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Microlympiidae, a new milliped family from North America, and *Microlympia echina,* new genus and species (Diplopoda: Chordeumatida: Brannerioidea)

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Abstract

A new genus and species of milliped, *Microlympia echina*, is described from Jefferson County, Washington, USA. The new species cannot be placed in any existing milliped family, due to a unique combination of characters and at least two significant autapomorphies. The new Family Microlympiidae is therefore established, placed in the Superfamily Brannerioidea, and compared with the related families Tingupidae, Niponiosomatidae, and Branneriidae.

Key words: Diplopoda, milliped, Chordeumatida, Brannerioidea, Microlympiidae, *Microlympia echina*, taxonomy, Washington (state)

Introduction

At least at the family level, the milliped fauna of the United States was thought to be well-known. The last North American milliped families to be named were Tingupidae and Apterouridae, established by H. F. Loomis in 1966. The genus *Tingupa*, upon which Loomis based his new family, had been described by Chamberlin in 1910 as a "craspedosomatid," a catch-all category for chordeumatid millipeds used at the beginning of the twentieth century, and Apterouridae was based on a new genus and species.

Work subsequent to 1966 has revealed many new North American milliped genera, and nearly all named genera have now been examined and placed in previously-known families. However, we are from time to time forcefully reminded that large parts of the North American continent remain *terra incognita* with respect to the soil and litter fauna. Even casual collecting in these regions, which must include nearly the entire Pacific coast from The Mexico/USA border north to Alaska, turns up many new species, frequent new genera, and now a new family.

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The junior author (WL), a specialist in terrestrial mollusks, has made numerous collections of millipeds and other litter-dwelling arthropods incidental to his search for slugs and snails. He has made some remarkable discoveries, including new species and genera in several milliped families that will significantly expand the faunal list for the state of Washington and North America in general. Many of these new taxa are in the Family Conotylidae, a chordeumatidan family characterized in part by rather long, acute segmental setae. The conotylids are winter-active and most of the species collected by WL were taken as adults in December, January, and February. Late in February and into March, juvenile conotylids appear in the collections, and adults become rare. When one of WL's collections included small, white millipeds with long segmental setae, the senior author (WS) assumed at first look that he was seeing juvenile conotylids. However, closer examination showed that the animals were in fact sexually mature despite their small size (3–4 mm long) and differed in several respects from the juvenile conotylids occurring with them—especially in the longer, curved segmental setae that created a bristly impression. Dissection of males showed that the gonopod complex (gonopods and ninth and tenth legpairs) was brannerioid in plan, but distinct from anything previously seen. Point-by-point comparison with three candidate brannerioid families (Branneriidae, Tingupidae, and Niponiosomatidae) underlined the uniqueness of the new species.

Figure 1 is a photomicrograph taken with the Microptics configuration of an Infinity long-distance microscope and Nikon D1-x digital camera. All drawings were made with a *camera lucida* at 200X and 400X, using material mounted in glycerine on microscope slides, under Nomarski differential interference contrast on an Olympus BX50 compound microscope.

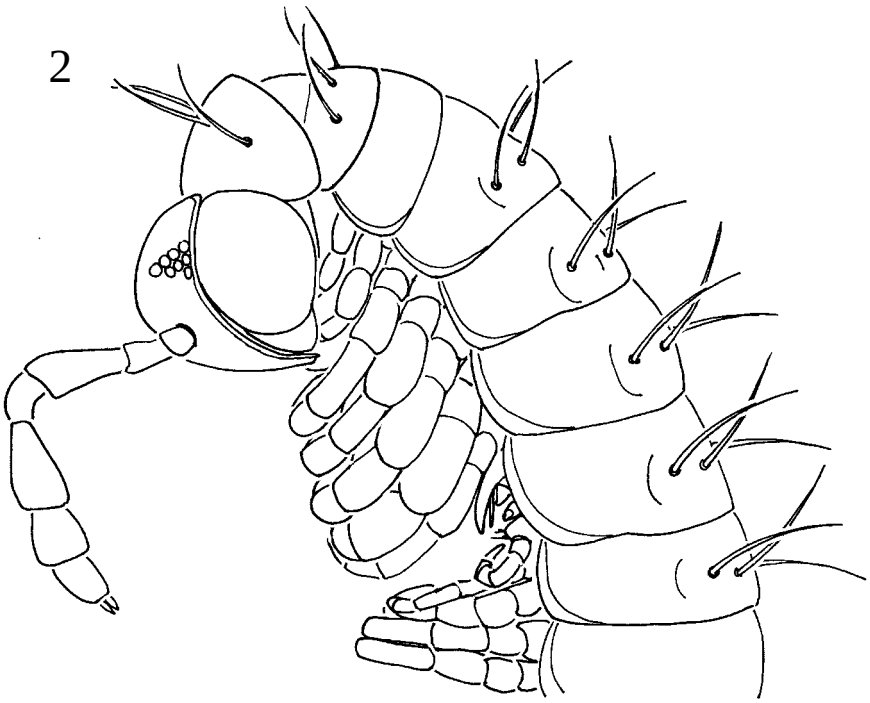
Taxonomy

Specimens are deposited in the Field Museum of Natural History, Chicago, IL, USA (FMNH), The American Museum of Natural History, New York, NY (AMNH), and the California Academy of Sciences (CAS).

Order Chordeumatida Koch 1847
Superfamily Brannerioidea Cook 1896
Family Microlympiidae, new

Type genus: *Microlympia* new genus, described below. Monobasic.

Diagnosis: Distinct from any other known chordeumatidan family in the ninth legs of the males, which consist of single, U-shaped articles, and the coxae of the tenth legs of males, with a unique anterior fringe on the coxal gland openings.



FIGURES 1-2. *Microlympia echina*, n. sp., male. 1, photomicrograph, lateral view of anterior end. 2, line drawing based on Fig. 1, to emphasize features such as reduced telopodites of legpair 11. Scale line = 0.35 mm (350 µ).

Description: Head and 28 trunk segments (including epiproct). Mentum not divided. Head rounded, broader than collum. Antennae short, clavate. Ocelli present in single or irregular double rows. Postcollum segments with smooth metaterga bearing 6 long, curved, smooth, acute setae. Outermost setae on pronounced swellings. Pregonopodal legs of males enlarged, with modified femora. Gonopods with two pairs of angiocoxal processes, the posterior as curved rods. Colpocoxites simple, poorly sclerotized sacs. Ninth legs of males strongly reduced to single, U-shaped articles; inner limb of each U with distinct gland channels connecting to bilaterally paired glands dorsal to sternum. Tenth legs of males with reduced telopodites arising from large coxosternum; anterior margins of coxosternal gland openings with 8-10 fimbriae, posterior margins with broad plates. Eleventh legs of males with slightly enlarged coxae and coxal glands, bearing small anterior-distal processes. Cyphopods of females with fused valves, large receptacle; coxae of second legpair with posterior projections.

Genus Microlympia, new genus

Type species: *Microlympia echina*, new species, by monotypy and present designation.

Etymology: The name *Microlympia* is a Latin neologism compounded from *micro-*, small, and *-olympia*, for the Olympic Mountains.

Diagnosis and description: As for the family, see above.

Microlympia echina, new species
Figs. 1-16

Types: Male holotype (FMNH), 16 additional male and 16 female paratypes (AMNH, CAS) from leaf litter in a red alder riparian forest on Alder Creek, 1.5 miles north of Hoh River, Jefferson Co, Washington, USA (47°49’43”N, 124°13’30”W), collected 28 March 2003 by W. Leonard; 3 male and 3 female paratypes collected at the same site, 1 March 2003.

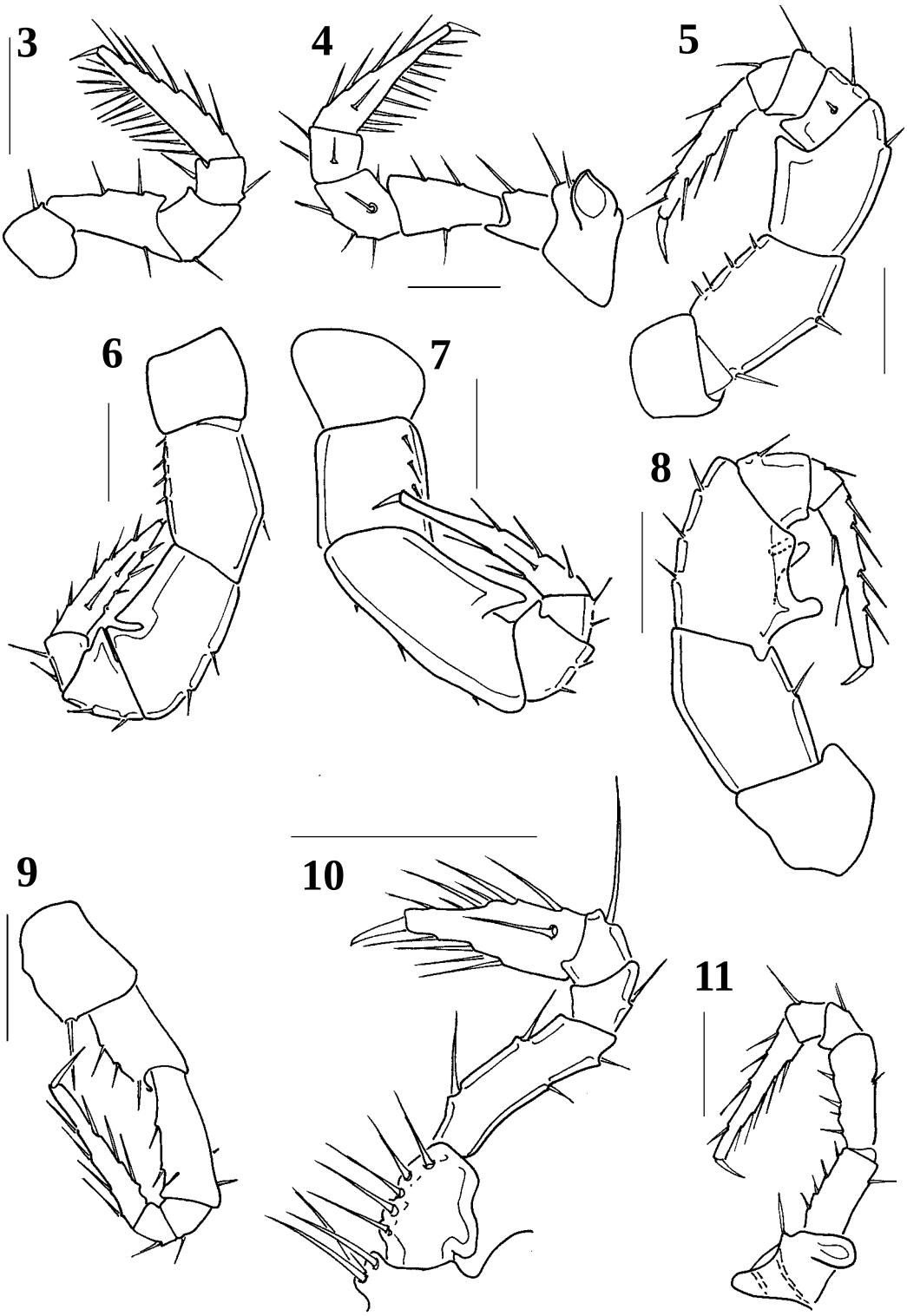
Etymology: Latin adjective, *echina* = spiny, referring to appearance of segmental setae.

Description: Male (Figs. 1, 2): Twenty-eight segments, two diplosegments anterior to epiproct legless. Length, 3.8 mm, width 0.35 mm. Third antennomere 5 times as long as wide, fifth antennomere 2 times as long as wide, length of sixth antennomere equal to width, sixth and seventh antennomeres subequal in length. Ocelli 8, in two rows of 4 and 3, plus single ocellus, well-formed, pigmented. Trunk segments with metaterga smooth, shining, segmental setae smooth, curving, about 1/2 width of terga, outer two setae on each side on tubercles, outermost seta on each side directed laterally, inner two setae

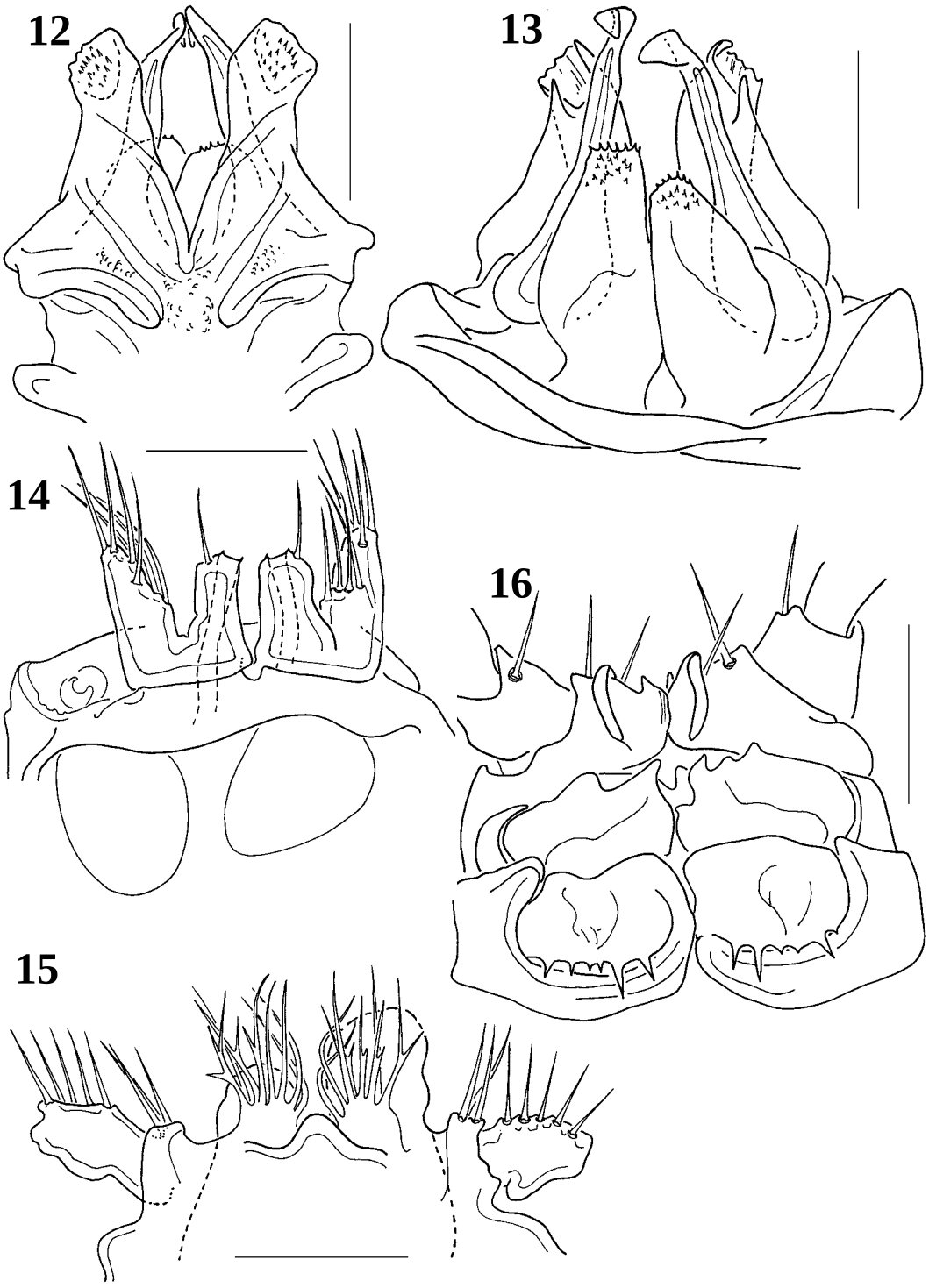
directed medially, arching over metaterga. Legpairs 1 (Fig. 3) and 2 (Fig. 4) with tarsal combs; coxae 2 with vas deferens opening through coxa on short tube. Legpair 3 encrassate, femur with short mediodistal projection (Fig. 5). Legpairs 4 (Fig. 6) and 5 (Fig. 7) similar, but with stronger femoral projection. Legpair 6 (Fig. 8) larger than preceeding legpairs, femur with additional basal process. Legpair 7 of normal size (Fig. 9). Gonopods in anterior view (Fig. 12) with broad sternum partially fused to coxae, anterior surface of coxae slightly roughened. Anterior angiocoxites (*acx*, Fig. 12, 13) broad at base, curving posteriorly, tips with small tooth-like fimbriae; posterior angiocoxites (*pcx*, Fig. 12, 13) sinuous, curving posteriorly. In posterior view (Fig. 13), anterior angiocoxites with concave tips, acute tooth subterminal; posterior angiocoxites with expanded tips; colpocoxites poorly sclerotized, irregular, sac-like, with many tiny, acute scale-like teeth. Ninth legpair (Fig. 14) with broad, well-developed sternum carrying spiracles, legs reduced to single, U-shaped article. Inner arm of U with terminal gland pore, seta; outer arm with subterminal and terminal groups of 4-5 setae. Large, globular glands dorsal to sternum. Tenth legpair (Fig. 15) with coxosternum bearing gland pores; anterior margins of gland pores with 8-10, fine, acute, branching fimbriae, posterior margins raised as broad, thin cuticular plates. Telopodite articles (Fig. 10) reduced to less than 1/2 length of normal legs. Eleventh legpair with somewhat reduced telopodites (Fig. 11), coxae with gland openings, anteriodistal projection. Coloration white, with faint dusting of purple-brown pigment around ocelli.

Female: Length, 4.0 mm, width, 0.38 mm. Nonsexual characters as described for male, but with 5 ocelli in row of 4, plus single ocellus. Cyphopods (Fig. 16) with fused valves (*v*, Fig. 16) and large receptacle (*r*, Fig. 16) distally toothed; teeth possibly interlock with thin, vertical processes on second leg coxae (*c*, Fig. 16).

Natural History Observations: All millipeds were hand collected while using an OptiVisor© 3x magnifying visor to visually search leaf litter and woody debris along an approximately 100-m long section of the valley bottom of Alder Creek, a tributary of the Hoh River. The site, which has a maritime climate with very high rainfall and relatively moderate temperatures, is located approximately 21 km inland from the Pacific coastline and lies within the coastal Sitka spruce zone (Franklin & Dyrness 1973, Henderson et al., 1989)—commonly referred to as temperate rainforest. The valley floor of Alder Creek is vegetated by a red alder (*Alnus rubra*)/sword fern (*Polystichum munitum*) community; approximately 20 m from the stream channel, the vegetation transitions to second-growth western hemlock (*Tsuga heterophylla*) forest. While millipeds were present in litter throughout the forest, they were noticeably most abundant beneath sword fern clumps and in mats of alder leaves abutting large logs. Both the dense thatch beneath sword ferns and large logs provide moist retreats that can buffer the effects of seasonal drying and changing temperatures, and apparently are important microhabitats for litter invertebrates in Pacific Northwest forests.



FIGURES 3-11. Right legs of *Microlympia echina*, n. sp., posterior views. 3, leg 1. 4, leg 2. 5, leg 3. 6, leg 4. 7, leg 5. 8, leg 6. 9, leg 7. 10, leg 10. 11, leg 11. All scale lines = 0.1 mm (100þµ)



FIGURES 12-16. *Microlympia echina*, n. sp. 12, gonopods, anterior view. 13, gonopods, posterior view. 14, male ninth legpair, anterior view. 15, male tenth coxosternum, anterior view. 16, cyphopods, ventral view. All scale lines = 0.1 mm (100 µ).

It is surprising *M. echina* has not been found in WL's collections from other survey sites in western Washington. *M. echina* appeared to be common at the Alder Creek site, and similar riparian forest habitat is widespread across much of lowland western Washington. Moreover, a comparable maritime climate extends along the entire Pacific Northwest coast. While it appears that *M. echina* may have a narrow distribution, we anticipate locating additional populations on the western Olympic Peninsula and, possibly, southern Vancouver Island, British Columbia, which harbors several regionally endemic invertebrate species (Ovaska et al., 2003; Gardner & Shelley, 1989; Shelley 1994) and genera (e.g., McKey-Fender et al., 1994) that also occur on the Olympic Peninsula.

Discussion: Monotypic genera and monobasic families are justified under a variety of circumstances (see Hormiga, 1994, for more detailed argumentation). Primary among these is the argument that the species or genera so designated represent isolated sister-groups of their closest relatives; this is possible where well-corroborated phylogenetic hypotheses are available—hardly the case in chordeumatid millipeds. Monotypy may be used to emphasize significant phenetic distance between the taxon in question and its nearest relatives, which distance may be narrowed by subsequent discoveries, resulting in the synonymy of the monotypic taxa (for examples, see Shear, 1972, 1990), or they may reflect the confidence of their describers that they will, with future work, "fill up" with additional species and genera. This may take a while. Loomis named the family Apterouridae in 1966; a second species in the family has only just been discovered (Shear, in press) and curiously, nearly simultaneously, the same thing has happened for the Brannerioidae (Shear, 2003) monotypic since 1896. In any case, it can be argued that monotypic higher taxa are at least temoporarily useful, though they contain phenetic, not phylogenetic, information. The family Microlympiidae is described here because while an obvious brannerioid, the new species cannot be placed in any of the named families. The current state of our knowledge of the brannerioid millipeds is manifestly incomplete, as new taxa are continually being discovered and described. The brannerioids are all very small millipeds, most of the species less than 5 mm in length, are inhabitants of the poorly collected forest leaf-litter habitat, and probably are for the most part winter-active. These factors have ensured that the growth of our understanding of the superfamily has been slow, and will probably continue to be so. Under the circumstances, the discovery of a new form that differs very significantly from those already known is best recognized by establishing a higher monotypic/monobasic taxon, which becomes a "red flag" encouraging systematists to look for additional, related species.

The form of the ninth and tenth legs in *Microlympia echina* is unique, providing two sound autapmorphies for the family. The pregonopodal leg modifications are not found elsewhere in Brannerioidea.

Comparisons with possible candidate families further emphasize the distant position of *Microlympia echina.* The family Tingupidae Loomis 1966 was originally monobasic but now contains three genera (*Tingupa* Chamberlin 1910 [ten species], *Buotus* Chamber-

lin 1940 [monotypic], and *Blancosoma* Shear and Hubbard 1998 [monotypic]). The gonopods of *Tingupa* were thoroughly studied by WS (Shear, 1981) and follow the typical brannerioid plan, with two-part angiocoxites and a lobe-like or sac-like colpocoxite. The three-branched posterior angiocoxite is remarkably uniform in the genus, while the anterior angiocoxite is divided on each side into median and lateral plates. The ninth legs retain 2 or 3 telopodite articles and the tenth legs are unmodified. Species of *Tingupa* are heavily sclerotized, have prominent metatergal paranota and a metatergal sculpture of short, thin, acute ridges (Shear, 1981, Figs. 1, 2). The segmental setae are short and spatulate. The unique ninth legpair and modified tenth legpair of *M. echina,* the lack of paranota and segmental sculpture, weak sclerotization and long, acute segmental setae all point to considerable differences from tingupids. The monobasic Japanese family Niponiosomatidae Verhoeff 1941 (Shear, 1988) is worth considering also, because of its close relationship to the Tingupidae and the many biogeographical connections between Japan and northwestern North America. The same arguments regarding the gonopod complex of tingupids vs. *Microlympia* can be made for this family. The Branneriidae Cook 1896 (Shear, 1972, 2003) consists of two species of *Branneria* from southeastern North America; the gonopods differ strongly from those of the tingupids, niponiosomatids and *Microlympia* in the presence of a pseudoflagellar branch. However, both the ninth and tenth legpairs are strongly reduced, the tenth much more so than in *Microlympia,* and the glands of the eleventh coxae may be vestigial. In addition, several taxa of small, obscure European chordeumatidans have been placed in Brannerioidea (Shear, 2000). The families Trachygonidae Cook 1896, Heterolatzeliidae Verhoeff 1897, and Chaemosomatidae Verhoeff 1913 remain poorly studied, and each contains one or a few species. Closer looks at these taxa may result in future synonymies in the Brannerioidea.

Some features of *Microlympia echina* deserve further comment. A trend toward reduction of segment number from the ground plan of 32 (Shear, 2000) often accompanies small size in chordeumatidan millipeds. The present minimum known number is 26 segments, found in both sexes of, for example, *Branneria carinata* (Bollman); many species have males with 28 segments and females with 30, while others have 28 segments in both sexes, as does *M. echina.* The legless condition of the two segments anterior to the epiproct in the present species suggests the possible future disappearance of those two segments altogether, giving 26-segmented males and females.

The absence in this species of the expected promentum, thought to be present in all members of the Suborder Craspedosomatidea (Shear, 2000) may be due to small size, but a discernable promentum is present in some tingupids of similar stature. It may be necessary in the future to re-evaluate the importance of this character.

Having evidently functional coxal glands on the ninth legpair is a plesiomorphic character. In more apomorphic forms, the glands are either vestigial (as in many trichopetalids), completely absent, or permanently extruded and sclerotized as colpocoxites (characteristic of the superfamily Heterochordeumatidea; Shear, 2000). In *M. echina,* this

plesiomorphic character is correlated with the highly apomorphic strong reduction of the legs themselves. The homologies of the remains of the reduced legs are phylogenetically important, but hard to establish in this species. One hypothesis is based on the presence of two groups of setae on the single articles--the basal group may represent the distal limits of the coxa, while the apical group may mark an extremely reduced telopodite. In other brannerioids, telopodite reduction takes place as a result of the loss of podomeres, not podomere fusion, so the telopodite remnant is likely to be the last vestige of the prefemur, fused to the reduced coxa. However, the question can only be answered by the examination of antepenultimate and penultimate males, none of which were collected.

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