

The Millipede Family Haplodesmidae (Diplopoda, Polydesmida) Recorded in Taiwan for the First Time, with the Description of a New Species

SERGEI I. GOLOVATCH^{1*}, ELENA V. MIKHALJOVA², ZOLTÁN KORSÓS³ AND HSUEH-WEN CHANG⁴

¹Institute for Problems of Ecology and Evolution, Russian Academy of Sciences, Leninsky pr. 33, Moscow 119071, RUSSIA

²Institute of Biology and Soil Science, Far Eastern Department, Russian Academy of Sciences, Prospekt Stoletiya 159, Vladivostok 690022, RUSSIA

³Department of Zoology, Hungarian Natural History Museum, Baross u. 13, H-1088 Budapest, HUNGARY

⁴Department of Biological Sciences, National Sun Yat-Sen University, 70 Lien-hai Rd., Kaohsiung 804 Taiwan, ROC

* Corresponding author. E-mail: sgolovatch@yandex.ru

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ABSTRACT.— The East Asian to Australasian millipede family Haplodesmidae is reported from Taiwan for the first time on the basis of *Eutrichodesmus taiwanensis* n. sp. This new species joins the newly established *peculiaris*-group which also includes the Japanese *Eutrichodesmus peculiaris* (Murakami, 1966), *E. nodulosus* (Verhoeff, 1939) and *E. silvaticus* (Haga, 1968), as well as *E. pectinatidentis* (Zhang, 1995), *E. anisodentus* (Zhang, 1995) and *E. soesilae* Makhan, 2010, this latter trio from continental China. The species group is characterized by complete volvation often showing an unusual overlap pattern which becomes typical from segment 3 or 4, the presence of only two transverse rows of metatergal tuberculations, the broad and dorsoventrally flattened epiproct (sometimes unusually spatuliform in the male), and the gonopods slender, fully to nearly fully devoid of a distofemoral process, but at least sometimes supplied with an accessory seminal chamber. All of these seven species are keyed. The genera *Kylindogaster* Verhoeff, 1939 and *Thelodesmus* Miyosi, 1951 are formally allocated in Haplodesmidae, this being confirmed in the former case and newly established in the latter one. The following new synonymies and combinations are proposed: *Kylindogaster* Verhoeff, 1939, *Thelodesmus* Miyosi, 1951, *Eucondylodesmus* Miyosi, 1956 and *Nanocondylodesmus* Zhang, 1995 = *Eutrichodesmus* Silvestri, 1910, all syn. n.; *E. nodulosus* (Verhoeff, 1939), comb. n. ex *Kylindogaster*; *E. armatus* (Miyosi, 1951), comb. n. ex *Thelodesmus*; *E. elegans* (Miyosi, 1956), comb. n. ex *Doratodesmus* Cook in Cook and Collins, 1895; *E. silvaticus* (Haga, 1968), comb. n. ex *Dimorphodesmus* Murakami, 1966; *E. pectinatidentis* (Zhang, 1995) and *E. anisodentus* (Zhang, 1995), both comb. n. ex *Nanocondylodesmus*; *Prosopodesmus similis* (Haga, 1968), comb. n. ex *Rhipidopeltis* Miyosi, 1958.

KEY WORDS: Haplodesmidae; taxonomy, *Eutrichodesmus*; new species; species group; Taiwan

INTRODUCTION

Both the East Asian to Australasian millipede family Haplodesmidae and its largest constituent genus *Eutrichodesmus* Silvestri, 1910 have been reviewed very recently (Golovatch et al., 2009a, b). The only changes made since have been the

synonymization of *Agathodesmus* Silvestri, 1910 with *Atopogonus* Carl, 1926 (Mesibov, 2009) and the description of *E. soesilae* Makhan, 2010 from continental China (Makhan, 2010). Prompted by the discovery of the first haplodesmid in Taiwan, another new *Eutrichodesmus*, we take the opportunity not only to describe it, but also to

update and refine the classification of this family through proposing a new family allocation and a number of synonymies and combinations. The first species group in *Eutrichodesmus* is also delimited here, with all of its seven constituent species keyed.

MATERIALS AND METHODS

The material serving as the basis for the present contribution was preserved in 75% alcohol and is currently shared between the collections of the National Museum of Natural Science, Taichung, Taiwan (NMNS), Department of Biological Sciences, National Sun Yat-Sen University, Kaohsiung, Taiwan (NSYSUB), Zoological Museum, State University of Moscow, Russia (ZMUM), Hungarian Natural History Museum, Budapest, Hungary (HNHM), Natural History Museum of Denmark, University of Copenhagen, Denmark (ZMUC), Muséum National d'Histoire Naturelle, Paris, France (MNHN), and Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia (IBSS), as indicated thereafter. Specimens were studied and illustrated using standard stereomicroscopic, photographic and drawing equipment.

SYSTEMATICS

Eutrichodesmus taiwanensis n. sp. (Figures 1 and 2)

Holotype.— ♂ (NMNS-6242-001), Taiwan, Taipei City, Wenshan Distr., Chih-Nan Temple, March 2002, leg. C.C. Chen et al.

Paratypes.— 19 ♂♂, 19 ♀♀ (NMNS-6242-002), 2 ♂♂, 3 ♀♀ (NSYSUB), 3 ♂♂, 3 ♀♀ (ZMUM), 2 ♂♂, 3 ♀♀ (HNHM), 2 ♂♂, 3 ♀♀ (ZMUC), 1 ♂, 1 ♀ (MNHN), 1 ♂, 2

♀♀ (IBSS), same locality and date, together with holotype.

Non-types.— 3 ♀♀, 3 juveniles (with 18 segments) (HNHM), Taiwan, Taichung County, Mts Dashue-san, logging road No. 210, *Cryptomeria* plantation, 2000 m a.s.l., 14 October 2007, leg. Z. Korsós. 2 ♂♂, 1 ♀ (NMNS), Taichung County, Heping Township, Sihuyuan Wind Gap, 2050 m, 21.VIII.2002, collector unknown. 1 ♂ (NSYSUB), Kaohsiung County, Liouguei, Shanping Workstation, May 2004, leg. Mei-Jhu Hung.

Name.— To emphasize the first haplodesmid formally recorded in Taiwan.

Diagnosis.— Differs from the closest congeners in the *peculiaris*-group mainly in the bifid gonopod endomere, coupled with the presence of a rudimentary distofemoral process (see also Key below).

Description.— Length ca 5.0 (♂) to 6.0 mm (♀), width ca 1.0 mm, body broadest on segments 5-16 (♂) or 5-17 (♀). Holotype ca 5.0 mm long and 1.0 mm wide. Coloration uniformly pallid to yellow (Fig. 1A).

Adults with 19 (♂) or 20 segments (♀), conglobation complete, pattern of volvation unusual for Haplodesmidae in overlap switching to typical starting already from segment 3 (Fig. 1B, C) (cf. Golovatch 2003).

Head slightly transverse (wider than high), rather densely pilose, microgranular and microvillose just below antennae and on vertex; epicranial suture shallow and wide. Antennae rather short and clavate; antennomere 6 longer than 5th, both with an evident dorso-apical pit containing a tight group of minute bacilliform sensilla; antennomere 8 with the usual four sensory

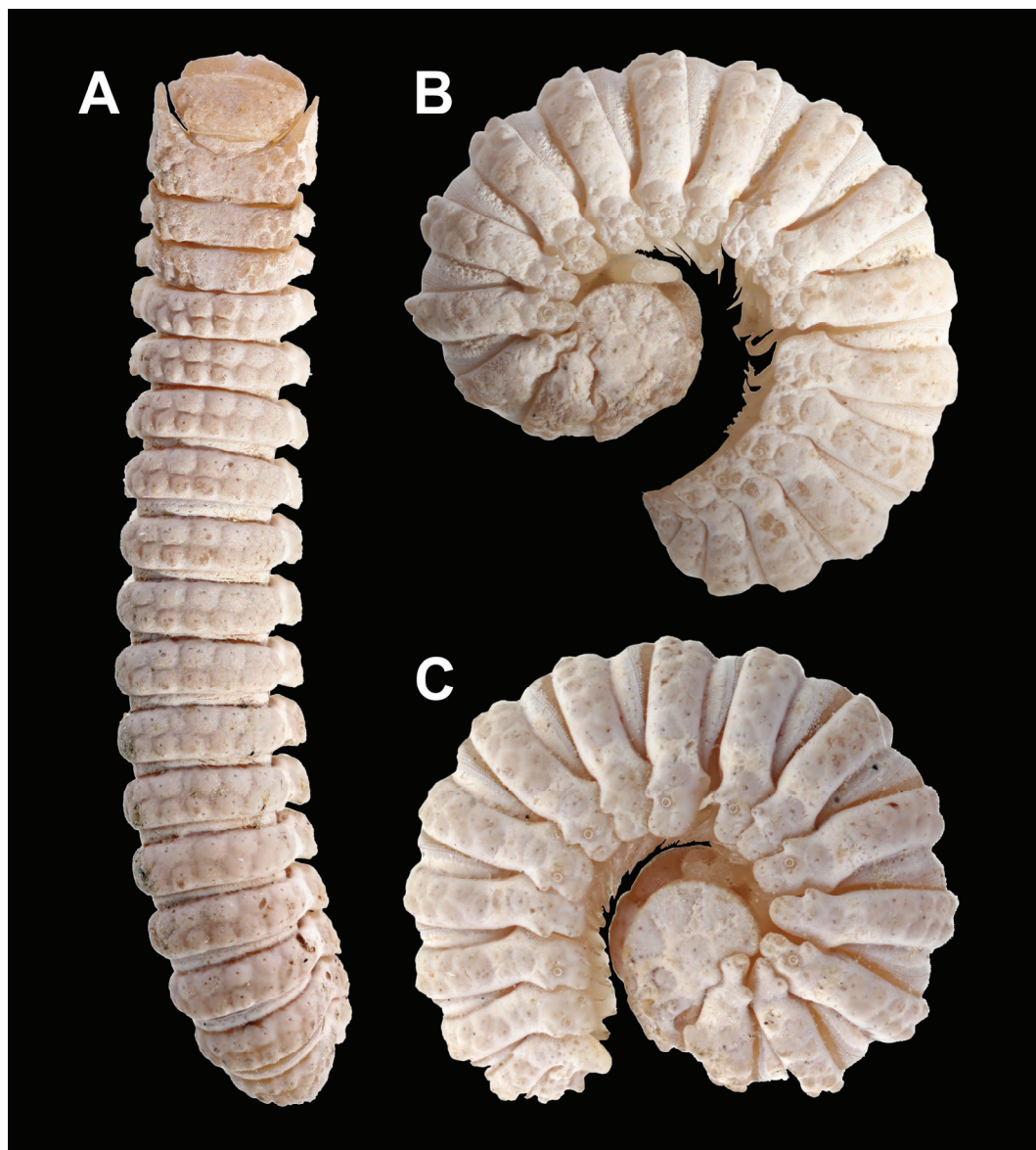


FIGURE 1. Habitus of *Eutrichodesmus taiwanensis* n. sp., paratypes ♀ (A, B) and ♂ (C), dorsal, lateral and lateral views, respectively. Photographed not to scale.

cones apically. Collum subtrapeziform, rather large, slightly broader than head, flattened mid-dorsally, not covering the head from above; entire surface microvillose, with four transverse rows of round bosses/tubercles (Fig. 1). Prozona very finely alveolate, collum and metaterga

covered with a cerotegumental crust held by abundant microvilli. Metatergum 2 with three, subsequent metaterga with two transverse and mixostictic (i.e. irregular in axial direction) rows of subequal, low, rounded bosses, each boss obviously supporting an abraded seta traced only as an

insertion point (Fig. 1A-C). Metaterga 2-4 evidently flattened mid-dorsally (Fig. 1). Paramedian mid-dorsal bosses in fore row or even in both rows on metatergum 5 often slightly higher than those on following metaterga. Paraterga strongly declivous, rather broad, rounded and very faintly bilobate laterally, evidently surpassing level of venter, caudolaterally at base with one distinct lobulation (Fig. 1B, C); paraterga 2 strongly enlarged, with a series of four bosses near anterolateral edge, schism and hyposchism both very small; paraterga 3 and 4 slightly shorter than others (Fig. 1B, C), overlap of following paraterga typical. Paraterga 17 and 18 either directed ventrocaudad (♂) or, like 19th, small and as usual strongly declined (♀) (Fig. 1B, C). Pore formula normal (5, 7, 9, 10, 12, 13, 15-19), ozopores evident, located near base of caudolateral lobulation. Pleurosternal ridges absent. Epiproct strongly broadened, either especially clearly flattened, subrectangular in lateral view, bare and roundly spatuliform in dorsal view, and carrying a minute middle knob as base (♂), or with three rows of bosses dorsally, dome-shaped, regularly sloping in lateral view and subtriangular in caudal view (Fig. 1B, C), i.e. just as described and depicted for *E. peculiaris* by Murakami (1966). Hypoproct and paraprocts typical of the genus.

Sterna usually with a deep, narrow, transverse depression between coxae. Legs rather long and relatively slender, barely reaching tips of paraterga; femoral and tarsal segments longest, subequal in length; claw normal, simple, very slightly curved ventrad; some setae with microdenticulations. ♂ coxa 8 clearly enlarged.

Gonopods (Fig. 2A-D) rather simple. Coxae subquadrate, large, microtuberculate on lateral face and with two macrosetae latero-apically. Telopodite only slightly

longer than coxite, rather slender throughout, setose in its basal one-third, with a small, subtriangular, low, lateral lobe obviously corresponding to a distofemoral process (dp) at about midway of seminal groove. No traces of a transverse sulcus near point of seminal groove's recurvature laterad. Seminal groove debouching in an evident accessory seminal chamber showing a pilose pad area and terminating near base both of a small, short, lobe-shaped exomere (ex) and a longer, slightly twisted, bifid endomere (en), latter clearly separated by a medial constriction and carrying a short, distally tuberculate, flagelliform outgrowth at base on lateral face.

Remarks.— This pallid species seems to inhabit the entire island and occurs at various elevations (up to the midmontane subtropical forest belt above 2000 m). We face a typical “doratodesmid” (capable of volvation, see Golovatch et al. 2009a) showing especially close affinities with three congeners: *Eutrichodesmus peculiaris* (Murakami, 1966), from Oshima, Niihama Prefecture, Shikoku Island, Japan (Murakami, 1966); *E. nodulosus* (Verhoeff, 1939), from a cave in the Ryukyu island of “Fukafugusa” (Verhoeff, 1939), a dubious locality because no such island exists in the Ryukyus, later reported also from Ishigaki and Iriomote islands (Omine, 1982), both lying south of Okinawa (ca 150 km east of Taiwan), as well as on Okinawa Island proper (Omine and Ito, 1998), the Ryukyus, Japan; and *E. silvaticus* (Haga, 1968), from Gooya, Hojoo-machi, Tagawa City, Fukuoka Prefecture, Kyushu Island, Japan (Haga, 1968). These four species seem to share complete volvation (albeit at least sometimes with an unusual overlap pattern which becomes typical already from segment 3), the presence of only two

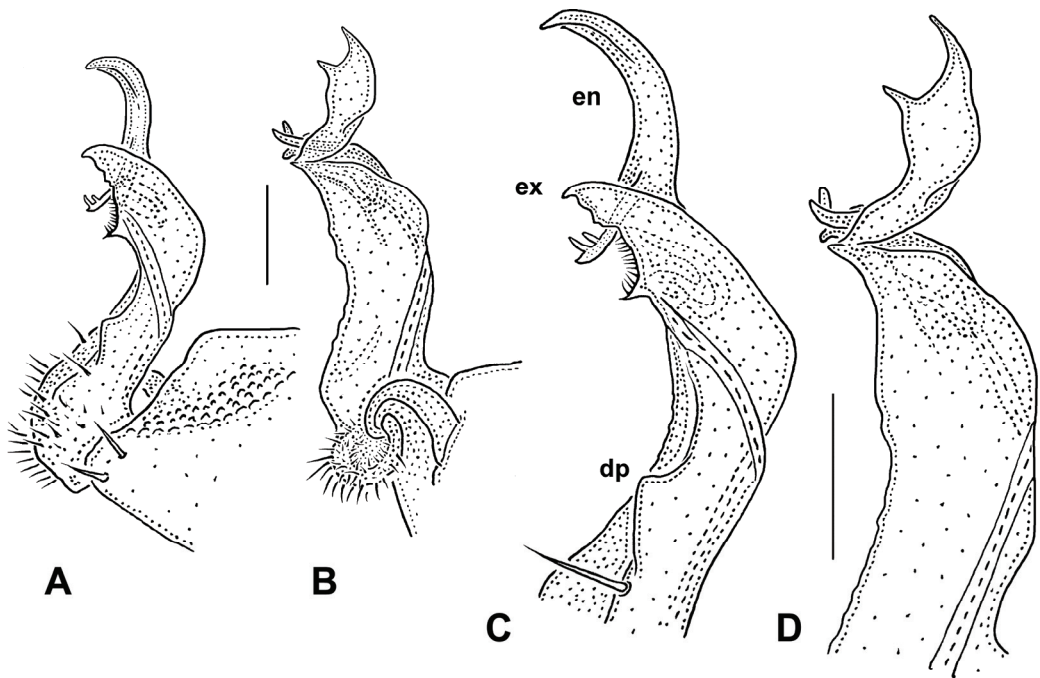


FIGURE 2. A-D. Gonopods of *Eutrichodesmus taiwanensis* n. sp., paratype ♂, lateral, submedial, lateral and submedial views, respectively. Scale bars: 0.1 mm.

transverse rows of metatergal tuberculations, the remarkably broad and dorsoventrally flattened epiproct (especially so in ♂), and the slender gonopods virtually or nearly devoid of a distofemoral process, but at least sometimes supplied with an accessory seminal chamber. This seems to warrant their assignment to a single species group, the *peculiaris*-group, the first to be delimited in *Eutrichodesmus*.

Murakami (1966), when describing his *Dimorphodesmus peculiaris*, correctly compared his new genus with *Eucondyloides* Miyosi, 1956, *Kylindogaster* Verhoeff, 1939 and *Doratodesmus* Cook in Cook and Collins, 1895. Both *Eucondyloides* and *Doratodesmus* have since been placed in Haplodesmidae, the genus *Eucondyloides* has been synonymized

with *Eutrichodesmus* Silvestri, 1910 (Golovatch et al., 2009a), while *Kylindogaster* was simply overlooked. Its only constituent species, *K. nodulosa* Verhoeff, 1939, was based on a single female specimen with 19 body segments, apparently adult because the body lumen was said to be filled with eggs (Verhoeff, 1939). Judged from the general body shape, the presence of only two transverse rows of bosses on most of the metaterga, albeit isostictic (i.e. regular in axial direction) and somewhat differentiated, the peculiar, strongly broadened epiproct, and provenance (the Ryukyus), there can be no doubt whatever that this species belongs in the *peculiaris*-group. This confirms the family allocation [in Doratodesmidae, a family currently considered as a junior synonym of

Haplodesmidae, see Golovatch et al. (2009a)] which seems to have first been proposed by Murakami (1993). This also implies the following formal nomenclatural changes: *Kylindogaster* Verhoeff, 1939 is another junior subjective synonym of *Eutrichodesmus* Silvestri, 1910, syn. n., while *Kylindogaster nodulosa* Verhoeff, 1939 is to be referred to as *Eutrichodesmus nodulosus* (Verhoeff, 1939), comb. n.

As regards *Dimorphodesmus silvaticus* Haga, 1968, also overlooked by Golovatch et al. (2009a), Haga (1968) quite correctly emphasized the especially evident similarities of this species to *D. peculiaris* and noted certain variation in the shapes of both exo- and endomere in *D. silvestris* and *D. peculiaris*. Now that *D. silvaticus*, too, joins the *peculiaris*-group, the following new combination results: *Eutrichodesmus silvaticus* (Haga, 1968), comb. n. ex *Dimorphodesmus* Murakami, 1966.

Among further omissions in Golovatch et al. (2009a, b), the status of *Nanocondylodesmus* Zhang, 1995 deserves special attention. This genus is known from two species, *N. pectinatidentis* Zhang, 1995, the type species from Mt Tianmu, Lin'an County, Zhejiang Province, China, and *N. anisodentus* Zhang, 1995, from Mt Wuyi, Fujian Province, China (Zhang, 1995a, b), both so strongly resembling the members of the *peculiaris*-group that we are also inclined to place them therein. Thus, they also show complete volvation (albeit with the overlap pattern becoming typical starting from segment 4 or 5), two transverse rows of more (*N. anisodentus*) or less (*N. pectinatidentis*) strongly differentiated tubercles on most of the metaterga, a flattened epiproct and, above all, slender gonopods devoid of a distofemoral process, but supplied with subequal and short exo- and endomere, the latter carrying several

spines as well. This implies the following new synonymy and combinations: *Nanocondylodesmus* Zhang, 1995 is still another junior subjective synonym of *Eutrichodesmus* Silvestri, 1910, syn. n., while *Nanocondylodesmus pectinatidentis* Zhang, 1995 and *N. anisodentus* Zhang, 1995 are formally to be transferred to *Eutrichodesmus*, both comb. n.

Another congener, *E. soesilae* Makhan, 2010, which superficially is especially similar to *E. anisodentus*, has just been described from Mt. Jinyun, Beibei District, Chongqing Municipality, China (Makhan, 2010). Its description, however poor (e.g. the number of body segments was miscounted as 19, actually being 20) and based on a single female specimen, still allows to treat it as a distinct species. Even though the gonopod structure of *E. soesilae* remains unknown, in all probability it also belongs in the *peculiaris*-group.

The following key can serve to separate all of the seven currently known species of the *peculiaris*-group:

- 1a Transverse rows of metatergal tuberculations isostictic. Adult ♀ with 19 body segments, < 4.5 mm long. The Ryukyus, Japan. *E. nodulosus*
- 1b Transverse rows of metatergal tuberculations mixostictic. Adult ♀ with 20 body segments, > 4.5 mm long. 2
- 2a Metatergal tuberculations usually well-differentiated, mid-dorsal ones evidently to very strongly enlarged at least on some segments. Mainland China. 3
- 2b Metatergal tuberculations uniform, like flat bosses. Japan and Taiwan. 5
- 3a 1+1 mid-dorsal tubercles only slightly higher than others and located only in 2nd row on segments 4-6(7). *E. pectinatidentis*

- 3b Mid-dorsal tubercles much higher than others and located in both rows at least on segments 4-16(17). 4
- 4a Most of tuberculations on collum obliterated, retained only near lateral edge. Mid-dorsal tubercles on penultimate segment low but evident, like a small crest. Chongqing Municipality.
..... *E. soesilae*
- 4b Almost entire collum covered with tuberculations. Mid-dorsal tubercles on penultimate segment nearly wanting, flat, not crest-shaped. Fujian Province.
..... *E. anisodentus*
- 5a Gonopod distofemoral process present, albeit rudimentary, like a small and low lobe; endomere simple and bifid, exomere stout and lobiform (Fig. 2. A-D). Taiwan. *E. taiwanensis* n. sp.
- 5b Gonopod distofemoral process obviously absent; endomere usually more complex, especially so distad; exomere not lobiform. Japan. 5
- 6a Exomere elongate rounded to unciform.
..... *E. peculiaris*
- 6b Exomere stout and unciform.
..... *E. silvaticus*

Because *Rhipidopeltis* Miyosi, 1958 has already been synonymized with *Prosopodesmus* Silvestri, 1910 (Golovatch, et al. 2009a), the likewise omitted species *Rhipidopeltis similis* Haga, 1968, from Kyushu, Japan (Haga, 1968), is to be transferred to *Prosopodesmus*, formally resulting in *Prosopodesmus similis* (Haga, 1968), comb. n.

In the latest review of Haplodesmidae (Golovatch et al., 2009a), the Japanese genus *Eucondylodesmus* Miyosi, 1956 was synonymized with, and its sole constituent species *E. elegans* Miyosi, 1956 transferred to, *Doratodesmus* Cook in Cook and Collins, 1895. Based on the detailed

description and fine illustrations of *E. elegans* as presented by Miyosi (1956), especially in the light of the variation in gonopod structure, both inter- and intraspecific, which is observed within the *peculiaris*-group of *Eutrichodesmus*, we are now inclined to reconsider the above synonymy and combination. Indeed, like in some species of the *peculiaris*-group, the gonopods of *E. elegans* are especially slender, each devoid of a distofemoral process, but supplied with a conspicuous hairy pad (apparently marking the orifice of an accessory seminal chamber), as well as with a spiniform exomere near the pad and a long, subfalcate endomere carrying numerous spiniform processes. Although formally this species cannot be treated as a member of the *peculiaris*-group because most of its metaterga show three, not two transverse rows of undifferentiated tuberculations, while the epiproct is not too conspicuously flattened, the following nomenclatural changes seem to be warranted: *Eucondylodesmus* Miyosi, 1956 is one more junior subjective synonym of *Eutrichodesmus* Silvestri, 1910, syn. n., while *Doratodesmus elegans* (Miyosi, 1956) ought to be transferred to *Eutrichodesmus*, comb. n.

The genus *Thelodesmus* Miyosi, 1951 was first proposed in the family Leptodesmidae (Miyosi, 1951), then moved to Vanhoeffeniidae (Miyosi, 1959), currently referred to Pyrgodesmidae (Hoffman, 1980; Murakami, 1993; Wang and Mauriès, 1996). Its type and only constituent species, *T. armatus* Miyosi, 1951, was originally described from “Yosihuzi-Mura, Kaminada-Mati (Ehimé-Ken)”, i.e. Ehime Prefecture, Shikoku Island, Japan, and has since been reported also from Urai, Taiwan (Wang, 1958; Korsós, 2004) and from Okinawa, the Ryukyus, Japan (Karasawa et al., 2008).

The original description alone (Miyosi, 1951) unequivocally implies, however, that *Thelodesmus* is actually another member of Haplodesmidae, again unfortunately overlooked by Golovatch et al. (2009a). Indeed, the collum in *T. armatus* is not flabellate to cover the head from above, i.e. a condition uncharacteristic of Pyrgodesmidae; the metaterga show 4-7 transverse rows of setigerous tuberculations, both abundant tergal setation and mid-dorsally undifferentiated tuberculations likewise being untypical of Pyrgodesmidae; the paraterga are so small that the body is not capable of volvation; paraterga 2 are only slightly enlarged compared to the subsequent ones. Both latter features commonly occur both in Haplodesmidae and Pyrgodesmidae. Yet the most remarkable character is gonopod conformation, which appears to be that of a typical *Eutrichodesmus* in showing both an evident distofemoral process and a transverse sulcus at about its midway, as well as an apparently subapically terminating seminal groove. As a result, in addition to the new family allocation, the following nomenclatural changes seem to be appropriate: *Thelodesmus* Miyosi, 1951 is yet one more junior subjective synonym of *Eutrichodesmus* Silvestri, 1910, syn. n., while *Thelodesmus armatus* Miyosi, 1951 is also to be transferred as *Eutrichodesmus armatus* (Miyosi, 1951), comb. n.

CONCLUSION

The first formal record of the millipede family Haplodesmidae in Taiwan has brought about not only the description of a new species, but also a new family allocation and numerous new synonyms and combinations. All this not only considerably refines the family's classification, which alone is important enough, but also clarifies

the identity of a number of hitherto dubious East Asian micropolydesmidans. Still much more work is needed to properly assess the real diversity and distribution of Haplodesmidae, as well as of all Polydesmida in the region as a whole and in Taiwan in particular.

In the large genus *Eutrichodesmus* which at present encompasses already 32 species, the first species group is delimited, the *peculiaris*-group. All of its seven species are keyed. Previously, only a few pairs of especially similar species were revealed therein, whereas the bulk remains yet too difficult to group into some coherent assemblages (Golovatch et al., 2009b). In general, if with our growing knowledge the *peculiaris*-group is to be promoted into a separate genus or subgenus, several genus-group names are readily available. The oldest is certainly *Kylindogaster* Verhoeff, 1939, but we still do not know the male of its only constituent species, *E. nodulosus* (Verhoeff, 1939). Moreover, even its type locality remains obscure. The second possible option is *Dimorphodesmus* Murakami, 1966, because its type species *D. peculiaris* Murakami, 1966, unlike that of *Kylindogaster*, is nicely documented.

One must be very critical before accepting at least some of the original or subsequent records of dubious forms, such as those by Verhoeff (1939), Omine (1982), Omine and Ito (1998) and Karasawa et al. (2008) in the Ryukyus, as well as by Wang (1958) in Taiwan, until a restudy and a proper description of pertinent material has been made.

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