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Two New Species in the Milliped Genus *Taiyutla* from British Columbia, Canada, and Washington, USA (Diplopoda, Chordeumatida, Conotylidae)

By William A. Shear

ABSTRACT

Taiyutla shawi and *T. lupus*, n. spp., are described from caves on Vancouver Island, British Columbia, Canada, and the former recorded from surface localities in Washington state, USA. Certain features of the two new species seem to blur distinctions between *Taiyutla* Chamberlin 1952, and *Conotyla* Cook and Collins 1895.

The milliped family Conotylidae, with species in North America, Japan, and northeastern Asia, is one of the best understood of all chordeumatidan families (Shear 1971, 1976). Conotylids are small to medium-sized chordeumatidans (6-20 mm long) that usually inhabit distinctly boreal biotopes, with their greatest abundance and diversity in montane forests, such as those of the Appalachian Mountains and northwestern Coast Ranges in North America, and the high peaks of Hokkaido in Japan. Due to their limited vagility and requirements for cool, moist habitats, species, particularly in the southern parts of the family's range, tend to occur on mountain-tops, be winter-active, and show restricted distributions. For example, in North America, northerly-occurring species (such as *Conotyla blakei* Verhoeff in the east and *C. albertana* Chamberlin in the west) tend to be widely distributed. Further south, species of *Conotyla* from the southern Appalachians and of *Taiyutla* from Oregon and California are often known only from their type localities, though they may be locally abundant (Shear 1971).

This pattern of speciation and mountain-top isolation is customarily attributed to Pleistocene glacial advances and retreats. During glacial maxima, psychrophilic species are pushed far to the south; when glaciers recede and climate warms, such populations are extinguished unless they find appropriate refugia, such as forests at high elevations. There, small populations and geographic isolation lead to speciation – distinct species on each colonized mountaintop. Caves represent other potential refugia for such animals, and a consistent pattern in certain *Conotyla* species is for populations to be epigeal in the northern parts of their ranges and troglomorphic or even troglomorphic in the south (i.e., *C. blakei* and *C. bollmani* (McNeill); see maps in Shear [1971]). If populations become entirely isolated in caves for a long enough time, distinct cave-limited species may evolve. This is the so-called “Pleistocene Effects” model (Holsinger 1988, Kane et al 1990). It should be noted that while this is a standard model for rapid divergence, particularly in Appalachian cave arthropods, it has recently been questioned by Hedin (1997) on the basis of molecular genetic data from the spider genus *Nesticus*.

The two new species described herein were both collected from caves, but only one of them (*T. lupus*) shows some slight degree of adaptation to the cave environment (reduced pigment, smaller ocelli).

Shelley (2002) reviewed the milliped fauna of Canada and stated: “Canada is the first large country in the world whose diplopod fauna is essentially completely known....(p. 1863)”. However, the maritime regions of the province of British Columbia remain poorly collected, especially for soil and litter-dwelling species. In the USA, recent collecting in northern California, Oregon and Washington is revealing an unexpectedly rich diplopod litter fauna (Shear & Leonard, 2003; Shelley, 2003). The discovery of new *Taiyutyla* species on Vancouver Island is not entirely unexpected. Previously the genus has been recorded from California, Oregon, and Montana, and recent collection has turned up several new species in Idaho. Subsequent to the Vancouver Island find, *Taiyutyla shawi*, n. sp., was also collected at two locations in Washington, USA.

The two new species are interesting in that in some ways they bridge morphological gaps in gonopod anatomy between *Taiyutyla* and *Conotyla*.

ACKNOWLEDGEMENTS

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FAMILY CONOTYLIDAE COOK

Subfamily CONOTYLINAE Cook

Genus *Taiyutyla* Chamberlin 1952

Taiyutyla Chamberlin 1952, p. 1; Shear, 1976, p. 6 (revision).

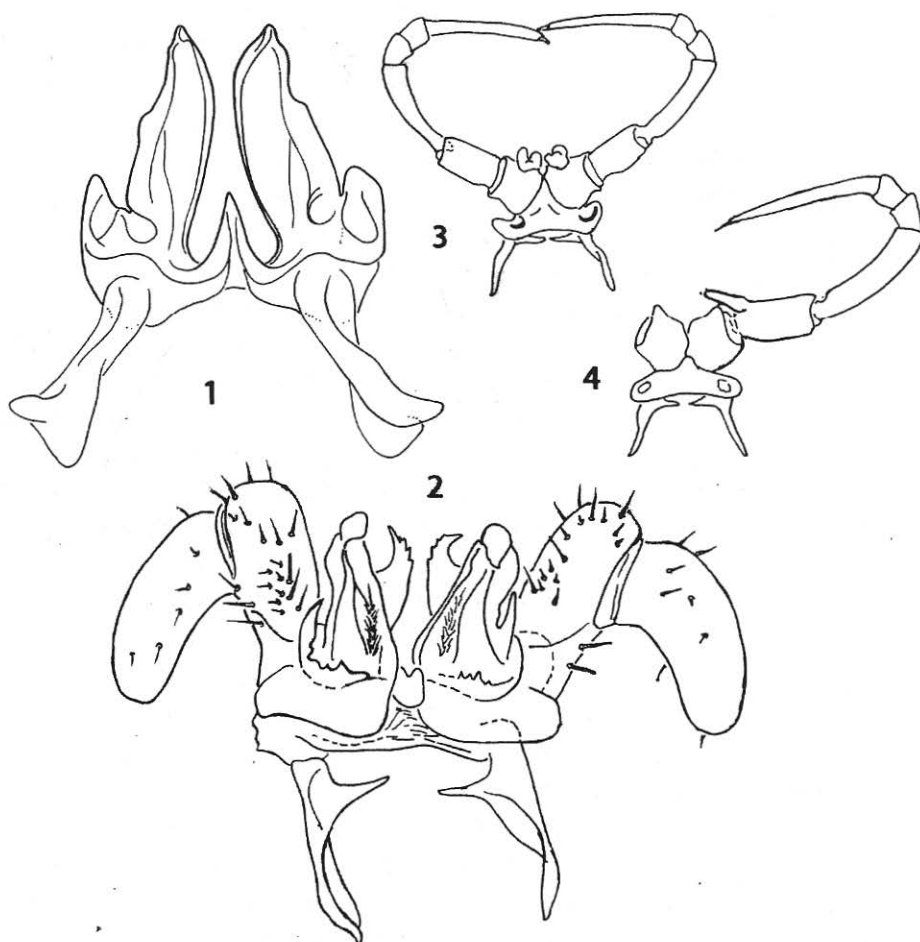
Type species: *Taiyutyla corvallis* Chamberlin 1952, by original designation.

Fourteen species of this genus are presently known, all from western North America; the two new ones are from western Canada. As I hinted in my 1976 treatment, it is difficult to separate *Conotyla*, *Taiyutyla* Chamberlin 1952, and *Plumatyla* Shear 1971 (known from a single species found in a few northern California caves and mines). The three genera show a complex overlapping pattern in their gonopod anatomy, and while it is appealing to keep *Conotyla* and *Taiyutyla* apart on geographical grounds, *Taiyutyla lupus*, n. sp., differs from the typical *Taiyutyla* gonopod pattern. As in *Conotyla* species, a branch of the anterior gonopod passes between the coxite and the prefemur of each posterior gonopod, yet the two-branched form of the anterior gonopod is not found in *Conotyla*, instead being common among *Taiyutyla* species. While the gonopods of *T. shawi* are more similar to those of other *Taiyutyla* species to the south, this species, like *T. lupus*, is somewhat larger than usual for *Taiyutyla* and shares with it the unusually strong paranota on the metazona (Fig. 5). Certainly it would be premature to synonymize the three genera without a more detailed analysis of the entire complex, and the study of new species of *Taiyutyla* may give a better sample of the range of variation in that nominal genus. Such a study is now in progress, based on a substantial number of new *Taiyutula* species sorted from Berlese sample residues from the Field Museum, Chicago, from new collecting efforts in Oregon and Washington, and from unsorted collections in the California Academy of Sciences, San Francisco. In addition, new conotylid species continue to be collected in the Rocky Mountains of North America (Shelley 1997), and a new genus was recently found in Japan (*Yasudatyula* Shear & Tsurusaki 1995). Collecting in late fall or winter will likely reveal new southern Appalachian species of *Conotyla* as well; I have females of an undoubted new species from Mount Pisgah, North Carolina, a new southernmost record for the genus in the east. So, despite the confidence in our knowledge of conotylids expressed earlier, there are still refinements to be made in our understanding of this entire family.

Taiyutyla shawi, new species

Figs. 1-4

Material: Male holotype, juvenile male paratype (VMNH) from Lower Hanging Sump Cave, 16 km southwest of Port McNeil (50.26.N; 126.55W), Vancouver Island, British Columbia, Canada, collected August 1997 by Patrick Shaw. Additional specimens: USA: WASHINGTON: *Grays Harbor Co.*: Along "Moclips" Road, 0.25 miles north of junction with US 101, 11 June 2002, W. Leonard, male (VMNH). *Thurston Co.*: Capitol State Forest, along tributary to Kennedy Creek (47.01.463N, 23.05.013W), 948 m, 15 September 2003, W. Leonard, male (VMNH).



Figs. 1-4. *Taiyutyla shawi*, n. sp., male. 1. Anterior gonopods, posterior view. 2. Posterior gonopods, posterior view. 3. Legpair 10, anterior view. 4. Right leg 11, anterior view.

Holotype: 13 mm long, 2.0 mm wide, antennal article 3 1.01 mm long. Thirty segments. Trunk segments with prominent paranota carrying two lateralmost segmental setae, one on anterior margin, second at posteriorlateral corner of paranotum; paranota conspicuous back to segment 26. Ocelli 22, well-formed, black, contiguous, in ovo-rectangular eyepatch. Color tan, indistinctly mottled darker on head and first few segments. Legs 1 and 2 reduced in size. Legs 3-7 more robust than legs posterior to pair 10, femora of legs 5 and 6 with proximal low knobs, leg 4 has slight swelling in same position. Anterior gonopods (Fig. 1) contiguous with sternum, sternum with triangular projection in midline; coxites simple, erect, not embracing coxites of posterior gonopods. Posterior gonopods (Fig. 2) with femora smaller than usual for genus; coxites complex, with posterior basal cupped region margined by irregular teeth, central ridge lightly fimbriated, apex blunt, subapical mesal branch curved, lightly fimbriated on edges. Legs 10 (Fig. 3) with small coxal glands, Legs 11 (Fig. 4) with prominent, axially directed prefemoral processes.

Notes: The gonopods of *T. shawi* seem to combine features of *Conotyta* and *Taiyutyla* species. The posterior gonopod coxites are complex and resemble those of *C. albertana* in some details, while the erect, simple, anterior gonopods, which do not laterally embrace the posterior gonopod coxites, are *Taiyutula*-like.

Lower Hanging Sump Cave is a short, phreatic cavern with only about 50 m of passage; the lower part floods seasonally, and in extreme rains the entire cave may be flooded. The surrounding vegetation is regenerating Western Hemlock, harvested about fifteen years ago. The elevation of the cave entrance is about 300 m. Two female conotyloid specimens were collected in Dreamtime Cave, about 20 km southwest of Port McNeil, but cannot with assurance be assigned to the present species. This is an extensive fossil cave with 1.2 km of known passages. The millipeds were collected in the entrance zone.

The species name honors Pat Shaw, the collector of the type series.

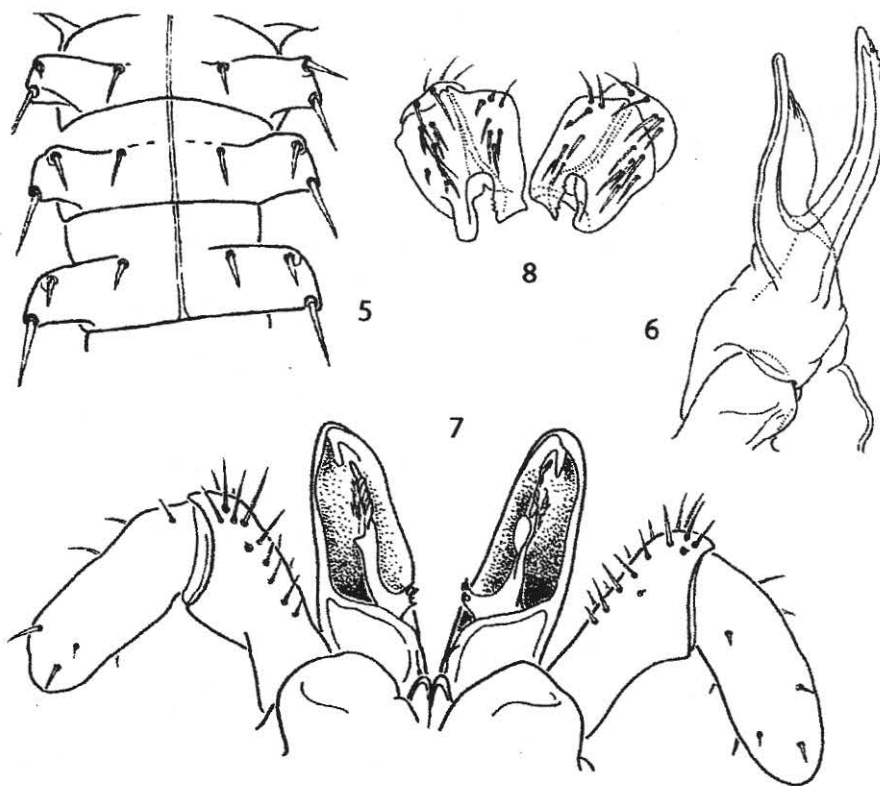
***Taiyutyla lupus*, new species**

Figs. 5-8

Material: Male holotype, 2 female paratypes (VMNH) from Wolf Creek Cave, 25 km southwest of the community of Lake Cowichan (48.46.N, 124.23W), Vancouver Island, British Columbia, Canada, collected 27 September 1997, by Patrick Shaw.

Holotype: Length, 16 mm, width 2.2 mm, antennal segment 3 1.15 mm long. Thirty segments. Trunk segments with prominent paranota as described for *T. shawi* (Fig. 5), but paranota slightly thinner, more polydesmid-like when seen in lateral view. Ocelli 20, depigmented but contiguous, regularly arranged in ovorectangular eyepatch. Color pale, yellowish white. Legs 1 and 2 reduced in size, legs 3-7 much

more robust than postgonopodal legs; legs 5-7 with ventrally enlarged coxae, leg 4 with large basal knob on femur, smaller, more distal knob on leg 5, legs 6 and 7 with large, acute knobs basal on prefemora, that of leg 7 the larger. Anterior gonopods (Fig. 6) two-branched, anterior branch slightly curved, rod-like, erect; posterior branch broadly flattened, extending posteriorly between coxite and prefemur of posterior gonopod. Posterior gonopods (Fig. 7) with simple, plate-like coxites bearing posterior fimbriated ridge, apically with small, hooked process; femora somewhat reduced compared to other *Conotyla* species. Legs 10 with small coxal glands, legs 11 with proximal process on prefemur.



Figs. 5-8. *Taiyutyla lupus*, n. sp. 5. Diplosegments 10, 11 and 12 of male, dorsal view. 6. Left anterior gonopod, posterior view. 7. Posterior gonopods, posterior view. 8. Cyphopods, ventral view.

Female paratype: Similar in most respects to male. Cyphopods as in Fig. 8.

Notes: While quite different from the preceding species, the gonopods of *T. lupus* still show some intermediacy; the two-branched condition of the anterior gonopods is not known in *Conotyla* species, but does appear in *Taiyutyla variata* Shear and *T. francisca* Shear (Shear, 1976). The simple posterior gonopod coxites are similar to those of some eastern North American species of *Conotyla*.

Wolf Creek Cave has about 300 m of known passages. The collection was made in the entrance zone. Vegetation in the area is regenerating western hemlock, harvested in the early 1970s. Elevation at the cave entrance is about 400 m.

The species name is a noun in apposition, Latin for "wolf" and refers to Wolf Creek Cave.

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Address of the author:

Dr. William A. Shear
Department of Biology
Hampden-Sydney College
Hampden-Sydney, Virginia 23943
wshear@email.hsc.edu