Zootaxa 5659 (3): 400–406
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5659.3.5
http://zoobank.org/urn:lsid:zoobank.org:pub:32BCDA59-5EB7-437B-B1D1-07169BC52110

Additions to the family Caseyidae Verhoeff, 1909. V. The new genus *Benlomondia* and two new species (Diplopoda, Chordeumatida, Striariidea, Caseyoidea)

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Abstract

The genus *Benlomondia* Shear & Marek, **gen. nov.**, and two new species, *Benlomondia benlomondensis* Shear & Marek, **sp. nov.**, and *Benlomondia mateo* Shear & Marek, **sp. nov.**, are described from Santa Cruz and San Mateo Counties, California, respectively. The new genus is similar to, but distinct from, *Opiona* Chamberlin, 1951.

Key words: California, millipedes

Introduction

The millipede family Caseyidae Verhoeff, 1909 is endemic to the Sierra Nevada and the western coastal region of North America, except for three species of *Underwoodia* Cook & Collins, 1895 (Shelley 1993), and ranges from Santa Cruz Co., California, to the southern coastal strip of Alaska. At present, the family comprises nine genera and 50 species. Gardner & Shelley (1989) summarized knowledge of the family up to 1988 and we, in a series of subsequent papers, have continued to update that account (Shear & Leonard 2007; Shear 2011; Shear & Crawford 2019; Shear 2021; Shear & Marek 2024, 2025). *Benlomondia* Shear & Marek, **gen. nov.**, consists of two species from Santa Cruz and San Mateo Cos., California. *Benlomondia benlomondensis*, **sp. nov.**, is known from three localities in Santa Cruz Co., Ben Lomond, a small community from which the genus and species takes its name, and two localities on the campus of the University of California at Santa Cruz, while *Benlomondia mateo,* **sp. nov.**, has been collected only at La Honda, San Mateo Co.

Methods

Specimens were field-preserved in various concentrations of alcohol but are now in 70% ethanol. Morphological studies were done using an Olympus SZH stereomicroscope and an Olympus BX50 compound microscope equipped with Nomarski optics. For scanning electron microscopy (SEM), specimens were first cleaned in an ultrasonic cleaner, then mounted on 12.7 mm diameter aluminum stubs using double-sided adhesive carbon discs and allowed to air-dry. These were sputter coated with a 40-nm thick layer of gold and palladium, using a Cressington 208HR sputter coater and a Cressington MTM20 thickness controller. SEM micrographs were taken with a FEI Quanta 600 FEG environmental scanning electron microscope. Micrographs were edited and refined using GIMP, and plates were composed in InkScape. Geographic coordinates were recorded from label data, and in some cases retrospectively georeferenced in Google Earth; some label data was imprecise, as discussed in the species descriptions. All coordinates were rounded off to three decimal places.

 Accepted by T. Wesener: 28 May 2025; published: 4 Jul. 2025

List of abbreviations

ac	angiocoxite
cc	colpocoxite
cl	coxal lobe of third legpair
cp	coxal process
cxs	gonopod coxosternum
cx(#)	coxa of numbered (#) legpair
g	gland opening
ga	gonapophysis
t(#)	telopodite of numbered (#) legpair
EMEC	Essig Museum of Entomology, University of California, Berkeley, CA
FMNH	Field Museum of Natural History, Chicago, Illinois

In the distribution sections, m and mm mean single and multiple males, respectively, and f and ff meant single and multiple females respectively.

Taxonomy

Order Chordeumatida Pocock, 1894

Suborder Striariidea Cook, 1896

Superfamily Caseyoidea Verhoeff, 1909

Family Caseyidae Verhoeff, 1909

Benlomondia Shear & Marek, new genus

Type species *Benlomondia benlomondensis* Shear & Marek, new species

Diagnosis. The minute size of its species (ca 5 mm) separates *Benlomondia* from other Caseyidae, which are larger than 8 mm in length, except for *Martenseya minutocaeca* Shear, 2021, but that species is eyeless while *Benlomondia* species have black, pigmented ommatidia. From members of the subfamily Ochrogrammatinae, *Benlomondia* is distinct in lacking broad lamellae projecting from the male mandibular stipes, and from species of *Caseya* Cook & Collins, 1895, in the male seventh coxae without modifications or processes. The status of the genus *Speoseya* Causey, 1963, is presently unclear, but that single species is twice the size of either of the two species of *Benlomondia.* Additionally, the new genus is distinct from the related genus *Opiona* Chamberlin, 1952, in several characters of the gonopods. In *Benlomondia* the sterna, coxae and angiocoxites of the gonopods are fused into single units on each side, and the angiocoxites, while separated left from right, are so tightly appressed in the midline that they are functionally one structure. While some species of *Opiona* have the distal elements of the gonopods arising from a coxosternum, in no case are these distal elements also part of the gonopod complex, and no species are known in which the angiocoxites are closely appressed. *Benlomondia* species gonopods also lack flagellocoxites, present in nearly all *Opiona* species, nor have vestigial articulated telopodites, a feature of more than half the species of *Opiona*. The ninth legs of *Benlomondia* have reduced telopodites which are laterally flattened, unlike the inflated button-shaped telopodites of *Opiona* species. The long coxal lobes, strongly reduced and modified telopodites of the third male legs characteristic of species of *Opiona*, are not seen in *Benlomondia.*

Etymology. The name of the new genus is feminine in gender and refers to the community of Ben Lomond, California, type locality of the type species.

Description. Tiny caseyid millipedes (< 5 mm long) with 30 postcephalic rings. Trunk tapering evenly anteriorly and posteriorly. Rings without shoulders or paranota, smooth and shining. Unpigmented except for faint grayish

mottling on anterior end of some individuals. Head (Fig. 1) with three or four black ommatidia on each side. Metazonites with few faint ventrolateral striae. Segmental setae in a straight posterior row, acute. Male mandibles not modified. First legpair of males incrassate, with one or two swordlike, slightly twisted macrosetae on femora and postfemora; tarsus with ventral comb of modified setae (Fig. 2). Second legpair of males reduced, coxae with short, curved gonapophyses densely set with long, curled setae (Figs 2, 3). Coxae of third legpair of males with short distal lobes, densely set with recumbent, curved setae and single long, acute terminal seta; telopodites slightly reduced, prefemora not enlarged and flattened (Figs 4, 10). Legpairs four to seven unmodified, hardly enlarged. Gonopod complex (Figs 5, 6, 9) consisting of sternum, coxa and angiocoxite fused on each side with angiocoxites tightly appressed to each other in midline; distally angiocoxites with complex branches and fine, unsocketed cuticular filaments posteriorly. Colpocoxites elongate, poorly sclerotized. Ninth legpair (Figs 7, 9) with telopodites and coxal processes roughly equal in size, coxal processes broad, curved, with pore at the base. Telopodites of a single podomere, laterally flattened, setose. Tenth legpair with enlarged coxae having anteriorly opening glands, coxae without posteriorly directed processes.

Notes. While the pregonopodal leg modifications of the two species of *Benlomondia* resemble those of species of *Opiona,* they are much less obvious. The gonapophyses of the male second legs are shorter than the femora; the telopodites of almost normal size, with the typical five postcoxal podomeres. The male third legs of *Opiona* species have very elongate projecting coxal lobes, with a strongly reduced telopodite attached about in the midlength of the lobes or even more distally. The femora of the third leg telopodites are typically expanded and flattened. *Benlomondia* species do not have such elongate coxal lobes and the attachment of an unreduced telopodite is more basal; the telopodite femora are cylindrical, not expanded or flattened. The tenth legpair coxae of *Opiona* species have hooked processes, which are absent in *Benlomondia* species. The lesser modifications seen in *Benlomondia* species may be associated with the unusually small size of the animals.

Benlomondia benlomondensis **Shear & Marek, sp. nov.**

Figs 1–8, 11

Types: Male holotype, male paratype and two female paratypes from Ben Lomond, Santa Cruz Co., California, 37.089°N, -122.089°W, collected 22 January 1955 by D. Burdick & M. Wasbauer. Parts of the holotype and paratype males are mounted on SEM stubs WS38-4. Types deposited in Essig Museum of Entomology, University of California at Berkeley, Berkeley, California (EMEC). Additional specimens: CALIFORNIA: Santa Cruz Co.: UCSC campus, ravine beside Earth Sciences Building, 36.998°N, -122.059°W, 15 February 2004, W. Leonard, m ff (VMNH); UCSC campus, Cave Gulch, near large cave opening, lat/long as above, 14 February 2004, W. Leonard, ff (VMNH).

Etymology. The species name refers to the type locality.

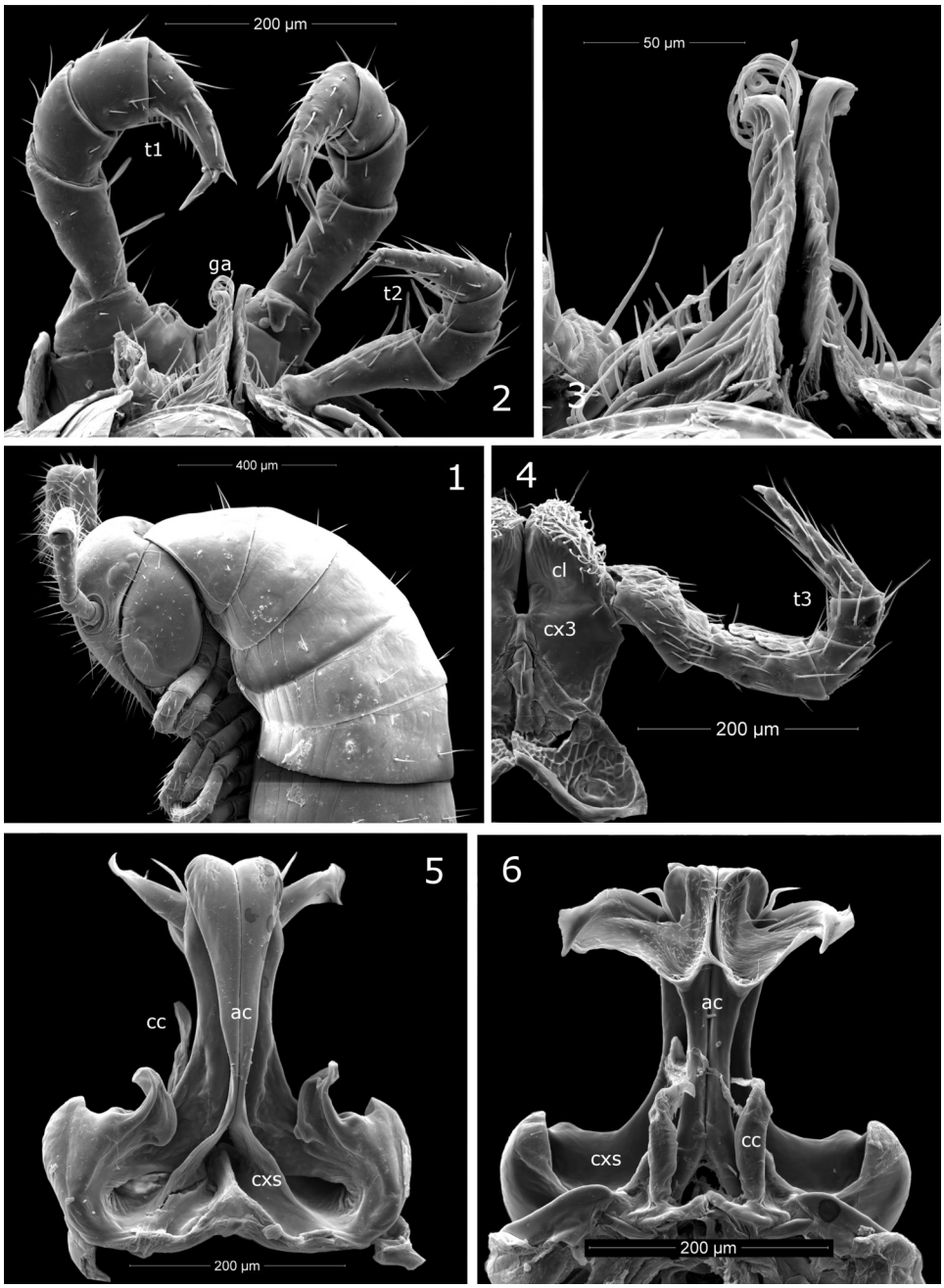
Diagnosis. Distinct from *Benlomondia mateo*, **sp. nov.**, in details of the gonopods and ninth legpair. In *B. benlomondensis*, the stem formed from the appressed angiocoxites is narrower than in *B. mateo* and the terminal branches are different (*cf.* Figs 6 and 9). The coxal processes of the ninth legpair (**cp**, Fig. 7) are apically bifid in *B. benlomondensis*, while those of *B. mateo* are entire, broader, and sickle-shaped (**cp**, Fig. 9).

Description. *Holotype male.* About 4.5 mm long, 0.52 mm in diameter. Eyepatch linear, consisting of four small, black ommatidia (Fig. 1). With the characters of the genus. Male first legpair incrassate, femora each with two twisted blade-like macrosetae, single similar macrosetae on postfemora, tarsi with ventral combs of 5–8 short setae (**t1**, Fig. 2). Male second legs with gonapophyses (**ga**, Figs 2, 3) shorter than femora, anteriorly hooked, densely set with long, thin curling setae. Opening of *vas deferens* or possible accessory pore not observed; telopodites not greatly reduced, without specialized setae (**t2**, Fig. 2). Male third leg coxae (**cx3**, Fig. 4) with low, short distal lobe with many recumbent, curled setae (**cl**, Fig. 4); telopodites not reduced, femora slightly depressed ventrally, otherwise unmodified (**t3**, Fig. 4). Legpairs 4–7 not incrassate. Gonopods in anterior view (Fig. 5) with coxae, sternum and angiocoxites of each side fused (**cxs**, Fig. 5), angiocoxites narrow. In posterior view (Figs 6, 11), angiocoxites distally broadly expanded, with three divisions: the posteriormost membranous and set with many fine cuticular filaments; the next anterior extending at right angles, with an acute basal branch and hooked apex; the most anterior rounded lobes with cuticular filaments (**ac**, Figs 5, 6, 11). Colpocoxites long, narrow, poorly sclerotized (**cc**, Figs 5, 6, 11). Ninth leg coxae (**cx9**, Fig. 7) with large distal processes (**cp**, Fig. 7), slightly twisted and bifid apically, gland openings at bases of processes (**g**, Fig. 7); telopodites single-articled, not exceeding coxal processes, laterally

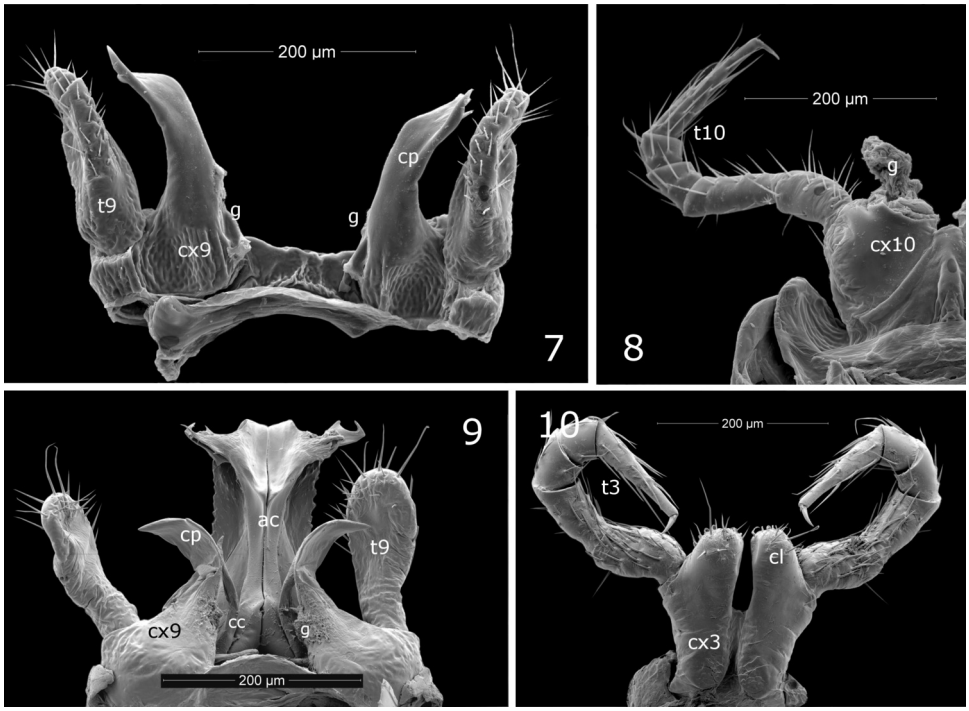
flattened, setose (**t9**, Fig. 7). Tenth coxae enlarged (**cx10**, Fig 8), bearing gland openings (**g**, Fig. 8). Telopodites (**t10**, Fig. 8) somewhat reduced.

Paratype female. As male in nonsexual characters, vulvae without distinguishing features.

Notes. The label for the holotype and accompanying paratypes provide no more detailed locality than "Ben Lomond," a small community north of Santa Cruz. Our coordinates are therefore for the center of town, though it is likely the specimens were collected elsewhere in the vicinity.



FIGURES 1–6. *Benlomondia benlomondensis,* **sp. nov.**, paratypes. **1**. Head and anterior end of female, lateral view. **2**. Legpairs 1 and 2 of male, anterior view. **3**. Gonapophyses. **4**. Left leg 3 of male, posterior view. **5**. Goonopods, anterior view. **6**. Gonopods, posterior view. **Abbreviations: ac**, angiocoxites; **cc**, colpocoxite; **cl**, coxal lobe; **cx3**, coxa of leg 3; **cxs**, coxosternite of gonopods; **ga**, gonapophysis; **t1**, telopodite of leg 1; **t2**, telopodite of leg 2; **t3**, telopodite of leg 3.



FIGURES 7–10. 7, 8. *Benlomondia benlomondensis,* **sp. nov.**, paratype male. **7**. Legpair 9, posterior view. **8**. Right legpair 10, anterior view. **9, 10**. *Benlomondia mateo,* **sp. nov.**, male holotype. **9**. Gonopods and legpair 9, posterior view. **10**. Legpair 3, anterior view. **Abbreviations: ac**, angiocoxite; **cc**, colpocoxite; cl, coxal lobe of leg 3; **cp**, coxal process; **cx3**, coxa of leg 3; **cx9**, coxa of leg 9; **cx10**, coxa of leg 10; **g**, gland opening; **t3**, telopodite of leg 3; **t9**, telopodite of leg 9; **t10**, telopodite of leg 10.

Benlomondia mateo Shear & Marek, sp. nov.

Figs 9, 10, 12

Type: Male holotype from La Honda, San Mateo Co., California, 37.320°N, -122.274°W, elev. ca. 400 ft asl, collected 18 April 1981 by D. Chandler. Parts of the holotype are mounted on SEM stub WS39-2. Holotype deposited in Field Museum of Natural History, Chicago, Illinois (FMNH).

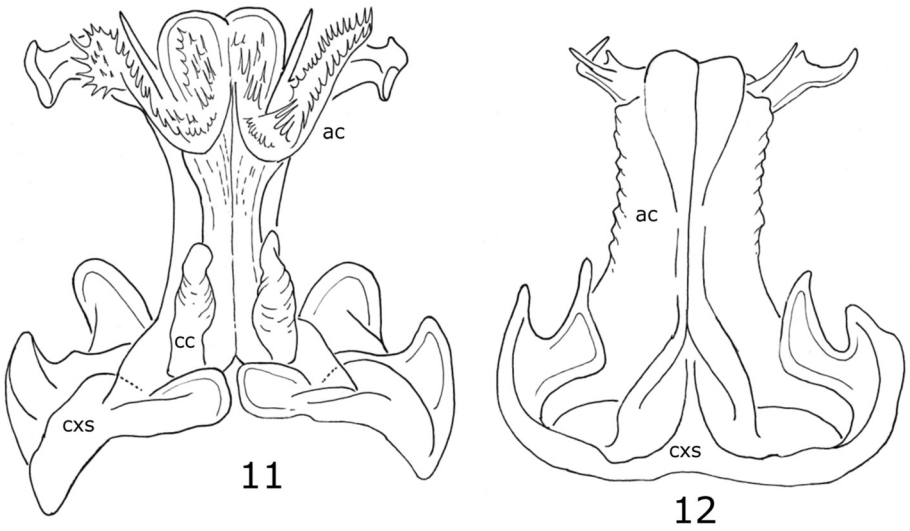
Etymology. The species name, a noun in apposition, refers to the type locality.

Diagnosis. Distinct from *Benlomondia benlomondensis,* **sp. nov.**, in the characters given in the description of that species. In addition, the colpocoxites of *B. mateo* are narrower, and because of the curvature of the coxal processes of legpair 9, the rather more pedunculate telopodites exceed the coxal processes (see Fig. 9).

Description. *Male holotype.* About 4.0 mm long, 0.49 mm wide. Linear eyepatch with three (four?) black ommatidia. Unpigmented. With the characters of the genus; pregonopodal leg modifications and coxae of legpair 10 essentially as described and illustrated for *B. benlomondensis,* **sp. nov.**, above (legpair 3 in Fig. 10). Gonopods in anterior view (Fig. 12) with broad base, margins of angiocoxite (**ac**, Fig. 12) stem irregularly serrate. In posterior view (Fig. 9), tips of angiocoxites flaring, with bifid lateral process, small acute process at base of lateral process. Flaring portion of angiocoxite tips with few fine, unsocketed cuticular filaments (**ac**, Fig. 9). Colpocoxites (**cc**, Fig. 9) weakly sclerotized, long, narrow, pointed. Legpair nine (Fig. 9) with broad coxae (**cx9**, Fig. 9) bearing bladelike, laterally curved processes (**cp**, Fig. 9); gland openings (**g**, Fig. 9) at bases of coxal processes. Telopodites laterally flattened, with distinct peduncle (**t9**, Fig. 9).

Females unknown.

Notes. As with the preceding species, the label simply gives the town of La Honda as the locality, so the coordinates we provide are for the city center, though the specimen was likely collected elsewhere.



FIGURES 11–12. 11. Gonopods of paratype *Benlomondia benlomondensis,* **sp. nov.**, posterior view. **12**. Gonopods of holotype *Benlomondia mateo,* **sp. nov.**, anterior view.

Discussion

The family Caseyidae is being revealed as much more diverse than shown in Gardner & Shelley's 1989 monograph. This is largely due to the discovery, in museum collections and fresh collecting, of small species that they may have overlooked. As with nearly all chordeumatidan millipedes from western North America, collections made in the warm, dry summers usually provide only juveniles, if any chordeumatidans at all. Adults are evidently present and active in cooler, wetter winter months, from November to February, though in favored localities adults can be found as early as October or as late as May. The very small caseyids (< 6 mm long) may also be missed by collectors because of their size or because they inhabit the deeper layers of litter, adjacent to the soil. For this reason, Berlese or flotation sampling is recommended in searching for these millipedes. The apparent limited distribution of these species is probably best regarded for now as an artifact of insufficient collecting.

This work was carried out under a grant from the National Science Foundation of the United States to Paul Marek, number 2433355.

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