9-16-2011

The Milliped order Glomeridesmida (Diplopoda: Pentazonia: Limacomorpha) in Oceania, the East Indies, and southeastern Asia; first records from Palau, the Philippines, Vanuatu, New Britain, the Island of New Guinea, Cambodia, Thailand, and Borneo and Sulawesi, Indonesia

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INSECTA MUNDI

A Journal of World Insect Systematics

0196

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Date of Issue: September 15, 2011

Center for Systematic Entomology, Inc., Gainesville, FL

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Insecta Mundi 0196: 1-11

Published in 2011 by
Center for Systematic Entomology, Inc.
P. O. Box 141874
Gainesville, FL 32614-1874 U. S. A.
http://www.centerforsystematicentomology.org/

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Printed copies deposited in libraries (ISSN 0749-6737)
Electronic copies in PDF format (On-Line ISSN 1942-1354, CDROM ISSN 1942-1362)

INSECTA MUNDI 0196: 1-11 2011

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Abstract. The taxonomically neglected milliped order Glomeridesmida and family Glomeridesmidae (infraclass Pentazonia, superorder Limacomorpha) inhabit 21, rather than seven, regions of the world, being newly recorded from Thailand; Cambodia; the Republics of Palau, the Philippines, and Vanuatu; New Britain, Bismarck Archipelago; the Island of New Guinea (both West Papua [formerly Irian Jaya], Indonesia, and Papua New Guinea); and Sulawesi and Borneo, Indonesia. Occurrence in Fiji is confirmed with two additional samples, and discovery is predicted in southern China, Myanmar, and perhaps Madagascar. Coupled with published localities, these records suggest subcontinuous (super)ordinal and familial ranges extending some 12,480 km (7,800 mi) southeastward from northwestern Thailand to Fiji. Though infrequently encountered, the taxa may actually be diverse and abundant within this area, which encompasses all of the Indochina and Malay peninsulas, the Philippines, Palau, the Island of Borneo and Indonesia, Papua New Guinea, the Solomon and Santa Cruz Islands, Vanuatu, and Fiji; it excludes Taiwan, Australia, New Caledonia, and the Loyalty Islands. The paucity of preserved individuals probably results from their dark pigmentations and minute sizes, adults being <6.5 mm long; Berlese extractions and sieved litter techniques are recommended over hand collecting. Glomeridesmida are much more continuous, widespread, and abundant in the "east" than previously believed and clearly do not comprise a minor, insignificant taxon. The first glomeridesmidan photos are published.

Keywords. Glomeridesmidae, Termitodesminae, Fiji, Bismarck Archipelago, Java, Sumatra.

Introduction

Aside from the two rarest – Siphoniulida, known only from Sumatra, Guatemala, and southern Mexico (Hoffman 1979, 1980, 1999; Sierwald et al. 2003; Shelley and Golovatch 2011), and Siphonocryptida, occurring in Madeira, the Canary Islands, Nepal, peninsular Malaysia, Indonesia (Sumatra), and Taiwan (Pocock 1894a; Wang and Tang 1965; Enghoff 1992, 2010; Enghoff and Golovatch 1995; Vicente and Enghoff 1999; Korsós 2004; Korsós et al. 2008, 2009; Arndt et al. 2008; Shelley and Golovatch 2011) – none of the 16 diplopod orders is more infrequently encountered than Glomeridesmida, the lone extant component of the superorder Limacomorpha. A representative of the infraclass Pentazonia, in which males possess telopods rather than gonopods, Glomeridesmida are known from seven regions of the world (Shelley and Golovatch 2011) and comprise one family, Glomeridesmidae, with two monotypic subfamilies, the nominate and Termitodesminae (Hoffman 1980, Shelley 2003). Hoffman et al. (1996, 2002) stated that the latter "surely merits family status," but it has never been formally elevated. Termitodesminae and *Termitodesmus* Silvestri, 1911, are known from Vietnam and India (Silvestri 1911a, b; Hirst 1911, 1913; Attems 1914, 1938, 1953; Golovatch 1983; Hoffman et al. 1996; Jeekel 2003; Enghoff et al. 2004; Shelley and Golovatch 2011); the nominate subfamily and *Glomeridesmus* Gervais, 1844, inhabit these countries and the rest of the ordinal range, and are most commonly encountered in the Neotropics, the largest occupied area. Not so in the east, however; occurrences in Vietnam, Sumatra, and Fiji are based on single samples, and that in Sarawak, on the Island of Borneo, is based on just two. Furthermore, documentations from Vietnam, Sarawak, and Fiji were only just provided (Shelley and Golovatch 2011).

While recently perusing samples from the American Museum of Natural History, New York, USA (**AMNH**), and the Queensland Museum, Brisbane, Australia (**QMBA**), I discovered three more "eastern" glomeridesmid/idan samples and specimens, two from Fiji (Viti Levu), confirming the prior citation, and one from the Republic of Palau (Babeldaob). I document these localities herein along with five from the Island of New Guinea, in both Papua New Guinea (PNG) and West Papua (formerly Irian Jaya), Indonesia, and one from New Britain, in the Bismarck Archipelago, PNG, based on samples in the Bishop Museum, Honolulu, USA (**BPBM**), and the National Museum of Natural History, Sofia, Bulgaria (**SOFM**). I also report Limacomorpha/Glomeridesmida/idae from the Philippines (Luzon), Vanuatu (Espiritu Santo, Malo), Cambodia, Thailand, and Borneo and Sulawesi, Indonesia, based on samples in the Muséum National d'Histoire Naturelle, Paris, France (**MNHN**), Zoological Museum of the Moscow State University, Russia (**ZMUM**), and Museum of Zoology, Chulalongkorn University, Bangkok, Thailand (**MZCT**). Additionally, I provide photos of the Palauan specimen, the first published of a glomeridesmid/idan, and update the ordinal biogeography. Hoffman (1980) stated, "…we know at present probably only a small fraction of the extant fauna," and indeed, this clearly is the case. The new samples expand known distributions (Shelley and Golovatch 2011) to such an extent that overall (super)ordinal and familial ranges can be projected in southeastern continental Asia, the East Indies, and Oceania.

Only two glomeridesmids have been described from the "eastern" area (Jeekel 2003), both from Indonesia. Pocock (1894a) proposed *G. sumatranus* for an individual from Mt. Singgalang, Sumatra, which he (Pocock 1894b) subsequently cited as did Attems (1907, 1914, the latter under *Zephroniodesmus* Pocock) and Wang (1967), who reported it from Singapore. Attems (1907) proposed *G. javanicus* for specimens from Tjibodas and Bogor (formerly Buitenzorg), Java, which he (Attems 1914, 1926) and Carl (1942) subsequently referenced. While the islands are large enough to harbor more than one species each, for simplicity, I assign these names to new samples from Sumatra and Java; however, Fiji, Vanuatu, New Britain, New Guinea, Luzon, and Palau are sufficiently distant that their glomeridesmids surely are not conspecific, and possibly not even congeneric. The type-species of *Glomeridesmus*, *G. porcellus* Gervais and Goudot, 1844, is from Colombia, and *G. sumatranus*, *G. javanicus*, and the Indian species, *G. indus* Carl, 1942, are sufficiently removed from both South America and the Neotropics that they likely require one or more new genera themselves. As Hoffman (1980) suggested, *Javadesmus* Verhoeff and *Zephroniodesmus*, erected for *G. javanicus* and *G. sumatranus*, respectively (Verhoeff 1929, Pocock 1894b), are available and may need to be revived. Until meaningful taxonomic studies are undertaken in Glomeridesmidae, little point is served by erecting additional generic and specific names that will require reassessment, and as evidenced by extruded ovipositors, most of the present individuals are females and lack telopods, which probably harbor important diagnostic features. Consequently, I do not name the forms that, based on remoteness, probably are undescribed; I focus instead on geography and report the new localities along with anatomical observations of the Palau and Fiji specimens. In the ensuing locality citations, the numbers of each sex are provided when known; otherwise, the total number of specimens is given after the institutional coden. Sampling dates were unavailable for MNHN samples.

Taxonomy

Genus *Glomeridesmus* Gervais, 1844

Glomeridesmus Gervais, 1844a: xxvii. Gervais 1844b: 61; 1847: 86; 1859: 2. Latzel 1884: 59, 124. Pocock 1894a: 332; 1894b: 476. Silvestri 1896: 201; 1898: 645; 1902: 183; 1903: 22. Brölemann 1898: 256. Attems 1928: 209. Verhoeff 1929: 1377. Loomis 1936: 9; 1964: 9; 1968: 7; 1975: 168. Carl 1941: 250; 1942: 134-167. Jeekel 1971: 33; 2003: 103. Shear 1973: 245. Hoffman 1980: 60; 1999: 19.

Zephroniodesmus Pocock, 1894b: 476. Silvestri 1896: 201; 1898: 645. Attems 1926: 116. Verhoeff 1929: 1377. Loomis 1936: 9. Carl 1942: 165. Jeekel 1971: 33.

Javadesmus Verhoeff, 1929: 1377. Carl 1942: 150, 165. Jeekel 1971: 33.

***Glomeridesmus sumatranus* Pocock, 1894a**

Glomeridesmus sumatranus Pocock, 1894a: 333. Wang 1967: 393. Jeekel 2003: 106.
Zephroniodesmus sumatranus Pocock, 1894b: 476. Attems 1914: 151.

Published records. Indonesia, Sumatra, West Sumatra Prov., Mr. Singgalang (Pocock 1894a, Jeekel 2003). *Singapore*, Bukit Timah (Wang and Tang 1965, Wang 1967).

New records. Indonesia, Sumatra, Bengkulu Prov., Krui, Pahmungan, litter and soil berlesates, L. Deharveng (MNHN-4). West Sumatra Prov., Muarabungo, Rantau Pandan, litter and soil berlesates, L. Deharveng, A. Bedos (MNHN-9); Koto aur Malintang, soil berlesate, L. Deharveng, A. Bedos (MNHN-1); and Sumpur Kudus, Sibiluru, Sangki system, by hand from Ngalau Surat Cave, L. Deharveng, A. Bedos (MNHN-6). South Sumatra Prov., Kubu Prau, litter berlesate, L. Deharveng (MNHN-2).

***Glomeridesmus javanicus* Attems, 1907**

Glomeridesmus javanicus Attems, 1907: 10, fig. xviii-xxii, pl. 1, fig. 4-8; 1914: 151; 1926: 116, fig. 116. Carl 1942: 136. Jeekel 2003: 104.

Published records. Indonesia, Java, West Java Prov., Tjibodas, Bogor (=Buitenzorg) (Attems 1907, Jeekel 2003).

New records. Indonesia, Java, West Java Prov., Bogor, by hand from Kebun Raya litter, L. Deharveng, A. Bedos (MNHN-2). Central Java Prov., Tulakan, Bungur, Gua Somopuro cave, by hand, L. Deharveng, A. Bedos (MNHN-2).

Remarks. While *G. javanicus* is the type species of *Javadesmus*, by subsequent monotypy of Carl (1942) according to Jeekel (1971), to the best of my knowledge the name has never been formally cited in combination with this genus.

***Glomeridesmus* spp.**

Published records.
East Indies.
Eastern Malaysia. Sarawak, Gunung Mulu National Park (Shelley and Golovatch 2011).
Island of New Guinea. New Guinea in general (Jeekel 2003). Papua New Guinea, high mountains (Hoffman 1980).
Papua New Guinea. Bismarck Archipelago, New Ireland, New Ireland in general (Hoffman 1980, Jeekel 2003; a voucher sample and/or repository were not provided).
Oceania. Fiji. Viti Levu, Nandarivatu (Shelley and Golovatch 2011).

New records.
Continental Asia.
Thailand: Chiang Mai Prov., Doi Inthanon, litter berlesate, L. Deharveng, A. Bedos (MNHN-8); and Doi Pui, litter berlesate, L. Deharveng, A. Bedos (MNHN-2). Sa Kaeo Prov., Khlong Hat Dist., Siwa Cave (13° 19' 15.8" N, 102° 19' 39.5" E), ~170 m, bat guano, MM, FF, juvs., 27 October 2010, N. Likhitrakarn (MZCT, ZMUM). **New Country Records for the Order, Family, and Genus.**
Cambodia: Kampot Prov., Phnom Laang, berlesate from Kien Krol G Cave, L. Deharveng, A. Bedos (MNHN-2). **New Country Record for the Order, Family, and Genus.**

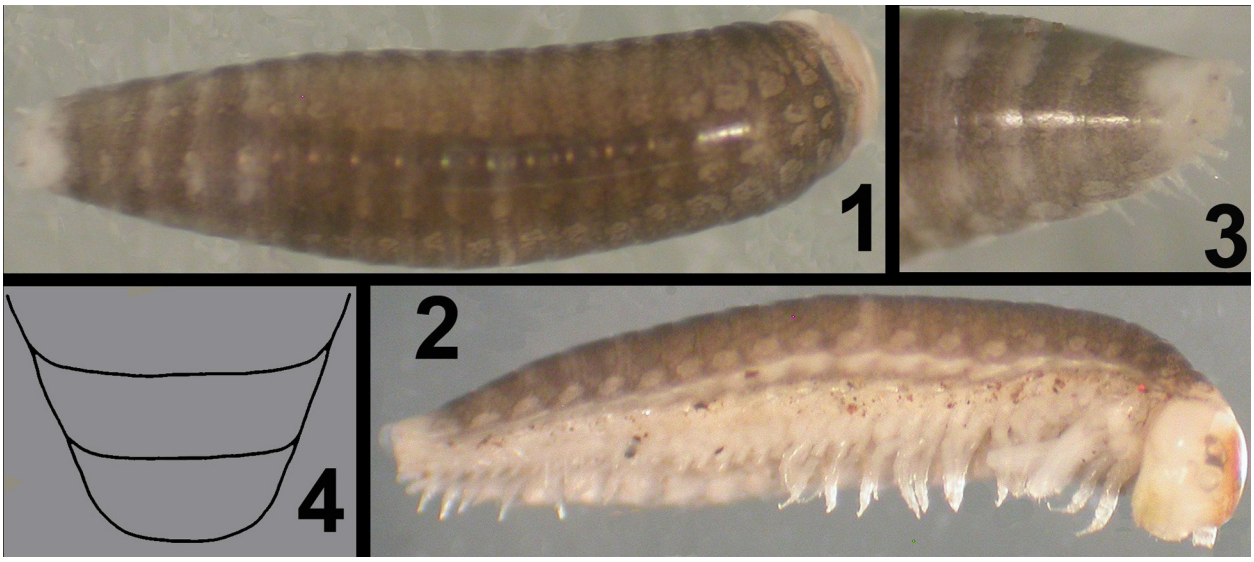
Asia Islands.
Philippines: Luzon, Mountain Prov., NE of Sagada, litter berlesate, L. Deharveng (MNHN-17). **New Country and Island Record for the Order, Family, and Genus.**
Indonesia: Borneo: East Kalimantan Prov., Berau Reg., Tubaan, Tabalar Ulu, Berantai, road to Gua Louwading Cave, litter berlesate, L. Deharveng, A. Bedos (MNHN-2); East Kutai Reg., Sangkulirang, Baai forest, soil berlesate, L. Deharveng, A. Bedos (MNHN-2), and by hand from Pengadan

Gua Mardua Cave, L. Deharveng, A. Bedos (MNHN-2). **New Provincial Records for the Order, Family, and Genus.**

Island of New Guinea: West Papua Prov., Star Mountains, Sibil Valley (berlesate), 1,250 m, F, 15-20 October 1961, L. and S. Quate (BPBM). **New Provincial Record for the Order, Family, and Genus.**

Sulawesi: South Sulawesi Prov., Maros, Bantimurung, by hand from litter, L. Deharveng (MNHN-2), by hand from Gua Mimpi Cave, L. Deharveng (MNHN-10), berlesate of corridor litter, L. Deharveng (MNHN-7), and Samaenre, Bottosiri, soil berlesate, L. Deharveng, A. Bedos (MNHN-3); Bone Reg., Desa Bonto Padang, Bontopadang, by hand from Leang Marapetang Cave, L. Deharveng, A. Bedos (MNHN-4); Gowa Reg., Malino, Lompobatang near Lembanna, litter berlesate, L. Deharveng (MNHN-100); Latimojong, litter sifting and berlesate, L. Deharveng, A. Bedos (MNHN-2). **New Island and Provincial Records for the Order, Family, and Genus.**

Remarks. Glomeridesmid/idan occurrences at western, eastern, and northern extremities of the Indonesian archipelago indicate occupation of intervening islands, particularly larger ones like Sumba, Flores, Timor, Halmahera, and Ceram.



Figures 1-4. Female glomeridesmid/idan from Palau. **1)** Dorsal view. **2)** Sublateral view. **3)** Caudal end, lateral view. **4)** Drawing of the epiproct and 19th and 20th terga, dorsal view.

Oceania

Palau: Babeldaob, abandoned road near quarry (7° 31' 29.2" N, 134° 36' 21.7" E), 25 m, F, 24 September 2010, R. Clouse, P. Sharma (AMNH). **New Country and Island Record for the Order, Family, and Genus.**

Anatomical features. Color (Fig. 1-3): Epicranium, frons, and genae white, interantennal region light brownish rust color. Tergites mottled gray of varying shades, darker and less mottled middorsally, with darker, irregularly subrounded splotches laterad on segments 5-19 at positions of ozopores and possibly indicating same; penultimate tergite whitish distad, light mottled gray proximad. Pleura, legs, and paraprocts white.

Length 3.4 mm, maximum width 1.1 mm; 21 segments including collum and epiproct. Head glabrous, only labral setae detectable at 100×. Antennae broken off at 1st article and missing. Organ of Tömösváry a comparatively large pit located sublaterad to antennal bases. Ocelli absent.

Tergites glabrous, entirely devoid of setae, glossy and polished; caudal margins closely appressed to succeeding terga, difficult to discern. Pleurae relatively long, those of segment 20 giving rise ventrolaterad to two minute, apically rounded cerci extending caudad. Sterna narrow, opposing coxae essentially contiguous. Legs not extending beyond pleural/tergal junctures. Epiproct apically broad, translucent

and virtually indetectable (Fig. 3-4); other caudal details not detectable. Ovipositors extending caudad to 7th legs (caudal pair on segment 6).

Remarks. One can reasonably anticipate occurrence beyond Babeldaob and throughout the Palauan Archipelago.

Fiji: *Viti Levu*, Nausori Highlands, 600 m, F, 13 July 1987, G.B. Monteith (QMBA); and road E of Monasavu Dam (17° 43' S, 178° 03' E), sieved rainforest litter, M, 26 July 1987, G.B. Monteith (QMBA).

Anatomical features. Color. Epicranium and interantennal region light rusty brown, frons and genae white. Terga mottled brownish gray, darkest mediad with light, cream-colored, longitudinal stripes laterad and then dark again along margins except for light subcircular spots at positions of ozopores and possibly indicating same. Color fading on penultimate tergite, epiproct clear and translucent. Pleurae white to cream colored; basal podomeres of first 4-6 leg pairs light mottled gray.

Length of male 5.5 mm, female 6.2 mm, maximum widths 1.3-1.4 mm, 21 segments including collum and epiproct. Epicranial and interantennal setae 1-1, frons moderately setose with minute and 1-1 longer setae. Antennae with 7 lightly hirsute articles becoming progressively more so distad, 3-6 clavate, 7 short and with four sensory cones roughly 1/3 as long as article.

Terga glossy and polished, caudalmost with a few lateral, filiform setae. Pleurae relatively long, those of segment 20 giving rise ventrolaterad to two minute, apically rounded cerci extending caudad. Legs not extending beyond pleural/tergal junctures, narrowly segregated by slender sternum, with 6 lightly setose podomeres, claws bent strongly ventrad basally. Ovipositors not extruded in female from Nausori Highlands.

Remarks. The identical, laterally-striped color patterns suggest that these individuals, from different sites on Viti Levu, are conspecific with each other and with that from Nandarivatu, and not conspecific with the Palauan individual, which is not striped. Though larger than the female from Palau, they are still small organisms, and the apparent male telopods are truly minute. The only meaningful glomeridesmid telopod drawings are by Carl (1942), of *G. indus*, and Shear (1973), of *G. sbordonii* Shear from Tabasco, Mexico, and there are no subsequent glomeridesmid telopod drawings at all. Scanning Electron Microscopy seems the most feasible way to study such appendages, as it affords the least damage, both to them and to the specimen as a whole.

All three Fijian specimens are from the main island, Viti Levu; occurrence can be reasonably anticipated on at least Vanua Levu, the other large island, if not also small islets.

Vanuatu: *Espiritu Santo I.,* Boutmas, Fapon Cave, by hand and litter berlesate, J. Lips, L. Deharveng, A. Bedos (MNHN-17), "Gouffre de Mba," cave berlesate, J. Lips (MNHN-3), and forest soil berlesate, L. Deharveng, A. Bedos (MNHN-5); Funafus, Riorua Forest, litter berlesate, L. Deharveng, A. Bedos (MNHN-10); Nambel, Amarur Grotto, litter berlesate, C. Rahmadi (MNHN-11); Penaoru, 1,200 m, litter berlesate, C. Villemant (MNHN-1); and Rotal, "Gouffre de Rotal," litter berlesate, C. Rahmadi (MNHN-8). **New Country and Island Records for the Order, Family, and Genus.**

Malo I., Avorani, forest litter berlesate, L. Deharveng, A. Bedos (MNHN-20). **New Island Record for the Order, Family, and Genus.**

Papua New Guinea: *Island of New Guinea*, *Morobe Dist.*, Nami Creek near Wau, 1,600 m, roots of fern, F, 13 October 1966, G.A. Samuelson (BPBM); Lake Trist, under bark, 1,600 m, F, juv., 21-26 November 1966, G.A. Samuelson (BPBM); and Gorokor, Mumeng (berlesate), 650 m, 2F, 16 August 1978, E.W. Littler (BPBM). *Western Prov.,* Finim tel, Selminum doline, 2,300 m, litter, juv., 2 October 1975, P. Beron, P. Chapman (SOFM). **New Country and Island Records for the Order, Family, and Genus.**

Bismarck Archipelago, New Britain, East New Britain, vicinity of Juvare, ?Cave Luminas II, F, 19 November 1975, P. Beron (SOFM). **New Island and Archipelago Record for the Order, Family, and Genus.**

Remarks. Coupled with the unsubstantiated record from New Ireland, these records imply occurrence in at least the larger islands of the Bismarck Archipelago, particularly Bougainville.

Figure 5. Known (isolated symbols and solid lines) and projected (dotted line) global distributions of Limacomorpha/Glomeridesmida/idea/inae. New records of *G. sumatranus* and *G. javanicus* lie within the outlined area around Sumatra and Java; other new records are denoted by triangles, those in Borneo and Vanuatu, and the eastern two in New Guinea, representing two or more closely proximate localities. The left question mark signifies potential occurrence in Madagascar; the right one denotes the general, unsubstantiated record from New Ireland (Hoffman 1980, Jeekel 2003).

Biogeographic Notes

With addition of the new records, the "eastern" and global distributions of Limacomorpha/Glomeridesmida/idae portray substantially different pictures from those known to Shelley and Golovatch (2011). Coupled with published localities from northern Vietnam and Singapore, documentations from Cambodia and Thailand imply occurrences throughout the Indochina and Malay peninsulas and suggest occupations of eastern Myanmar and southern China (Yunnan Province and perhaps Hainan Island); corroboration from Fiji shows that the taxa truly do occur there, at least on Viti Levu. This country/archipelago is also considerably less isolated with documentations from Vanuatu, New Britain, both halves of New Guinea, and Sulawesi. Coupled with those from the Island of Borneo, records from Babeldaob (Palau) and Luzon indicate occurrence throughout the Philippine archipelago. Overall, Glomeridesmida are now known from 21 areas rather than seven, and while the Neotropical region is still largest, enough "eastern" records now exist to project subcontinuous occurrence from northwestern Thailand to Palau and Fiji, an irregularly oblong, tropical area ~12,480 km (7,800 mi) long that traverses the Equator, is oriented in a northwest/southeastward direction, and narrows toward the latter extremity (Fig. 5, area encircled by dots). In addition to eastern Myanmar and southern China, occurrences can also be projected for Laos, Brunei, Bougainville (Bismarck Archipelago), and all of Malaysia (both western/peninsular and eastern), Indonesia, and the Solomon and Santa Cruz islands. Consequently, two sizeable limacomorph/glomeridesmidan areas probably exist in addition to the small one in India and the Bolivian point locality – that in the Neotropics and the projected "eastern" area that encompasses southeast Asia, the East Indies, and western Oceania. Taiwan may lie outside the "eastern" area, and while occurrences in the Solomon and Santa Cruz islands are plausible, I doubt that Limacomorpha/Glomeridesmida inhabit New Caledonia and the Loyalty Islands, only 100 km (62 mi) to the west, because none are present in the hundreds of vials of small-bodied New Caledonian millipeds in the QMBA, which were extracted from berlesates and sieved litter. If the taxa are present in New Caledonia, I would expect at least one individual in this many samples, but I scanned all the vials without seeing a single specimen. Consequently, I exclude New Caledonia and the Loyalty Islands from the projected area in Fig. 5.

Australia and New Guinea occupy the same tectonic plate; according to http://www.scotese.com/earth.htm they have joined and separated repeatedly, the latest dissociation occurring ~10,000 years ago in the post-Pleistocene, when the Arafura Sea formed between them from the melting of continental glaciers. Despite the prior unions, significant faunal differences exist; the monofamilial orders Glomeridesmida and Stemmiulida, inhabiting New Guinea, have never been encountered in Australia, whereas the reverse is true for Sphaerotheriida and Epinannolenidea (order Spirostreptida) (Shelley and Golovatch 2011). Likewise in Polydesmida, the only native Australian families are Haplodesmidae (suborder Polydesmidea), Dalodesmidae (Dalodesmidea), and Paradoxosomatidae (Strongylosomatidea) (http://www.polydesmida.info/millipedesofaustralia/polydesm/polydesm.html); Platyrhacidae (Leptodesmidea)

and Pyrgodesmidae (Polydesmidea), indigenous to the Island of New Guinea (Silvestri 1920; Hoffman 1980, 1997a, b, 1998, 2001, 2006; Golovatch et al. 2008), are unknown from Australia. It seems plausible that Glomeridesmida and these other New Guinean taxa inhabit northern Queensland, particularly the Cape York peninsula, which appear to have received little sampling.

Aside from secondary northward dispersal in the Western Hemisphere, Glomeridesmida is entirely Gondwanan, but the presence of a Carboniferous (~350 million year old [my]), Scottish, "glomeridesmidan-like" fossil, indicates that Limacomorpha arose **before** the Early Ordovician (~480 million years ago [ma]) rifting of the Avalonia terrane from "Gondwana I" (deriving from breakup of the supercontinent Pannotia in the Early Cambrian, ~540 ma). Avalonia subsequently drifted northward and merged with Baltica and then Laurentia, thereby ferrying ancestral limacomorphs into future Laurasia. Shelley and Golovatch (2011) therefore postulated Late Cambrian (~500 ma) origin of the superorder, but Glomeridesmida itself had to arise on "Gondwana I" **after** this rifting and **before** the "proto-southeast Asia" terranes split in the Early Devonian, ~400 ma. The authors thus postulated mid-Ordovician ordinal origin, ~460 ma but misprinted as ~480 ma in Shelley and Golovatch (2011:70), in the area of the latter terranes, and Glomeridesmidae/inae/Termitodesminae necessarily arose at the same place and time unless extinct subfamilies existed. The new records do not affect these conclusions, but others must be modified. While Siphoniulida is apparently nearing extinction with Siphonocryptida second (Shelley and Golovatch 2011), Glomeridesmida clearly is not third in this category or anywhere near this status; aside from these two taxa, no extant diplopod order faces relatively "imminent" extinction. As Glomeridesmida/idae/inae are known from, or can be reasonably projected for, the aforementioned countries, regions, and islands in Asia, the East Indies, and Oceania, they may be as abundant in the projected "eastern" range as in the Neotropics. Assuming eventual connection of the Bolivian and large Neotropical regions, Glomeridesmida probably inhabits only three regions of the world, the Neotropical, the Indian, and the "eastern"; conceivably, the last two areas also connect, though present records do not suggest such. Glomeridesmida is far from the third most fragmented chilognath order and appears to be more continuous, widespread, and abundant in the "east" than its Gondwanan pentazonian counterpart, Sphaerotheriida (superorder Oniscomorpha), whose distribution is considerably more fragmented (Jeekel 1974, Wesener and Vandenspiegel 2009, Wesener et al. 2010, Shelley and Golovatch 2011).

Beyond lack of sampling, the paucity of published "eastern" glomeridesmid/idan records seems attributable to their minuteness, and at 3.4 mm long, the Palau female is the smallest adult that I have seen. Most new individuals, apparently adults, are <6.5 mm long, and collectors searching (sub)surface environments would have difficulty seeing such minute millipeds in a rainforest with diminished light when the organisms as well as the soil are darkly colored (Fig. 1-3). They were recovered primarily from berlesates and sieved litter, which seem better methods of obtaining "eastern" representatives than hand sampling. In the Neotropics, by contrast, epigean glomeridesmidans are larger and more readily visible; the individuals I found in Colombia and Peru (Shelley and Golovatch 2011) were exposed simply by raking litter. As most Indonesian/East Asian/Oceanian diplopods have been taken by hand sampling, it is not surprising that glomeridesmids/idans were infrequently encountered.

While small in comparison to the known Neotropical and projected "eastern" areas, the Indian region contains both subfamilies, with more termitodesmines being named and described than glomeridesmines. Since it was joined to India as an independent island for ~20 my in the mid-Cretaceous, from ~120-100 ma, one can reasonably anticipate both subfamilies in Madagascar, if sufficient habitat remains on this environmentally disrupted island. Sphaerotheriida, the other Gondwanan pentazonian, occupies both areas (Jeekel 1974, Wesener and Vandenspiegel 2009, Wesener et al. 2010, Shelley and Golovatch 2011), and logically, the same should hold for Glomeridesmida. Again, sieving litter and Berlese sampling seem the most likely methods of discovering them.

Conclusion

Glomeridesmida hold the dubious distinction of being the most neglected order in a relatively neglected zoological class. In the past 15 years, the other 15 orders, including even Siphoniulida and Siphonocryptida, have received at least one definitive, generic- or higher-level, taxonomic/systematic treatment; glomeridesmidans, however, have been ignored. Thirty-six years have elapsed since the last new species description, *G. albiceps* Loomis, 1975, from Jamaica, which lacked telopod drawings, and

the only publication exclusively on the order since then is Jeekel's (2003) catalogue, which listed 26 nominal species in *Glomeridesmus* and five in *Termitodesmus*. Hoffman (1980) labeled Glomeridesmida as "the second smallest ordinal group of Diplopoda," and Jeekel (1971, 2003) characterized it as both a "small order" and a "minor but distinctive group of diplopods." These descriptors are rendered obsolete by the enormity of the emerging "eastern" range area. Jeekel (2003) also noted that the "Indo-Australian area is hopelessly undercollected with regard to these small animals," that "mechanical collecting techniques may yield many new and unexpected discoveries," and that "serious study of the morphology of Glomeridesmida will reveal the existence of several distinct genera." The new records lend credence to these statements, particularly the under-investigated nature of the "eastern" region and the fact that techniques like Berlese sampling and sieving litter enhance our ability to find such minute diplopods; additionally, it is virtually inconceivable that *Glomeridesmus* is the only component of Glomeridesminae. Detailed systematic studies are sorely needed in Glomeridesmida as the picture is emerging of a diverse, speciose order, and a logical first step might be formally elevating Termitodesminae to full family status. Having now seen a specimen of these bizarre pentazonians, I fully concur with prior recommendations (Hoffman et al. 1996, 2002; Shelley 2003) and wonder if even higher hierarchical status may be warranted. To my eye, the oniscomorph pentazonians that comprise two distinct orders, Glomerida and Sphaerotheriida, have much more in common and resemble each other to a much greater degree than do the two limacomorph subfamilies, but informed decisions can only result from detailed systematic studies. Suffice it to say that the emergence of a potentially massive glomeridesmidan fauna in an enormous area encompassing southeastern Asia, the East Indies, and western Oceania emphasizes the need for taxonomic research on the lone extant component of Limacomorpha.

Acknowledgments

I thank R. Clouse, for shipping the AMNH sample; S. Swift, for access to the BPBM holdings; O. Seeman, for access to and loaning QMBA samples; L. Deharveng, for providing records from the MNHN; and P. Stoev, for checking samples in the SOFM. Sergei Golovatch obtained the Sa Kaeo, Thailand, record and provided pre-submission reviews of the manuscript. Dr. Clouse and P. Sharma's expedition to Micronesia was funded by a Putnam Expedition Grant from the Museum of Comparative Zoology, Harvard University, and A. Olsen assisted in the field; the Palau specimen was gifted to the AMNH by the Belau National Museum. Additional pre-submission reviews were provided by W.A. Shear and R.L. Hoffman; Fig. 1-3 were taken by A.E. Bogan, and J. Raine assisted with preparing the map.

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Received May 25, 2011; Accepted July 5, 2011
Subject edited by G. B. Edwards.