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SOME TARDIGRADES FROM COLORADO, WITH A DESCRIPTION OF A NEW SPECIES OF *MACROBIOTUS* (MACROBIOTIDAE: EUTARDIGRADA)

R. Deedee Kathman

Abstract.—Fourteen species of tardigrades were found above 3200 m on Mt. Evans and an additional species was found at 3963 m at Guenella Pass, Colorado. One of the species from Mt. Evans, *Macrobiotus caelicola,* is new to science. It differs from other *Macrobiotus* species by having a combination of the following characters: the presence of ventral and dorsal pores covering its body, the large size and shape of the claws and dentate lunules, two macroplacoids and no microplacoid, and the shape and size of the eggs.

Thirty-one species of tardigrades have been reported from Colorado (Higgins 1959, Baumann 1960, Landreth & Thomas 1970, Anderson et al. 1984, Beasley 1989). The most recent of these publications (Beasley 1989) increased the number from 17 species to the present 31. During the present study, 15 species were collected: five are new to Colorado and one is new to science.

Materials and Methods

Five samples of moss were collected on Mt. Evans between 3262 m and the summit at 4348 m, and one sample each was collected at 3659 m and 3963 m at Guenella Pass, both in Clear Creek County, Colorado, U.S.A. All seven samples were collected on 11–12 Aug 1986.

Each sample of moss was placed in a paper bag and air-dried for several months, then removed from the bag, placed in a stoppered funnel and allowed to soak in water for eight hours, after which the moss was removed and shaken in a separate container of water several times. The water and its contents were poured through a 45 μm sieve to retain the tardigrades, which were placed in a gridded petri dish and extracted under a stereomicroscope. Each tardigrade was placed directly into Hoyer's mounting medium on a microscope slide and overlain with a cover slip. After complete drying of the mountant, the cover slip was ringed with nail polish to prevent further air penetration.

Identifications were made using a phase-contrast compound microscope with oil immersion. All measurements were made using a calibrated eyepiece micrometer. All drawings were done with a drawing tube attached to the compound microscope.

Results

All seven samples contained tardigrades, with a total of 263 individuals belonging to 8 genera and 15 species, distributed among the sites as shown in Table 1. One of these species, *Isohypsibius pappi,* is new to North America, and three of the species, *Hebesuncus conjungens, Diphascon nodulosum* and *D. pingue,* are reported from Colorado for the first time. The new species, *Macrobiotus caelicola,* is described below.

Taxonomic Account

Eutardigrada Marcus, 1927
Macrobiotidae Thulin, 1928
Macrobiotus Schultze, 1834
Macrobiotus caelicola, new species
Fig. 1

Description.—Holotype. Total length 620 μm; colorless; eyes present (Fig. 1A). Entire ventral and dorsal surfaces covered with ir-

Table 1. Numbers of individuals in each species found at two locations in Clear Creek County, Colorado. General distributions and descriptions for each species are given in Ramazzotti and Maucci (1983).

	Guenella Pass		Mt. Evans			
	3659 m	3963 m	3262 m	3811 m	4299 m	4348 m
Echiniscus blumi Richters, 1903		19				
Echiniscus wendti Richters, 1903		1			1	
Milnesium tardigradum Doyère, 1840	1	91			15	
Hypsibius convergens (Urbanowicz, 1925)	1		2			1
Ramazzottius oberhaeuseri (Doyère, 1840)			4		1	
Isohypsibius pappi (Iharos, 1966)			1			
Isohypsibius landalti (Iharos, 1966)			1			
Hebesuncus conjungens (Thulin, 1911)				2		
Diphascon nodulosum (Ramazzotti, 1957)			8			
Diphascon pingue (Marcus, 1936)			1			11
Diphascon recamieri Richters, 1911				1		
Macrobiotus caelicola new species					46	
Macrobiotus harmsworthi Murray, 1907			16	2		1
Macrobiotus hufelandi Schultze, 1834			3	9		10
Minibiotus intermedius (Plate, 1888)		2		1		

regularly-shaped, equal-sized pores (example of pores in posterior end shown in Fig. 1A). Buccal lamellae present. Buccal ring with distinct dentation. Buccal tube with ventral tube support; buccopharyngeal tube 66 μm long, 5 μm wide. Pharyngeal bulb large, wider than long; apophyses large; 2 macroplacoids, the first 8 μm long, the second 6 μm long; no microplacoid (Fig. 1B). Furcae as shown in Fig. 1C. Doubleclaws large, Y-shaped; 2 large accessory points on each primary branch; primary branch long and thin, 17.5 μm in leg II, 32.5 μm in leg IV; secondary branch short and close to base, 12.5 μm in leg II, 20 μm in leg IV; lunules large and dentate (Fig. 1D, E). Sclerotized bar below the claws on the first 3 pairs of legs (Fig. 2D). USNM 235439.

Paratypes.—Total length up to 668 μm. Buccopharyngeal tube length 66–70 μm, width 5–6 μm, distance between stylet support insertion and end of tube (= pharyngeal tube length) 13–15 μm. First macroplacoid length 8–10 μm, second macroplacoid length 6–8 μm, with the first always longer than the second. Sclerotized bar below the claws in all specimens. 45 specimens: USNM 235440–235442; 2 specimens in Dastych collection (Hamburg, West Germany); 2 specimens in Kristensen collection (University of Copenhagen, Denmark); remaining specimens in Kathman collection (Sidney, British Columbia).

Eggs.—Eggs round, up to 124 μm in diameter; covered with projections up to 34 μm long (Fig. 1F); projections thin, with dark patches on exterior, apices divided into multi-tipped points, some with tiny setae projecting from them (Fig. 1G); egg surface smooth between projections. USNM 2354431–235444.

Type locality.—All specimens were collected on 11 Aug 1986 at 4299 m, Mt. Evans, Clear Creek County, Colorado, U.S.A.

Etymology.—*Caelicola* is a masculine Latin word meaning dweller in heaven; this species is thus named because it was found at such a high altitude as well as pertaining to the surname of the person in charge of the Mt. Evans Research Station, Dr. Robert Angell.

Discussion

This is the first report of a *Macrobiotus* species with a sclerotized bar below the claws. It is generally thicker and larger than

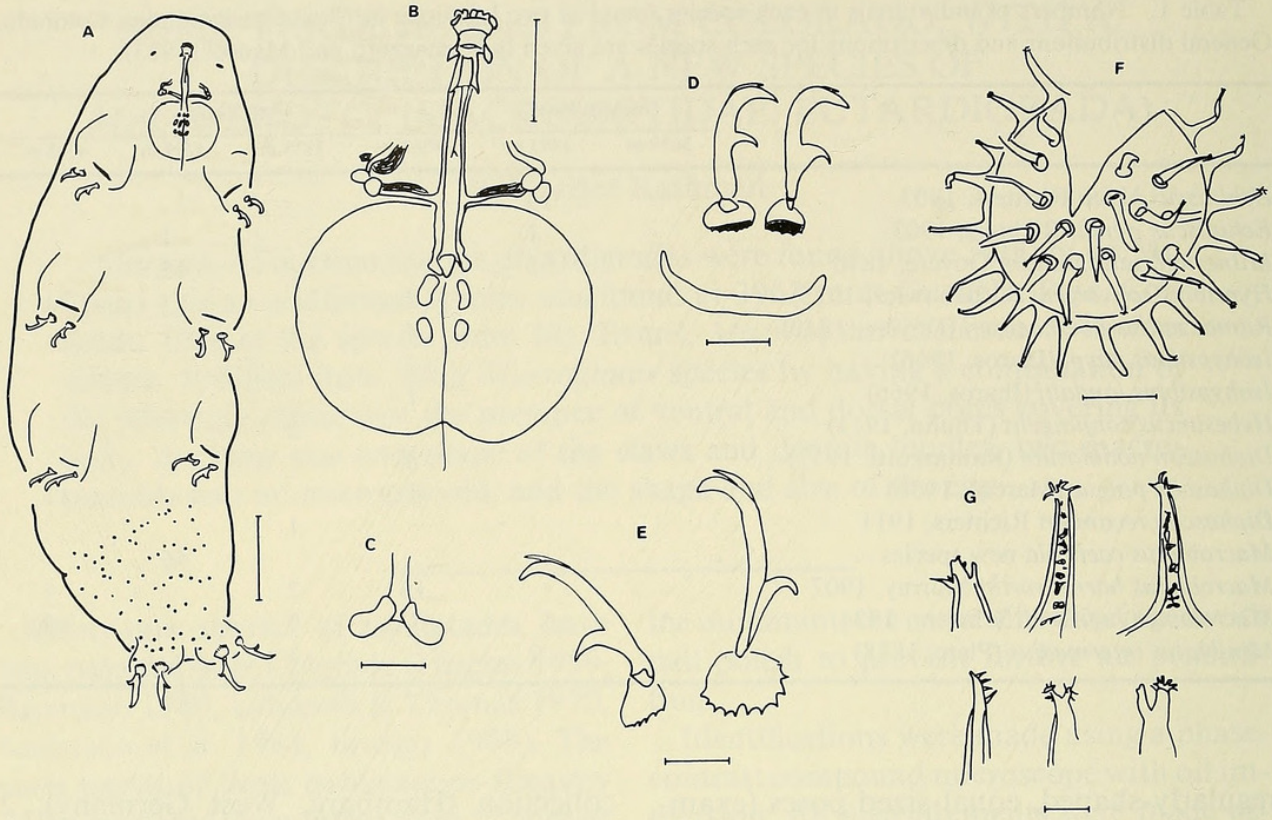

Fig. 1. *Macrobiotus caelicola.* A, Entire animal, ventral view, pores cover entire ventral and dorsal surfaces; B, Buccopharyngeal apparatus; C, Furca; D, Claws of 2nd leg; E, Claws of 4th leg; F, Egg (split); G, Projections on egg. Scale bars in μm as follows: A, 80; B, 24; C, D, 10; E, 12; F, 40; G, 12.

those bars found in species of *Diphascon* or *Isohypsibius,* at least superficially more closely resembling the leg plate of some echiniscids. The lower portion of the bar appears to have two distinct elliptical areas with fine spine-like granulation, but these could not be clearly discerned using light microscopy, even at 2000× magnification and using phase contrast lenses.

This species is most similar to *Macrobiotus islandicus* Richters, 1904 but differs in the following characters. *Macrobiotus islandicus* has small pores arranged in transverse rows on the dorsal and lateral surfaces, while *M. caelicola* has irregularly-spaced pores not in transverse bands covering both the dorsal and ventral surfaces. The width of the buccal tube for *M. islandicus* is much larger than for *M. caelicola,* with the width to length ratio being approximately 14% for *M. islandicus* and 7.5–8.5% for *M. caelicola.* There is a curve in the rostral part of the buccal tube for *M. islandicus,* while the buccal tube for *M. caelicola* is straight. Both macroplacoids are longer in *M. islandicus* than in *M. caelicola,* and their profiles are smooth in *M. islandicus* but rough-edged in *M. caelicola.* In *M. islandicus* the secondary branch of each doubleclaw is inserted halfway or slightly more than halfway up the primary branch, while in *M. caelicola* the secondary branch is inserted approximately one-third of the distance from the base of the primary branch; both branches are longer and thinner in *M. caelicola.* The lunules are always obvious and dentate in *M. caelicola.* The eggs of *M. caelicola* are larger (mean diameter of 120 μm) than for *M. islandicus* (90–100 μm diameter). The projections on the eggs of *M. islandicus* are 11–12 μm maximum length, while those of *M. caelicola* are much longer (mean length = 20 μm for 9 eggs), reaching 34 μm in some eggs. No other *Macrobiotus* species have eggs

with the characters of *M. caelicola.* If eggs are not used for differentiation from other species, there are only two other moss-dwelling *Macrobiotus* species with the combined characters of cuticular pores, two macroplacoids, and no microplacoid. They are *M. islandicus* and *Macrobiotus annae* Richters, 1908. *M. caelicola* differs from *M. islandicus* as discussed above, and from *M. annae* in that *M. annae* is a small tardigrade (length to 370 μm) and has a narrow buccal tube (3 μm), a small oval pharynx, small claws, and small smooth lunules.

The 15 species of tardigrades collected during this study increase the number known from Colorado from 31 to 37. Although all 15 species were collected at high altitudes, none of them appear to be restricted to these altitudes, since all of them (except the newly reported species) have been reported elsewhere at much lower altitudes.

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Literature Cited

Anderson, R. V., R. E. Ingham, J. A. Trofymow, & D. C. Coleman. 1984. Soil mesofaunal distribution in relation to habitat types in a shortgrass prairie.—Pedobiologia 26:257–261.

Baumann, H. 1960. Beitrag zur Kenntnis der Tardigraden in Nord-Amerika.—Zoologischer Anzeiger 165:123–128.

Beasley, C. W. 1989. Taradigrada from Gunnison County, Colorado, with the description of a new species, *Diphascon craigi.*—The Southwestern Naturalist. (In Press)

Higgins, R. P. 1959. Life history of *Macrobiotus islandicus* Richters with notes on other tardigrades from Colorado.—Transactions of the American Microscopical Society 78:137–154.

Landreth, K., Jr., & B. O. Thomas. 1970. Studies of the egg laying process in Tardigrada [*Hypsibius (Isohypsibius) augusti*] in Weld County.—Journal of the Colorado–Wyoming Academy of Science 7:9.

Ramazzotti, G., & W. Maucci. 1983. Il phylum Tardigrada.—Memorie dell'Istituto Italiano di Idrobiologia 41:1–1012.

Department of Biology, P.O. Box 1700, University of Victoria, Victoria, British Columbia, Canada V8W 2Y2; (Present address) 10651 Blue Heron Road, Sidney, British Columbia, Canada V8L 3X9.