A mysterious dwarf: Suthepiidae nov. fam., a new harvestman family from mountains of northern Thailand (Arachnida: Opiliones: Laniatores)

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Abstract: A new family of laniatorean harvestmen from northern Thailand is proposed, Suthepiidae fam. nov., which comprises one new genus and one new species, Suthepia inermis sp. nov. This family stands out by characters hitherto unknown or rarely recorded for Opiliones, and close relatives of this taxon are presently not discernible. Important characters are a short and compact penis with a massively enlarged distal part with a rich armament of sclerites and membranes which can be moved and everted by hemolymph pressure during mating; the pedipalp of males and females is without raptorial adaptations, i.e. elevated sockets (= apophyses) carrying strong distal spines are completely absent, therefore no prey capture basket is present; the male pedipalpal tarsus is enlarged and compressed, its dorso-distal double apophysis presumably contains a gland; the pedipalpal claw is weak, not longer or stronger than long hyaline setae on the dorso-distal apophysis of the tarsus. The only specimens presently known were found in litter of a few forested mountain stocks, between 450 m and 1400 m altitude. A brief overview of Southeast Asian laniatorean families is presented.

Keywords: Supra-generic systematics - genital morphology - new genus - new species - Southeast Asia.

INTRODUCTION

In the last twenty years the supra-generic classification of Opiliones has undergone dramatic changes, especially with the onset of molecular techniques. In the suborder Laniatores a number of clades were identified, several of them on the basis of molecular data, and subsequently defined by morphological characters; male genital characters played a major role. Many of the at first genetically defined lineages were assigned familial rank (Sharma & Giribet, 2011) and to a large extent the South American fauna is concerned, less so tropical Asian and African faunas (Kury, 2018). From 2000 onwards 20 family-level taxa were proposed, 16 in the suborder Laniatores, the majority of them from the Neotropics (Kury, 2018). The laniatorean fauna of Southeast Asia, however, remained relatively unchanged, with only few recently defined and/or described families. From mainland Southeast Asia, the Sunda Region and the Philippines only few families are known, and several of them contain largely unrevised subfamilies: Assamiidae, Biantidae, Podoctidae and Epedanidae. The Sandokanidae (previously Oncopodidae), with several recently established genera and many meticulously described species, present an agreeable exception (Martens & Schwendinger, 1998; Schwendinger & Martens, 1999, 2002; Schwendinger 2006). Recent additions to the Southeast Asian laniatorean fauna are the families Beloniscidae (Kury et al., 2019), Tithaeidae and Petrobunidae (Sharma & Giribet, 2011), all defined on the basis of molecular genetics.

Here I present a previously unknown laniatorean species from the mountains of northern Thailand with unusual characters in male and female genitalia and in the male pedipalp. This species cannot be attributed to any extant opilionid genus or family and it is therefore here proposed as a representative of a new family-level taxon.

MATERIAL AND METHODS

Original line drawings were produced using a camera lucida attached to a Carl Zeiss research microscope. The photograph (Figs 1-2) was taken with a Nikon D810 attached to a SMZ 800 microscope. Measurements were taken by means of a micrometer disc attached to a Leitz stereomicroscope. Measurements of the pedipalps, the penis and the ovipositor were taken from the original drawings. All measurements are given in mm.
Abbreviations of morphological terms

Apo  apophysis
Cx  coxa
Fe  femur
Ia  lateral
Mt  metatarsus
Op anale  operculum anale
Op gen  operculum genitale
Pt  patella
Ta  tarsus
Ti  tibia
Tu  tubercle
Tu oc  tuber oculorum, ocularium
Tr  trochanter
I, II... XII January, February... December

Museum acronyms

CJM  Private collection of J. Martens, Mainz, Germany
MHNG  Musée d’histoire naturelle de Genève, Switzerland
SMF  Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main, Germany

TAXONOMIC PART

Suborder Laniatores Thorell, 1876
Infraorder Grassatores Kury, 2003
Family Suthepiidae fam. nov.

Type genus: Suthepia gen. nov.

Included genera: Presently only one, the type genus.

Diagnosis: A family of the order Opiliones, suborder Laniatores, infraorder Grassatores with the following characters: Small species with less than two mm body length. Body surface of males and females rather smooth, without conspicuous tubercles, thorns or setae. Penis stout, distal half strongly enlarged laterally and dorso-ventrally, with complex hemolymph-pressure-driven system of sclerites and membranes, with an eversible prickly funnel in its interior, and with pairs of single setae plus pairs of groups of setae. Ovipositor short, with three pairs of long sub-apical setae on ventral side. Pedipalp in males and females smooth, without any apophyses carrying setae (i.e. not the raptorial type of laniatorean pedipalps); tarsus of males enlarged, bilaterally compressed, with scattered distal setae slightly longer than and as strong as tarsal claw. Male genital morphology highly complex, with a complicated set of sclerites and membranes, with an eversible prickly funnel and with a complex eversible system including a prickly funnel; ovipositor with three pairs of slender sub-apical setae only on ventral side). Currently no close relationships to any extant Southeast Asian laniatorean family is discernible (see Discussion).

Suthepia gen. nov.

Type species: Suthepia inermis sp. nov. by monotypy and designation.

Included species: Only the type species.

Diagnosis: As given for the family Suthepiidae: Pedipalps not forming a catching basket, completely devoid of any apophyses carrying spines in both sexes; pedipalpal tarsus in males compressed and deepened, with apical setae more or less as long and strong as tarsal claw. Male genital morphology highly complex, with a complicated set of sclerites and membranes, with an eversible prickly funnel and with a complex.

Figs 1-2. Suthepia inermis sp. nov., body in dorsal view. (1) Female paratype. (2) Male holotype. Scale line 0.5 mm. Photograph by J. Severin.
arrangement of single setae and small groups of setae. Body largely unarmed, no conspicuous apophyses, thorns, granules or setae present. Small species with a body length of less than 2 mm.

**Name:** The Latinized generic name refers to one of the localities of the type material, the Doi Suthep, a mountain in northern Thailand. The gender is female.

**Distribution:** Currently known from four mountains of northern Thailand

*Suthepia inermis* sp. nov.

Figs 1-44

**Holotype:** SMF; male; THAILAND, Chiang Mai Province and District, Doi Suthep, 1300 m; J. Trautner and K. Geigenmüller leg.; 26.I.1989.

**Paratypes:** SMF; 1 female; collected together with the holotype. – MHNG; 1 male, 1 female; Chiang Mai Province, Chomthong District, Doi Inthanon, 1080 m; 24.II.1987. – MHNG; 2 females; Doi Inthanon, Pha Mon Valley, 910 m; 23.II.1987. – MHNG; 1 female; Chiang Mai District, Doi Suthep, 1150 m; 14.II.1987. – MHNG; 2 males, 2 females; Doi Suthep, 750 m, 17.X.1990. – MHNG; 1 female; Doi Suthep, 1090 m, 17.XII.1990. – MHNG; 2 males, Chiang Mai Province, Chiang Dao District, Doi Chiang Dao, 840 m; 21.II.1986. – MHNG; 2 males, 4 females; Doi Chiang Dao, 450 m, 7.III.1987. – MHNG; 1 female; Doi Chiang Dao, 510 m; 22.IX.-25.X.1990 (in pitfall traps). – MHNG; 3 males, 2 females; Chiang Mai Province, Mae Taeng District, Huay Nam Dang, 1400 m; 17.XII.1990. All MHNG specimens leg. P.J. Schwendinger.

**Diagnosis:** A small species with a rather pyriform body, its dorsal side without tubercles or spines, with smooth surface; Tu oc low, broader than long, rounded. Chelicera strong, proximal article massively inflated in distal half. All articles of male pedipalp set with scattered setae, without apophyses and without spines; tarsus compressed and dorso-ventrally extended, with two rounded apophyses distally and dorso-distally, a smaller and a larger one, tarsal claw weak, not longer or stronger than longest apical seta. Female pedipalp generally as in male, but tarsus not enlarged and compressed, without apophyses, carrying a stronger claw.

**Name:** The Latin adjective “inermis” means without weapons and refers to the largely unarmed body of males and females, devoid of tubercles, spines and large sensilla.

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Figs 3-8. *Suthepia inermis* sp. nov, male holotype (3, 5-6), female paratype. (4, 7-8). (3-4) Habitus, lateral view. (5, 7) Habitus, dorsal view, (6, 8) Habitus, ventral view. Scale line 0.5 mm.
Figs 9-16. *Suthepia inermis* sp. nov., pedipalps of male holotype (9-12) and of female paratype (13-16). (9, 13) Right pedipalp, retrolateral view. (10, 14) Same, prolateral view. (11, 15) Right pedipalpal tarsus, retrolateral view. (12, 16) Same, prolateral view. Scale lines 0.3 mm.
Description: MALE. Body, dorsal side (Figs 1, 5): Dark brown, without any light markings, pyriform (in dorsal view), prosomal part of dorsal scutum narrower than opisthosomal part, the latter continuously enlarged, broadest in proximal part. Fused opisthosomal tergites I-V without sulci. Free opisthosomal tergites I-III visible from above. Anterior margin of dorsal scutum with a small pointed projection; Tu oc low, dorsally rounded, separated from anterior margin of dorsal scutum by half its length; eyes small, with black surrounding ring. A row of minute tubercles on posterior margin of free opisthosomal tergite III; no strong setae; otherwise surface smooth but not shiny.

Body, ventral side (Fig. 6): On Cx I-II two relatively large elongate tubercles dorso-laterally; a row of minute tubercles on last free tergite and on Op anale. Op gen (Fig. 6) broader than long, slightly enlarged posteriorly, horizontally divided into a slim movable anterior part and a much larger immovable posterior part. Op gen continuous with the stigmatic segment.

Figs 17-32. Suthepia inermis sp. nov., male paratype (17-20, 25-28), female paratype (21-24, 29-32). (17-24) Femora I-IV, retrolateral view. (25-32) Tarsi I-IV, retrolateral view. Scale lines 0.3 mm.
Figs 33-44. *Suthepia inermis* sp. nov., male holotype (33-38), female paratype (39-44). (33) Penis in dorsal view. (34) Same in ventral view. (35-36) Same in lateral view. (37, 39) Right chelicera, prolateral view. (38, 40) Same in retrolateral view. (41) Whole ovipositor, ventral view. (42) Distal part of ovipositor, ventral view. (43-44). (43) Single claw of leg I of female, retrolateral view. (44) Double claw of leg IV of female, retrolateral view. Scale lines: 0.3 mm (33-36; 37-41), 0.05 mm (42), 0.07 mm (43-44).
Table 1: Leg articles of males (females in parentheses)

|     | Tr     | Fe      | Pt      | Ti     | Mt      | Ta     | Total |
|-----|--------|---------|---------|--------|---------|--------|-------|
| I   | 0.2 (0.25) | 0.6 (0.55) | 0.2 (0.2) | 0.4 (0.45) | 0.65 (0.7) | 0.6 (0.6) | 2.65 (2.75) |
| II  | 0.25 (0.25) | 0.8 (0.8) | 0.35 (0.3) | 0.8 (0.7) | 0.9 (0.9) | 1.05 (1.05) | 4.15 (4.0)  |
| III | 0.25 (0.2)  | 0.6 (0.6) | 0.25 (0.25) | 0.45 (0.4) | 0.5 (0.6) | 0.6 (0.5) | 2.60 (2.55) |
| IV  | 0.3 (0.25)  | 0.8 (0.8) | 0.25 (0.3) | 0.65 (0.7) | 0.9 (0.9) | 0.9 (0.95) | 3.85 (3.9)  |
by hand, all others were sieved from forest litter. The collecting months are I, II, III and X, XII; all in the pre- or post-monsoon season when collecting (especially sieving) is easier due to reduced precipitation. Apparently this species is eurychronous.

The localities at only 450 m and 510 m altitude at the foot of the Doi Chiang Dao are exceptional from an ecological point of view. These are one of the few stands of evergreen forest in the lowlands of northern Thailand. In that seasonally dry region this forest type is usually found only above 1000 m. Apparently the rainwater which drains underground from the limestone slopes of Doi Chiang Dao (2175 m) resurfaces at the foot of the mountain and causes humid conditions all year round which in turn sustain an evergreen forest (P.J. Schwendinger, personal communication).

DISCUSSION

The opilionid fauna of Thailand

Our basic knowledge of opilionids of northern Thailand is relative good. A Thai-Danish expedition (led by Bertel Hansen and Birgit Degerbol) collected there in 1958-1959 on Doi Suthep and Doi Inthanon, not far from the provincial capital Chiang Mai. Suzuki (1985a, b) worked on this rich material and described a number of new genera and species. In addition, in numerous, often voluminous papers Seisho Suzuki brought to our attention the rich fauna of Southeast Asian opilionids, always accompanied by meticulous drawings of the habitus, external and genital morphology showing a wealth of details (e.g., Suzuki, 1969a, b, and the two publications mentioned above). In this, he stands among the pioneers of Asian arachnology. For more than 35 years Peter J. Schwendinger has collected in northern Thailand as well as all over Thailand and Southeast Asia. To mention only his results concerning Opiliones, he discovered on Doi Inthanon the first Asian mainland representative of ortholosmatine Nemastomatidae (Schwendinger & Gruber, 1992), and his sandokanid studies (under Oncopodidae) led to an advanced level of knowledge on this group all over Southeast Asia (e.g., Martens & Schwendinger, 1998; Schwendinger, 2006; Schwendinger & Martens, 1999, 2002). He, too, helped to disentangle the mysterious cyphophthalmid Fangensis leclerci Rambla, 1994, and he identified several species of this genus overlooked by Rambla (Schwendinger & Giribet, 2005). Last but not least, he added considerable material to the present study.

Laniatorean families in Southeast Asia

Ten laniatorean families are known from Southeast Asia. All belong to the infraorder Grassatores, and all species in this group lack an internal penis muscle. All species in the Infraorder Insidiatores Loman, 1901 possess this inner organ. All flexible distal penis parts of Grassatores are moved by internal hemolymph pressure. Molecular analyses confirmed the monophyly of the Grassatores, but not that of the Insidiatores, their alleged sister group (Sharma & Giribet, 2011, 2014).

The Sandokanidae (previously Oncopodidae) is a widespread and species-rich, mostly Southeast Asian family with marginal populations in the southwestern Chinese province of Sichuan and on the southern fringes of the Nepal Himalaya. The phylogenetic placement of Sandokanidae within the Grassatores tree remains debatable (Sharma & Giribet, 2011).

Assamidae is represented in Southeast Asia by several widespread subfamilies, with strongholds in the Himalayas westward to Kashmir (J. Martens, unpublished data). It is one of the two mainly Southeast Asian families which are represented by many species also in sub-Saharan Africa. Together with the sub-Saharan African Pyramidopidae, the Assamidae form the superfamily Assamioidea (Sharma et al., 2011).

Stygnommatidae is primarily a Neotropical family, but it is said to occur also in Indonesia and Malaysia (González, 2007). If this turns out to be correct, it would be the only laniatorean family with American-Asian connections. This is disputable.

Biantidae is fairly widespread in Southeast Asia (with a large unstudied material housed in the MHNG, P.J. Schwendinger, personal communication, and in the CJM from the Himalayas). An area along the Himalayan main range, which extends from southeastern Tibet over the Indian and Nepalese Himalayas to northern Pakistan, is especially rich in species (Martens, 1978, 2017; Gong et al., 2018).

All Southeast Asian species are believed to belong to the nominate genus (Martens, 1978). The family is also widely distributed in India and in tropical Africa including Madagascar, in the latter area with a number of diverse genera and many species. Biantidae is sister to a lineage comprising the Stygnommatidae (Neotropical, Indonesia, Malaysia; see above) and the Samoidae, all three families plus the Biantidae and Podoctidae form the superfamily Samoioidea. Podoctidae occur all over Southeast Asia, with a concentration of species in the Philippines, from where large numbers of species are known. Epedanidae is species-rich in Southeast Asia, with many genera and species described from Thailand. Recent additions to the Southeast Asian laniatorean fauna are:

Beloniscidae was established by Kury et al. (2019) on a number of genera described but poorly and insufficiently defined by C.-F. Roewer. Two subfamilies are included, Beloniscinae and Buparinae. Tithaeidae was separated from the Epedanidae by molecular analyses (Sharma & Giribet, 2011). The two genera Tithaeus Thorell, 1891 and Metalithitaes Suzuki, 1969 occur in Sundaland, i.e. the Thai-Malay Peninsula, Sumatra, Java and Borneo. The family was also reported.
from northern Vietnam and southern China. More genera, established by C.-F. Roewer but not yet analysed, likely belong to this family too.

Petrobunidae is represented by a recently described genus and three species (Sharma & Giribet, 2011); it is known only from the Philippine islands of Palawan and Panay. An undescribed morphospecies was reported from Taiwan. The Japanese *Proscotolemon sauteri* Roewer, 1916 was recovered as nested within this family (Aharon et al., 2020). Molecular sequence data do not support any superfamily-level placement of the Petrobunidae, although it clusters with other Southeast Asian families in all analyses and it is recovered as sister to the Epedanidae (Sharma & Giribet, 2011).

**The case of the Suthepiidae**

A number of traits characterize *Suthepia* gen. nov. and make it unmistakable; up to now it is not possible to attribute this genus, which belongs to the Grassatores, to any of the established Asian families. Even to affiliate it with one of the more or less soundly established superfamilies proves to be difficult. One superfamily, the Epedanoidea, which is not well supported genetically, harbors six apparently related families, the Epedanidae, Trithaeidae, Podoctidae, Sandokanidae and Petrobunidae, all more or less restricted to Southeast Asia. The recently established Belonisicidae were not included in that study (Sharma & Giribet, 2011). The Suthepiidae, primarily by geographical indication, may belong to this cluster. The families Biantidae and Assamiidae occur also in the Afrotropics, at least in the Biantidae have larger numbers of genera and species in Africa than in Asia. The set of Neotropical families placed in the superfamilies Gonyleptoidea and Zalmoxoidea do not seem to have close affinities to *Suthepia* nov. gen.

**External morphology; appendages:** Unique characters of *Suthepia* gen. nov. are the spineless pedipalps in combination with an enlarged and compressed, sexual dimorphic male pedipalpal tarsus. Normally laniatorean pedipalps are equipped with numerous strong setae, often raised on small apophyses, to form an effective prey-catching basket, i.e. the raptorial type of pedipalps (Wolff et al., 2016). The species of only few laniatorean genera and families lack this basket system, i.e. in the phalangiid genus *Himalphalangium* Martens, 1973 (Martens, 1973b). Internal morphology; genital apparatus: Penial characters are important for defining opilionid families. Within genera and species of a given family basic characters in penial morphology and the mode of insemination are generally uniform (Martens, 1986, Macías-Ordóñez et al., 2010). The stout penis of *Suthepia inermis* sp. nov., with a massive basal part and a strongly enlarged distal part, is markedly distinct from the penes of species of all other Old World and especially Asian opilionid families. However, the functionality of this complicated system of sclerites, membranes and scattered single setae or groups of setae is far from being fully understood. Apparently this system can be unfolded by hemolymph pressure during courtships and copulation. This assumption is backed by the presence of a prickly funnel in the centre of the enlarged distal part of the penis. A prickly funnel is typical for penes of African and Asian Assamiidae (Bauer & Prieto, 2009; Kauri, 1961, 1985; Martens, 1977), and it was shown that the protruding funnel everts the end of the seminal duct, the stylus, to an exposed position (Martens, 1977). Prickly funnels are present also in the penes of New World Stygnopsidae (Mendes & Kury, 2007). Apparently such an inverted collar, which harbours the end part of the seminal duct, evolved several times in the Laniatores. Although it must be regarded as a highly apomorphic character, the presence of a prickly funnel consequently is not a reliable indicator for close relationships among opilionid families. Movable penis
parts, which in the resting position are retracted into the distal part of the penis trunk, are present also in Biantidae (Kauri, 1961, 1985; Martens, 1978), and in Epedanidae (Zhang & Martens, 2020). However, in these instances no invagination is present to harbour the distal part of the seminal duct. In Sandokanidae (formerly Oncopodidae), Tithaeidae and Stygnopsidae movable penis parts are also present, together forming the glans which is connected to the trunk by a membrane (the glans is slightly inverted in the sole sandokanid species of the genus Martensiellus Schwendtner, 2006) This system is movable by hemolymph pressure too.

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