NOTES ON THE ENDEMIC CHILEAN TERRESTRIAL DRYOPID *SOSTEAMORPHUS VERRUCATUS* HINTON 1936 (COLEOPTERA: DRYOPIDAE)

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ABSTRACT

New information on the geographic and environmental distribution of Chile's only known terrestrial dryopid is provided. External morphology, reproductive periods and life stages are described.

Key words: Dryopidae, *Sosteamorphus*, terrestrial, leaf litter, reproduction

RESUMEN

Se proporciona nueva información sobre la distribución geográfica y ambiental de *Sosteamorphus verrucatus* Hinton, 1936, único driópido conocido de Chile, terrestre y endémico a estes país. Se describen la morfología externa, período de reproducción y estados de desarrollo.

Palabras claves: Dryopidae, *Sosteamorphus*, terrestre, hojarasca, reproducción

INTRODUCTION

The family Dryopidae has many genera for which the adults are known from streams and ponds throughout the world. However, there is an increasing number of genera in which the adults are terrestrial and found in forest leaf litter. Most of these occur in tropical to subtropical environments (Kodada 1996; Kodada *et al*. 2000, 2007, 2009, 2013; Perkins 1997; Perkins and Spangler 1985). All known larvae and pupae are terrestrial (Jäch 1998). While aquatic dryopids are often quite numerous in the streams and ponds, terrestrial dryopids usually are only known from one or a few adults.

Sosteamorphus verrucatus Hinton was described from six specimens found in the Germain collection at the British Museum of Natural History (Hinton 1936). The holotype is card mounted. It has four labels: a white circle with red border, labelled Type (printed); a light blue circle with Chili (handwritten), 65/65 on the reverse; a red rectangle, HOLOTYPE (printed) and verrucatus (handwritten); and a white rectangle with a red band on one side on which Type and Sosteamorphus verrucatus 3/5' Hntn (handwritten. Four paratypes bear the blue circle with Chili (handwritten) and 65/65 (handwritten) on reverse. These four are obviously from the same collection as the holotype. The fifth paratype is from a different collection and bears the following labels: a white rectangle with Chili (handwritten); a white rectangle with Fry Coll. 1905. 100.; a white rectangle with Germain (handwritten); and an orange rectangle with PARATYPE (printed) and S. verrucatus HE Hinton (handwritten). Two paratypes are dissected with the parts on the point. The genders of the type series were not noted, and Hinton did not describe the genitalia. Dajoz (1973), apparently unaware of Hinton's description, described the same species as *Chiloéa chilensis* Dajoz from four specimens and designated a new family, Chiloéidae, for this species. Dajoz's description is much more detailed than Hinton's description, and it included a description and illustration of the ovipositor. A year later Solervicens (1974), working with 67 specimens, described the biology and distribution of *Chiloéa chilensis* Dajoz. Arias (2000) summarized the distribution of *S. chilensis* (Dajoz) [sic] and associated it with certain Chilean trees, using information from museum specimens. Kodada and Jäch (2005), in their review of Dryopidae, list *Chiloéa* Dajoz as a synonym of *Sosteamorphus* Hinton and cite the latter as monospecific. Carlton (2014) provides a brief overview of the species.

Association of *S. verrucatus* with soil and leaf litter is noted by all authors since Dajoz (1973). Solervicens (1974) particularly noted that collection was by processing leaf litter in Berlese funnels. Little

else has been published on *S. verrucatus*, and few museums or collections have any specimens due, in part, to the known distribution being restricted to southern Chile and, in part, to the difficulty in actually finding adults. I was able to collect a few specimens while working in southern Chile in 2007 and 2008. Those provoked me to further investigate this interesting species. I wished to determine how many species are present in *Sosteamorphus*, how much morphological variation is present, what are its periods of reproductive activity, and to find new, or to verify old, ecological information.

MATERIALS AND METHODS

Hinton's type series (6 specimens) was examined in the Natural History Museum (London, England). Other specimens were borrowed from The Field Museum (Chicago, Illinois) and Albert Allen (Boise, Idaho). Specimens in the Museo Nacional de Historia Natural de Chile and the Bohart Museum of Entomology Collection (University of California, Davis, California) were examined on-site to obtain additional locality data. My collections included specimens found by Charles Griswold and Hanna Wood (California Academy of Sciences) and me during soil and litter sifting in 2007 and 2008. Additional specimens were obtained from Tomás Cekalovic (Concepción, Chile). The specimens examined for this study totaled 437 adults, 1 larva and 107 eggs. I dissected the genitalia of many of the specimens to determine gender and to see if females had developed eggs.

RESULTS AND DISCUSSION

Distribution and Numbers

Solervicens (1974) lists the species' distribution as being from the province of Elquí (31º 45' S) to the province of Chiloé (43º S), and from near the Pacific coast into the Andes Mountains. Newer collections have extended this range further south to the province of Aysen and have filled it in, including adding distributions on several offshore islands (Table 1). Solervicens (1974) also thought they occurred within an elevational distribution of 200-300 m. Newer collections extend this from near sea level to 650 m.

The collection method required to find *S. verrucatus* does seem to limit their discovery. As noted earlier, leaf litter sifting and putting the sifted material into a Berlese funnel is usually required to find specimens. This is largely because of their small size, debris coating, and tendency to remain quiet after disturbance. Sometimes the sifted material can be spread on a large white sheet and the litter moved around to uncover specimens. However collection is done, patience is required to find more than a few specimens. Despite the difficulties, the greatest number of specimens collected on a single date was 37, taken in February. Adults have been found in leaf litter from 9 October (Solervicens 1974) through 13 March (Table 1). Their greatest abundance is during the austral summer months of January through March. Teneral adults were found from 11 January to 27 February, but mostly in February, and the tenerals from January were mainly from late in the month. Although *S. verrucatus* has been associated with leaf litter from various particular trees (Solervicens 1974), they actually occur in leaf litter found in almost any forest with moist litter.

External morphological variation

The most conspicuous variation that occurs between specimens is their debris covering. Shortly after emergence, adults cover their dorsal surface (except scutellum) (Figure 1) with lots of tiny debris particles that are "glued" to the surface. The mechanism of the "glueing" is unknown. A hypothesis is that the dorsal surface has glands that secrete sticky substances that then have debris particles adhere to the sticky substance. In this respect adult *Sosteamorphus* are similar to many adult *Georissus* Latrielle (Coleoptera: Georissidae) (Shepard 2003) and many adult *Lepicerus* Motschulsky (Coleoptera: Lepiceridae) (Shepard *et al*. 2005), other inhabitants of sand and organic matter. This makes them rather difficult to distinguish in the leaf litter or in the sifted material. The gross structure of the dorsum remains – various bumps and ridges – but the setation and the punctuate striae become totally obscured. Only newly emerged adults have the punctuate striae visible. Figure 1 shows the progressive obscuring of surface structure with increasing incorporation of soil debris on the dorsal surface.

TABLE 1. Collection records for specimens with data beyond "Chile". Names are listed as they occur on labels. Some suggested corrections are noted in parentheses.

Province	Locality	Date	Specimens
Arauco	Pata de Gallina	27 I 2002	1 adult
Arauco	Lago Lanalhue	11 I 2007	5 adults
Arauco	Isla Moche: Monte Alemparte	15 I 1995	2 adults
Arauco	Lago Lanalhue: Lincuyin	24 II 2007	22 adults
Arauco	Isla Moche: Caleta del Derrumbe	18 I 1995	8 adults
Arauco	Isla Moche: km 1 Estea Las Travesia	16 I 1995	4 adults
Arauco	Isla Moche: Monte Alemparte	15 I 1995	3 adults
Arauco	Isla Moche: Caleta del Derrumbe	18 I 1995	2 adults
Arauco	Lago Lanalhue	24 II 2007	2 adults
Aysen	Puerto Chacabuco	21 II 1982	2 adults
Chiloé	Isla Chiloé: Puente La Caldera	15 II 1993	3 adults
Chiloé	Isla Chiloé: Chepu	21 II 1997	4 adults
Chiloé	Isla Lemuy: Puerto Haro	12 II 2004	6 adults
Chiloé	Isla Chiloé: Puente La Caldes	4 I 1998	5 adults
Chiloé	Isla Chiloé: Chepu	23 I 2007	1 adult
Chiloé	Isla Chiloé: Chepu	19 II 2004	2 adults
Chiloé	Isla Quinchao: Quetro	21 II 2005	7 adults
Chiloé	Isla Chiloé: Chepu	21 II 1997	4 adults
Chiloé	Isla Chiloé: Chepu	9 II 1999	1 adult
Chiloé	Isla Chiloé: Chepu	14 I 2002	1 adult
Chiloé	Isla Chiloé: San Antonio de Chadmo	12 II 2003	2 adults
Chiloé	Isla Chiloé: Estero Llicaldad	6 II 2001	3 adults
Chiloé	Isla Chiloé: Chepu	15 II 2003	3 adults
Chiloé	Isla Chiloé: km 1 W de Huillinco	24 I 1998	1 adult
Chiloé	Isla Chiloé: Vilopolle	23 I 1998	1 adult
Chiloé	Isla Quinchao: Hullar Bajo	22 I 2000	1 adult
Chiloé	Isla Chiloé: San Antonio de Chadmo	21 I 2007	1 adult
Chiloé	Isla Quinchao: Hullar Alto	17 II 1995	1 adult
Chiloé	Isla Chiloé: Cucao	8 II 1994	2 adults
Chiloé	Lago Huillinco	21 II 1997	7 adults
Chiloé	Isla Chiloé: km 2 S Lago Nari	18 I 1998	4 adults
Chiloé	Isla Quinchao: Hullar Alto	6 II 1988	4 adults
Chiloé	Isla Chiloé	21 I 2007	7 adults
Chiloé	Isla Chiloé	18 I 1998	7 adults
Chiloé	Isla Chiloé: Hullar Bajo	22 I 2000	4 adults
Chiloé	Isla Chiloé: Estero Llicaldad	6 II 2001	37 adults
Chiloé	Isla Chiloé: Cucao	9 II 1994	4 adults
Chiloé	Isla Quinchao	17 II 1995	4 adults
Chiloé	Isla Chiloé: Chepu	12 II 1994	14 adults

Province	Locality	Date	Specimens
Chiloé	Isla Chiloé: Chepu	23 I 2007	12 adults
Chiloé	Isla Chiloé: Tepu (= Chepu?)	18 II 2005	28 adults
Chiloé	Isla Chiloé: Estero Llicaldad	6 II 2001	2 adults
Chiloé	Isla Quinchao: Quetro	21 II 2005	2 adults
Chiloé	Isla Chiloé: km 2 S Lago Nari	18 I 1998	1 adult
Chiloé	Isla Quinchao: Hullar Bajo	22 I 2000	1 adult
Chiloé	Isla Chiloé: Estero Llicaldad	24 I 1998	34 adults
Chiloé	Isla Chiloé: Chepu	31 I 2001	16 adults
Chiloé	Isla Chiloé: Estero Llicaldad	24 I 1998	1 adult
Chiloé	Isla Chiloé: Puente La Caldera	15 II 1996	14 adults
Chiloé	Isla Chiloé: San Antonio de Chadmo	21 II 2007	1 adult
Chiloé	San Juan de Chadmo	20 II 1997	1 adult
Chiloé	Ahonil Alto	10 II 1988	2 adults
Chiloé	Isla Chiloé: Chapu (Chepu)	22 II 1994	4 adults
Llanquihue	Cruce Abtao	7 II 1988	2 adults
Llanquihue	Km 2 N de Parguz	23 II 1997	7 adults
Malleco	Monumento Nacional Contulmo	2 II 2005	9 adults
Osorno	cruce camino Pucatrihue a Bahia Manza	6 III 2001	15 adults
Osorno	Pucatrihue	II 1985	5 adults
Osorno	cruce camino Pucatrihue a Bahia Manza	23 I 2007	9 adults
Valdivia	Parque Oncol	31 I 2004	1 adult
Valdivia	Parque Oncol	11 II 2004	1 adult
Valdivia	Parque Oncol:Sendero Colfuco	19 I 2007	1 adult
Valdivia	Parque Oncol	14 II 2004	1 adult
Valdivia	Parque Oncol:Sendero Tepuales	3 I 2002	2 adults
Valdivia	cruce entrada al Parque Oncol	14 I 2001	5 adults
Valdivia	Parque Oncol	8 II 2003	1 adult
Valdivia	Parque Oncol	27 I 2001	1 adult
Valdivia	Parque Oncol	6 II 2000	1 adult
Valdivia	km 1 antes cruce Cuiñancoi-Parque	Oncol13 I 2001	3 adults
Valdivia	Parque Oncol:Sendero Punucapa	5 II 1999	4 adults
Valdivia	Parque Oncol:Sendero Cerro Onco	(no date)	2 adults
Valdivia	Parque Oncol:Sendero Tepuales	10 II 2004	2 adults
Valdivia	Parque Oncol:Sendero Punucapa	3 I 2002	2 adults
Valdivia	Parque Oncol:Sendero Punucapa	19 I 2007	1 adult
Valdivia	Parque Oncol:Sendero Punucapa	13 IV 2001	2 adults
Valdivia	Parque Oncol:Sendero Punucapa	17 I 2007	2 adults
Valdivia	Parque Oncol:Cerro Oncol	4 II 2004	1 adult
Valdivia	Parque Oncol	9 I 2001	3 adults
Valdivia	Parque Oncol:Sendero Quitaqui	19 I 2001	1 adult

Province	Locality	Date	Specimens
Valdivia	Parque Oncol:Sendero Quitaqui	8 II 2000	2 adults
Valdivia	Parque Oncol:Sendero Quitaqui	13 II 2000	2 adults
Valdivia	Parque Oncol:Sendero Tepuales	5 II 2004	2 adults
Valdivia	Parque Oncol:Sendero Tepuales	14 II 2004	1 adult
Valdivia	Parque Oncol:Sendero Tepuales	19 II 2000	1 adult
Valdivia	Parque Oncol:Sendero Tepuales	5 II 2004	2 adults
Valdivia	Parque Oncol:cruce camino Curiñauco	6 I 2002	2 adults
Valdivia	Parque Oncol	14 II 2000	1 adult
Valdivia	cruce camino al Parque Oncol	20 II 2000	4 adults
Valdivia	Parque Oncol:Sendero Cerro Oncol	3 II 2004	2 adults
Valdivia	Parque Oncol:Sendero Cerro Oncol	no date	1 adult
Valdivia	Parque Oncol:Sendero Tepuales	3 I 2002	1 adult
Región X	Lago Huillinco:8.4 km SE Cucao	3-4 II 2008	6 adults
Región X	12 km NW Valdivia	21-22 II 2008	4 adults; 1 larva
Región X	12 km NW Valdivia	22 II 2008	4 adults
Región X	12 km NW Valdivia	27 II 2008	3 adults
Región X	Chaihuin: Reserva Costera Valdiviana	27 II 2008	2 adults
Región X	12 km NW Valdivia	24 II 2008	3 adults
Región X	PN Vincente Perez Rosales	17 XII 1972	1 adult
Región X	Chaihuin: Reserva Costera Valdiviana	27 II 2008	2 adults

The most obvious morphological variation concerns the size of the adults. There are two size classes, a small morph and a large morph. Most populations contain both morphs, but some are entirely composed of the large morph. I have not been able to associate any environmental or geographic variable with the two sizes. Perhaps the larger morph develops from larvae that have a two year stadium and smaller morphs have larvae with a one year stadium.

Although there is considerable overlap in the size of males and females overall, males are usually shorter than females (♂ length: 2.8-4.0 mm; ♀ length: 3.1-4.6 mm), except when a population has the two size morphs, each of which contain both genders. Small males are 2.81-3.43 mm long (pronotum + elytra) while large males are 3.50-4.00 mm long. Small females are 3.3-4.1 mm long and large females are 3.66-4.60 mm long. Recognition of the two size morphs is easiest in males where there is no overlap in the size ranges. This was what led to the recognition of the two size morphs rather than just a big range in size.

Males and females can be separated externally by the structure of the last abdominal ventrite. In males this ventrite is flat. In females there is a gently sloping medial ridge in the apical half of the last ventrite. Females also have a tuft of setae on either side of the midline at the ventrite apex, as illustrated by Dajoz (1973).

Dajoz (1973) illustrated the female genitalia for the first time. It is type 1 in the female genitalia classification of Kodada and Jäch (2005). Hinton (1936) and Dajoz (1973) both failed to describe or illustrate the male genitalia. The male aedeagus (Figure 2) is well sclerotized with the parameres longer than the penis. The phallobase is longer than the parameres and it is tubular. The parameres bend ventrally at their midpoint. The fibula is well sclerotized, about 2/3 as long as the aedeagus, and split basally into a Y-shape. I have found nothing that suggests the presence of more than one species. Thus, I agree with Kodada and Jäch (2005) that *Chiloéa* is a junior synonym of *Sosteamorphus*, and that *C. chilensis* Dajoz is a junior synonym of *S. verrucatus* Hinton.

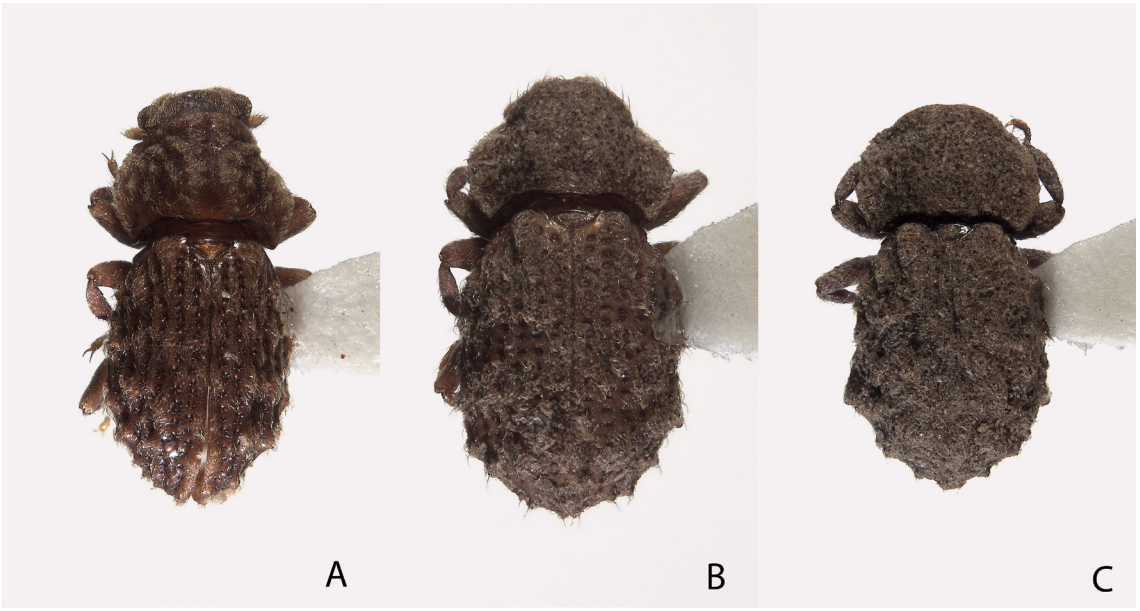

FIGURE 1. *Sosteamorphus verrucatus*: A- clean adult; B –adult with debris partially covering the dorsal surface; C - adult with debris completely covering the dorsal surface.

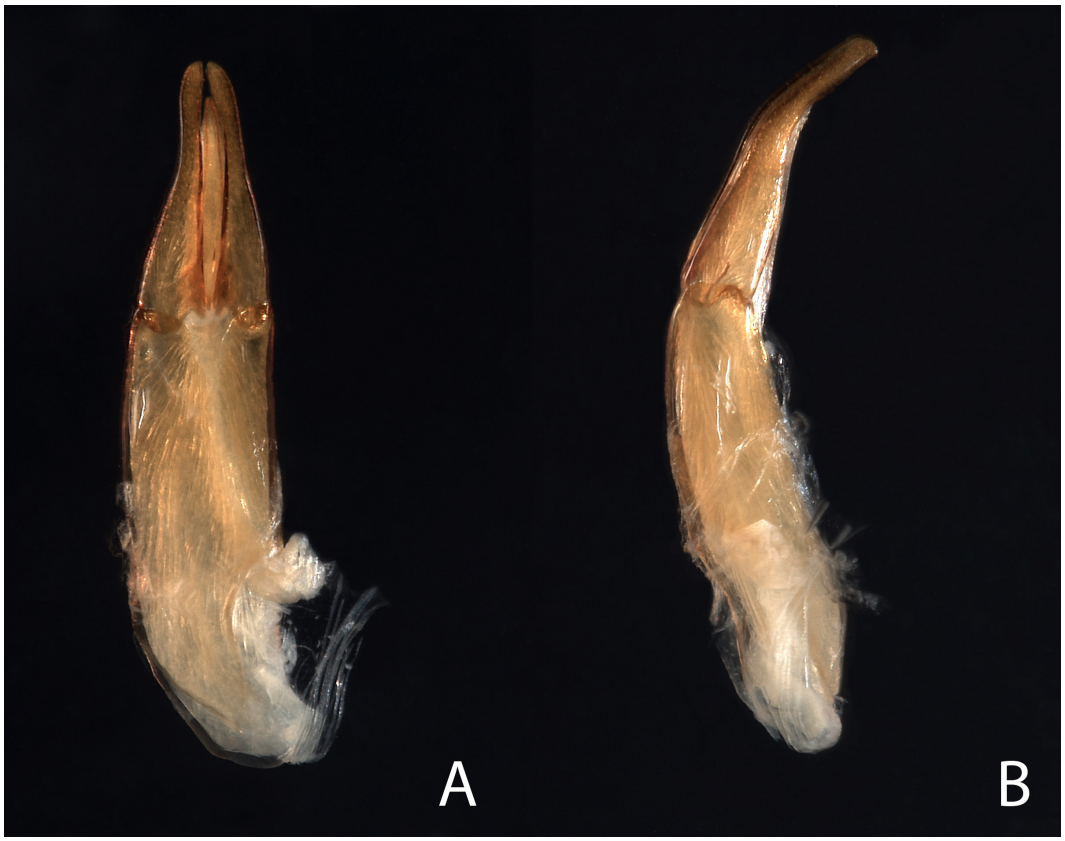

FIGURE 2. *Sosteamorphus verrucatus*: male genitalia. A – Dorsal view; B – Lateral view.

FIGURE 3. *Sosteamorphus verrucatus*: larva. A – Ventral view; B – Lateral view.

Sex ratios and reproductive periods

Most collection events, even those made by collectors experienced with *Sosteamorphus*, contain only a few adults. But this study examines sufficient adults to make reasonable estimates of the sexual ratio. In almost all cases there is a skewing toward males. Examples from individual collection events include: 7♂, 3♀ (2.33:1); 10♂, 6♀ (1.67:1); 9♂, 3♀ (3.0:1); 13♂, 8♀ (1.63:1); 24♂, 10♀ (2.4:1); 26♂, 12♀ (2.16:1). This is also true when working with counts from combined collection events (such as for individual months or specific localities): 75♂, 36♀ (2.08:1); 54♂, 33♀ (1.64:1). Assuming that equal numbers of each gender are produced at mating, either females are lost more often than males, or else females have a slightly different microhabitat. Perhaps during oviposition females burrow deeper into the soil where they are more difficult to capture.

The reproductive period may be determined from either the period of adult occurrence (October through April) or the period when the females are carrying eggs. However, the life cycle is not known so it would be safest to estimate the reproductive period as when most adults are found, or January through February. Considering when females are carrying eggs, the reproductive period can be estimated as occurring from January through March.

Eggs

One hundred and seven eggs were dissected from females. They were taken from females collected from 3 January through 6 March. Dissectable females are lacking from outside of these dates. The number of eggs per dissected female and the number of females with that many eggs were: 0-22; 1-18; 2-13; 3-9; 4-1; 5-2; 6-0; 7-2; 8-1. The highest monthly total of eggs was found in females from January (55) and February (36).

The eggs are cylindrical, with rounded ends. Their dimensions are: L = 1.0-1.1 mm; W = 0.31-0.33 mm (N=21; 10 from small morph females and 11 from large morph females). Eggs from small morph females are the same size as those from large morph females. The surface has a medial band of many fine, longitudinal striations. The striations are visible only in newly dissected eggs as the eggs swell soon after being placed in glycerin. This morphology is found in eggs of other dryopids (Kodada and Jäch 2005; Shepard unpublished data).

Larva

Only a single larva (Figure 3) has been found during the field work for this study. The identification was made by association with adults and due to there only being one terrestrial dryopid known from Chile. It was taken in Parque Oncol, northwest of Valdivia, on 22 February 2008. It has a morphology typical for dryopids (Kodada and Jäch, 2005), but is correspondingly small (L=1.5 mm; W=0.3 mm). The body is yellowish. Each side of the cranium has six eyespots - two dorsal, three in a lateral group and one by the mandibular base. The body has scattered long erect setae. The venter of abdominal segment IX has a large flat operculum.

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