

A new genus and species of Cyphophthalmi (Arachnida: Opiliones) from the north-eastern states of India

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We describe a new genus and new species of Cyphophthalmi from north-eastern India, from the unexplored and extremely wet region lying between China, Bangladesh, Myanmar, and Bhutan. *Meghalaya annandalei* sp. nov., from the Mehao Wildlife Sanctuary, Arunāchal Pradesh, is an interesting Cyphophthalmi, with eyes located anterior to the ozophore, a modified tibia of leg III of males, and a robust subtriangular adenostyle. The new genus has overall resemblance to the members of the family Stylocellidae, but also has important differences for other characters, which resemble those of the members of the other tropical families Ogoveidae and Trogloniridae. The discovery of additional specimens belonging to other undescribed species indicates the need for arachnological research in that part of south-eastern Asia. © 2007 The Linnean Society of London, *Zoological Journal of the Linnean Society*, 2007, 151, 663–670.

ADDITIONAL KEYWORDS: Himalayas – new genus – Ogoveidae – south-east Asia – Stylocellidae.

INTRODUCTION

Cyphophthalmid research has bloomed significantly since the publication of the most-recent catalogue of this suborder of Opiliones (Giribet, 2000), with 24 species and three genera (*Karripurcellia* Giribet, 2003; *Iberosiro* de Bivort & Giribet, 2004; *Aoraki* Boyer & Giribet, 2007) described since then. During this time, the genus *Cyphophthalmus* Joseph, 1868 has been resurrected (Boyer, Karaman & Giribet, 2005), the genus *Fangensis* Rambla, 1994 has been revised with the addition of three new species (Schwendinger & Giribet, 2005), and the Australian and New Zealand genera *Austropurcellia* Juberthie, 1988, *Neopurcellia* Forster, 1948, and *Rakaia* Hirst, 1925, as well as species included therein, have been redefined with the addition of the new genus *Aoraki* Boyer & Giribet, 2007 for a group of pettalid species occurring in the south island and the south-western part of

the north island of New Zealand (Boyer & Giribet, 2007).

New research has also contributed to expand the distribution ranges of Cyphophthalmi. *Karripurcellia* added a new biogeographical region, Western Australia, to the temperate Gondwanan family Petalidae (Giribet, 2003), and Stylocellidae is now known to occur from northern Thailand to western New Guinea (Rambla, 1994; Clouse & Giribet, 2007).

With respect to the Asian continent, three families have been reported so far. The sironid genus *Cyphophthalmus* (as *Siro*) is known from the far-western part of Asia in Turkey (Gruber, 1969), whereas the sironid *Suzukielus* Juberthie, 1970 is widely found in Honshu, Japan (Juberthie, 1970b; Giribet, Tsurusaki & Boyer, 2006). Closer to the Indian subcontinent, the pettalid genus *Pettalus* Thorell, 1876 is now known to have three described and many undescribed species in Sri Lanka (Hansen & Sørensen, 1904; Sharma & Giribet, 2006). Finally, the family Stylocellidae has shown a burst of diversity (most of it still undescribed; P. J. Schwendinger,

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pers. comm.) in peninsular Malaysia and Thailand (Schwendinger, Giribet & Steiner, 2004; Schwendinger & Giribet, 2005).

Bastawade (1992) reported the presence of Cyphophthalmi from India, from the state of Arunāchal Pradesh (Fig. 1), one of the Seven Sister States of north-eastern India. Arunāchal Pradesh borders the state of Assam to the south and Nagaland to the south-east. Myanmar lies to the east of the state, Bhutan to the west, whereas the McMahon Line separates it from the zone of control of the People's Republic of China to the north.

The specimen collected by Bastawade is a female that was considered to belong to the family Sironidae for 'being totally blind' (Bastawade, 1992: 268), although all the members of the families Neogoveidae, Ogoveidae, and Troglosironidae are also blind. We have been able to re-examine the female specimen reported by Bastawade (1992), which has a clear eye lens located anterior to the ozophore (although the left eye lens appears dark in colour, hence the possible confusion). This specimen resembles some members of the family Stylocellidae. We have also been able to examine additional material collected by Bastawade, including two males from Arunāchal Pradesh, which we use to describe a new genus and new species of somewhat uncertain affinity, but the female reported by Bastawade (1992) is not described, as no males can be associated with it. The new species shares traits with Stylocellidae and Ogoveidae, although it also shows notable differences from these families. We were also able to inspect three other Indian Cyphophthalmi specimens from Meghālaya – another of the Seven Sister States – collected in 1978 and 2004, and deposited at the Muséum d'histoire naturelle, Geneva (MHNG), which was brought to our attention by P. J. Schwendinger.

Examination of the Indian material clearly indicates that it constitutes a new genus, so far considered of uncertain phylogenetic affinity. Here we describe the new genus and a new species from the Arunāchal Pradesh material.

MATERIAL AND METHODS

One male holotype and one male paratype were photographed under a Leica MZ 12.5 dissecting microscope using a mounted JVC KY-F70B digital camera. Digital images captured at different focal planes were assembled using the application Auto-Montage Pro Version 5.00.0271 by Syncroscopy. We did not obtain permission for studying the specimens under the scanning electron microscope.

The spermatopositor of the paratype was studied from a temporary mount after placement for about 1 min in hot lactic acid and deposition in glycerol.

Measurements were taken using a grid on the stereomicroscope. Tarsal claws were excluded from the measurements. The position of the adenostyle on tarsus IV was measured from the distal end of the tarsus. Measurements separated by a slash indicate length/width.

Repository institutions are abbreviated as follows: MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA; MHNG, Muséum d'histoire naturelle, Genève, Switzerland; ZSI, Zoological Survey of India, Kolkata, India.

MEGHALAYA GEN. NOV.

Diagnosis: Medium-sized cyphophthalmids with eye lenses anterior to the ozophores (Figs 2C, 3B); ozophores of type 1, situated on carapace margin (Juberthie, 1970a) (Fig. 3B), opening subterminally (Novak & Giribet, 2006), and with spiral ornamentation (de Bivort & Giribet, 2004). Anterior margin of carapace projecting anteriorly (Fig. 2A). Transverse prosomal sulcus present, V-shaped. Transverse opisthosomal sulci present. Mid-dorsal, longitudinal opisthosomal sulcus present, and formed by a sparser cuticular ornamentation (Fig. 2A). Chelicerae not of the protruding type (Giribet, 2003) (Fig. 2A); widest part of



Figure 1. Map of India with the known localities for members of *Meghalaya gen. nov.* The solid star shows *Meghalaya annandalei sp. nov.* from Arunāchal Pradesh; the empty stars show the localities for two undescribed species from Meghālaya.



Figure 2. *Meghalaya annandalei* sp. nov., holotype. A, dorsal view. B, ventral view. C, lateral view. Arrows indicate the ventro-prolateral modification of the tarsus IV of males. Scale bars = 1 mm.

second cheliceral segment near the base and without ornamentation; most-basal article with dorsal crest and two ventral processes. Palp trochanter without ventral process. Second article of palp ornamented in more than half of its length. Metatarsus of all legs ornamented; tarsi almost completely ornamented; with a distinct solea on leg I; claws of all legs smooth,

without comb-like modifications or lateral pegs. Tibia of leg III of males modified, subtriangular, with the widest part near the patellotibial joint (Fig. 4A). Tarsus IV of males not divided, but highly modified with a deep depression in ventro-retrolateral position (Figs 2A, B, 4B); Rambla's organ absent. Adenostyle conspicuous, subtriangular, robust, and sclerotized (Figs 2C, 4B, C); located in the most distal half of the tarsus. Coxae of leg II fused to coxae of legs III and IV. Sternum present. Proximal end of coxae I or III of males not meeting along the midline; male gonostome semicircular, large, as large as the proximal ventral part of coxae of leg IV. Spiracles C-shaped (Fig. 3C). Conspicuous ventral depression in the opisthosomal anterior sternites (Figs 2C, 3C). Sternal opisthosomal glands absent. Sternites 8 and 9 and tergite IX free (Fig. 3D). Anal plate and anal region without modifications. Anal glands absent. Hansen's organ absent.

Spermatopositor studied for a single species, as in *Meghalaya annandalei* sp. nov. (Fig. 5). Ovipositor not available for study (only one damaged female available).

Included species: *M. annandalei* sp. nov., the type species of the genus. The genus description is also based on three male specimens from three additional localities from Meghālaya (MHNG), and a poorly preserved female specimen from Arunāchal Pradesh (ZSI).

Phylogenetic position: At present the genus cannot be assigned to any of the known families of Cyphophthalmi with certainty (see Discussion below), and therefore we prefer to leave its familial placement as uncertain.

Etymology: Meghālaya literally means 'The Abode of Clouds' in Hindi and Sanskrit, in reference to the Himalayan region where the new genus occurs – although the Meghālaya region is not part of the Himalayas proper.

MEGHALAYA ANNANDALEI SP. NOV. (FIGS 2–5)

Type material: Male holotype (ZSI) from Mehao Wildlife Sanctuary, Arunāchal Pradesh, Dibang Valley District India, collected 10–13 September 1991 by D. B. Bastawade. One male paratype (ZSI), with the same collecting data as the holotype.

Diagnosis: Medium-sized (*c.* 3.6 mm) cyphophthalmid with eyes located anteriorly to the ozophores (Figs 2C, 3B), a conspicuous opisthosomal ventral depression (Figs 2C, 3C), rhomboidal in shape, reaching the anterior part of the opisthosomal sternite V, and reaching

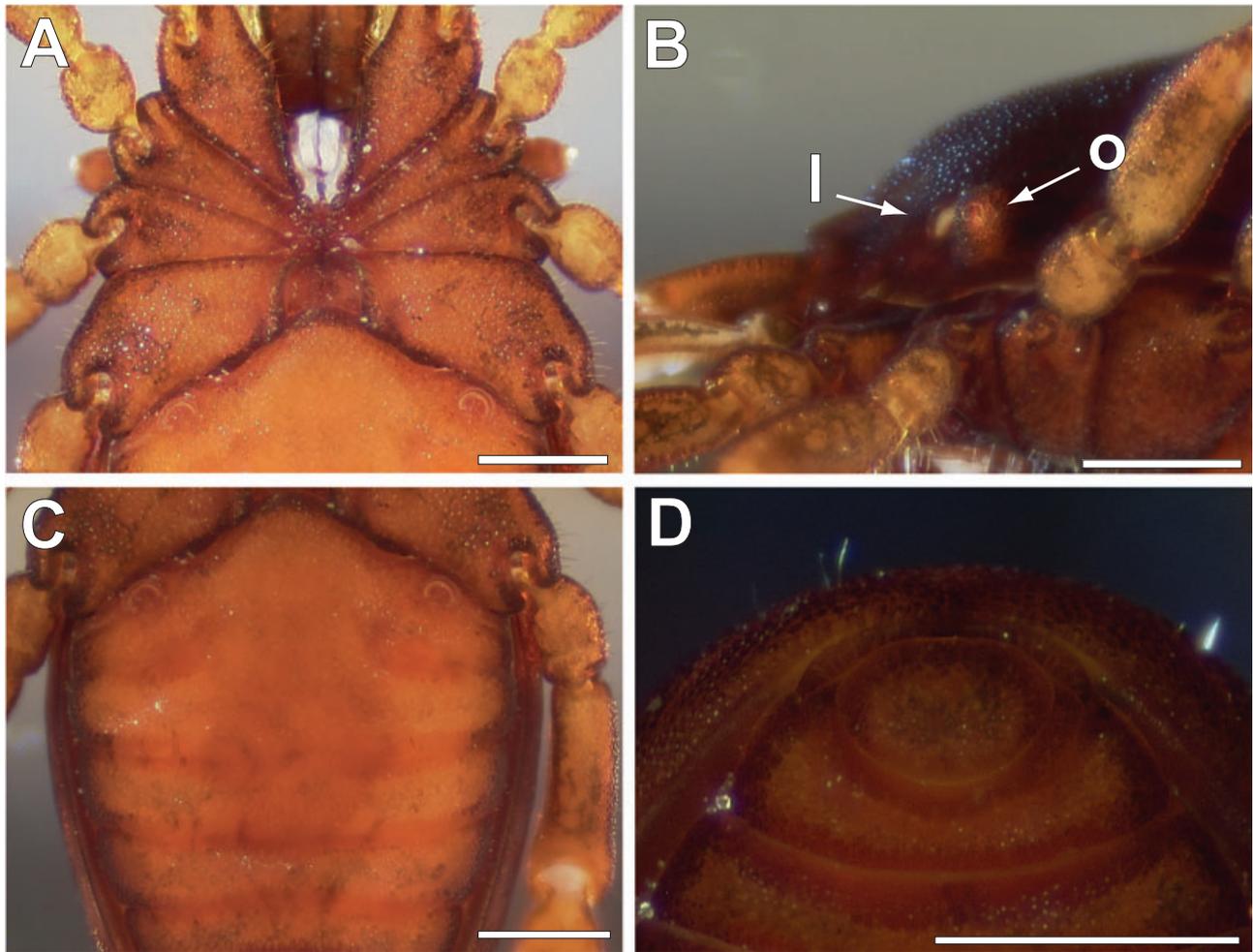


Figure 3. *Meghalaya annandalei* sp. nov., holotype. A, detailed view of the prosomal ventral complex. B, detail of the left ozophore (o) and eye lens (l). C, detailed view of the opisthosomal sternal region. D, detailed view of the anal region. Scale bars = 500 μ m.

its maximum width towards the posterior margin of opisthosomal segment 3. Tibia of leg III clearly enlarged, about twice as deep at the basal end when compared with the proximal end (Fig. 4A). Adenostyle large and robust, subtriangular, with cuticular ornamentation, and not fringing at the tip (Figs 2C, 4B, C). Ventro-retrolateral depression of tarsus IV of male deep, and occupying nearly all of the tarsal length (Figs 2A, B, 4B, D).

Description: Same as for diagnosis of genus and species. Body length, 3.62 mm; maximum body width, 2.00 mm at third opisthosomal segment; length/width ratio, 1.8. Distance between ozopores, 1.95 mm. Opisthosomal sternal depression 0.80-mm long, 0.66-mm wide. Table 1 lists the appendage measurements of the holotype.

Adenostyle located in the distal half of the tarsus (Fig. 4B, C); 0.11 mm from base to tip, 0.13 mm at the

base; large and robust, subtriangular, with cuticular ornamentation, and not fringing at the tip. Ventro-retrolateral depression of tarsus IV of male deep, and occupying nearly all of the tarsus length (Fig. 4B).

Spermatopositor in dorsal view (Fig. 5A, C) with six pairs of long microtrichia on each side, bases fused at midline. Dorsal microtrichia basally smooth, apically serrated, and terminating with hair-like structures. Central pair of dorsal microtrichia significantly thicker than other pairs. Ventral side (Fig. 5B, D) smooth, without denticles or ornamentation. Distal margin of spermatopositor flattened, not semicircular. Five pairs of serrated ventral microtrichia on distal margin, all terminating in hair-like structures; first (central) pair reduced and bearing three hair-like structures, and fourth (second-to-outermost) pair reduced. One reduced, smooth pair of microtrichia on termini of distal margin, projecting towards the midline.

Female unknown.

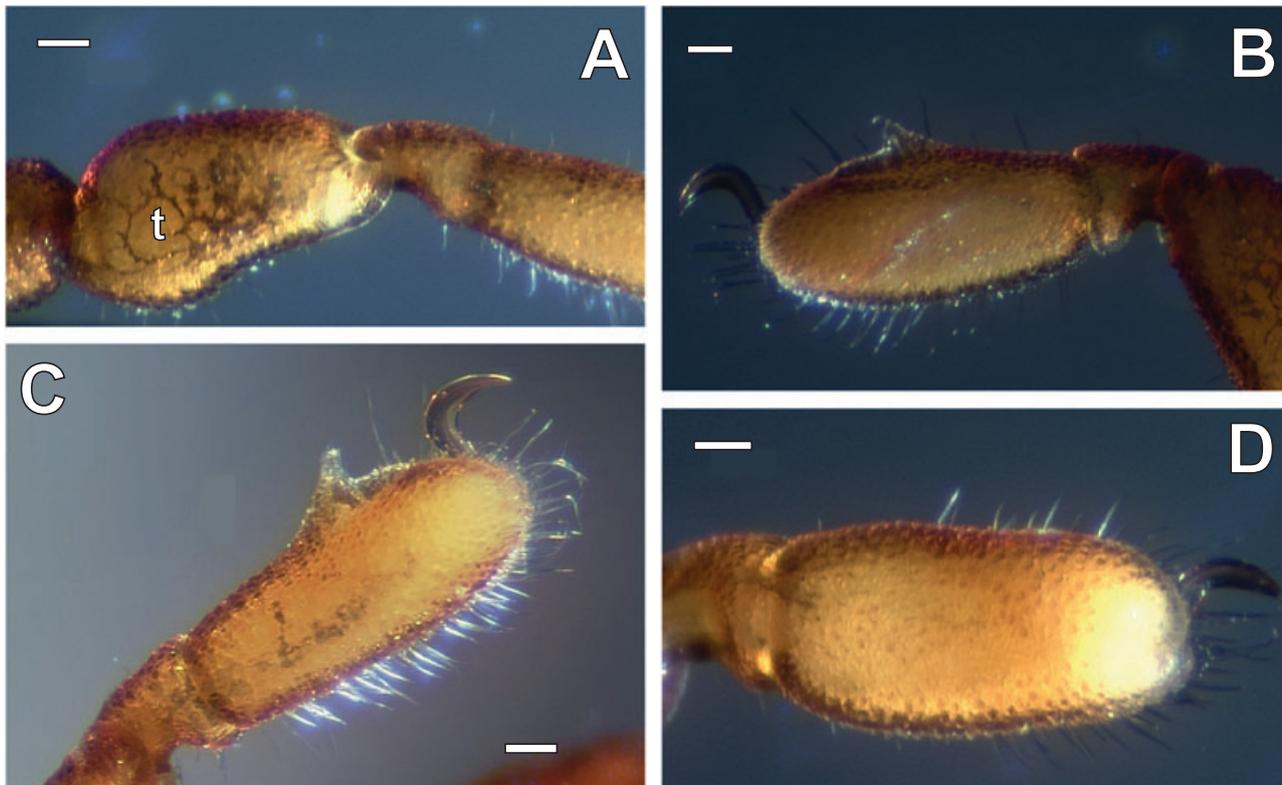


Figure 4. *Meghalaya annandalei* sp. nov., holotype. A, enlarged tibia III (t). B, metatarsus and tarsus IV bearing the thorn-like adenostyle, retrolateral view. C, metatarsus and tarsus IV bearing the thorn-like adenostyle, prolateral view. D, metatarsus and tarsus IV, ventral view. Scale bars = 100 μ m.

Etymology: The species is named after Thomas Nelson Annandale (1876–1924), first director of the Zoological Survey of India from 1916 to 1924. He established the Institute by segregating it from the Indian Museum to become an independent research organization for zoological taxonomy and faunal surveys of British India, including Sri Lanka and Burma.

MEGHALAYA SPP.

Other material examined: One female (ZSI) from Miao, Arunāchal Pradesh, Changlang District, India, 600 m a.s.l., collected 6 March 1990 by D. B. Bastawade (this is the specimen reported by Bastawade in 1992). One male (MHNG) from Khasi Hills, between Mawsynram and Balat, 16 km from Mawsynram, Meghālaya, India, 1000 m a.s.l., collected 27 October 1978 by C. Besuchet and I. Löbl. One male (MHNG) from Khasi Hills, above Shillong, North face, Meghālaya, India, 1850–1950 m a.s.l., collected 25 October 1978 by C. Besuchet and I. Löbl. One male (MHNG, MCZ DNA102051) from Tura trail (25°30'28"N, 90°13'54"E), Tura Peak, West Garo Hills District, Meghālaya, India, 650 m a.s.l., collected 14

October 2004 by G. Cuccodoro, C. Carlton, R. Leschen and D. Erne.

This material may well correspond to four new species: the one from Miao known only from a female specimen, and the other three from Meghālaya, known by a single male each. We prefer to postpone the description of these new species until more material becomes available for study.

DISCUSSION

Meghalaya annandalei sp. nov. represents the first described species of Cyphophthalmi for India, and probably corresponds to a different species than the female previously reported in the arachnological literature (Bastawade, 1992). Although it clearly does not belong to the family Sironidae, as previously reported by Bastawade (1992), the phylogenetic affinities of this species are still uncertain.

Phylogenetic analysis of *M. annandalei* sp. nov. using the published data matrices from Giribet & Boyer (2002) and de Bivort & Giribet (2004) render *Meghalaya* gen. nov. as the sister group to either Stylocellidae or the remainder cyphophthalmid species, depending on the rooting position, an issue

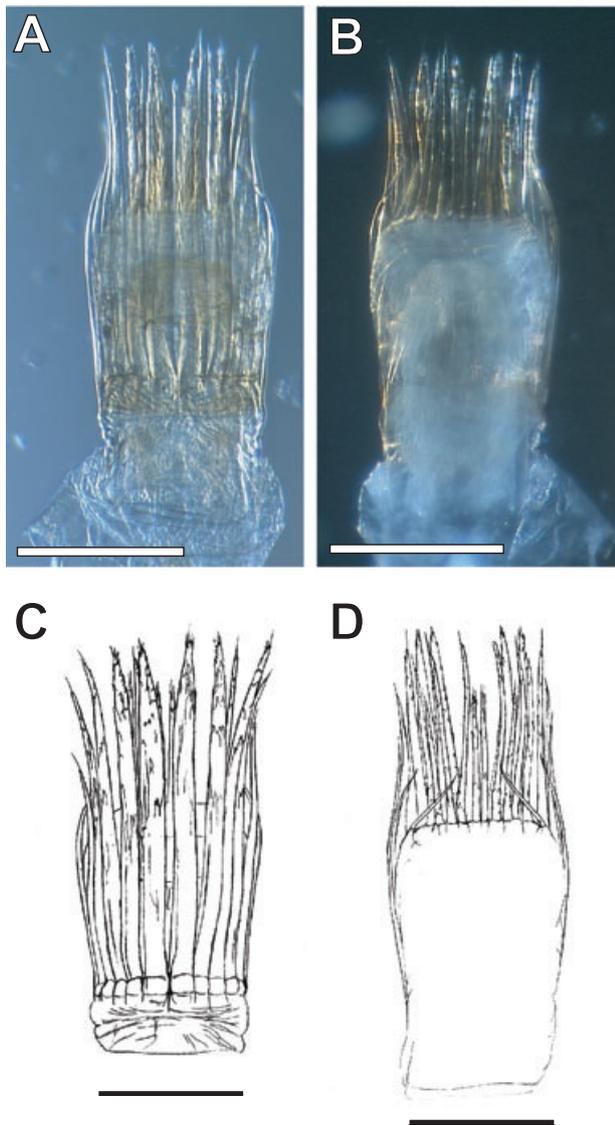


Figure 5. *Meghalaya annandalei* sp. nov., spermatopositor paratype. A, photograph, dorsal view. B, photograph, ventral view. C, line drawing, dorsal view. D, line drawing, ventral view. Scale bars = 300 µm.

that remains unresolved morphologically. The addition of molecular data from *Meghalaya* specimens may be necessary to unambiguously assign the new genus to a cyphophthalmid family.

Geologically the Arunāchal Pradesh state sits on the boundary between the Eurasian Plate and the Indo-Australian Plate. Geographically the closest cyphophthalmids are stylocellids of the genus *Fangensis*, whereas the Sri Lankan pettalids of the genus *Pettalus* are located c. 2800 km away. *Meghalaya* gen. nov. also occurs on the Indo-Australian plate (the reported specimens from the Meghālaya state are not described; see the empty stars in

Table 1. Appendage measurements for holotype length/width measurements are given in mm, and the length/width ratios are shown in parentheses

Chelicera	2nd article	Mobile digit	Fe	Pa	Ti	Ta	Total
Palp	1.15/0.24 (4.8)	0.37/0.06 (6.2)	0.56/0.14 (4.0)	0.40/0.13 (3.1)	0.42/0.11 (3.8)	0.40/0.12 (3.3)	n/a
Legs	Tr	Tr	Fe	Pa	Ti	Ta	Total
Leg I	0.34/0.32 (1.1)	0.97/0.29 (3.3)	0.80/0.33 (2.4)	0.55/0.30 (1.8)	0.68/0.26 (2.6)	0.83/0.32 (2.6)	3.66
Leg II	0.32/0.27 (1.2)	0.80/0.33 (2.4)	0.63/0.34 (1.9)	0.39/0.30 (1.3)	0.58/0.35 (1.7)	0.68/0.22 (3.1)	2.97
Leg III	0.33/0.27 (1.2)	0.63/0.34 (1.9)	0.87/0.40 (2.2)	0.45/0.33 (1.4)	0.62/0.41 (1.5)	0.62/0.27 (2.3)	2.87
Leg IV	0.42/0.33 (1.3)	0.87/0.40 (2.2)		0.55/0.37 (1.5)	0.74/0.43 (1.7)	0.75/0.34 (2.2)	3.54

Tr, trochanters; Fe, femur; Pa, patella; Ti, tibia; Mt, metatarsus; Ta, tarsus.

Fig. 1), although these are still found geographically much closer to stylocellids than to pettalids. Morphologically *Meghalaya* gen. nov. has striking similarities to stylocellids, such as the eyes with a lens located anterior to the ozophores, the ornamentation of the metatarsi and tarsi of the walking legs, and the lack of modifications on the tarsal claws. The modified tarsus IV of males is somewhat reminiscent of the special type of Rambla's organ found in *Fangensis insulanus* Schwendinger & Giribet, 2005, although the depression in *Meghalaya* is ventroretrolateral in position as opposed to the more dorsal retrolateral position of the depression in *F. insulanus*. However, *Meghalaya* differs from stylocellids in the ozophore position, which is of type 1 instead of type 2, and in the lack of ornamentation on the second cheliceral segment: both characters used to diagnose the family Stylocellidae (Giribet, 2002, 2007b). *Meghalaya* gen. nov. also differs from Stylocellidae in the type of adenostyle, which instead resembles that of the afro-tropical genus *Ogovea* (Giribet & Prieto, 2003; Giribet, 2007a). There are also certain similarities, but yet important differences, in the spermatopositor organs of stylocellids and *Meghalaya*. Stylocellid spermatopositors are generally semicircular or bilobular distally (Hansen & Sørensen, 1904; Shear, 1993; Schwendinger *et al.*, 2004; Schwendinger & Giribet, 2005), with the base of the dorsal microtrichia forming a V. *Meghalaya* has a spermatopositor that is more rectangular, and the dorsal microtrichia are inclined perfectly horizontally (Fig. 5A, C). Likewise, the ventral microtrichia are disposed horizontally (Fig. 5B, D). The presence of a conspicuous ventral depression in the opisthosomal region resembles that of some troglосironids (Giribet, 2007c; Sharma & Giribet, 2007), or the aforementioned genus *Ogovea*, although no gland seems to open in *Meghalaya*.

The finding of Cyphophthalmi in the easternmost side of the Himalayas and in the Khāsi Hills of north-eastern India opens the possibility of the presence of this interesting group of Opiliones in China, Myanmar, Bhutan, and Bangladesh. In fact, the presence of Cyphophthalmi in Thailand, arguably a better explored country in south-east Asia, has only been known since 1994 (Rambla, 1994), and an enormous level of diversity with disparate morphologies remains to be studied and described (e.g. Peter Schwendinger, unpubl. data). This should also be the case for north-eastern India and its surrounding nations.

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