal viz., Jaldapara Wild Life Sanctuary and Gorumara National Park. Collections were made through mouth operated aspirator from leaf litter of the forest soil and also by beating the grasses and forest litters.

In laboratory, specimens were mounted under a cover slip in Hoyer's solution, and were studied under a Leica Digital Module (DM 2500) microscope and identified using keys and illustrations of Christiansen and Bellinger^[13]. Photographs were taken under a Leica Digital Module R (DMR) microscope using amounted Leica DFC 295 digital camera, and were Enhanced with Photoshop CS4 (Adobe Inc.).

All specimens and permanent slides have been deposited in the Apterygota Section, Zoological Survey of India (ZSI), and Kolkata.

Abbreviations

Abd = abdominal segment, Ant = antennal segment, Mac = macrochaetae, AN= antennal, s= sutural; ZSI = Zoological Survey of India, (Kolkata).

Results

Two collembolan species belonging to two genera of families Entomobryidae and Paronellidae were identified as a result of the survey of which both the species of collembola *Sinella jaldaparaensis* sp. nov. And *Cyphoderopsis gorumaraensis* sp. nov. Were described as a new to science from two different protected areas of West Bengal, India. The current systematic position, diagnosis of the genus, key to the species from India, detailed descriptions of each species and differences between closely related species and ecology are also discussed.

Taxonomic position

Family Entomobryidae Schäffer, 1896 Genus Sinella Brook, 1882 Type species: Sinella curviseta Brook, 1882 Diagnosis of the genus:

Members of the genus *Sinella* is characterized by four segmented antennae without apical bulb, reduced eye number (0–6 each side), pigment reduced or absent, absence of dental spines and scales and bidentate mucro. A total of 3 *Sinella* species have been recorded from India, all are eyed species. Here, fourth eyed *Sinella* species described in this paper.

Key to the species of Sinella from India

- 1. Omma 2+2.....2–Omma 6+6.....3
- 2. 2.Unguis without unpaired inner teeth.....S. nigropunctata (Imms, 1912)–Unguis with 1–2 unpaired inner teeth....S. curviseta Brook, 1882
- 3. Unguis without inner fourth tooth; ungual inner paired teeth at about 0.25 distance from base.*S. siva* (Imms, 1912)–Unguis with inner fourth tooth; ungual inner paired teeth at about 0.33 distance from base....*S. jaldaparaensis* sp. nov.

Sinella jaldaparaensis sp. nov. (Figs. 1–4)

Material examined

Holotype: female on slide, INDIA, West Bengal, Alipurduar district, 50 Feet Beat, North range, Jaldapara NP., latitude 26°69.534' North and longitude 89°280.481' East, date 02.x.2015, coll. G.P.Mandal, (Registration No. 2626/H14) deposited in the National Zoological Collection, Zoological Survey of India, Kolkata. Paratypes: 4 specimens on slide, same data as Holotype (Registration No. 2627/H14) and 5 specimens in ethyl alcohol, same data as Holotype (Registration No. 2627/H14) deposited in the National Zoological Collection, Zoological Collection, Zoological Collection, Zoological Collection, Zoological Survey of India, and Kolkata.

Description

Body length up to 1.51 mm (excluding appendages). Colour. Body colour whitish-brown. Eye black. A pigmented dot between two eyes. Ant. I & II pigmented distally with blue,

Ant. III & IV pigmented. Laterally, pigmented line from head to abdomen VI. Abd. III with transverse band as a whole. Legs pigmented laterally. Furcula not pigmented (Fig. 1A, 1B). Antennae. 2.5 To 2.6 times as long as cephalic diagonal. Antennal segments ratio as I: II: III: IV = 1: 1.8: 1.9: 2. Smooth spiny micro chaetae at base of antennae 3 dorsal, 3 ventral on Ant. I, 2 ventral, 1 external on Ant. II. Two internal 'S' of Ant III organ rod-like. Ant. IV without apical bulb (Fig. 1C, 1D, 2A). Head. Omma 6+6, equal in size, not separate (Fig. 2B). Labral papilla absent. Prelabral & labral chaetae 4/5, 5, 4, all smooth. Mandible teeth 4+5; tip of lateral process of labial palp reaching beyond apex of labial papilla. Sub apical chaetae of maxillary outer lobe thicker than apical one, 3 smooth sub-lobal hairs on maxillary outer lobe (Fig. 2C). Papilla E with 4 guard setae; lateral process of labial palp thick as normal chaetae. Chaetae X, X₂, X₄, ciliate. Cephalic groove with '6' setae; Clypeal chaetae 6, all are ciliate (Fig. 2D), dorsal cephalic chaetotaxy with 4 antennal (An), 5 sutural (s) and 4 mac in Gr. II (Fig. 2E). Thorax. Thoracic segments ratio as Th. I: II: III as 1: 1.7: 1.3. Unguis with one outer tooth and 4 inner teeth, '2' paired teeth unequal at 33 x base, outer one large. Unguiculus outer edge smooth (Fig. 2F). Tenant hairs clavate, subequal to unguis. Trochanteral organ with about 10 smooth spiny chaetae in 'V' shaped form (Fig. 3A). Inner differentiated tibiotarsal chaetae ciliate with ciliations closely appressed to axis (Fig. 3B). Abdomen. Relative length index of Abd. I : II : III : IV : V : VI as 1 : 1.2 : 1 : 4.3 : 0.8 : 0.7. Abd. IV 4.1 times as long as Abd. III. in length along dorsal middle. Ventral tube anteriorly with 5+5 ciliate setae, 2 of them much larger & thick (Fig.3C), posteriorly with 9 smooth chaetae in three rows (Fig.3D). Manubrium without smooth chaetae. Manubrium: mucrodens as 1: 1.6. Distal smooth part of dens 2.0 times of mucro in length; mucro bidentate with two teeth subequal; basal spine short with tip reaching the sub apical tooth (Fig. 3E). Chaetotaxy. Th. II with 3 medio-medial, 3 medio-lateral and 12-14 posterior macrochaetae (Fig. 3F). Th. III with 18 macrochaetae (Fig. 4A). Abd. I with 1 mac, Abd. II with 4 mac; Abd. III with 2 mac; Abd. III with 2 s-chaetae; Abd. IV with 3 cental, 5 lateral macrochaetae, 8-10 s-chaetae. Abd. V with '3's-chaetae (Figs.4B-4F).



Fig 1: Sinella jaldaparaensis sp. nov..: 1A & 1B: Habitus, Dorsolateral view; 1C: Ant.II; 1D: Ant.III.

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Fig 2: Sinella jaldaparaensis sp. nov..: 2A: Ant.IV without apical bulb; 2B: Ommatidia; 2C: Mouthparts; 2D: Clypeal chaetae; 2E: Chaetotaxy of head; 2F: Unguis and unguiculus.







Fig 4: Sinella jaldaparaensis sp. nov..: 4A: Th.III Chaetotaxy; 4B: Abd. I mac; 4C: Abd. II mac; 4D: Abd. III mac; 4E: Abd. IV mac & s-chaetae; 4F: Abd. V s-chaetae.

Ecology

Found in leaf litter and dried decomposed leaves of grasslands and moist deciduous forests.

Etymology

The species is named after type locality, Jaldapara National Park, West Bengal, India.

Family Paronellidae Borner, 1913

Tribe *Callyntrurini* Mitra, 1913 Genus *Cyphoderopsis* Carpenter, 1917 Type species: *Cyphoderopsis kempi* Carpenter, 1917

Diagnosis of the genus

Medium sized Paronellidae of 0.8 to 2.5 mm. Body colour usually white or weakly pigmented. Habitus rather broad, antennae shorter than body. Eyes usually absent but ocular patch and well-developed eyes can be found in some species (0+0 to 6+6 eyes). Scales generally absent on legs, present on antennae, head, body and furca. Antennae with 4 segments, Ant. I the shortest and Ant. IV the longest; Ant. IV not subdivided. Tenant hair either pointed on clavate. Claw with 0–2 inner teeth. One (*ceylonica* group) or two (*kempi* group) rows of dental spines. Forth abdominal segment 3 to 7 times as long as the third measured along dorsal axis. Furca well developed, about 1.8 to 2.8 times as long as body. Mucro rather stout, straight, normally with 3 main teeth, the apical one blunt, the sub-apical one small and acute, the dorso-basal one acute and longer with 0–5 toothless basally.

Key to the world species of the genus *Cyphoderopsis* (modified after Jantarit *et al.* 2013)

- 1. Dens with one row of dental spines.....2– Dens with two rows of dental spines......6
- 2. Eyes present or indistinct, but with pigmented ocular patch.....3– Eyes absent without pigmented ocular patch.....4
- 3. Eyes present (3+3) and pigmented.....*C. sexocellata* (India) Eyes not distinct but with ocular pigmented patch....*C. gorumaraensis* sp. nov. (India)
- 4. Manubrium larger than mucrodens...5– Manubrium shorter than mucrodens....*C. nayakensis* (Afganistan)
- 5. Claw with 1 internal tooth....C. ceylonica (Sri Lanka)– Claw with 2 strong internal teeth...C. nepalensis (Nepal)
- 6. Eyes present or indistinct, but with pigmented ocular patch...7- Eyes absent without pigmented ocular patch...11
- 7. Eyes not distinct with ocular pigmented patch....8– Eyes present....9
- 8. Mucro elongate with lateral line....*C. kempi* (India)– Mucro short and smooth...*C. lamottei* (Guinea)
- Eyes 1+1; claw with very long distal inner tooth...C. madagascarensis (Madagascar)
 – Eyes more than 1+1; claw different...10
- 10. Eyes 5+5.....*C. decemoculata* (India)– Eyes 6+6......*C. pauliani* (Ivory Coast)
- 11. Claw curved thin without inner teeth......*C. gracilis* (India)– Claw short or moderately thin, not curved, and with inner teeth.....12
- 12. Tenant hairs of tibiotarsi thick & clavate; claw with two inner teeth....*C. khaophang* (Thailand)– Tenant hair of tibiotarsi thin, smooth & acuminate...13
- 13. Th. II with 3 macrochaetae; claw with one inner tooth....C. cavicola (Thailand)– Th. II with 4 macrochaeta...14
- 14. Ventral tube with 3+3 macrochaeta anteriorly; claw with one inner tooth...*C. phangnga* (Thailand) Ventral tube with 4+4 macrochaeta anteriorly; claw with two inner teeth...*C. thachana* (Thailand).

Cyphoderopsis gorumaraensis sp. nov.

(Figs. 5–7 & table 1)

Material examined

Holotype: female on slide, INDIA, West Bengal, Jalpaiguri Gorumara Beat, Gorumara N.P., latitude district, 26°47.272'North longitude 88°50.487'East, and date 24.viii.2016, coll. G.P.Mandal, (Registration No. 2624/H14) deposited in the National Zoological Collection, Zoological Survey of India, Kolkata. Paratypes: 4 specimens on slide, same data as Holotype (Registration No. 2625/H14) and 14 specimens in ethyl alcohol, same data as Holotype (Registration No. 2625/H14) deposited in the National Zoological Collection, Zoological Survey of India, and Kolkata.

Description

Habitus relatively short. Body length 0.9-1.2 mm excluding antennae & furcula (Fig. 5). Lengths of body parts in Table1. Forth abdominal segment 4.25 times as long as the third one along axis. Furca well developed, 2.2-2.5 times shorter than body length. Body colour greyish white. Eyes not distinct with ocular pigmented patch (Fig. 6A). Scales present on antennae, head, body and furca, absent on ventral tube. Scales are hyaline, rounded, truncate & elongate. Head with strong ciliated/serrated macro & microchaetae (Fig. 6B). Mouth parts. Mandible head with 4 (left) and 5 (right) teeth. Maxilla head stocky, with tridentate claw and 6 ciliate lamellae. Labial basis chaetotaxy: M1 M2 Re L1 l2, outer maxillary lobe with one basal chaetae, a simple palp and two sublobal hairs. Labral formula 4/5, 5, 4 with 4 prelabral chaetae bent & ciliate, labral chaetae smooth & acuminate (Fig.6C). Antennae. Antennae about 1.5 times as long as head. Scales present dorsally on Ant. I & II. Ordinary chaetae as ciliate mesochaetae, numerous on all antennal segments, few smooth basal microchaetae on Ant. I, II & III. S-chaetae of various types, present on all segments. Ant. IV not subdivided or annulated, apical bulb absent, subapical organ rather long, thick, slightly thickened distally (Fig. 6D). Dorsal chaetotaxy. Dorsal chaetae of 6 types: ciliate, very long & thin trichobotria; serrated or ciliate mac, serrated & thin mesochaetae, modified mesochaetae around trichobotria. Sens of 2 types: dark, short, straight, pointed and longer, thinner, hyline (type 2). Trichobothria formula 0, 0/0, 2, 3, 3. (Fig. 6E). Macrochaetae formula 0/4, 0/0, 2, 4, 5. Dorsal pseudopore formula 1, 1/1, 1, 1, 1+4. Large number of dorsal macrochaetae on head present. Cephalic mesochaetae little shorter than macrochaetae, feebly serrated, equal, symmetrically arranged. Leg. Tibiotarsus chaetotaxy composed of strongly to weakly ciliate mesochaetae, 9-10 serrated/ ciliate mesochaetae arranged in distal rows, one strong serrated macrochaetae at 60% inner, one thick smooth ventro-subapical chaetae on hind tita, a dorso-apical tenent hair thin, smooth & acuminate in all tita (Fig. 6F). Unguis small, 6–7 times shorter than tita, moderately slender, one pair inner basal teeth, and the outer one is almost wing-like. Unguiculus pointed, lanceolate & elongate, external edge smooth (Fig. 7A). Trochenteral organ with 10-12 strong, straight, pointed, chaetae in a 'V' shape (Fig. 7B). Ventral tube. 3+3 long serrated macrochaetae anteriorly and both ciliate & smooth mesochaetae on each lateral flap (Fig. 7C) Furca. Tenaculam with 4 teeth on each branch and a strong, densely serrated, bent distally chaetae. Manubrium about 1.2 times longer than macrodens. Dens 3-3.5 times as long as mucro (Fig. 7D). Manubrium with dorsal ciliate mesochaetae, four strong, serrated macrochaetae, present two of which are distal end ventrally with elongate, slender scales and a distal group with 2-3 + 2-3 ciliate mesochaetae. Dens elongate, with single row of spines, consisting of 15-16 thick, serrated chaetae blunt apically (Fig. 7E). Dental scales elongate, enlarged distally. Mucro rather short and rather long, straight with 3 main teeth, the apical one blunt, the subapical one small, the dorso-basal are acute & large, with 1-3 toothless basally (Fig. 7F).

Table1. Cyphoderopsis gorumaraensis n. sp., measurements in µm from holotype (slide no. 2624/H14).

Body	Head	Ant.	Ant. I	Ant. II	Ant. III	Ant. IV	Th. II	Th. III
1047	234	372	55	98	70	149	145	86
Abd. I	Abd. II	Abd. III	Abd. IV	Abd. V	Abd. VI	Man	Dens	Mucro
54	57	76	323	46	26	244	150	50

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Fig 5: Cyphoderopsis gorumaraensis sp. nov. : Habitus, dorsolateral view;



Fig 6: *Cyphoderopsis gorumaraensis* sp. nov. : 2A: Pigmented ocular patch; 2B: Setae on head; 2C: Mouthparts; 2D: Antennae; 2E: Trichobotria on Abd. III; 2F: Tenent hair.



Fig 7: *Cyphoderopsis gorumaraensis* sp. nov. : 3A: Unguis & unguiculus; 3B: Trochanteral organ; 3C: Ventral tube; 3D: Manubrium & dens; 3E: Dental spines; 3F: Mucro.

Ecology

Found in leaf litter and dried decomposed leaves of moist deciduous forests.

Etymology

The species name is taken from the type locality, Gorumara National Park, West Bengal, India.

Discussion

The new species Sinella jaldaparaensis sp. nov. is closest to Sinella siva (Imms, 1912) having 6+6 omma, unguiculus without teeth, colouration of antennae, transverse black dot between two eyes, but differs clearly from its phenetically close congener S. siva in many important respects, such as: colouration of body (lateral pigmented line from head to Abd. VI, Abd. III with transverse band, absent in S. siva), unguis with four inner teeth, two paired, one mid and one apex and one outer tooth (unguis with three inner teeth, without outer tooth in S. siva); ungual inner paired teeth at about 0.33 distance from base (ungual inner paired teeth at about 0.25 distance from base in S. siva); trochanteral organ with 10 smooth spiny setae in 'V' shape arrangement (unknown in S. siva), less no of macrochaetae on Throrax & Abdomen, and mucro bidentate, basal spine short with tip reaching the sub apical tooth(mucro tridentate in S. siva).

Cyphoderopsis gorumaraensis sp. nov. differs from other species of *ceylonica* group (one row dental spine) having dorsal macrochaetae on head, with distinct large pigmented ocular patch and trochanteral organ with 10–12, strong, straight pointed setae. *Cyphoderopsis gorumaraensis* sp. nov. differs clearly from its phenetically close congener *C. sexocellata* having similar claw, dens with single row of dental spine, mucro long but it clearly differs from it by absence of 3+3 eyes, presence of sensory setae on Ant. III & IV, trochanteral organ with 10–12 strong, straight setae, unguiculus lanceolate type and 3+3 anterior setae on ventral tube.

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