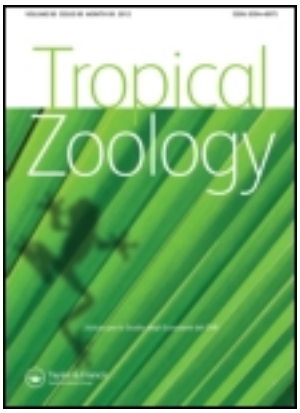

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Remarks on some tardigrades of the African fauna with the description of three new species of Macrobiotus Schultze 1834

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Remarks on some tardigrades of the African fauna with the description of three new species of *Macrobiotus* Schultze 1834

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Ten species of tardigrades are recorded. Three of them, *Macrobiotus radiatus*, *Macrobiotus vanescens*, and *Macrobiotus iharosi* are new for science; two species, *Macrobiotus sapiens* Binda & Pilato 1984 and *Isohypsibius kristenseni* Pilato et al. 1989, are new for the African fauna.

Macrobiotus radiatus n. sp. differs from the other species of the *harmsworthi* group in the characters of the eggs and in other characters regarding various structures (buccal armature, or placoids length, or the insertion point of the stylet supports, or the claws length).

Macrobiotus vanescens n. sp. is similar to *Macrobiotus richtersi* Murray 1911 and to *Macrobiotus peteri* Pilato et al. 1989 but differs from them in some characters regarding the bucco-pharyngeal apparatus, the claws and the eggs.

Macrobiotus iharosi n. sp. differs from *Macrobiotus echinogenitus* Richters 1904 in the characters of the eggs, and from *Macrobiotus sapiens* Binda & Pilato 1984 in some characters of the bucco-pharyngeal apparatus and of the claws.

KEY WORDS: African fauna, Tardigrada, *Macrobiotus radiatus* n. sp., *Macrobiotus vanescens* n. sp., *Macrobiotus iharosi* n. sp.

We studied some moss, lichen and soil samples collected in Tanzania, Mozambique, South Africa and Namib Desert (South West Africa), and we found 10 species; three of them are new for science; two species are new for the African fauna. We found again *Ramazzottius szepticki* Dastych 1980 of which only one specimen (the holotype) was known.

With this report 110 species of tardigrades are known for the African fauna.

Pseudechiniscus jiroveci Bartos 1963

Mosses from Tanzania (Ngorongoro): 55 specimens; South Africa (Tzitzikama): 8 specimens.

Only a young specimen (the holotype from China) and 6 South-African specimens (BINDA 1984) were known. Our 63 specimens are identical to those described by BINDA. We must underline that the body length reaches 170 µm and that the median plate 3 has a longitudinal fold as do other median plates. These folds can disappear under pressure from the coverglass.

Echiniscus longispinosus Murray 1907

Mosses from South Africa (Tzitzikama): 17 specimens.

BINDA (1984) found this species in South Africa and pointed out its individual variability of the lateral and dorsal appendages (she recognized 8 morphotypes). Our report confirms BINDA's statements.

The species is known for the South Africa only.

Macrobiotus radiatus n. sp. (Fig. 1)

Mosses from Tanzania (Ngorongoro): 41 specimens and 5 eggs (1 of them embryonated).

Length up to 630 µm; body colourless; eyes absent; cuticle smooth, without pores but finely dotted on the legs. The mouth is terminal and provided with 10 peribuccal lamellae. Bucco-pharyngeal apparatus of *Macrobiotus* type, i.e. with rigid buccal tube provided with a ventral strengthening bar. In a specimen 410 µm long the buccal tube, measured from the stylet sheaths to the base of the pharyngeal apophyses, is 47.33 µm long and 8.27 µm wide (*pt* = 17.49)[1]. In the population the stylet supports are inserted at 73.66-76.39% of the buccal tube length (*pt* = 73.66-76.39). A band of teeth is present in the anterior portion of the buccal cavity (Fig. 1B); a crown of triangular, well developed teeth and 3 dorsal and 3 ventral transversal ridges are present posteriorly. Very rarely a few supplementary teeth can ben present between the crown of triangular teeth and the transversal ridges. The medio-dorsal and the medio-ventral ridges can ben subdivided into two teeth.

[1] *Pt* is the percent ratio between the length of a structure and the length of the buccal tube measured from the anterior margin of the stylet sheaths (more precisely from the transversal, dorsal ridges of the buccal cavity) to the base of the pharyngeal apophyses (PILATO 1981).

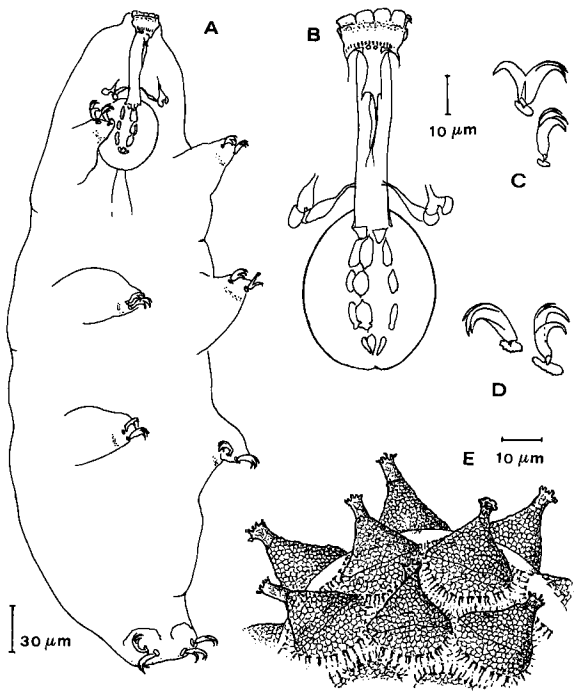

Fig. 1. — *Macrobiotus radiatus* n. sp.: (A) overall view; (B) bucco-pharyngeal apparatus; (C) claws of the second pair of legs; (D) claws of the hind legs; (E) detail of the egg.

The pharyngeal bulb (Fig. 1B) is 47 µm long and 39.5 µm wide in a specimen 417 µm long; it has apophyses, 3 rod-shaped macroplacoids and a microplacoid. The placoids are arranged in an arcuate line. The first macroplacoid is almost as long as the third one; the second macroplacoid is shorter than the first and the third ones. In the above-mentioned specimen 410 µm long, the entire line of placoids is 30.34 µm long (*pt* = 64.1), the line of the macroplacoids 24.32 µm (*pt* = 51.38), the first macroplacoid 8.2 µm (*pt* = 17.33), the second 6.71 µm (*pt* = 14.18), the third 8.31 µm (*pt* = 17.56), and the microplacoid 5.33 µm (*pt* = 11.26).

The branches of the claws, of *hufelandi* type, are connected for less than half their length, and are stout (Fig. 1C-D); the main branches are provided with well developed accessory points and at the base of the claw a clearly visible lunula exists.

In the above-mentioned specimen 410 µm long, the outer claws in the first pair of legs are 13.86 µm long (*pt* = 29.28), in the third pair of legs 15.1 µm (*pt* = 31.9) and in the hind legs 15.5 µm (*pt* = 32.75). The margin of the lunulae is smooth in the first three pairs of legs; finely denticulated in the hind legs.

On the first three pairs of legs, near the lunulae, a cuticular thickening, not very distinct, is present.

The eggs, free laid, are spherical and have (Fig. 1E) conical, well developed, processes. Only one egg was undeformed and measurable; its diameter is 85.74 µm

without the processes, and 124.5 µm including them. The processes (11 in the optical section, 20-22 per hemisphere), are 20-22 µm long; their basal diameter has the same length. Some processes are conical in shape with pointed apex; more frequently they have a conical basal portion and a cylindrical terminal portion with indented apex. A septum is visible between the two portions. The basal portion of the processes has a reticular sculpture (the meshes are small and almost isodiametrics) whereas the terminal portion (often quite unsculptured) has a vague sculpture. The base of the processes has a crown of elongated dots from which fine stripes radiate forming a radiant crown. The stripes relative to every process almost reach those of the surrounding ones, but they are not connected with them; the egg shell is not areolated.

Macrobiotus radiatus is similar to many species of the *harmsworthi* group but it differs from them in the characters of the eggs. In particular it differs from *M. diffusus* Binda & Pilato 1987, from *M. mauccii* Pilato 1974, *M. furciger* Murray 1906, *M. gildae* Maucci & Durante Pasa 1980 and from *M. australis* Pilato & D'Urso 1976 by having the stylet supports inserted on the buccal tube in a more cephalic position. It differs from *M. gildae* by having shorter claws, and from *M. australis* in some characters of the buccal armature. It differs from the oculated species of the group by lacking eyes. It differs from *M. orcadensis* Murray 1907, *M. arguei* Pilato & Sperlinga 1975, *M. nuragicus* Pilato & Sperlinga 1975, *M. blocki* Dastych 1984, from *M. furciger* and from *M. montanus* Murray 1910 by having a longer placoid and macroplacoid line, and, *M. nuragicus* excepted, by having a longer microplacoid; it differs from *M. arguei* by lacking cuticular tubercles.

The holotype (slide no. 3708) and the paratypes are preserved in the Binda & Pilato collection, Dipartimento di Biologia Animale, University of Catania.

Macrobiotus sapiens Binda & Pilato 1984

Lichen from Namib Desert (South West Africa): 7 specimens.

The *pt* values relative to the insertion point of the stylet supports on the buccal tube agree with the values indicated as characteristics of the species (77.77-81.26). The claws are slender. These two characters allow us to distinguish, even in the absence of the eggs, *Macrobiotus sapiens* from *Macrobiotus echinogenitus* Richters 1904 where the dorsal ridges of the buccal armature are, as in *M. sapiens* joined in a single ridge (BINDA 1988); in *M. echinogenitus* the stylet supports are inserted on the buccal tube at 74.42-76.36% of its length [in other species there is a significantly smaller difference (PILATO et al. 1982) since the individual variability of that character is very reduced].

Macrobiotus sapiens has been found in Sicily and it is new for the African fauna.

Macrobiotus vanescens n. sp. (Figs 2-3A-C, F)

Mosses from Tanzania (Ngorongoro): 143 specimens and 53 eggs (some of them embryonated).

Length up to 600 µm, body (Fig. 2) colourless; eyes absent; cuticle smooth without pores but finely dotted on the legs. The bucco-pharyngeal apparatus (Fig. 3A)

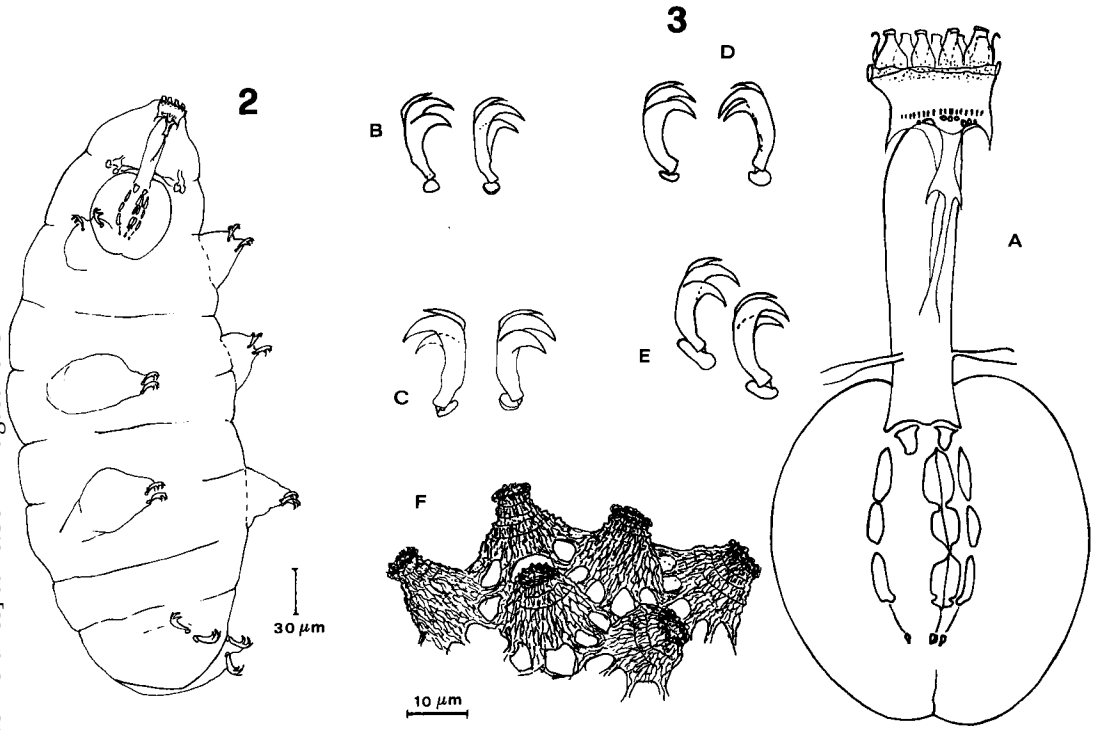

Fig. 2. — *Macrobiotus vanescens* n. sp.: overall view.

Fig. 3. — (A-C, F) *Macrobiotus vanescens* n. sp.: (A) bucco-pharyngeal apparatus; (B) claws of the third pair of legs; (C) claws of the hind legs; (F) detail of the egg. (D-E) Claws of *Macrobiotus richtersi:* (D) claws of second pair of legs; (E) claws of the hind legs.

is of the *Macrobiotus* type i.e. with rigid buccal tube and with the ventral strengthening bar present; the mouth is terminal and provided with 10 peribuccal lamellae. In a specimen 525 µm long the buccal tube, measured from the stylet sheaths (more precisely from the transversal, dorsal ridges of the buccal armature) to the base of the pharyngeal apophyses, is 65.6 µm long and 13.7 µm wide (*pt* = 20.8). The stylet supports are inserted on the buccal tube at 77.31-79.42% of its length (*pt* = 77.31-79.42). The buccal armature is of the *richtersi* type (PILATO 1972); an anterior band of teeth and a posterior crown of triangular, well developed, teeth are present; in the caudal portion of the buccal cavity 3 dorsal and 3 ventral transversal ridges are present that can be subdivided into a series of teeth. Pairs of triangular teeth can be very close (but not joined).

The pharyngeal bulb (Fig. 3A) has apophyses, 3 macroplacoids and, far away from the third macroplacoid, a little, faint, sometimes almost invisible microplacoid (the specific name refers to these characters of the microplacoid). In the same above-mentioned specimen 525 µm long the entire line of macroplacoids is 34.7 µm long (*pt*

= 52.87), the first macroplacoid 12.19 µm (*pt* = 18.57), the second 8.85 µm (*pt* = 13.48), the third 12.52 µm (*pt* = 19.08), the microplacoid 2.68 µm (*pt* = 4.08). The third macroplacoid can be a little longer or shorter than the first one; the second is the shortest. A cuticular connection between the third macroplacoid and the microplacoid is present.

The claws, of *hufelandi* type, have well developed accessory points and lunulae. The basal portion of the claws, observed in lateral view (Fig. 3B-C) appear narrow (chiefly on the first three pairs of legs) and not a little enlarged as in *M. richtersi* Murray 1911 (Fig. 3D-E); for this character the claws appear more slender than those of *M. richtersi*. In the same specimen the outer and the inner claws on the third pair of legs are 15.53 µm and 15.10 µm long respectively (*pt* = 23.66 and 23), on the hind legs the posterior and the anterior claws are 20.36 µm and 19.67 µm long respectively (*pt* = 31.02 and 29.97). On the first three pairs of legs, near the lunulae, a faint cuticular thickening, sometimes difficult to see, is present.

The eggs, free laid, are spherical, areolated and have (Fig. 3F) tronco-conical processes (9-12, very often 11, in the optical section; 18-20 per hemisphere). Their diameter is 83-93 µm without processes, and 117-125 µm with the processes; these structures are 16-17 µm long; their basal diameter is 24-25 µm. Their surface has a reticular sculpture with elongated meshes; their distal end is irregularly indented, almost pimply, but not subdivided into distinct points. Almost always their surface is transversally annulated.

Macrobiotus vanescens is very akin to *M. richtersi* but differs from it by having smaller, faint (sometimes almost invisible) microplacoid; by having the basal portion of the claws narrower; by having the stylet supports inserted on the buccal tube in a more cephalic position (but a little overlap of the *pt* values is possible: 77.31-79.42 in *M. vanescens* and 79.2-81.81 in *M. richtersi*); by having a marked difference between the second macroplacoid on one hand and the first and the third on the other hand; by having the distal end of the egg processes strongly indented, almost pimply, and by having the egg processes surface almost always transversally annulated.

Macrobiotus vanescens differs from *M. peteri* Pilato et al. 1989 by having shorter, faint microplacoid and longer claws (Table 1); by producing bigger eggs with less numerous processes; by having the distal end of the egg processes indented, almost pimply, but not subdivided in distinct points; and by having the egg processes almost always transversally annulated.

The holotype (slide no. 3710) and the paratypes are preserved in the Binda & Pilato collection, Dipartimento di Biologia Animale, University of Catania.

Macrobiotus iharosi n. sp. (Fig. 4, 5A-B, 6A-C)

Mosses from Tanzania (Ngorongoro): 261 specimens and 29 eggs (some of them embryonated).

Body colourless up to 500 µm long; cuticle smooth with circular and elliptical pores and finely dotted in the legs. The bucco-pharyngeal apparatus (Fig. 5A-B) is of *Macrobiotus* type, i.e. with rigid buccal tube and with ventral strengthening bar present. In a specimen 365 µm long the buccal tube, measured from the anterior margin of the stylet sheaths to the base of the pharyngeal apophyses, is 33.75 µm long and 3.73 µm wide (*pt* = 11.07). The stylet supports are inserted on the buccal tube at

Table 1.
Dimensions of specimens of *Macrobiotus vanescens* n. sp. and of *Macrobiotus peteri* Pilato et al. 1989.

	M. vanescens	*M. peteri*
Body length	525	239
Buccal tube length	65.63	40.6
Buccal tube width	13.68 *pt* = 20.85	7.14 *pt* = 17.3
Stylet supports	*pt* = 79.42	*pt* = 80.65
Macroplacoids line	34.7 *pt* = 52.87	22.32 *pt* = 54.97
First macroplacoid	12.19 *pt* = 18.57	6.71 *pt* = 16.53
Second macroplacoid	8.85 *pt* = 13.48	4.75 *pt* = 11.7
Third macroplacoid	12.52 *pt* = 19.08	6.06 *pt* = 14.92
Microplacoid	2.68 *pt* = 4.08	2.68 *pt* = 6.6
Outer claws of the third pair of legs	5.53 *pt* = 23.66	7.94 *pt* = 19.56
Outer claws of the hind legs	20.36 *pt* = 31.02	9.9 *pt* = 24.38

Measurements in µm.

72-75.21% of its length (*pt* = 72-75.21). The mouth is terminal and provided with 10 peribuccal lamellae. In the buccal cavity an anterior band of very fine teeth, very difficult to see, a posterior band of minute teeth and 3 dorsal and 3 ventral transversal ridges are present. The dorsal ridges are joined to one another to form a single, long, transversal ridge.

In the above-mentioned specimen 365 µm long, the pharyngeal bulb is 29.8 µm long and 26.9 µm wide. It has apophyses, 2 rod-shaped macroplacoids and a microplacoid. The entire line of placoids is 17.19 µm long (*pt* = 50.64), the line of macroplacoids is 14.52 µm long (*pt* = 43.02), the first macroplacoid 8.42 µm (*pt* = 24.95), the second 5.35 µm (*pt* = 15.82), the microplacoid 2.36 µm (*pt* = 6.99). The first macroplacoid has a very clear central incision.

The claws, of *hufelandi* type, have (Fig. 6B-C) well developed accessory points and distinct lunulae whose margin is smooth on the first three pairs of legs and almost denticulated on the hind legs. The outer claws of the third pair of legs are 11.1 µm long (*pt* = 32.9), the inner claws 10.1 µm (*pt* = 28.89); on the hind legs the outer claws are 12.41 µm long (*pt* = 36.77) and the inner claws 11.83 µm (*pt* = 35.05).

The eggs, free laid, are (Fig. 6A) very similar to those of *Macrobiotus sapiens* Binda & Pilato 1984. Their diameter, without processes, is 65-70 µm; the processes (about 30 in the optical section and 106-126 per hemisphere), are 4-5 µm long, their basal diameter is 5-5.5 µm, the terminal disc has about 8 marginal teeth and a diameter of 3.6-4.2 µm. The egg shell has a reticular sculpture as in *M. sapiens*.

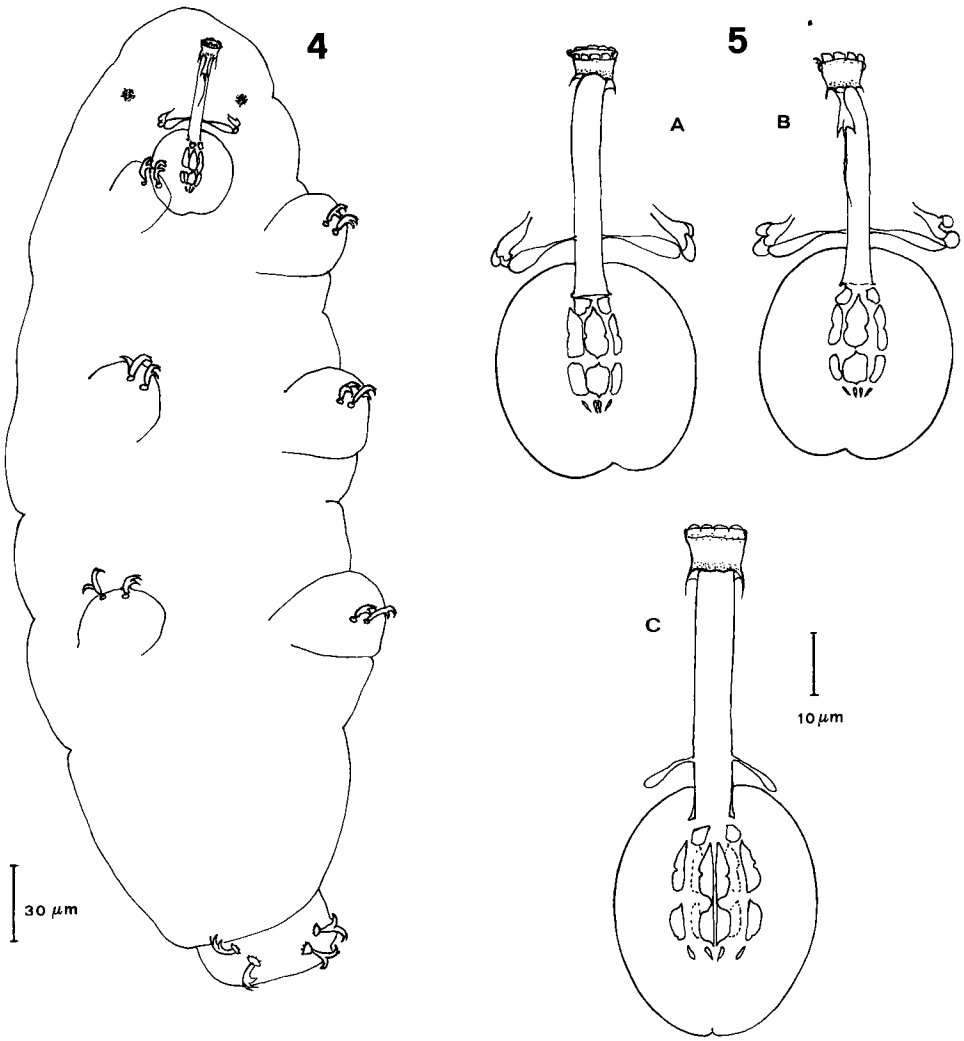

Fig. 4. — *Macrobiotus iharosi* n. sp.

Fig. 5. — (A-B) Bucco-pharyngeal apparatus of *Macrobiotus iharosi* n. sp. in dorsal and ventral view respectively. (C) Bucco-pharyngeal apparatus of *Macrobiotus sapiens*. Specimens of very similar body size have been chosen.

Macrobiotus iharosi (Fig. 5A-B) differs from *M. sapiens* (Fig. 5C) by having clearly smaller (shorter and narrower) buccal tube (in Fig. 5 the buccal apparatuses of specimens having the same body size are drawn); by having the stylet supports inserted on the buccal tube in a more cephalic position (*pt* = 72-75.21 in *M. iharosi* and 75.52-78.81 in *M. sapiens*). The claws (Fig. 6B-C) of *M. iharosi* are shorter and clearly less slender; the lunulae have denticulated margin in the hind legs. In *M. iharosi* the terminal disc of the egg processes is smaller than the base whereas in *M.*

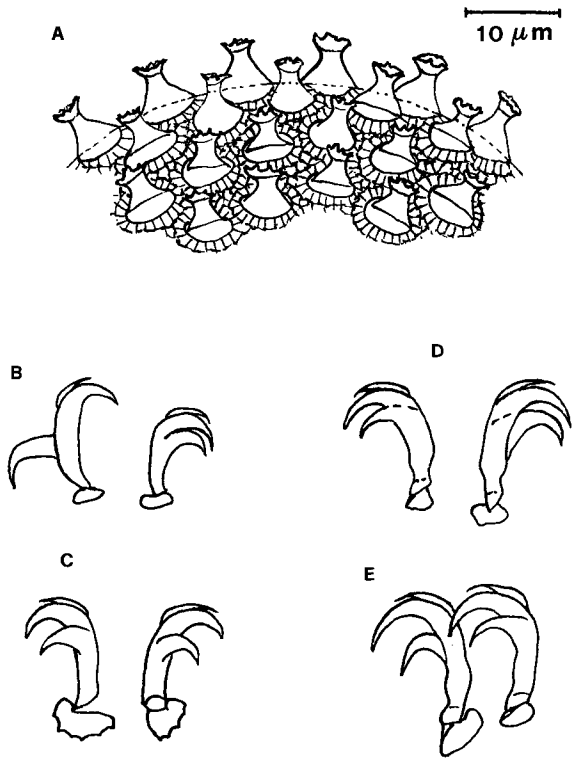

Fig. 6. — (A-C) *Macrobiotus iharosi* n. sp.: (A) detail of the egg; (B-C) claws of the third and of the fourth pair of legs respectively. (D-E) Claws of *Macrobiotus sapiens:* (D) claws of the third pair of legs; (E) claws of the fourth pair of legs. Specimens of very similar body size have been chosen.

sapiens the terminal disc and the basal diameter are almost the same length. In Table 2 specimens of *M. iharosi* and of *M. sapiens* of the same body size are compared; it should be noted that in *M. iharosi* the buccal tube is shorter, thus the *pt* values relative to the claws appear almost similar in the compared species whereas the absolute values of the length are very different.

Macrobiotus iharosi differs from *M. echinogenitus* Richters 1904 by producing completely different eggs and by having a very weak buccal armature (particularly the anterior band of teeth that often is almost invisible).

M. iharosi differs from *M. hufelandi* Schultze 1833 by having the 3 dorsal ridges of the buccal armature joined to form a single, long, transversal ridge; by having the stylet supports inserted on the buccal tube in a more cephalic position (*pt* = 72-75.21 in *M. iharosi*, 77.77-81.26 in *M. hufelandi*), and producing eggs different in some characters.

We name the species *M. iharosi* in honour to Prof. Gyula Iharos (Hungary).

The holotype (slide no. 3750) and the paratypes are preserved in the Binda & Pilato collection, Dipartimento di Biologia Animale, University of Catania.

Table 2.
Dimensions of specimes of *Macrobiotus iharosi* n. sp. and of *Macrobiotus sapiens* Binda & Pilato 1984 with very similar body size.

	M. iharosi	*M. sapiens*
Body length	365	360
Buccal tube length	33.75	37.13
Buccal tube width	3.73 *pt* = 11.07	5.69 *pt* = 15.34
Stylet supports	*pt* = 74.73	*pt* = 78.81
Macroplacoids line	14.52 *pt* = 43.01	16.58 *pt* = 44.67
First macroplacoid	8.42 *pt* = 24.95	9.40 *pt* = 25.31
Second macroplacoid	5.34 *pt* = 15.82	5.95 *pt* = 16.03
Microplacoid	2.36 *pt* = 6.99	2.54 *pt* = 6.84
Outer claws of the third pair of legs	11.10 *pt* = 32.90	13.83 *pt* = 37.24
Outer claws of the hind legs	12.41 *pt* = 36.77	15.31 *pt* = 41.20

Measurements in μm.

Minibiotus intermedius (Plate 1889)

Mosses from Tanzania (Ngorongoro): 3 specimens and 1 egg; South Africa (Tzitzikama): 6 specimens.

The cuticle has big perlae. The diameter of the egg is 56 μm without the processes and 69.6 μm including them which have the typical shape but are 6.8-7.2 μm high. In the optical section we count 16 processes. A typical egg has a diameter of 40-50 μm and 17-38 processes, 3-5 μm high, in the optical section. The differences may be due to the individual variability. *Minibiotus intermedius* is considered a cosmopolitan species.

Isohypsibius kristenseni Pilato, Catanzaro & Binda 1989

Soil from Mozambique (Inhambane): 1 specimen.

This species was recently found in a Sicilian river, Torrente Cutò (Nebrodi Mounts); our specimen was found in a soil sample. As in the typical specimens, it was not possible to discern if on the first three pairs of legs the lunulae are present or not. They are definitely present, large but poorly sclerified, on the hind legs.

Isohypsibius kristenseni is new for the African fauna.

Hypsibius dujardini (Doyère 1840)

Mosses from Tanzania (Ngorongoro): 29 specimens.

The *dujardini-convergens* group requires a specific study. We attribute (according with BERTOLANI 1982) to *H. dujardini* 29 specimens having smooth cuticle, two macroplacoids and a small septulum, and a cuticular thickening between the claws of the hind legs.

Hypsibius dujardini is considered a cosmopolitan species.

Ramazzottius szepticki (Dastych 1980)

Moss from Tanzania (Ngorongoro): 2 specimens.

Only one specimen (the holotype) was known of this species. As we found 2 specimens perfectly corresponding to the description of DASTYCH, we only add some descriptive details here.

The apophyses for the insertion of the stylet muscles have the shape described by BINDA & PILATO (1986) as characteristic for the genus *Ramazzottius*. On the head, instead of the eyes, two elliptical organs are present as in the other species of the genus.

In a specimen about 260 μm long the buccal tube, measured from the anterior margin of the stylet sheaths to the base of the pharyngeal apophyses, is 28.13 μm long and 1.89 μm wide (*pt* = 6.7). The stylet supports are inserted at 62.58% of the buccal tube length (in the second specimen at 63.23%). Posteriorly to the stylet supports the tube wall is thickened as in the other species of the genus (BINDA & PILATO 1986). The pharyngeal bulb (in the same specimen about 260 μm long) is 25.4 μm long and 21.8 μm wide. The entire line of the macroplacoids is 6.99 μm long (*pt* = 24.5); the first macroplacoid is 3.63 μm long (*pt* = 12.9); the second macroplacoid is 2.94 μm long (*pt* = 10.45). The inner claws of the second and of the third pair of legs are 8.27 μm long (*pt* = 38.7); unfortunately the other claws are not measurable.

The species was only known for South Africa.

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