

ON A NEW SPECIES OF SILVERFISH OF THE GENUS *CTENOLEPISMA* (ZYGENTOMA: LEPISMATIDAE) FROM KAWAL TIGER RESERVE, TELANGANA, INDIA

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ABSTRACT

A new species of the genus *Ctenolepisma* Escherich, 1905 is described from Kawal Tiger Reserve, Telangana, South India: *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. This species is compared with related previously described species belonging to the subgenus *Ctenolepisma* s. str.

Keywords: Zygentoma, *Ctenolepisma*, Lepismatidae, Kawal Tiger Reserve, Telangana, India

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RESUMEN

Una nueva especie del género *Ctenolepisma* (Zygentoma: Lepismatidae) de la reserva Kawal Tiger, Telangana, India

Se describe una nueva especie del género *Ctenolepisma* Escherich, 1905, recogida en la Reserva Kawal Tiger, en el estado de Telangana (India meridional): *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Esta especie se compara con otras previamente descritas y relacionadas, pertenecientes al subgénero *Ctenolepisma* s. str.

Palabras clave: Zygentoma, *Ctenolepisma*, Lepismatidae, Reserva Kawal Tiger, Telangana, India.

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Introduction

The largest genus of Lepismatidae (order Zygentoma = Thysanura s.str.) is *Ctenolepisma* Escherich, 1905 at the moment. Wygodzinsky (1955) divided the genus into two subgenera: the subgenus *Sceletolepisma* for species with 2+2 bristle combs on urotergite I, and the subgenus *Ctenolepisma* s. str., which bears 1+1 combs on this urotergite. Irish (1987) redefined the two subgenera on the basis of the presence (subgenus

Sceletolepisma) or absence (*Ctenolepisma* s. str.) of medial combs on the urosternites.

The subgenus *Ctenolepisma* globally contains about 40 species (Smith, 2018) distributed over all the continents except Antarctica and also Australia where only introduced species of this genus are known. In India poor attention has been given to free-living Lepismatidae. To date only five species are known under the subgenus *Ctenolepisma* from this country: *C. (C.) alticola* Silvestri, 1935, *C. (C.) boettgerianum*

Paclt, 1961, *C. (C.) longicaudatum* Escherich, 1905, *C. (C.) nigrum* (Oudemans, 1890) Escherich, 1905 and *C. (C.) tripurensis* Hazra, Biswas & Mitra, 2000. Therefore, the finding of a new species belonging to this subgenus is an important contribution to the knowledge of the Indian fauna of Lepismatidae.

Material and methods

Specimens were collected using an aspirator and fixed in 70% alcohol. They were dissected, cleared, and mounted using Tendeiro solution (Molero-Baltanás et al., 2000). Phase contrast and PlasDIC Microscope (Zeiss) were used for identification of insects. One specimen was dehydrated with absolute alcohol and coated with gold for SEM (Carl Zeiss) examination. The two specimens mounted on slides have been deposited in the National Zoological Collection, Zoological Survey of India, Kolkata (NZC/ZSI).

The use of neuter gender for *Ctenolepisma* species is followed, according to the Opinion 2427 of the International Commission on Zoological Nomenclature, which ruled that *Lepisma* Linnaeus, 1758 and all generic names derived from this generic name (i.e., those ending in *-lepisma*) are now ruled to be of neuter gender (ICZN, 2018).

Results

Ctenolepisma (Ctenolepisma) kawalense sp. nov.

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Figs 1–19

MATERIAL EXAMINED

Holotype. ♀, Pathatharlapadu forest, Kawal Tiger Reserve, Nirmal District, Telangana, India [19°8'86" N, 78°63'5" E], 11.ix.2019, coll. Dr. S. S. Jadav, under bark of a Sal tree (*Shorea robusta*), Registration number 3199/H14, Zoological Survey of India, Kolkata.

Paratype. 1 ♂, same locality as holotype, 11.ix.2019, coll. Dr. S. S. Jadav, Registration number 3200/H14, Zoological Survey of India, Kolkata.

A third specimen (female) was collected in the same locality and date and was used for SEM studies.

DESCRIPTION

Body length of female up to 13.6 mm; of male up to 13.1 mm. Base colour (in spirit) dorsally whitish yellow with a covering of light brown scales, ventrally whitish yellow. Shape of the body elongate, more or less parallel sided, dorso-ventrally compressed anteriorly, sub-cylindrical posteriorly; thorax slightly wider than abdomen (Fig. 1). Faintly brownish pigments are distinct on the segments of maxillary palp; lateral margins of labial palp; upper part of coxa, lower part of trochanter, lateral margin of femur; anterior and posterior margin of tibia and mid-internal portion of



Fig. 1.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Female. Habitus (dorso-lateral view).

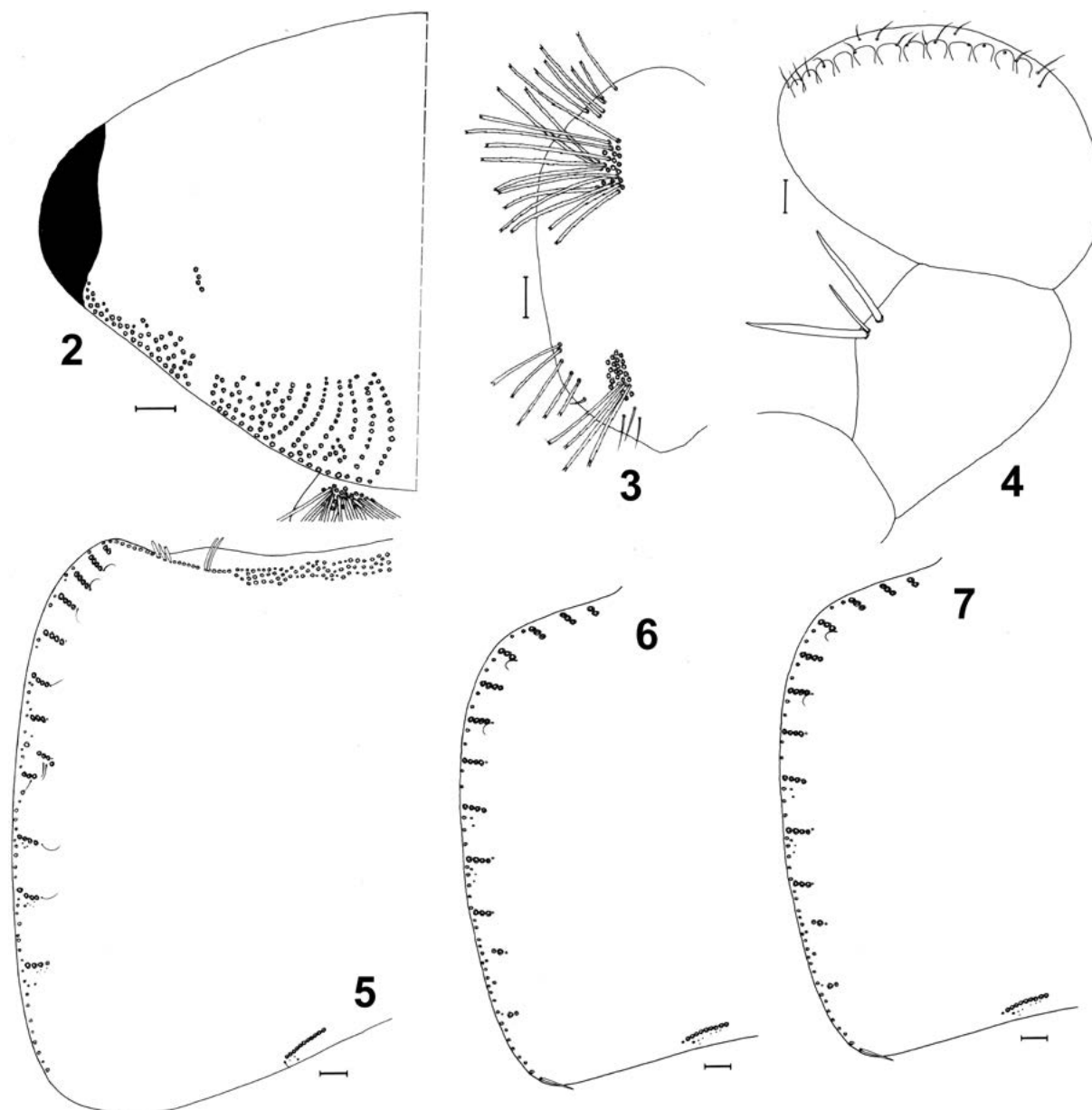
Fig. 1.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Hembra. Aspecto general en vista dorso-lateral.

the entire first segment of tarsomere. Antennae and caudal appendages with alternating dark and light bands of brown pigmentation. Scales covering the head (but absent from clypeus and labrum) and all the body dorsally and ventrally; appendages lacking scales with the exception of the antennal scapus, coxae and femora.

Head (Fig. 2) semi-circular in outline anteriorly; frons bearing two very conspicuous tufts of stout cephalic setae, pectinate and radially arranged. There are numerous bifid and pectinate macrosetae present in both clypeus and labrum; those of the clypeus are grouped in two tufts composed of 25–27 each (Fig. 3). Eyes relatively small, located well behind antennae. Head wider (2.1 mm) than long (1 mm). Antennae broken in female and in male up to 8.8 mm, shorter than body and reaching the IVth abdominal segment when directed backwards.

Maxillary palp lost during dissection in the holotype; in a paratype the apical article is about 6.8 times longer than wide and a little shorter than the penultimate. Apical article of labial palp (Fig. 4) sub-globular in shape, about 2.5 times wider at the apex than at the base and 1.3 times wider than long; it bears twelve sensory papillae arranged in a single row.

Medial part of the pronotal collar (Fig. 5) composed of 3–4 rows of macrosetae and both lateral parts contain a single row of smooth macrosetae. Lateral margins of pronotum with 12+12 combs composed of 2–4 macrosetae each. One trichobothrial area on each side, associated to the inner side of the last comb (N). Mesonotum (Fig. 6) lateral margins with 14+14 combs each consisting of 1–4 macrosetae, including one trichobothrial area in the inner comb (N). The positions of trichobothria on pronotum and mesonotum are not visible in the mounted specimen. Metanotum (Fig. 7) lateral margins with 12+12 combs composed of 1–4 macrosetae including two trichobothrial areas situated in the inner side of the comb N and the outer



Figs. 2–7.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Female (holotype). 2) Head chaetotaxy. 3) Clypeus with tufts of macrosetae. 4) Labial palp with sensory papillae on the apical article. 5) Pronotum, left side. 6) Mesonotum, left side. 7) Metanotum, left side. Scales: 0.1 mm, except for Fig 4: 50 μ m.

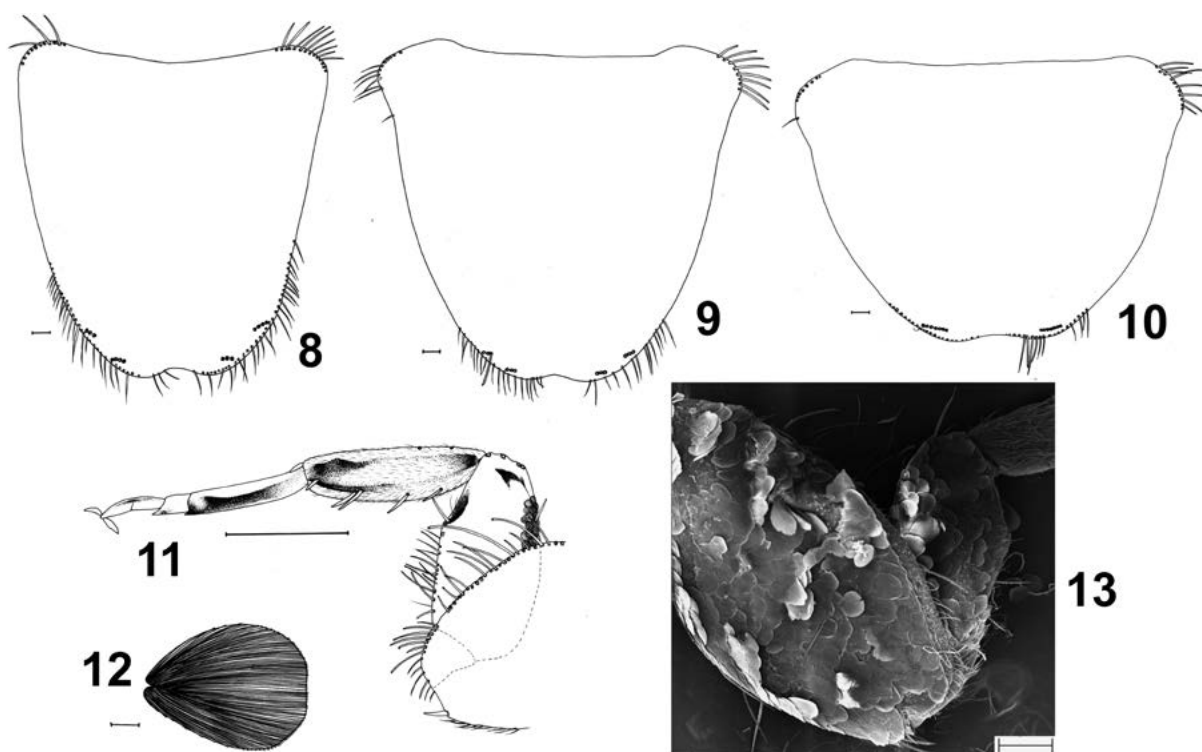
Figs. 2–7.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Hembra (holotipo). 2) Quetotaxia cefálica. 3) Clipeo con mechones de macroquetas. 4) Palpo labial con papilas sensoriales en su artejo apical. 5) Pronoto, lado izquierdo. 6) Mesonoto, lado izquierdo. 7) Metanoto, lado izquierdo. Escalas: 0.1 mm, excepto la Fig 4: 50 μ m.

side of the comb N–1. Hind borders of pro, meso and metanotum with 1+1 bristle combs composed of 10–11 macrosetae each.

Prosternum (Fig. 8) 2.1 mm in length, its length/width ratio about 1.1, subtriangular, posteriorly elliptical in shape; apex is deeply concave; and has 2+2 bristle combs each composed of 3–4 macrosetae. Mesosternum (Fig. 9) 2.1 mm in length, its length/width ratio about 0.9, semi-elliptical in shape, with concave apex and 2+2 subapical bristle combs each composed of 3 macrosetae. Metasternum (Fig. 10) 1.7 mm in length, its length/width ratio about 0.7; posterior margin broadly rounded with

concave apex, with 1+1 bristle combs each composed of 7 macrosetae; the distance between these combs is about 6.7–9.7 times the width of a comb in prosternum, 7.8–10.7 times the width of a comb in mesosternum and 3.4 times the width of a comb in metasternum.

Legs stout; femora short, one strong seta each on their outer and inner margin distally near the junction of tibiae; tibiae and tarsi moderately elongate; pretarsi with slightly curved claws (Fig. 11). Coxae and femora with scales (Figs. 12–13). Length/width ratio of protibiae about 2.4 times longer than wide; protibiae have two macrosetae inserted in their dorsal margin and five



Figs. 8–13.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Female. 8) Prosternum. 9) Mesosternum. 10) Metasternum. 11) Hind leg. 12) Femoral scale (hind leg). 13) SEM image showing the covering of scales and setae of coxa and femur of hind leg. All illustrations of holotype; Fig. 13 corresponding to another specimen. Scales: Fig. 8–10: 0.1 mm; Fig. 11: 1 mm; Fig. 12: 20 μ m; Fig. 13: 300 μ m.

Figs. 8–13.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Hembra. 8) Prosterno. 9) Mesosterno. 10) Metasterno. 11) Pata posterior. 12) Escama del metafémur. 13) Imagen de MEB mostrando el recubrimiento de escamas y setas de la coxa y el fémur de la pata posterior. Todas las figuras corresponden al holotipo, excepto la Fig. 13, obtenida de otro espécimen. Escalas: Fig. 8–10: 0.1 mm, Fig. 11: 1 mm; Fig. 12: 20 μ m; Fig. 13: 300 μ m.

macrosetae in their ventral margin. In the protarsus, the length of tarsomere I is about 0.53 mm; of tarsomere II is about 0.16 mm; of tarsomere III is about 0.22 mm and of tarsomere IV is about 0.26 mm. Mesotibiae 3.9 times longer than wide, with six dorsal and five ventral macrosetae. In the mesotarsus, the length of tarsomere I is about 0.98 mm; of tarsomere II is about 0.26 mm; of tarsomere III is about 0.21 mm and of tarsomere IV is about 0.26 mm. Metatibiae about 3.5 times longer than wide, with two dorsal and four ventral macrosetae. In the metatarsus, the length of tarsomere I is about 1.1 mm; of tarsomere II is about 0.47 mm; of tarsomere III is about 0.42 mm and of tarsomere IV is about 0.65 mm.

Urotergite I with 1+1 bristle-combs, each composed of 7 macrosetae. Urotergites II–VI with 3+3 bristle-combs, each composed of 5–10 macrosetae, and urotergite VII and VIII with 2+2 bristle-combs, each composed of 7–12 macrosetae. Urotergite IX without bristle combs. Urotergite X (Fig. 14) trapezoidal, shorter than wide at its base (length 0.8 mm, base width 1.65 mm, apical width 0.82 mm), ratio length/width about 0.48, posterior margin slightly concave. It has 1+1 bristle-combs of 6 macrosetae each.

Urosternites I and II without setae, III–VIII with 1+1 lateral bristle-combs, each composed of 10–16

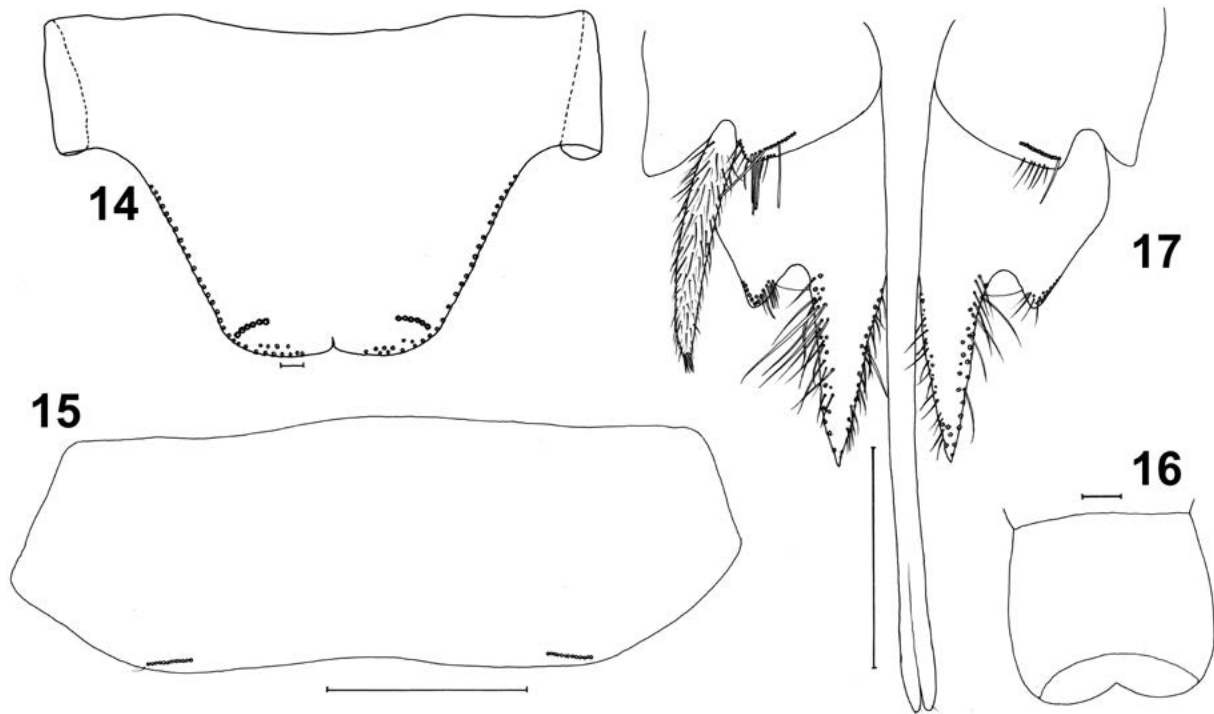
macrosetae. The width of the bristle combs and the gap distances between them varies in each urosternum, so that the ratio between the distance between the combs and the width of a comb varies from 4.1 on urosternite VII to 7.7 on urosternite III (Fig. 15).

Both sexes with two pairs of styli, inserted on segments VIII and IX. In the female, the ratio length of styli IX/ length of styli VIII is about 1. Posterior margin of the coxite VIII round. Inner process of the coxite IX long, triangular and pointed at tip, in the female about 2.3 times longer than wide at its base and 4 times longer than the outer process. Penis as in Fig. 16. Ovipositor very long (Figs. 17–18), with 56–58 divisions, surpassing the apex of the inner process of the coxite IX by 3.4 times the length of this process. The apical parts of gonapophyses are not sclerotized, both the anterior and posterior apices carry fine bristles; the anterior one with two long setae (Fig. 19).

Caudal filament 9.3 mm in length, cerci 7.4 mm in length.

DISTRIBUTION AND ECOLOGY

Ctenolepisma (C.) kawalense sp. nov. was generally most numerous beside small hill stream under bark of Sal trees, in the Pathatharlapadu forest at Kawal Tiger



Figs. 14–17.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. 14) Urotergite X of the holotype. 15) Urosternite III of the holotype. 16) Penis of the paratype. 17) Ovipositor of the holotype, with VIIIth and IXth coxite and VIIIth styli. Scales: Fig. 14, 16: 0.1 mm, Fig. 15, 17: 1 mm.

Figs. 14–17.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. 14) Uroterguito X del holotipo. 15) Uroesternito III del holotipo. 16) Pene del paratipo. 17) Ovopositor del holotipo, mostrando los coxitos VIII y IX y el estilo VIII. Escalas: Fig. 14, 16: 0.1 mm, Fig. 15, 17: 1 mm.



Reserve, Nirmal District, Telangana, Southern India. The species is found in red laterite soil of tropical semi-evergreen forest in Indian Deccan plateau. The protection of this Tiger reserve habitat will help to conserve of this rare *Zygentoma* species.

ETYMOLOGY

The species is named after the name of the locality Kawal Tiger Reserve, Telangana, India, which is the type locality.

Discussion

The new species described here, *Ctenolepisma (C.) kawalense* sp. nov., belongs to a group of species of the subgenus *Ctenolepisma* s. str. that have trapezoidal

Figs. 18–19.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Female. 18) Coxite IX and ovipositor. 19) Tip of anterior and posterior gonapophyses. Scales: Fig. 18: 100 µm; Fig. 19: 20 µm.

Figs. 18–19.– *Ctenolepisma (Ctenolepisma) kawalense* sp. nov. Hembra. 18) Coxito IX y ovopositor. 19) Extremo de las gonapófisis anteriores y posteriores. Escalas: Fig. 18: 100 µm; Fig. 19: 20 µm.

Table 1.– Characters of thoracic sternites that are useful to distinguish *C. kawalense* sp. nov. when compared with related species (those with trapezoidal urotergite X, 3+3 bristle combs in urosternites II–VI, 2 pairs of styli and macrosetae of combs of thoracic sternites arranged in a single row). The number of bristle combs of metasternum is not included, because all of these species have only one pair (sometimes *C. ciliatum* has two pairs).

Tabla 1.– Caracteres de los esternitos torácicos útiles para distinguir *C. kawalense* sp. nov. cuando se compara con especies relacionadas (las que poseen uroterguito X trapezoidal, 3+3 peines de macroquetas en los uroterguitos II–VI, 2 pares de estilos y macroquetas de los peines de los esternitos torácicos dispuestas en una sola fila). El número de peines del metasterno no se incluye, ya que todas las especies tienen un solo par (algunos *C. ciliatum* poseen 2 pares).

Species	Number of bristle combs		Number of macrosetae per comb		
	Prosternum	Mesosternum	Prosternum	Mesosternum	Metasternum
<i>C. kawalense</i> sp. nov.	2 pairs	2 pairs	3–4	3	7
<i>C. ciliatum</i>	3–9 pairs	2–3 pairs	3–8	3–12	12–18
<i>C. longicaudatum</i>	2–4 pairs	1–3 pairs	3–9	4–20	17–22
<i>C. abyssinicum</i>	2–3 pairs	1 pair	3–6	7–9	8–11
<i>C. somaliense</i>	2–4 pairs	1–2 pairs	3–7	14–18	14–16

tenth urotergite, 3+3 bristle combs in urotergites II–VI and two pairs of styli: *Ctenolepisma* (*C.*) *longicaudatum* Escherich, 1905 and *Ctenolepisma* (*C.*) *ciliatum* (Dufor, 1831) are the more widespread species of this group, although some records of these silverfish, especially of the first one in natural habitats and of the second one out of the Mediterranean region, could correspond to misidentifications or undescribed taxa. In Africa, two species can be included in this group: *C. abyssinicum* Mendes, 1982, from Ethiopia, and *C. somaliense* Mendes, 1988 from Somalia. In Western Asia, two additional species of this group have been described: *Ctenolepisma* (*C.*) *iranicum* Molero-Baltanás, Kahrarian & Gaju, 2016 from Iran and, *Ctenolepisma* (*C.*) *armeniicum* Molero-Baltanás, Gaju-Ricart, Bach de Roca & Mendes, 2010 from Armenia and Iran. These could be the species that are more related to the Indian fauna of the subgenus *Ctenolepisma* s. str. Perhaps *C. (C.) barchanicum* Kaplin, 1985 could also be related, but this species from Turkmenistan has only one pair of styli.

The most important differences of the Indian *C. kawalense* sp. nov. with the aforementioned species are the following:

A striking character of the new species is the presence of a large number of sensory papillae (12) arranged in a single row on the apical article of the labial palp (Fig. 5). Most species of the genus *Ctenolepisma* have only three to five papillae. The only related species that can bear a similar number of papillae is *Ctenolepisma* (*C.*) *longicaudatum* Escherich, 1905. In this synanthropic species, some specimens with a high number of sensory papillae can be found occasionally, though this number is variable, and its typical number is five. *C. somaliense* has usually five papillae, but sometimes bears one to two additional small papillae. *Ctenolepisma venkataramani* Hazra, Jana, Mandal & Molero-Baltanás, 2022, a recently described species from Andhra Pradesh (India) has also an unusually high number of sensory papillae (Hazra et al.,

2022), but this number is lower (nine in the studied specimens) and the shape of its thoracic sternites is clearly different.

The most remarkable character of *Ctenolepisma* (*C.*) *kawalense* sp. nov. is the shape of thoracic sternites, that are very widened apically and their posterior margin are rounded and clearly concave. All the remaining related species mentioned above have more acute (or, at least, convex) apical parts; only the metasternum of *C. somaliense* is slightly concave. The only species of the subgenus *Ctenolepisma* with trapezoidal urotergite X and a similar shape of thoracic sternites is *C. latisternatum* Mendes, 1993, from Central Africa (Congo), but this African species is clearly different in several characters, such as the number of styli (three pairs) or the shape of the urotergite X.

Ctenolepisma iranicum and *C. armeniicum* have double bristle combs, i.e., their macrosetae are arranged in two rows, but in the remaining related species, including *Ctenolepisma* (*C.*) *kawalense* sp. nov., they are arranged in one single row, at least on mesosternum and metasternum. When comparing these species with only one single row of macrosetae in thoracic sternites, the number of combs of these sternites and the number of macrosetae in each comb is also useful for distinguishing the new species, as shown in Table 1. In general, a lower number of macrosetae per comb can be observed in the new species from India.

The ovipositor of the new species has about 56–58 divisions, which is higher than in all related species (35–49 in *C. ciliatum*, 40–45 in *C. longicaudatum*, about 45 in *C. armenicum*, 41–48 in *C. iranicum*, 47–49 in *C. somaliense*, and about 40 in *C. abyssinicum*).

In the new Indian species, we have detected that the styli of segment IX are similar in size to those of segment VIII, whilst in other species we have observed that styli IX are usually larger. It is possible that equality of size is achieved in all species of *Ctenolepisma* when

completely developed but, if in some adult forms the definitive size of the VIII styli is smaller than those inserted in the coxite IX, this character may be of taxonomic interest. Unfortunately, it is not mentioned in most descriptions, so a comparison with previously described species is not possible.

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