

**A NEW *PETTALUS* SPECIES
(OPILIONES, CYPHOPHTHALMI, PETTALIDAE)
FROM SRI LANKA WITH A DISCUSSION ON THE
EVOLUTION OF EYES IN CYPHOPHTHALMI**

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ABSTRACT. A new species of Cyphophthalmi (Opiliones) belonging to the Sri Lankan genus *Pettalus* is described and illustrated. Characterization of male and female genitalia and SEM illustrations are included, representing the first such analysis for the genus. This constitutes the first species of *Pettalus* to be described since 1897, although information on other morphospecies recently collected in Sri Lanka indicates that the number of species on the island is much higher than previously thought. The presence of eyes in pettalids is illustrated for the first time and the implications of the presence of eyes outside of Stylocellidae are discussed.

Keywords: Gondwana, *Pettalus lampetides*, Sri Lanka

A dearth of collections and plentitude of mysteries have long been the hallmarks of the cyphophthalmid fauna of Sri Lanka, arguably the most enigmatic among this suborder of Opiliones. Only two species—the first one originally assigned to the genus *Cyphophthalmus*—have been formally recognized, both over two centuries ago: *Pettalus cimiciformis* (O. Pickard-Cambridge 1875) and *P. brevicauda* Pocock 1897. The former species was described from a single male specimen collected in an unspecified locality in “Ceylon”, and the latter from an adult male and a male juvenile collected in Pundaluoya (specimens deposited at the BMNH). All three specimens, collected in the 19th century, feature a peculiar modification of the terminal opisthosomal tergites that forms the “tail” characteristic of male *Pettalus*.

Subsequent to the original descriptions (O. Pickard-Cambridge 1875; Pocock 1897), Hansen & Sørensen (1904) undertook redescription of the anatomy of the specimens for their monograph. However, the original descriptions conflict significantly with those of Hansen & Sørensen (1904), possibly because the two species were confused with each other

during redescription. Study of the specimens of *P. brevicauda* was not resumed until two recent cladistic analyses of the cyphophthalmid genera (Giribet & Boyer 2002) [these specimens are referred to, erroneously, as *P. cimiciformis* in this publication, following redescription by Hansen & Sørensen (1904)] and specifically of the family Pettalidae (Giribet 2003). Due to the paucity of available specimens known until the publication of these articles, SEM studies and details of the genitalia of the genus *Pettalus* have heretofore not been undertaken.

An entomological research expedition to Sri Lanka in 1970 by collectors Claude Besuchet and Ivan Löbl led to the collection of 75 *Pettalus* specimens currently deposited at the Muséum d’histoire naturelle, Ville de Genève, which have never been previously studied. Preliminary analysis of these specimens has revealed eight morphospecies, which differ considerably from the two previously described species of *Pettalus*. Here we describe the first new species belonging to the genus *Pettalus* from that collection, and for the first time provide details of the genitalia and SEM studies for the genus. The new species is smaller than the two previously described species. It is, however, not the smallest species collected, as pending descriptions will clarify.

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This constitutes the first report and description of a species belonging to *Pettalus* since 1897.

METHODS

Abbreviations.—Specimens are lodged in the following institutions: BMNH = The Natural History Museum, London (UK); MCZ = Museum of Comparative Zoology, Harvard University, Cambridge (USA); MHNG = Muséum d'histoire naturelle, Ville de Genève (Switzerland). Nomenclature on cuticular ornamentation follows Murphree (1988). One male and one female specimen were examined with a Scanning Electron Microscope (SEM) FEI Quanta 200. The holotype was photographed in dorsal, ventral and lateral positions using a JVC KY-F70B digital camera mounted on a Leica MZ 12.5 stereomicroscope. A series of images (from 10 to 15) were taken at different focal planes and assembled with the dedicated software package Auto-Montage Pro Version 5.00.0271 by Syncrosopy. All measurements are given in mm, unless otherwise indicated.

TAXONOMY

Family Pettalidae Shear 1980

Genus *Pettalus* Thorell 1876

Pettalus Thorell 1876: 469.

Type species.—*Cyphophthalmus cimiciformis* O.P.-Cambridge 1875, by monotypy.

Pettalus lampetides new species
(Figs. 1–24)

Type material.—SRI LANKA: *Province of Uva*: male holotype, Dyaluma Falls [ca. 6°44'N, 81°01'E], 25 January 1970, C. Besuchet and I. Löbl (MHNG). Paratypes: 5 males, 2 females, same collecting data as holotype (MHNG); 1 male, 1 female (for SEM) same collecting data as holotype (MCZ 62997, 62998); 1 male, 1 female, same collecting data as holotype (MCZ 62999).

Additional material studied.—SRI LANKA: *Province of Uva*: 10 juveniles, same collecting data as holotype (MHNG). At least one large juvenile belongs to a different species, and therefore we cannot confidently assign the juveniles to *P. lampetides*.

SRI LANKA: *Central Province*: Pundaluooya [ca. 7°02'N, 80°40'E], type specimens of *Pettalus brevicauda* (BMNH).

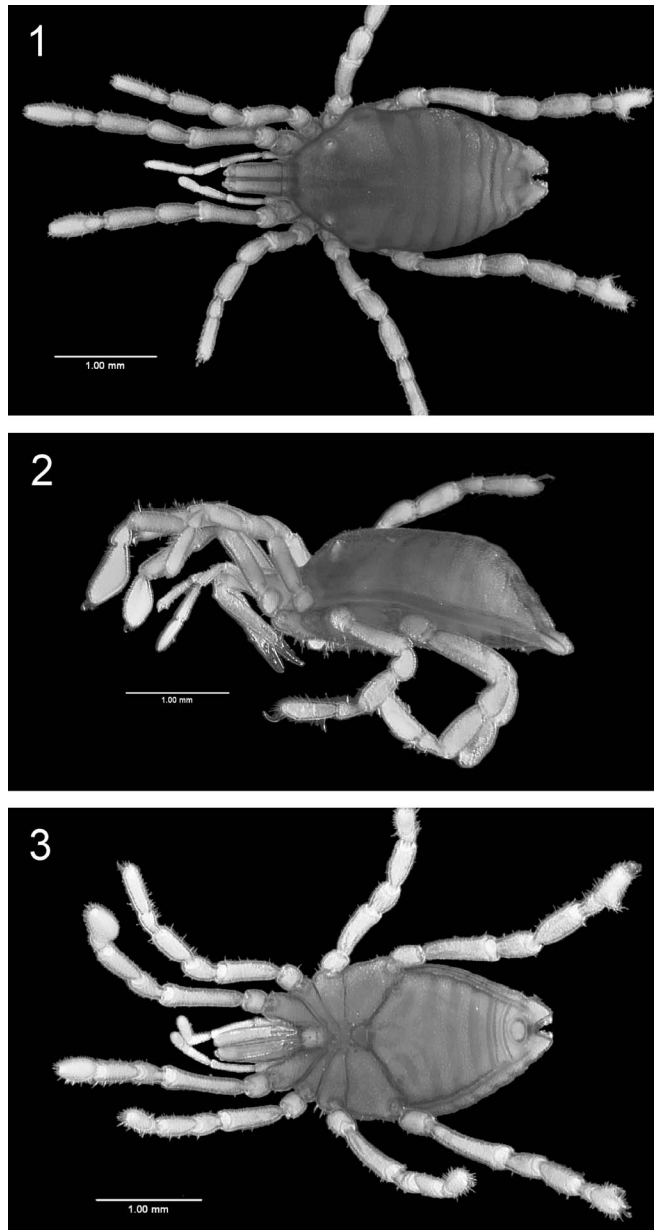
Etymology.—The specific epithet refers to

the mythological character that was killed by the warrior Pettalus in Ovid's *Metamorphoses*, Book Five (Ovid, trans. 2004).

Diagnosis.—Small pettalid with distinct bilobed terminal opisthosomal tergite. Ozophores of type 3. Eyes present. Chelicerae of protruding type, proximal article with dorsal and ventral crest, and double cheliceral dentition. Palpal trochanter without ventral process. First and second coxae of walking legs free, third coxae fused to fourth. Adenostyle lamelliform, in most-proximal region of tarsus IV. Spiracles in the shape of an open circle. Sternal opisthosomal glands absent. Sternites 8 and 9 and tergite IX free, not forming a corona analis. Male and female lacking anal glands and modifications of anal region. Penis short, of microtrichal formula 2–6–8, with two movable fingers in gonopore complex. Ovipositor, composed of two apical lobes and 28 circular articles; three terminal articles before apical lobe longer than reminder articles; setae on third terminal article longer than those on more proximal articles; setae on the two terminal articles much longer. Each apical lobe carrying several setae, including a long terminal seta and a multibranching sensitive process.

Description.—Total length of male holotype (one female paratype from MHNG in parentheses) 2.48 (2.62), width across ozopores 0.88 (0.86), greatest width 1.44 (1.48), equally wide on widest part of prosoma and on second abdominal segment (Fig. 1); length-width ratio 1.72 (1.78).

Body orange to reddish brown (when preserved in ethanol) depending on incidence of light. Body almost entirely covered by a dense tuberculate-granulate microstructure. Anterior portion of prosoma tapering towards the anterior margin where the chelicerae insert (Fig. 1). Eyes present (Figs. 10–11). Ozophores conical, of type 3 of Juberthie (1970); see a re-definition of the types of ozophores in Giribet (2003) (Figs. 1, 2, 11). Transverse opisthosomal sulci conspicuous (Fig. 1). Mid-dorsal longitudinal opisthosomal sulcus absent (Fig. 1). Posterior end of the opisthosomal region clearly bilobed in males as a result of an extension of tergite VIII, which tapers, forming the characteristic tail of the genus (Figs. 1–4); tergites VI to VIII clearly concave (Fig. 2). Dorsal part of tergite VIII covered with a high concentration of setae (scopula); ventral

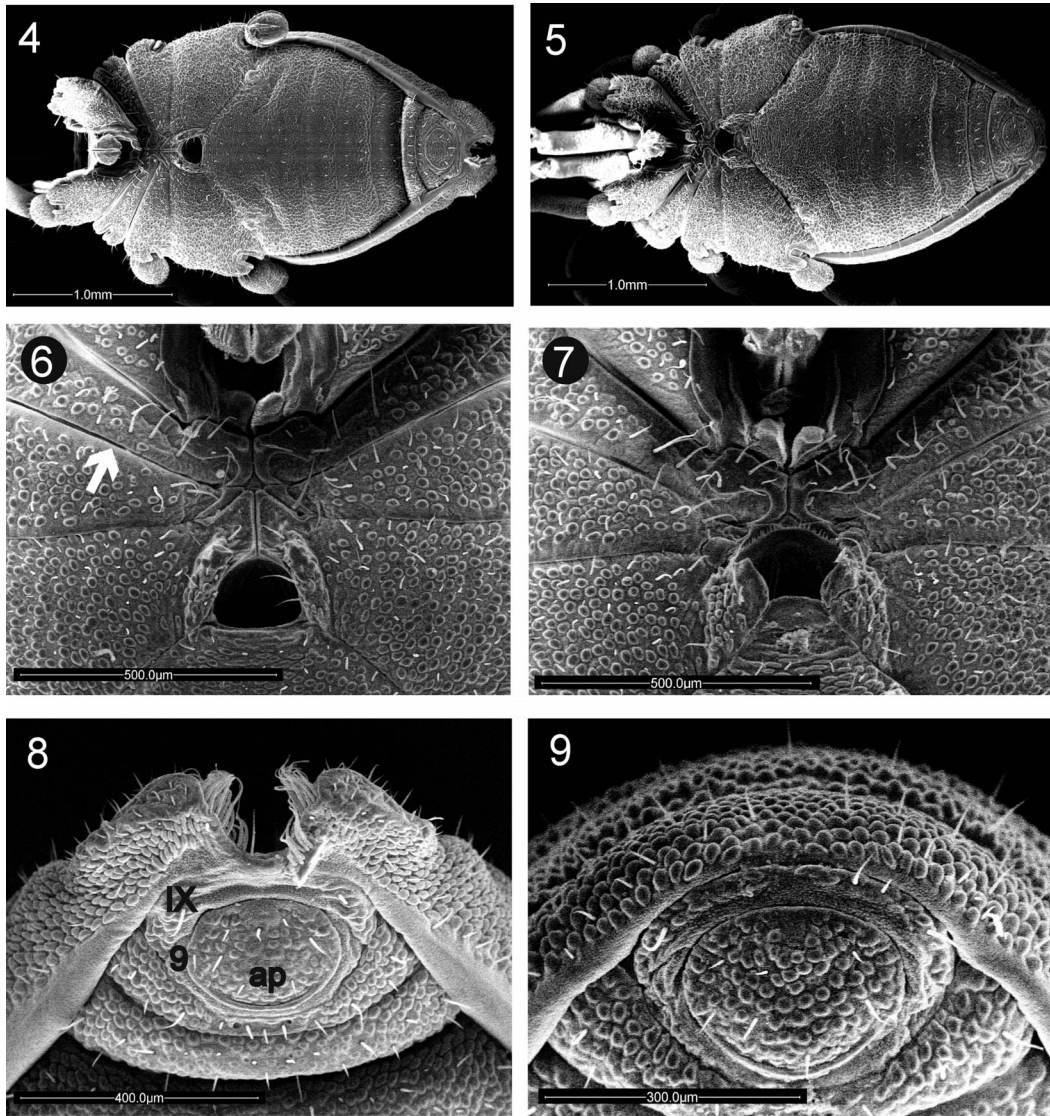


Figures 1–3.—*Pettalus lampetides* new species: 1. Dorsal view of male holotype; 2. Lateral view of male holotype; 3. Ventral view of male holotype.

side only with cuticular ornamentation, without setae (Figs. 1, 3, 4, 8). Female posterior opisthosomal region without clear modifications (Figs. 5, 9).

Coxae of legs I and II movable, coxae of legs III and IV fused. Ventral prosomal complex of male with coxae of legs II and IV meeting in the midline, but coxae I and III not

so (Fig. 6). Pore of coxal gland opening between coxae III and IV (Fig. 6). Sternum absent. Gonostome sub-semicircular, approximately as long as wide; lateral walls formed by elevated endites of coxae IV. Ventral prosomal complex of female with only coxae II meeting in the midline (Fig. 7). Spiracles typical of pettalids, in the form of an open circle

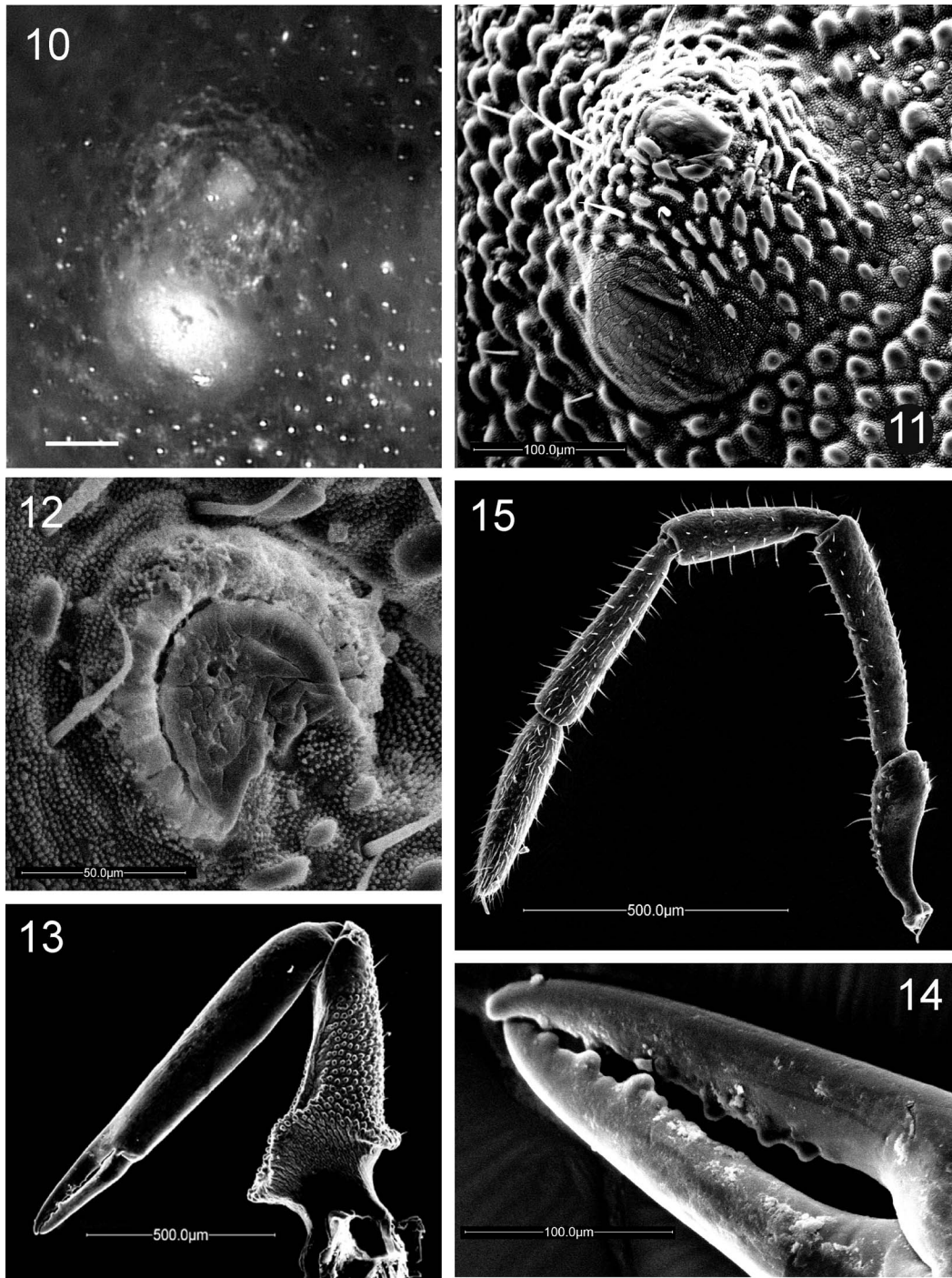


Figures 4–9. *Pettalus lampetides* new species: 4. Ventral view of male paratype; 5. Ventral view of female paratype; 6. Sternal region of male paratype; 7. Sternal region of female paratype; 8. Anal region of male paratype showing the anal plate (ap) and sternite 9 embedded by tergite IX; 9. Anal region of female paratype.

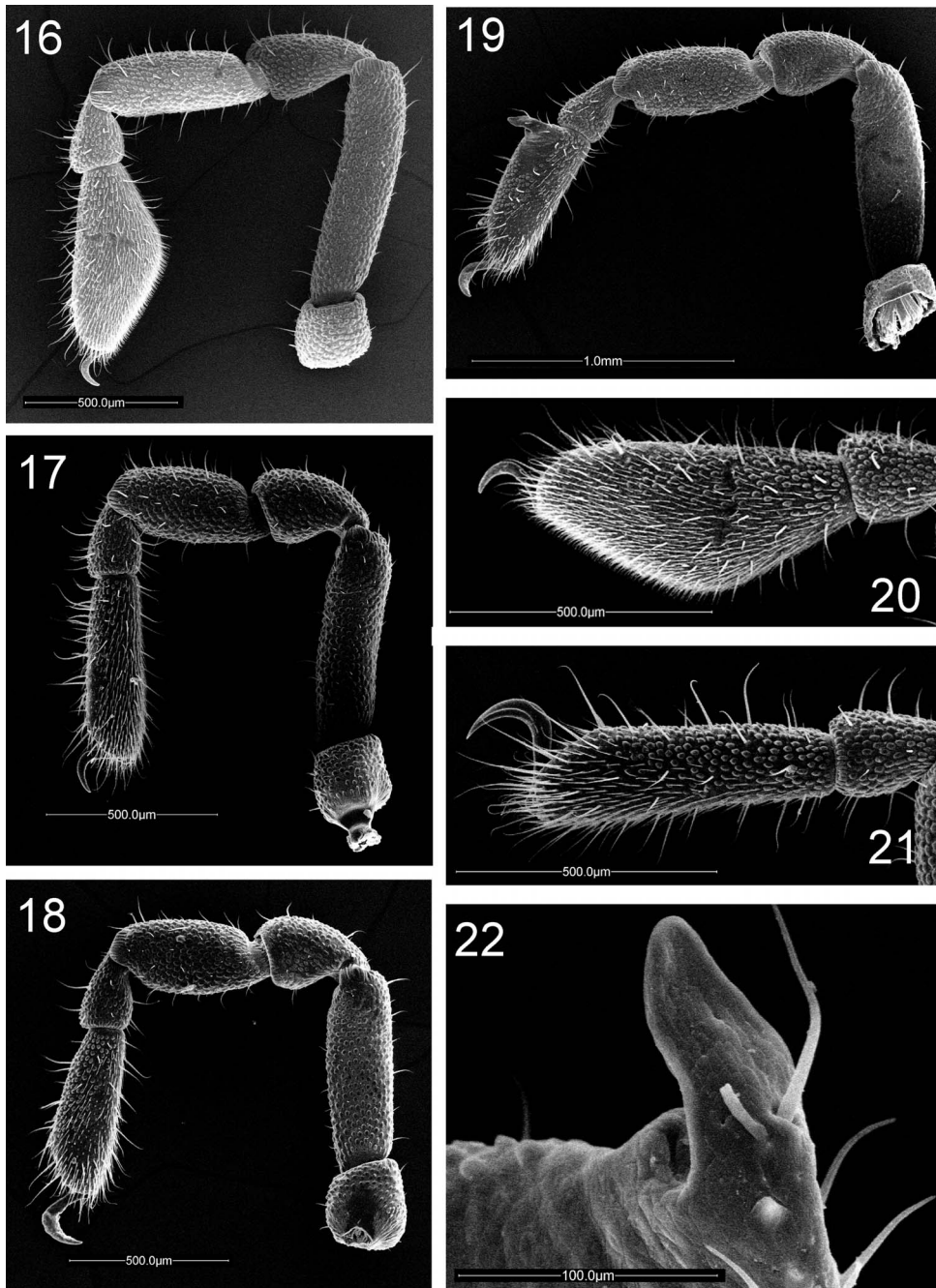
(Fig. 12), opening towards the postero-lateral side. Sternal opisthosomal glands absent. Sternites 8 and 9 and tergite IX free in males and females, not forming a corona analis (Figs. 8–9). Relative position of sternite 9 and tergite IX of pettalid type, sensu Giribet & Boyer (2002), where the sternite is embedded by the tergite. Anal plate without modifications, in ventral position in males and females (Figs. 8–9). Anal plate 0.18 (0.19) long and 0.27

(0.27) wide. Anal gland pores absent (Figs. 8–9).

Chelicerae (Fig. 13) of protruding type, with the dorsal crest clearly visible from above (Fig. 1); relatively slender; with few setae. Granulation restricted to the proximal article covering almost the entire surface, but not the most-distal portion. Proximal article of male and female paratypes examined by SEM 0.97 (0.90) long, 0.36 (0.35) deep, with con-



Figures 10–15. *Pettalus lampetides* new species: 10. Left eye and ozophore of female paratype examined by light microscopy (scale bar = 50 μm); 11. Left eye and ozophore of male paratype examined by SEM; 12. Spiracle of male paratype; 13. Lateral view of left chelicera of male paratype showing dorsal and ventral crests; 14. Detail of the dual dentition of the cheliceral distal segments; 15. Left palp of male paratype.



Figures 16–22. *Pettalus lampetides* new species: 16. Male left leg I; 17. Male left leg II; 18. Male left leg III; 19. Male left leg IV; 20. Detail of male left tarsus I; 21. Female left tarsus IV; 22. Detail of adenostyle.

Table 1.—Leg measurements in mm for paratypes of *Pettalus lampetides* examined by SEM (MCZ 62997, 62998). Data represent male/female values and (ration of the sexes).

	Tr	Fe	Pa	Ti	Mt	Ta	Total
Leg I	0.21/0.25 (0.84)	0.73/0.20 (3.7)	0.42/0.22 (1.9)	0.50/0.21 (2.4)	0.26/0.18 (1.4)	0.57/0.28 (2.0)	2.69
Leg II	0.22/0.23 (0.96)	0.56/0.18 (3.1)	0.34/0.22 (1.6)	0.39/0.22 (1.8)	0.25/0.16 (1.6)	0.46/0.17 (2.7)	2.22
Leg III	0.22/0.26 (0.85)	0.57/0.22 (2.6)	0.35/0.23 (1.5)	0.41/0.24 (1.7)	0.24/0.16 (1.5)	0.39/0.19 (2.1)	2.18
Leg IV	0.30/0.31 (0.97)	0.72/0.26 (2.8)	0.45/0.25 (1.8)	0.51/0.27 (1.9)	0.28/0.18 (1.6)	0.48/0.24 (2.0)	2.74
Leg I	0.17/0.26 (0.65)	0.69/0.69 (3.5)	0.38/0.22 (1.7)	0.44/0.20 (2.2)	0.25/0.17 (1.5)	0.52/0.25 (2.1)	2.45
Leg II	0.19/0.21 (0.90)	0.51/0.51 (2.6)	0.32/0.22 (1.5)	0.35/0.21 (1.7)	0.21/0.16 (1.3)	0.36/0.16 (2.3)	1.94
Leg III	0.22/0.23 (0.96)	0.54/0.54 (2.8)	0.33/0.21 (1.6)	0.38/0.21 (1.8)	0.24/0.15 (1.6)	0.43/0.15 (2.9)	2.14
Leg IV	0.29/0.26 (1.1)	0.74/0.74 (3.0)	0.40/0.25 (1.6)	0.48/0.24 (2.0)	0.28/0.18 (1.6)	0.50/0.18 (2.8)	2.69

spicuous dorsal crest that extends ventrally but without forming a ventral process, and single posterior ventral process. Second article 1.17 (1.15) long, 0.18 (0.17) deep, subcylindrical, its widest portion towards the first third of its length; dentition irregular. Distal article 0.31 (0.31) long, 0.05 (0.05) deep, with the two types of dentition typical of pettalids (Fig. 14).

Palp (Fig. 15) without ventral process in trochanter; without conspicuous modifications. Length/width (length-width ratio in parentheses) of palpal articles from trochanter to tarsus of male paratype examined by SEM [of female paratype in square brackets]: 0.32/0.12 (2.8) [0.32/0.10 (3.2)]; 0.47/0.09 (5.2) [0.47/0.09 (5.2)]; 0.32/0.1 (3.2) [0.32/0.09 (3.6)]; 0.42/0.09 (4.7) [0.39/0.09 (4.3)]; 0.36/0.09 (4.0) [0.35/0.09 (3.9)]; total length 1.86 [1.84]. Palpal claw 0.04 (0.04) long.

Legs (Figs. 16–21) with all claws smooth, lacking dentition or lateral pegs. Surfaces of all trochanters, femurs, patellae, tibiae and metatarsi granulated. Granulation of all tarsi concentrating in the dorsal side. Tarsus I with a distinct solea (Figs. 16, 20).

Leg measurements of male and female paratypes examined by SEM are provided in Table 1: length/width (length-width ratio in parentheses). Tarsus IV of males not divided, carrying a lamelliform adenostyle in most proximal region of tarsus (Fig. 19). Adenostyle of male paratype examined by SEM 0.11

long (Fig. 22). Tarsus IV of female without modifications (Fig. 21).

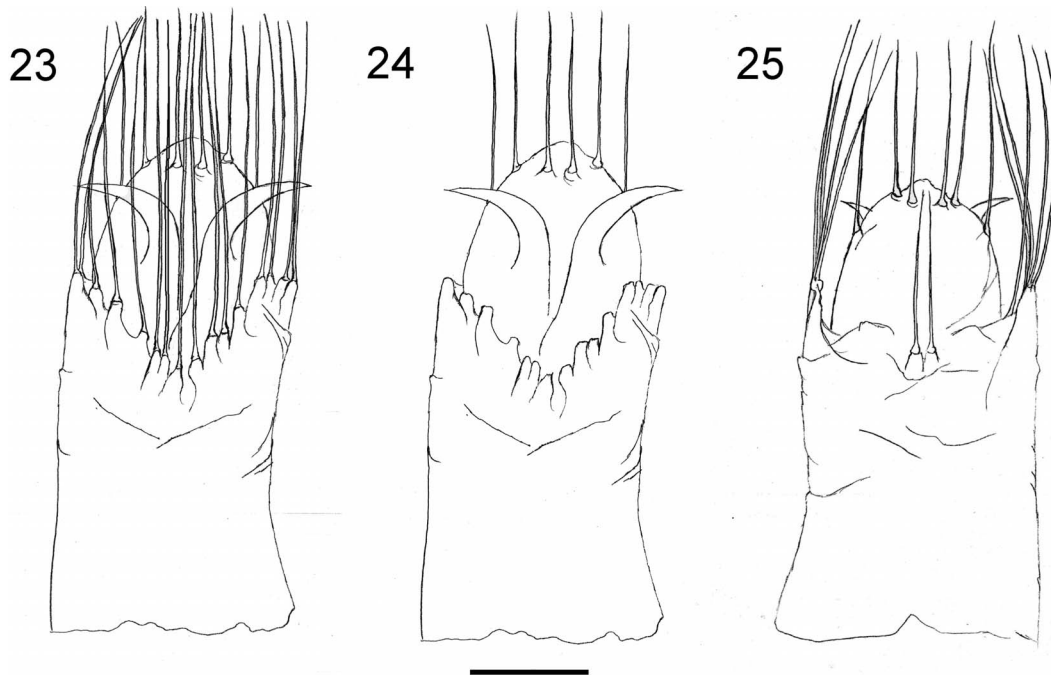
Penis (Figs. 23–25) short, typical of pettalids. Microtrichal formula 2–6–8 (one penis studied). Dorsal side of penis with a group of eight long microtrichia on each side, with bases arranged in a “V” and not fused. Rounded distal margin of penis with six apical microtrichia, and two short microtrichia adjacent ventrally. Gonopore complex with two distinct movable fingers in the shape of curved hooks.

Ovipositor (Figs. 26–27) long, composed of two apical lobes and 28 circular articles (one ovipositor studied), each of the latter furnished with 8 equally long setae. Three terminal articles before apical lobe longer than remainder articles; setae on third terminal article longer than those of more proximal articles; setae on the two terminal articles much longer. Each apical lobe carrying several setae, including a long terminal seta and a sensitive process with a multibranching seta (Fig. 27).

Variation.—Range of measurements in males ($n = 8$) and females ($n = 4$; in parentheses): Body length 2.36–2.58 (2.62–2.70), maximum (and anterior) width 1.40–1.50 (1.42–1.50).

Distribution.—Known only from the type locality. A recent expedition in June 2004 by the authors to Diyaluma Falls did not result in new specimens of this species.

Remarks.—*Pettalus lampetides* is consid-



Figures 23–25. *Pettalus lampetides* new species: 23. Total penis, dorsal view; 24. Dorsal view showing apical microtrichia and movable fingers; 25. Ventral view. Scale bar = 125 μm .

erably smaller than the other two described species of *Pettalus*. In comparison with *P. brevicauda*, the “tail” extension of *P. lampetides* is much shorter and less conspicuous. In lateral view *P. brevicauda* tapers starting from the first opisthosomal segments, whereas *P. lampetides* tapers more abruptly beginning in the middle of the opisthosoma (Fig. 2). The tail of *P. brevicauda* is globose, whereas that of *P. lampetides* is flat. Finally, the chelicerae of *P. lampetides* are of the protruding type, where the dorsal crest does not articulate with the anterior margin of the carapace, whereas in *P. brevicauda* the dorsal crest articulates with the anterior part of the carapace while in resting position.

DISCUSSION

Pettalus lampetides clearly belongs to the genus *Pettalus* on the basis of the apomorphic modification of the terminal opisthosomal tergites forming a “tail” shared by the previously described species of *Pettalus*. In addition, the typically double cheliceral dentition, ozophore type, and male genitalia support its placement in the family Pettalidae. Due to the age of the available collection and the lack of

recently collected specimens in the aforementioned expedition in June 2004, molecular analysis of specimens was not attempted at this time.

Despite the paucity of described *Pettalus* species, as many as ten new species may be available for description and study in the collections from the 1970 MHNG expedition and 2004 MCZ expedition. A third collecting trip by S. Mahunka & L. Mahunka-Papp yielded one female specimen deposited at the Hungarian Natural History Museum (Budapest). The occurrence of these species in a relatively small area suggests significant diversity of cyphophthalmid fauna in Sri Lanka. Due to the small size and leaf-litter habitat of most cyphophthalmid species, it is probable that additional species could be discovered in the subcontinental region. Studying this fauna could be of extreme importance not only for characterizing a putative radiation in Sri Lanka, but also for biogeographical studies of Gondwanan fauna.

Evolution of Eyes in Cyphophthalmi.—

From the 140 species and subspecies described to date in the Opiliones suborder



Figure 26–27. *Pettalus lampetides* new species: 26. Total ovipositor, dorsal view; 27. Detail of ovipositor tip (scale bar = 156 μ m).

Cyphophthalmi (see online catalog of Cyphophthalmi at <http://collections.oeb.harvard.edu/Invertebrate/Cyphophthalmi/species.cfm>), only those of the genus *Stylocellus* (family Stylocellidae) were so far known to have eyes (Hansen & Sørensen 1904; Shear 1980; Giribet & Boyer 2002; Giribet et al. 2002). All described members of the five remaining families are eyeless. However, in his description of *Austropurcellia scoparia* Juberthie (1988: 133) reported the presence of an undescribed species of *Neopurcellia* with eyes from a batch of eleven new species collected in Queensland (Australia) and borrowed from Valerie Todd Davies (Queensland Museum,

Brisbane). The existence of a pettalid with eyes was again mentioned by Rambla and Juberthie (1994), but ignored in subsequent papers by Juberthie, including descriptions of new species from Queensland (Juberthie 1989, 2000). However, the title of Juberthie's paper of 2000 once more seems to refer to the presence of eyes in pettalids by specifically mentioning the blindness of the new species: "A new blind Cyphophthalmi (Opiliones) from Queensland (Australia)". Why would anyone describe a pettalid species as a "blind Cyphophthalmi" when all known members of this family (and most other cyphophthalmids) are blind? Due to the lack of physical proof,

the citation in Juberthie (1988) and the odd title of his 2000 description were regarded as questionable (Giribet 2003). However, the implications of the presence of eyes in pettalids could be of fundamental importance for reconstructing the common ancestor of Cyphophthalmi and the phylogeny of Opiliones.

Stylocellids are currently considered to be the sister group to all other cyphophthalmids (Giribet & Boyer 2002). Due to the questionable homology of eyes in Cyphophthalmi and in other Opiliones, and due to the apparent lack of eyes in one of the two clades of Cyphophthalmi (which comprises five of the six families currently recognized), it was equally parsimonious to reconstruct the common ancestor of Cyphophthalmi with or without eyes. However, if eyes homologous to those of stylocellids were found in its sister clade—as reported by Juberthie (1988)—it would be most parsimonious to infer a cyphophthalmid ancestor with eyes.

The new species of *Pettalus* described here is interesting in that—like the *Neopurcellia* mentioned by Juberthie (1988)—it has eyes. Re-examination of the older species of *Pettalus* as well as all new specimens deposited at the MCZ or the MHNG shows that all Sri Lankan pettalids have eyes. These are located at the base of the type 3 ozophores (Figs. 10–11) and clearly show a transparent cornea. The eyes resemble those of stylocellids, but they are incorporated into the base of the ozophores, while in stylocellids the eyes are located anterior to, and not incorporated into, the ozophores.

The discovery of eyes in this pettalid is truly remarkable, but certainly not an exception. Re-study of species from other genera has shown that eyes may be more widespread within pettalids than previously thought, as they are also present in *Chileogovea* (see de Bivort & Giribet 2004: fig. 11j). Therefore, at least four previously described species of pettalids have eyes, even though they had not been noticed by previous authors during more than 135 years of knowledge of these pettalids. In addition, the Indian cyphophthalmids reported by Bastawade (1992) also bear eyes like those of stylocellids.

Arachnids typically have a pair of median eyes and a variable number of lateral eyes (Paulus 1979; Weygoldt & Paulus 1979; Giribet et al. 2002). Opiliones remain a mystery

because most Phalangida (the non-cyphophthalmid Opiliones) bear a pair of median eyes (sometimes these migrate laterally as in the biantid-like families, and in Stygnidae and some Epedanidae) whereas the eyes present in some Cyphophthalmi are thought to be homologous to the lateral eyes of other arachnids (Shear 1993; Giribet et al. 2002), but other opinions exist. Hansen & Sørensen (1904: 35) maintained that the eyes of *Stylocellus* correspond morphologically to the pair of median eyes in other Opiliones. However, the presence of eyes in only some members of a single family of Cyphophthalmi, i.e. Stylocellidae, questioned the true homology of cyphophthalmid eyes, because, if they were not homologous to the median eyes of Phalangida, they could be apomorphic for the genus *Stylocellus*. The presence of eyes in some members of the sister clade of Stylocellidae suggests that eyes may have been present in the common ancestor of all Cyphophthalmi and, therefore, strengthens the case for homology.

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