

DESCRIPTION OF A NEW TARDIGRADE, *MACROBIOTUS BARBARAE* (EUTARDIGRADA: MACROBIOTIDAE) FROM THE DOMINICAN REPUBLIC

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Abstract.— A moss sample collected in the Dominican Republic contained tardigrades and their eggs, including adults and eggs of a new species, *Macrobiotus barbarae* **sp. nov.** The new species belongs to the *harmsworthi* group and it is most similar to *M. ovostriatum* Pilato et Patané, 1998 and *M. pseudonuragicus* Pilato *et al.*, 2004 in the character of egg areolation. It differs from *M. ovostriatum* above all by larger body size and wider buccal tube, better developed oral cavity armature (the first band of teeth is present and the second band of teeth forms a ring of triangular teeth) and indentation of hind lunulae. *M. barbarae* **sp. nov.** differs also from *M. pseudonuragicus* in details of the egg projections (in *M. pseudonuragicus* the terminal portion of processes is short, not elongated and divided into several short points whereas in the new species the terminal parts are elongated and generally not divided). Differences between the new species and other similar members of the *harmsworthi* group are also discussed.



Key words.— Tardigrada, new species, *Macrobiotus barbarae* **sp. nov.**, *harmsworthi* group, Dominican Republic.

INTRODUCTION

Our knowledge on tardigrades of the Dominican Republic is relatively poor. There have been sixteen species reported from this country so far (Schuster and Toftner 1982): *Bryodelphax dominicanus* (Schuster et Toftner, 1982), *Echiniscus cavagnaroi* Schuster et Grigarick, 1966, *E. virginicus* Riggan, 1962, *Pseudochiniscus suillus* (Ehrenberg, 1853), *Milnesium tardigradum* Doyère, 1840, *Doryphoribius evelinae*

(Marcus, 1928), *D. flavus* (Iharos, 1966), *Itaquascon pawlowski* Węglarska, 1973, *Macrobiotus areolatus* Murray, 1907, *M. coronatus* de Barros, 1942, *M. cf. hufelandi* C.A.S. Schultze, 1833, *M. liviae* Ramazzotti, 1962, *M. richtersi* Murray, 1911, *M. sp.*, *Minibiotus intermedius* (Plate, 1888), and *Minilentus dubius* (Schuster et Toftner, 1982).

In this paper, a new *Macrobiotus* species found in a moss sample collected in the eastern part of the Dominican Republic is described and figured. It is

the third Tardigrada species new to science described from this country.

MATERIAL AND METHODS

A moss sample was collected by the first author in the Dominican Republic in November 2004. In the sample 8 adults and 5 eggs (including one with a developed embryo) belonging to the new species were found. All specimens and eggs were mounted on microscope slides in Hoyer's medium.

All measurements are given in micrometers [μm]. Structures were measured only if their orientation was suitable. Body length was measured from the mouth to the end of the body, not including the hind legs. Buccal tube length and the level of the stylet support insertion point were measured according to Pilato (1981). Buccal tube width was measured as the external diameter at the level of the stylet support insertion point. Only external claws were measured. Lengths of the claw branches were measured from the base of the claw to the top of the branch, including accessory points. The *pt* ratio is the ratio of the length of a given structure to the length of the buccal tube expressed as a percentage (Pilato 1981). In the description of the holotype, the *pt* is given after μm value [in square brackets and in *italics*]. Terminology describing the oral cavity armature is given according to Michalczyk and Kaczmarek (2003).

Photomicrographs and measurements were made using the Phase Contrast Microscope (PCM) Olympus BX41 with a digital camera Olympus Camedia C-7070.

TAXONOMY

Macrobotus barbarae sp. nov. (Figs 1–15)

Material examined. Holotype and 12 (7 adults, 4 eggs, 1 egg with an embryo) paratypes are preserved at the Department of Animal Taxonomy and Ecology, A. Mickiewicz University, Umultowska 89; 61-614 Poznań, Poland.

Description. Adult (measurements of holotype): Body length 490.6 (Fig. 1). Body transparent/white, eyes generally absent. Cuticle smooth and without pores, apart from legs II–IV where fine, regular granulation is present (better developed on legs IV) (Figs 6, 8).

Bucco-pharyngeal apparatus of *Macrobotus* type (Figs 2–5). Mouth terminal, surrounded by ring of 10 peribuccal lamellae.

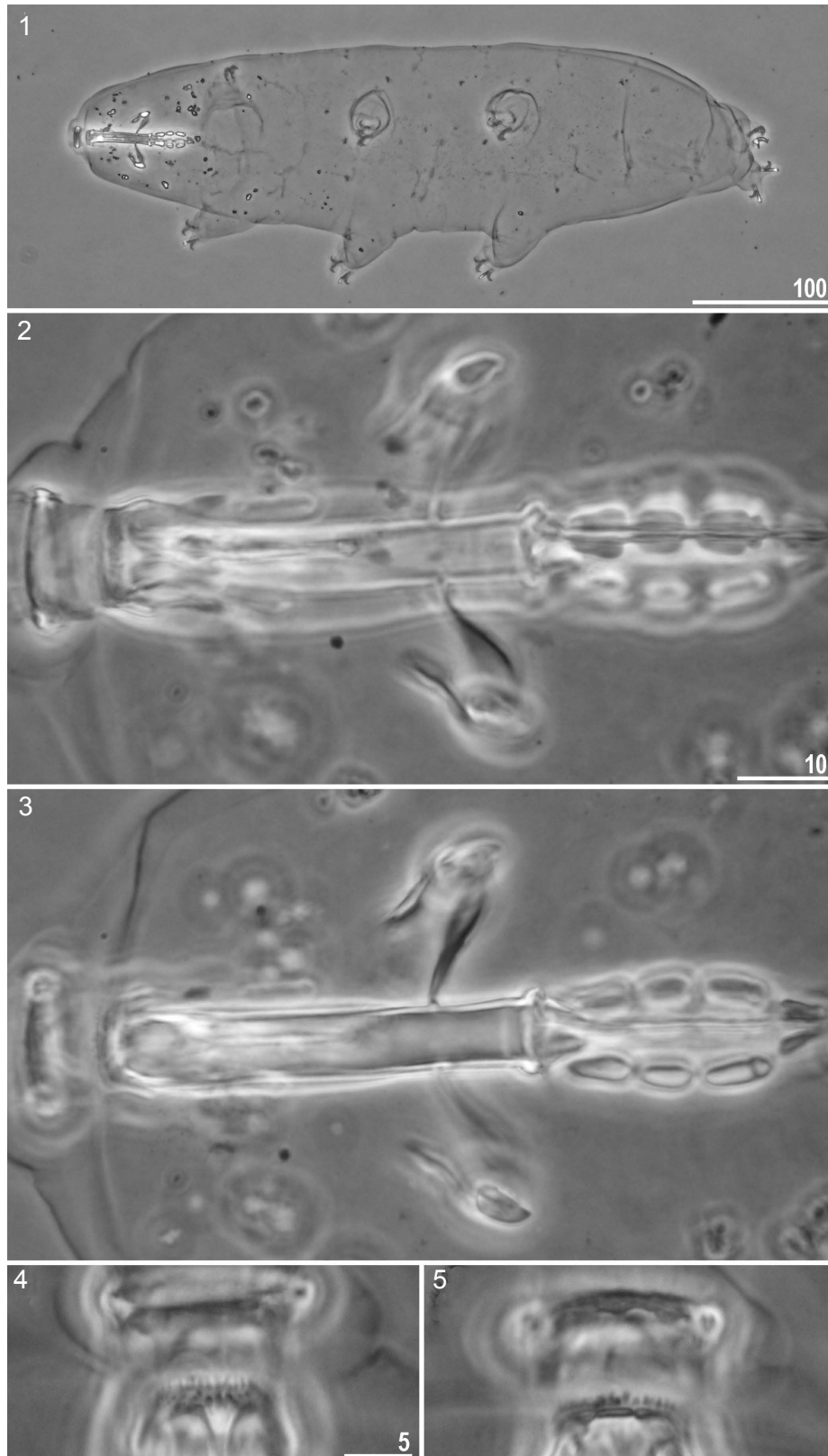
Oral cavity armature of *harmsworthi*-type (Figs 2–5), with three bands of teeth (Figs 4–5). Teeth of the

first band are smaller than those of the other two bands and are in the shape of very small granules. They are present in the anterior portion of the oral cavity just behind the peribuccal lamellae. This band of teeth is continuous and looks the same on all oral cavity walls, usually consisting of a few irregular rows of teeth. The second band of teeth: these are much larger than those of the first band and clearly smaller than those of the third band of teeth. They are in the shape of small ridges parallel to the main axis of the buccal tube. They are positioned in the posterior portion of the oral cavity just before the third band of teeth. This band of teeth is continuous and arranged in one row. Most teeth are uniform and regular in the shape of ridges, only sometimes joined one-by-one. Joined teeth are H- and V-shaped. All teeth in this row have the same length. The third band of teeth: these are larger than those in the other two rows. They are in the shape of transverse ridges/baffles or/and granules. They are positioned in the rear of the oral cavity just behind the second band of teeth and just before the buccal tube opening. Usually this band is not continuous and is divided into two series: ventral and dorsal. Dorsal series consist of one median and two lateral teeth and these teeth are thinner and longer than ventral ones. Ventral series consist of two lateral teeth and a few median teeth.

Buccal tube 47.0 long and 6.7 [14.3] wide (wall 0.7 [1.5] thick) (Figs 2–3) with one clearly visible bend in anterior part of tube (visible in lateral view). Stylet supports inserted on buccal tube at 36.4 [77.4]. Ventral buccal lamina 27.6 [58.7] long. Pharyngeal bulb almost spherical with distinct, triangular apophyses, three macroplacoids and microplacoid. First macroplacoid thinner anteriorly, 6.2 [13.2] long, second oval, 5.0 [10.6] long, both without constrictions. Third macroplacoid 7.7 [16.4] long, with distinct constriction in sub-terminal part. Microplacoid relatively large, tear-shaped 5.0 [10.6]. Macroplacoid row 22.7 [48.3] long. Placoid row 28.6 [60.9] long.

Claws of *hufelandi*-type, stout (Figs 7–9). Primary branches with distinct accessory points. Lunules smooth on legs I–III and with small teeth on legs IV. Claws I: primary branch 11.5 [24.5] long, secondary branch 9.1 [19.4] long, II pb. 11.9 [25.3], sb. 9.6 [20.4]; III pb. 11.9 [25.3], sb. 9.8 [20.9]. Claws IV unmeasurable in holotype due to their orientation, in all specimens slightly longer than claws I–III. Very faint bar-like structures below lunules visible on legs I–III (Fig. 7).

Eggs. Transparent/white, laid freely, spherical with areolation and conical processes (Figs 10–15). Processes with elongated flexible terminal portion very often broken and sometimes bifurcated. Processes consisting of double wall with transverse supporting walls that form 'cells' visible as reticular design in light microscope (Figs 12–15). 'Cells' in polygonal shape and



Figures 1–5. *Macrobiotus barbarae* sp. nov. (1) Habitus; (2–3) buccal apparatus; both the same scale: (2) ventral view; (3) mid-section; (4–5) oral cavity armature, both the same scale: (4) ventral teeth; (5) dorsal teeth (PCM).

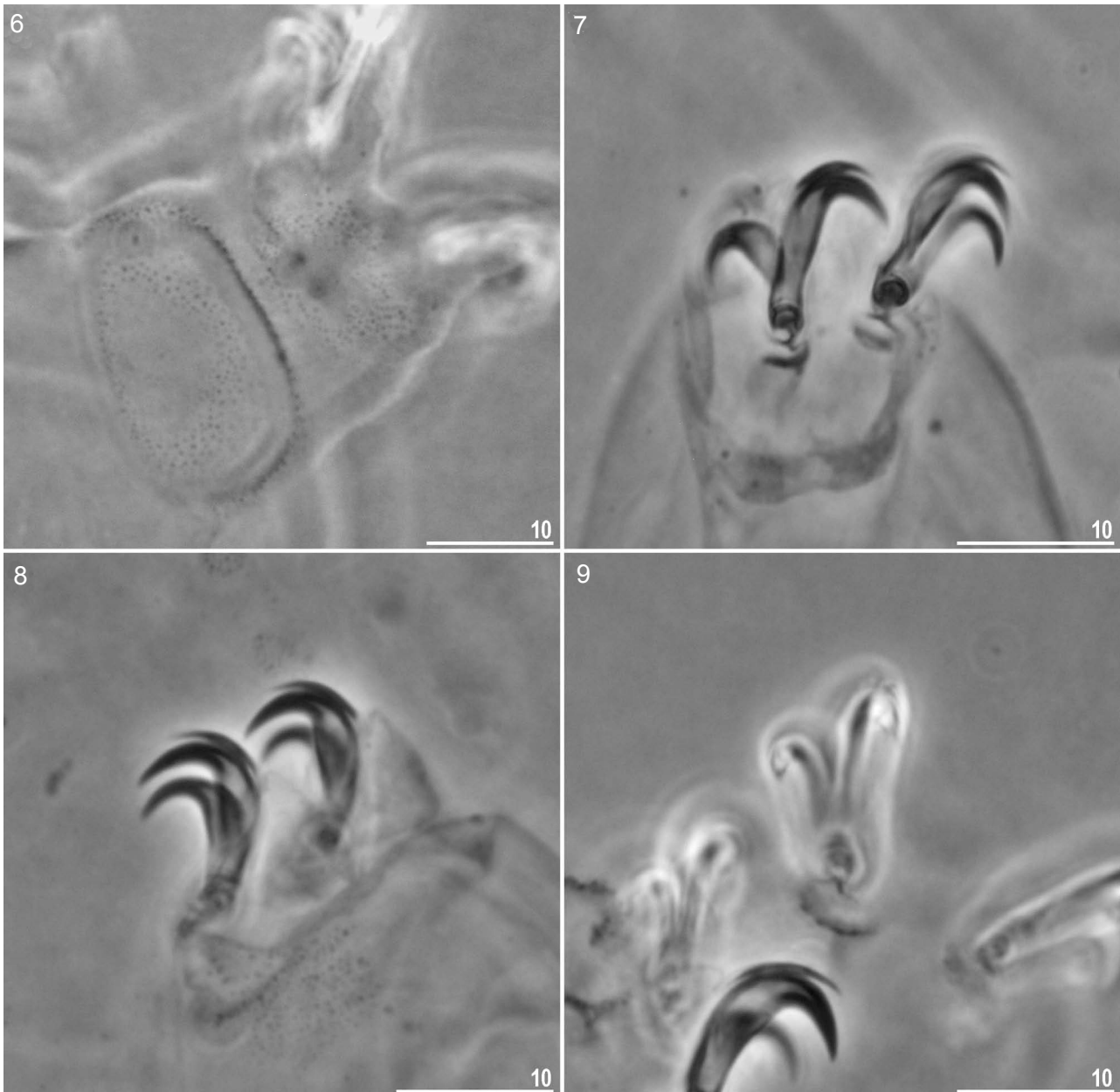
various sizes. Areolae big, tetra-, penta- or hexagonal. Each process is surrounded by 5 or 6 neighbouring processes and 5 or 6 areolae are present around each process (thus only one areola lies between each two neighbouring processes). Ridges delimiting areolae reticulated in the same way as processes. Surface of areolae covered with small irregular (round or slightly elongated) wrinkles or dots. Wrinkles slightly bigger on the areolae margins and absent in a narrow strip between each areola and a base of process (Fig. 11).

Remarks. Results of simple statistical analysis of measurements and *pt* values of selected morphological structures for 8 specimens and 4 eggs are given in Tables 1–2.

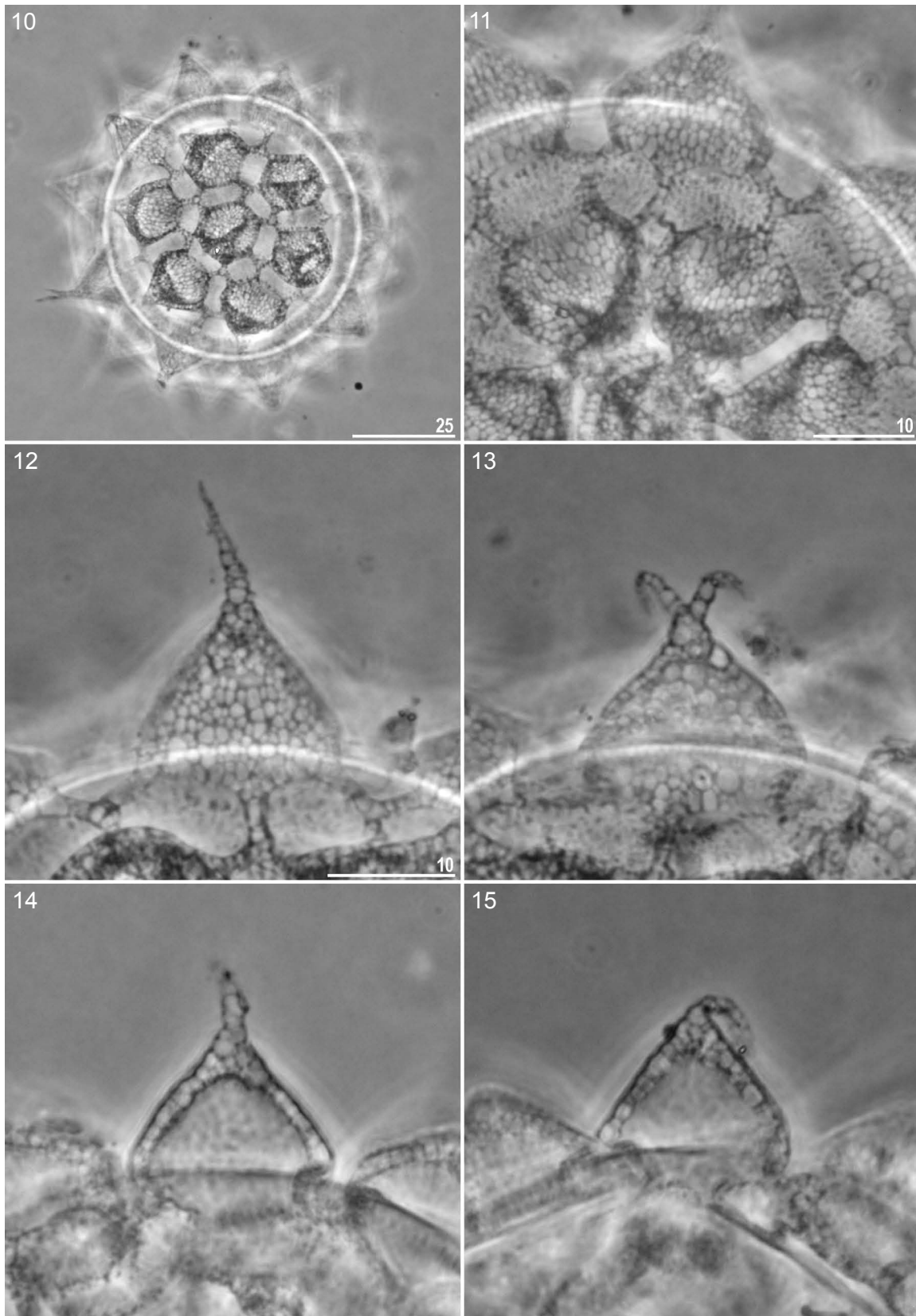
Among 8 mounted specimens, only one had eyes.

Type locality. Central America; Dominican Republic; Puerto Plata Province; hills near Puerto Plata; moss from tree trunk; November 2002; leg. Ł. Kaczmarek.

Etymology. We take great pleasure in dedicating this species in honour of the first author's mother Mrs. Barbara Kaczmarek.



Figures 6–9. *Macrobiotus barbarae* sp. nov. (6) Granulation on the dorsal cuticle of a hind leg; (7–8) claws: (7) leg I; (8) leg II; (9) lunules with small teeth on claws IV (PCM).



Figures 10–15. *Macrobiotus barbarae* sp. nov. (10) Egg; (11) egg surface; (12–15) processes, all the same scale: (12–13) surface; (14–15) mid-sections (PCM).

Differential diagnosis. *Macrobiotus barbarae* sp. nov. belongs to the *M. harmsworthi* group of species. Species of the group have three macroplacoids and a relatively large microplacoid situated close to the third macroplacoid. Thirty species and one subspecies of the *harmsworthi* group were listed in Binda and Pilato (1994), Claps and Rossi (1997), Pilato and Binda (2001), Michalczyk and Kaczmarek (2003), Pilato *et al.* (2000, 2004, 2006), Tumanov (2005) and Pilato and Lisi (2006a, b). The eggs of the *harmsworthi* group species have conical processes (different in the shape and size and sometimes with elongated and divided apices) and the shell between processes can be with or without areolation. *M. barbarae* sp. nov. belongs to the subgroup of species with areolated eggs along with *M. hieronimi* Pilato et Claxton, 1988, *M. nuragicus* Pilato et Sperlinga, 1975, *M. ovostratus* Pilato et Patanè, 1998, *M. pseudoliviae* Pilato et Binda, 1996 and *M. pseudonuragicus* Pilato, Binda et Lisi, 2004.

Macrobiotus barbarae sp. nov. differs from most similar *M. ovostratus* by the absence of eyes, by differences in the oral cavity armature appearance: the first band of very small teeth is present (absent in *M. ovostratus*) and the second band of teeth forms a single row of large teeth (a band of less developed teeth is present in *M. ovostratus*). Moreover, the new species has dentate lunules on IV pair of legs, slightly larger body size (260.3–512.1 in *M. barbarae* sp. nov. and

256.0–317.0 in *M. ovostratus*), higher egg processes (18.4–24.0 in *M. barbarae* sp. nov. and up to 19.0 in *M. ovostratus*) and absence of true stripes inside of areolae (present in *M. ovostratus*) (Pilato and Patanè 1998).

The new species differs also from:

1. *M. nuragicus* by the absence of eyes, the presence of sculptured areolation between the egg processes (no sculpture mentioned in the description of *M. nuragicus*), by a different shape of egg processes: elongated terminal portion not divided into many tips and the processes height (18.4–26.5 in *M. barbarae* sp. nov. and about 16.0 in *M. nuragicus*) (Pilato and Sperlinga 1975).

2. *M. pseudonuragicus* by larger body size (260.3–512.1 in *M. barbarae* sp. nov. and 315.0–360.0 in *M. pseudonuragicus*), by absence of granulation on the cuticle apart from legs II–IV (cuticle with granules, including legs, in *M. pseudonuragicus*), by the length order of macroplacoids having third macroplacoid longest (3-1-2 in the new species and 1-3-2 in *M. pseudonuragicus*), by the presence of dentate lunules on legs IV (smooth in *M. pseudonuragicus*), by longer egg processes with elongated portion not subdivided into more than two tips (18.4–26.5 in *M. barbarae* sp. nov. and 14.0–16.5 in *M. pseudonuragicus*), different egg shell design inside of areolae (small dots forming irregular design in the new species and a few central

Table 1. Measurements [in μm] and *pt* values of selected morphological structures of specimens of *Macrobiotus barbarae* sp. nov. mounted in Hoyer's medium (range refers to the smallest and the largest structure found among all measured specimens; N – number of specimens/structures measured, SD – standard deviation).

Character	N	Range		Mean		SD	
		μm	<i>pt</i>	μm	<i>pt</i>	μm	<i>pt</i>
Body	8	260.3–512.1	803.7–1075.8	403.2	968.6	95.5	86.8
Buccal tube	8	28.0–51.7	–	41.3	–	7.4	–
Stylet support insertion point	8	21.6–40.2	77.1–80.2	32.3	78.2	5.9	1.2
Buccal tube external width	8	3.4–8.3	12.1–16.1	5.8	13.9	1.5	1.3
Ventral lamina	7	16.9–32.7	58.2–63.2	24.8	60.4	5.1	1.8
Macroplacoid 1	8	3.2–7.4	11.4–14.3	5.6	13.4	1.2	0.9
Macroplacoid 2	8	2.8–6.1	9.5–12.7	4.6	10.9	1.1	1.2
Macroplacoid 3	8	3.4–8.6	12.1–16.6	6.0	14.3	1.6	1.6
Microplacoid	8	2.0–5.1	7.1–12.2	4.0	9.5	1.1	1.5
Macroplacoid row	8	11.4–26.6	40.3–51.5	19.2	45.9	5.0	4.8
Placoid row	8	14.3–32.4	49.9–62.7	23.9	57.2	6.1	5.2
Claw 1 – primary branch	4	6.4–12.0	22.9–27.6	10.4	25.3	2.7	2.1
Claw 1 – secondary branch	4	4.7–9.1	16.8–19.4	7.6	18.4	2.0	1.2
Claw 2 – primary branch	5	6.5–13.0	23.2–30.0	11.0	26.8	2.6	2.7
Claw 2 – secondary branch	5	4.7–10.0	16.8–23.0	8.4	20.2	2.1	2.3
Claw 3 – primary branch	4	10.4–12.9	25.3–29.7	11.8	27.1	1.0	1.9
Claw 3 – secondary branch	4	8.0–9.8	20.5–22.6	9.2	21.2	0.8	1.0
Claw 4 – primary branch	4	13.4–15.5	30.0–33.4	14.4	31.9	0.9	1.4
Claw 4 – secondary branch	4	9.5–10.3	19.9–23.3	9.9	22.0	0.4	1.5

Table 2. Measurements [in μm] of selected morphological structures of eggs of *Macrobotus barbarae* sp. nov. mounted in Hoyer's medium (N – number of eggs or structures measured, min/max – the smallest/largest structure, SD – standard deviation).

Character	N	Min	Max	Mean	SD
Diameter of egg without processes	4	63.8	71.0	67.9	3.3
Diameter of egg with processes	4	106.0	115.0	109.2	4.0
Processes height	12	18.4	26.5	21.4	2.2
Processes base width	12	13.1	19.9	16.5	1.9
Distance between processes	12	3.8	7.6	5.5	1.2
Number of processes on the circumference of egg	4	10.0	10.0	10.0	0.0

stripes and many marginal dots in *M. pseudonurgicus*) (Pilato *et al.* 2004).

3. *M. hieronimi* by the absence of eyes, by a slightly narrower buccal tube (*pt* of its width is nearly 17% in the holotype of *M. hieronimi*), clearly more posteriorly inserted stylet supports (max. *pt* = 74.8 in *M. hieronimi*), shorter macroplacoids, a shorter macroplacoid row as well as by a shorter placoid row, by unequal length of macroplacoids (all macroplacoids are of almost the same length in *M. hieronimi*), by shorter egg processes (25.0–34.0 long in *M. hieronimi*) and by a stronger sculpture of areolae surface (only fine striae can be seen on some eggs of *M. hieronimi*) (Pilato and Claxton 1988).

4. *M. pseudoliviae* by the absence of eyes, by having less numerous and relatively bigger teeth on hind lunulae, by having smaller eggs (egg diameter 72.0–78.0 without and 156.0–177.0 with processes in *M. pseudoliviae*), by having much shorter and narrower egg processes (42.0–56.0 long and 28.0–45.0 of basal diameter in *M. pseudoliviae*), by having fewer number of areolae around each process (about 16 smooth areolae in *M. pseudoliviae*) (Pilato and Binda 1996).

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