

Halechiniscidae and Echiniscoididae from the Western Mediterranean Sea. (Tardigrada : Heterotardigrada).

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Abstract : In the Orosei Gulf, off Sardinia (Tyrrhenian Sea) two new species of Heterotardigrada have been found : a Styraconyxinae, *Paratanarctus kristenseni* n. g., n. sp. and an Echiniscoididae, *Echiniscoides bruni* n. sp. Furthermore a population of *Tholoarctus natans* has been found. The presence in the latter of peduncles in all the toes suggests the necessity to institute a new subspecies.

Résumé : Au large de la Sardaigne (Mer Tyrrhénienne), deux espèces de Heterotardigrades ont été trouvées : une de la famille des Styraconyxinae, *Paratanarctus kristenseni* n. g., n. sp. et une de la famille Echiniscoididae, *Echiniscoides bruni* n. sp. Par ailleurs, une population de *Tholoarctus natans* a été trouvée. La présence chez cette dernière espèce de pédoncules sur toutes les extrémités suggère la nécessité de créer une nouvelle sous-espèce.

INTRODUCTION

In 1985 in Sardinia, many samples of sediment were collected from the bottom of the Orosei Gulf (40° 20' 30" N - 9° 40' 15" E) in order to study the meiobenthos, and in particular the Tardigrada. All the data of this research will be published in a paper as soon as possible ; the careful and meticulous examination of the numerous samples, which is still in progress, is revealing numerous species of Heterotardigrada some of which are new. Some of the first results have been already published (D'Addabbo Gallo *et al.* 1989, Grimaldi de Zio *et al.* 1988, 1990 a-b, 1991). In the present paper two other new species of Heterotardigrada, Arthrotardigrada and Echiniscoidea, and a new subspecies of *Tholoarctus natans*, are described.

Paratanarctus kristenseni n.g., n. sp.

Family Halechiniscidae Thulin, 1928

Diagnosis :

Arthrotardigrada without strongly sclerotized dorsal segmental plates. Complete or incomplete set of cephalic appendages ; secondary clavae sometimes club-

shaped or dome-shaped or indistinguishable. Each adult leg with four digits bearing claws either simple or with accessory hooks. Peduncles sometimes present in the digits ; seminal receptacles generally present. Cirrus E often with a basal accordion-shaped articulation.

Subfamily Styraconyxinae Kristensen & Renaud-Mornant, 1983

Diagnosis :

Halechiniscidae with peduncles present either on all digits or only on the first and fourth ones, or absent. Heart-shaped proximal pads sometimes present at the base of second and third digits. Crescent-shaped claws with one, two or no accessory points, according to the genera. Complete set of cephalic cirri always present. Secondary clavae sometimes absent. Primary clavae and fourth papillae similar. Cuticular plates absent.

Genus : *Paratanarctus*, n.g.

Diagnosis :

Styraconyxinae with a complete set of cephalic sense organs. Cephalic cirri short and thin, primary clavae tubular, P_4 coxal, cirrus E articulated with an elementary accordion-plated portion. Lance-shaped tarsus with pretarsus. Basal pads on all the digits. All the claws with external dorsal calcars. Peduncles not present.

Type-species : *Paratanarctus kristenseni* n. sp. (Figs. 1, 2 ; Tab. I)

Etymology :

Paratanarctus means close to *Tanarctus* (from the grec word parà = close to) ; the species is dedicated to prof. R. M. Kristensen.

Holotype : adult female 125 μm long, 55 μm wide. The cephalic region is rounded, with a subterminal buccal cone. The set of cephalic appendages is complete. All the cephalic cirri are very short and thin : the dorsal medial cirrus (15 μm) has a small cirrophorus. The dorsal internal cirrus, very near to the mouth, consists of a scapus (4 μm) and a small terminal spike-like flagellum (2 μm). The ventral external cirrus has a 5 μm long scapus and a 2 μm long flagellum. The lateral cirrus (11 μm) and the primary clava (6 μm) are located on the same cirrophorus. The primary clava is elongated, almost tubular, with a terminal pore and a "van der Land's body" inside its base. The cirrus is dorsal to the primary clava. The secondary clava (8 μm), is located between the external and the internal cirri ; it is lens-shaped (Fig. 1 A, D, D', G).

Cirrus E (15 μm) has an articulated basal region with twelve wide and parallel folds (Fig 1 H).

The legs have a lance-like tibia and a tarsus which bears the two external digits whereas a bell-shaped pretarsus (5 μm) bears the two medial digits. No peduncles are present in the digits which do however have some oblique folds and a proximal pad.

The external claws are simple, whereas the medial ones have an accessory dorsal hook. All the claws are sheathed and have a mid-dorsal calcar (Figs. 1 B, C - 2).

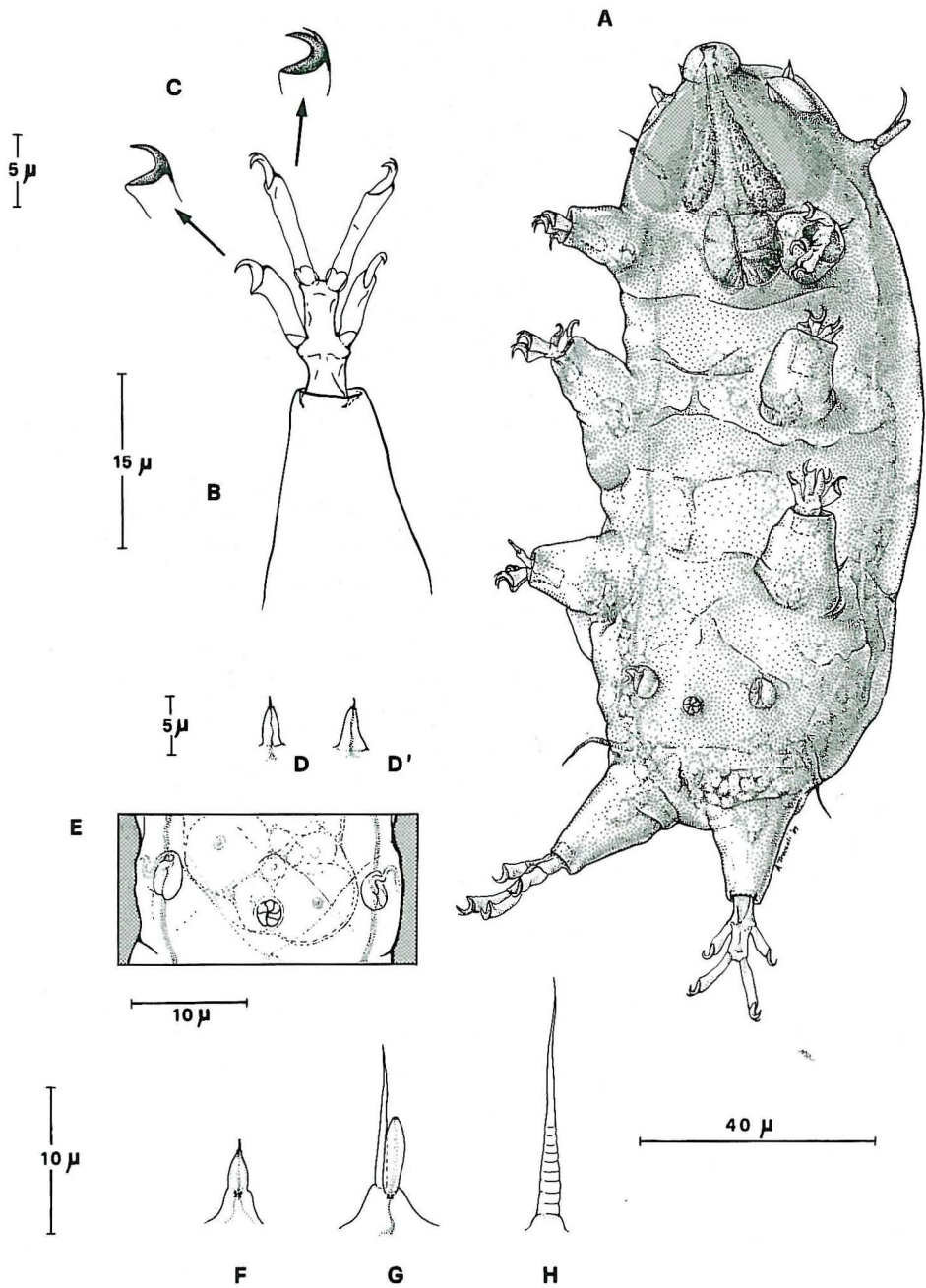


Fig. 1 : *Paratanarctus kristenseni* n.sp. **A** - Adult female (holotype) ventral view. **B** - Fourth pair leg. **C** - Internal and external claws. **D** - External cirrus. **D'** - Internal cirrus. **E** - Female ventral region with gonopore and seminal receptacles. **F** - P₄. **G** - Primary clava and lateral cirrus. **H** - Cirrus E.

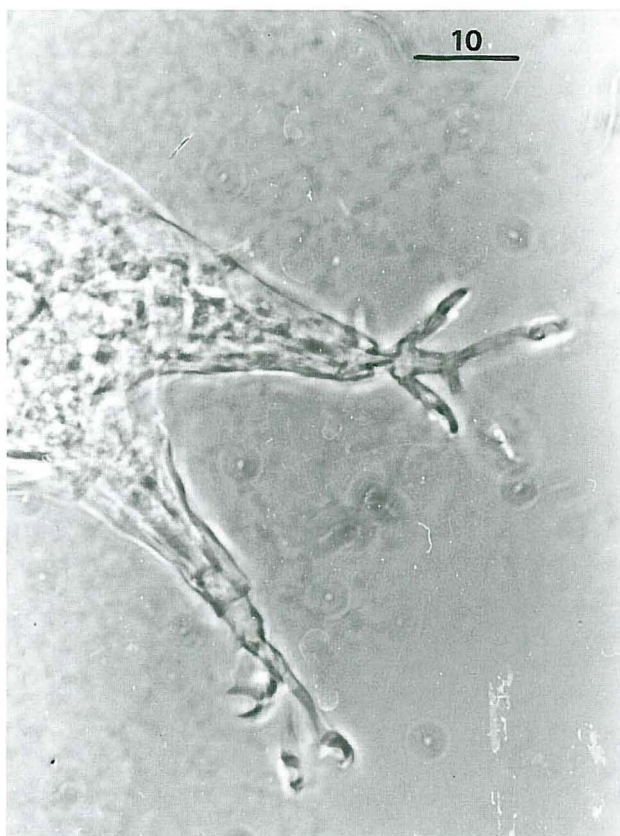


Fig. 2 : *Paratanarctus kristenseni* n.sp. Fourth pair leg (Scale bar = 10 μ m).

TABLE I

Measurements (in μ m) of *Paratanarctus kristenseni* n.sp. (all adult females)

	holotype		paratypes	
L	125	143	185	144
W	55	42	85	55
mC	15		10	
iC	6	5	5	5
eC	7	6	4	4
LC	11	11	12	13
Cl1	6	5	9	8
Cl2	8			
P ₄	4 + 1	3 + 1	5 + 1	
CE	15	20	25	20
A-G	9	7		

Sense organs on all the legs. The first leg spine (P_1) is like the cephalic cirri : it consists of a scapus and a bristle, whereas the second and third leg spines (P_2 and P_3) are short bristles. The sense organ of the fourth leg (P_4) is a papilla with a small and thin terminal tube (1 μm). It is located on the coxa with a short cirrophorus and it has a basal refractive "van der Land's body" (Fig. 1 F).

The rosette-like gonopore is, as usual, ventral. Seminal receptacles are present. They are vesicular (5 μm), and protrude slightly on the lateroventral body surface. They are in a position slightly anterior to the gonopore and open laterally (Fig. 1 E). Type material : holotype adult female, slide SF. 309016. Paratypes (four females) : slides SF 309017, SF. 309018, SF 309019, SF 309020 (in authors' collection).

Type locality :

Scala di Ferro in the Orosei Gulf (Sardinia), Italy ; samples collected in September 1985.

Ecology : subtidale, - 38 m of depth, in sandy detritus covered with green algae.

DISCUSSION

The new species is interesting because even though it shows evident affinities with both the genera *Styraconyx* and *Tanarctus*, it cannot be included in either of these two genera. In fact the general body shape and the head morphology, the cephalic sense organs distribution and structure, are typical of some species of the genus *Styraconyx*, whereas the leg morphology is very close to the *Tanarctus* leg shape : the tibia is lance-like and the tarsus bell-shaped. Furthermore there is a pretarsus which bears the medial digits, which is much more evident than the "poigne" of the sub-family Tanarctinae (Renaud-Mornant, 1987a) ; a pretarsus of this sort also exists in the genus *Archechiniscus* (see Grimaldi de Zio & D'Addabbo Gallo, 1987). At the base of the digits there is a pad-shaped fold as in *Styraconyx*, the presence of which could justify the total absence of peduncles, as suggested by Kristensen & Renaud-Mornant (1983). Pad-like folds, although not described by Renaud-Mornant, are also present in some species of the genus *Tanarctus* : in fact in her drawing of *Tanarctus gracilis* a thick fold is distinguishable at the digit base (Renaud-Mornant, 1980), whereas in *T. heterodactylus* Renaud-Mornant (1980) describes folds in the base of the medial digits, and in *T. helleouetae* the same author indicates a heart-shaped basal pad in the digits (Renaud-Mornant, 1984). The total absence of peduncles can be considered as an apomorphic condition. The claws are neither like those of *Styraconyx*, nor those of *Tanarctus*, but strongly resemble those of *Halechiniscus*. The P_4 is like that of *Styraconyx* and *Halechiniscus*, while the secondary clavae are dome-shaped as in *Styraconyx* and *Archechiniscus*.

Paratanarctus greatly differs from *Tanarctus* particularly in the primary clavae and P_4 which in the latter are very long and sometimes complicated (Renaud-Mornant, 1980, 1984 ; Lindgreen, 1971 ; Mc Kirdy, Schmidt, Mc Ginty Bayly, 1976 ; Grimaldi de Zio *et al.*, 1982) and in its lenticular secondary clavae.

Cirrus E morphology is very primitive with an elementary articulation which is not present in either *Styraconyx* and *Tanarctus*.

On the basis of all these elements, *Paratanarctus*, with the one species *P. kristenseni*, is a new genus of Styraconyxinae. It adds new evidence of a connection between the sub-families Styraconyxinae and Tanarctinae (Kristensen & Renaud-Mornant, 1983) and with the sub-family Halechiniscinae.

Tholoarctus natans pedunculatus n. subsp. (Figs. 3, 4, 5 ; Tab. II).

Family Halechiniscidae Thulin, 1928

Subfamily Styraconyxinae Kristensen & Renaud-Mornant, 1983.

Genus *Tholoarctus* Kristensen & Renaud-Mornant, 1983.

Diagnosis :

Styraconyxinae with barrel-shaped epicuticle all around the body ; the body elongated and thin. Complete set of cephalic appendages. Ovoid primary clavae ; enlarged secondary clavae. Leg sense organs only on the first (P_1) and fourth (P_4) pair of legs. P_4 consisting of a papillar basal part and a terminal short spike. Cirri A and E with cirrophori, partially included in funnel-shaped cuticular folds. All the claws with two accessory points : one dorsal and one internal near the base. Males and larvae can have simple claws in the external digits. Buccal tube with two lateral projections at mid-length. Long and thin stylet supports. Stylets without articulation on the buccal tube. Placoids, small or absent ; three small apodemes can be observed in the anterior part of the pharyngeal bulb.

Type species : *Tholoarctus natans* Kristensen & Renaud-Mornant, 1983.

General diagnosis :

Tholoarctus with sexual dimorphism concerning the body size, cuticle and claws. Long cephalic cirri consisting only of scapus and flagellum, without a tapering terminal part. Primary ovoid clava and cirrus A almost completely contained in a cuticular fold into which they can be retracted. Legs, head and the most sense organs retractable in an epicuticle funnel shaped fold. Only the terminal flagellar part of the cirri A and E can extend out of the funnel. P_4 consisting of a papilla, included in a cuticular sheath, with a terminal spine emerging from it.

Tholoarctus natans natans Kristensen & Renaud-Mornant, 1983.

Diagnosis :

Tholoarctus natans with peduncles only in the external fingers of the adults. Terminal part of the external digit flexible because the peduncles do not reach the claw bases.

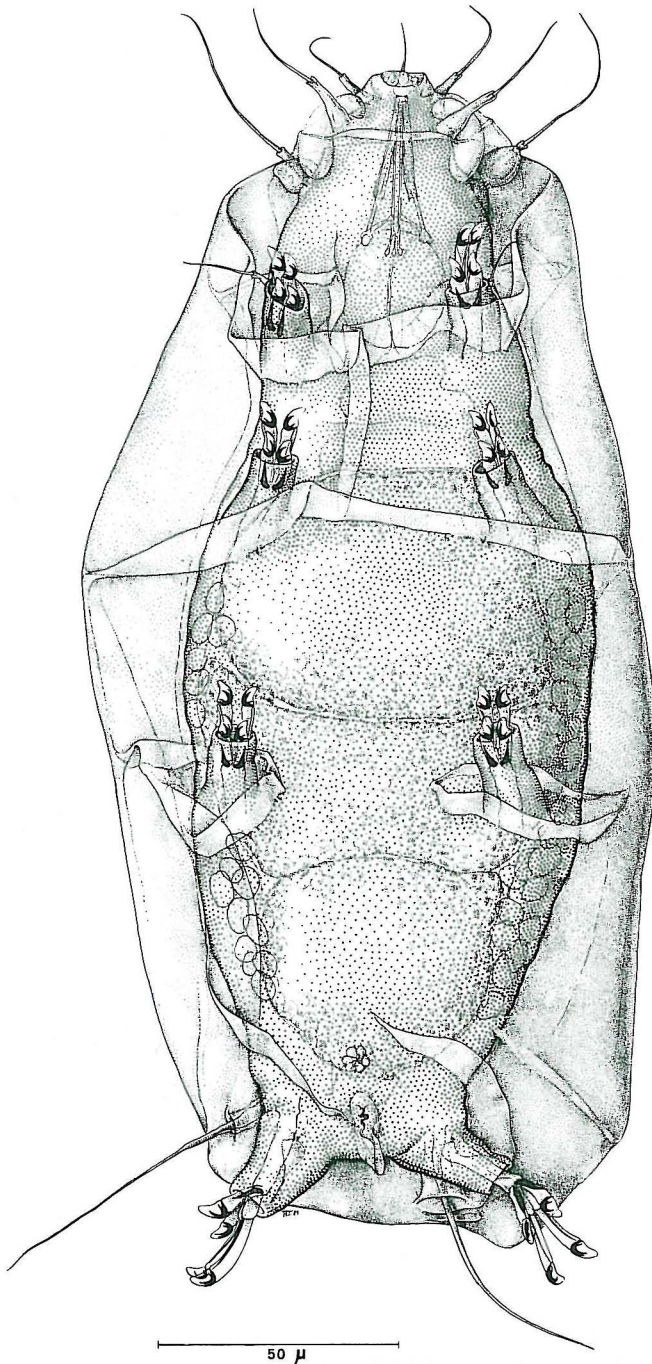


Fig. 3 : *Tholoarctus natans pedunculatus* n.subsp. Adult female (holotype) ventral view.

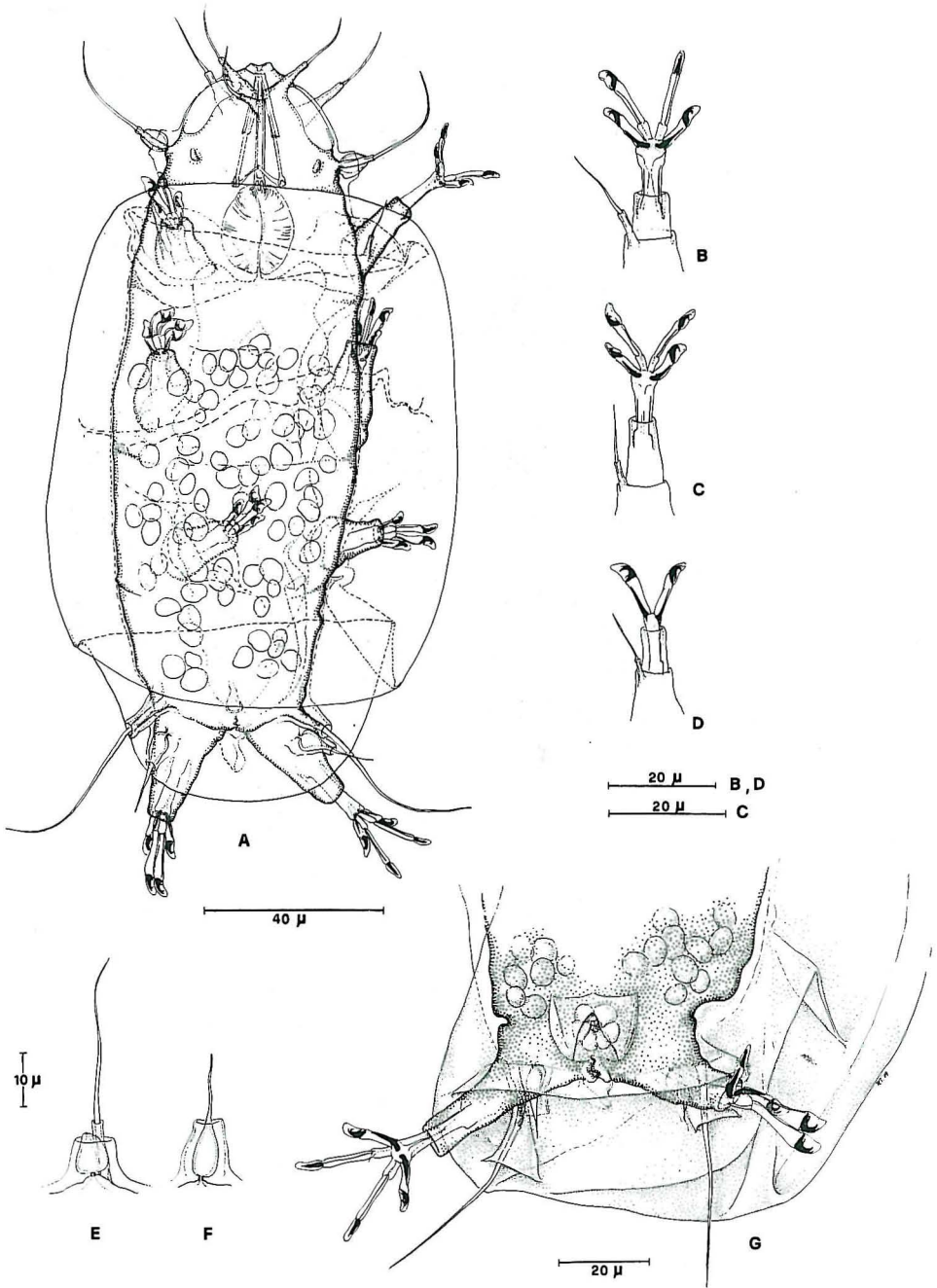


Fig. 4 : *Tholoarctus natans* subspecies *pedunculatus* n. subsp. A - Adult male ventral view . B - Adult female first leg. C - Second stage larva first leg. D - First stage larva first leg. E Primary clava and lateral cirrus. F - P₄. G - Adult female caudal ventral region.

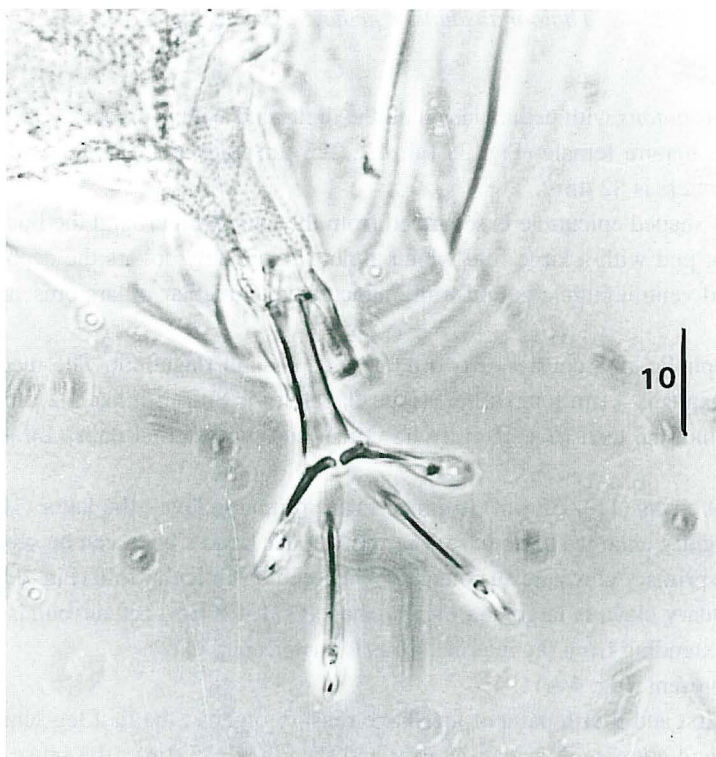


Fig. 5 : *Tholoarctus natans* subspecies *pedunculatus* n. subsp. Fourth pair leg. Peduncles are visible in all the digits (Scale bar = 10 μ m).

TABLE II

Measurements (in μ m) of the adults of *Tholoarctus natans pedunculatus* n.subsp.

	n	min	max	\bar{x}	female holotype	male allotype
L	6	160	320	222	225	165
W	4	83	140	106	115	90
mC	4	22	26	24	14	17
iC	4	23	34	28	22	24
eC	4	27	45	33	34	27
IC	3	40	54	46	46	39
Cl ₁	4	8	10	9	10	7
Cl ₂	4	22	27	23	21	19
CE	4	41	50	46	63	50
P ₁	1	17	17	17	23	15
P ₄					15	19
1De	2	8	10	9		5
1Di	2	12	15	13		9
4De	4	8	12	9	13	6
4Di	4	15	22	18	16	14

Tholoarctus natans pedunculatus n. subsp.

Diagnosis :

Tholoarctus natans with peduncles on all the digits and with eye-spots.

Holotype : mature female (Fig. 3, Tab. II), 225 μm long and 115 μm wide (the width without the cuticle is 82 μm).

The barrel-shaped epicuticle is separated from the cuticle all around the body. It extends at the anterior end with a large fold which almost completely covers the cephalic region ; the dorsal and ventral cuticle is uniformly punctuated. Cuticular pillars present also on the legs.

All the cephalic cirri consist of two parts : scapus and flagellum. The medial cirrus is dorsal : its scapus is 4 μm long, whereas the flagellum is 8 μm ; it has a 2 μm basal cirrophorus. The internal cirri (6 + 16 μm) are dorsal and the external ones (14 + 20 μm) are ventral.

The lateral cirrus (11 + 35 μm) is dorsal to the primary clava ; the latter (10 + 7 μm) is ovoid and slightly enlarged at its base where a Van der Land's body can be observed ; lateral cirrus and primary clava are surrounded by a common cuticular fold (Fig. 4 E).

The secondary clava is large and kidney-shaped (21 + 8 μm) ; it surrounds the external cirrus base, extending from the internal cirrus to the primary clava.

Eyes are present (Fig. 4 A).

Only the first and fourth pairs of legs have sensory organs ; the first leg sense organ (P_1) is very long and consists of scapus (8 μm) and flagellum (15 μm) ; the sense organ of the fourth leg (P_4), similar to the primary clava, consists of a pear-shaped proximal portion (9 x 5 μm) and a tubular terminal spine (6 μm) ; it is almost completely inclosed in a cuticular fold (Fig. 4 F).

Cirrus E consists of scapus (8 μm) and flagellum (55 μm) ; the scapus, with an accordion plated portion, is contained within a bell-shaped cuticular fold.

Each leg ends with four digits. In the first three pairs of legs the external digits (7 μm) have peduncles with two small lateral processes at 1/4 of their length, whereas at 1/2 of their length they become so thin as to be indistinguishable ; the peduncle proximal part is spoon-shaped. The internal digits (10 μm) have proximal heart-shaped pads and very thin simple rod-shaped peduncles. All the peduncles reach the claw bases. The digits, peduncles and claws of the fourth pair, are longer and larger ; the peduncles, in particular, are much more evident (Fig. 5). The internal and external claws are similar : they have two accessory hooks : one dorsal and one internal near the base.

The claw sheath is very large and completely covers the claw.

The rosette-shaped gonopore is partially covered with two large cuticular folds (Fig. 4 G). On each side of the gonopore are the openings of the seminal receptacles each consisting of a vesicular latero-dorsal portion and a slightly sinuous ventral duct.

The anus is located at the posterior end between the fourth pair of legs.

The distance between anus and gonopore is 8 μm .

Type locality : Orosei Gulf, Sardinia (Sample 13/D collected in September 1985).

Ecology : subtidal, - 30, - 40 m of depth, in coralligenous detritus.

Allotype : mature male, 165 μm long and 90 μm wide (the width without the cuticle is 56 μm) (Fig. 4 ; Tab. II). The general body shape is as in the female, with the epicuticle almost completely separated from the cuticle, all around the body.

TABLE III

Measurements (in μm) of larval stages of *Tholoarctus natans pedunculatus* n. subsp.

	1st stage		2nd stage		
		n	min	max	\bar{x}
L	125	4	145	230	183
W	65	4	65	92	78
mC					
iC	18	3	16	25	19
eC	23	3	25	33	30
IC		3	33	49	38
Cl ₁	8	3	10	11	10
Cl ₂		2	16	23	19
CE	37	4	40	65	50
P ₁					
P ₂					
1De					
1Di	10				
4De		1	6	6	6
4Di	14	1	12	12	12

The shape and length of the cephalic cirri is as in the holotype : medial cirrus 17 μm , internal cirri 24 μm , external cirri 31 μm (15 + 16 μm), lateral cirri 39 μm (10 + 29 μm) and primary clavae 7 x 9 μm . The primary clava is pear-shaped. The secondary clava is 19 μm long and 5 μm wide and lens-shaped. It is more flattened than in the female and extends from the internal cirrus to the primary clava base.

In the male the external claws are simple, whereas the internal ones have a dorsal spur and a ventral accessory hook.

The gonopore is covered with a crescent fold which can protrude to become a tubular copulatory organ.

Type locality : Orosei Gulf, Sardinia (Sample 33/D), collected in May 1988.

Ecology : subtidal, - 80, - 100 m of depth, in coralligenous detritus with sand.

Paratypes (Tab. III)

First stage larva 125 μm long and 45 μm wide (with the cuticle the width is 65 μm). This specimen also has the general body shape of the adults, with a cuticle which almost completely envelops the body.

Only two toes are present ; they have the same length as the medial ones of the adults (14 μm in the fourth pair). They have very thin rod-shaped peduncles, which become thinner towards the claws (Fig. 4 D).

The claws, completely contained within the claw sheath, have a dorsal spur and an internal basal accessory point.

Neither anus, nor gonopore are present.

Type locality : Orosei Gulf, Sardinia, sample D/1 collected in May 1988.

Ecology : subtidal, - 5,- 20 m of depth, in sand of a Posidonia meadow.

The second stage larva is like the adult with the exception of the gonopore which is still not present.

Type locality : Orosei Gulf, Sardinia, samples E/9, SF, CP, collected in September 1985 and May 1988.

Ecology : subtidal, - 50, - 60 m of depth in coralligenous detritus (Sample 13/E), - 38 m of depth in sandy detritus covered with green algae (Sample SF) - 52 m of depth in organogenous detritus (Sample CP).

Type material : holotype : slide C/2 308095 ; allotype : slide D/4 308099 ; paratypes : one first stage larva : slide D/1 309003 ; four second stage larvae : slides E/9 309002, SF 308094, CP 308092, CP 309004 in authors' collection.

Discussion

The thyrrenian *Tholoarctus* shows strong affinities with *Tholoarctus natans natans* Kristensen & Renaud-Mornant, 1983, *Styraconyx testudo* D'Addabbo *et al.*, 1984 and *S. qivitoq* Kristensen & Higgins, 1984, but it differs from these species mainly in the presence of evident peduncles in all the toes and eyes. The medial toe peduncles are very thin and rod like. Furthermore they become much more slender near the claw base, though they are always evident. The external digit peduncles have a spoon-shaped proximal part, whereas the distal portion, which nearly reaches the claw base, becomes gradually thinner in the terminal part of the finger. The development of the cuticle is like in *T. natans natans*, much more evident than in *S. testudo* and *S. qivitoq*, also in the ventral as well as in the dorsal region. As in *T. natans natans*, there are only P_1 and P_4 and this can be considered an important distinctive characteristic, because in *S. testudo* the leg appendages are P_1 , P_2 , P_3 and P_4 . Slight differences in the size or shape of the primary and secondary clavae are not sufficient to create a new species, but we believe that the presence of the peduncles in all the toes, and eyes could be sufficient to designate the new Mediterranean subspecies *Tholoarctus natans pedunculatus*.

Echiniscoides bruni n.sp.

E. sigismundi is a cosmopolitan species (Pollock, 1975) which for a long time was also the one species of the genus. Renaud-Mornant in 1976 described the subspecies *E. sigismundi polynesiensis* and then Kristensen and Hallas (1980) the neotype *E. sigismundi sigismundi* with the other subspecies *E. s. groenlandicus*, *E. s. galliensis*, *E. s. hispaniensis* and

E. s. mediterranicus, and the new species *E. hoepneri*. In 1981 Bellido and Bertrand described *E. travei* from Kerguelen. In 1982 Hallas and Kristensen found the two new species *E. higginsi* and *E. pollocki*.

The three specimens of *Echiniscoides* found in the Orosei Gulf have such evident peculiarities as to allow the institution of the new species *E. bruni*.

Family Echiniscoididae Kristensen & Hallas, 1980

Diagnosis :

Unplated marine Echiniscoidea Marcus, 1927, without toes. Secondary clava dome-shaped or indistinct. Other cephalic appendages and leg appendages small. Cirri A and E similar. The fourth leg appendage (P_4) is papillar like the primary clava.

Genus *Echiniscoides* Plate, 1889 (emended Hallas & Kristensen, 1980)

Echiniscoididae with more than four claws on each leg in adult specimens. Claw without spurs. Tidal or subtidal form.

Type species : *Echiniscoides sigismundi* (M. Schultze, 1865).
Echiniscoides bruni. n. sp. (Figs 6, 7, 8 ; Tables. IV and V).

Etymology : dedicated to the marine biologist Bruno Scotto di Carlo who died in 1989.

Diagnosis :

Echiniscoides with dorsal cuticle strongly sculptured. Sculptures consisting of polygonal plates arranged in parallel lines, all round the body. No pillars are evident in the cuticle. All the legs in the adults have ten claws, whereas in the first stage larvae the claw formula is eight, seven, seven, eight. Lateral cephalic projections are small or not evident. Eyes are present. The secondary clava is lens-shaped. Sense organs are present on the first, third and fourth pair of legs.

Holotype : adult female, 188 μm long and 75 μm wide (Tab. IV). The cephalic head shape is as normal for the genus, without lateral projections (Figs. 6, 7).

The cephalic appendages are : internal, external and lateral cirri, primary and secondary clavae.

The internal cirri, which are dorsal, are very small (3.8 μm) and consist of a short 2.5 μm basal papilla with a terminal tuft of a few short setae (1.3 μm).

The external ventral cirri (2.5 μm) are like the internal ones.

The lateral cirri are 12 μm long and have evident annulated bases. The primary clava (4 x 4 μm), close to the lateral cirrus, has a van der Land's body inside its base and a terminal pore (Figs. 7, 8).

The secondary clava is lens shaped, 11 μm wide and 3.3 μm thick, attached directly to the head.

The mouth opening is terminal with an evident peribuccal ring ; the pharyngeal tube, CaCO_3 incrustated, is 43 μm long ; the stilets are 46 μm long with 30 μm sheaths.

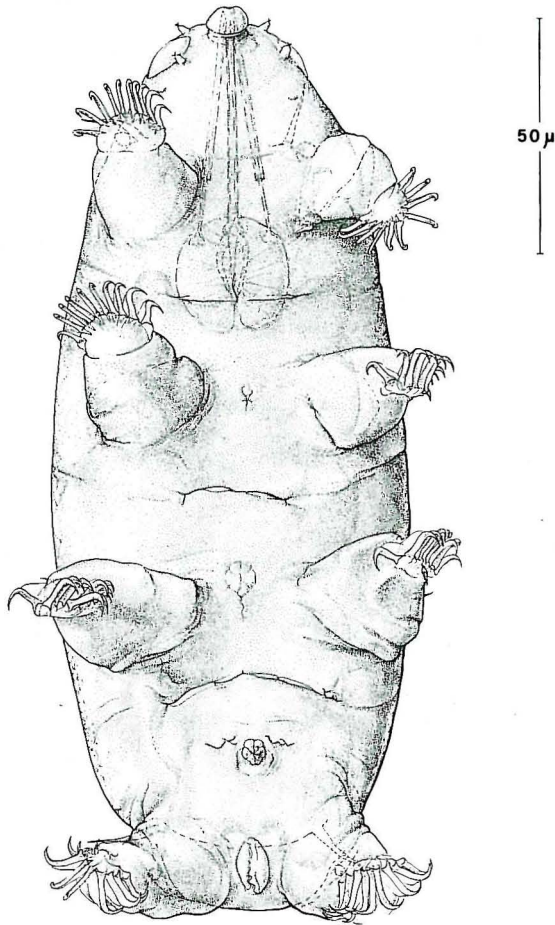


Fig. 6 : *Echiniscoides bruni*, n.sp. Adult female (holotype) ventral view.

The buccal canal ends in the pharyngeal bulb (23 x 26 μm) with three short placoids (14 μm).

All the legs have ten claws. The claws are of different lengths : the external ones are the shortest (5 μm), whereas the central ones are the longest (8 μm). The mean length of the two or three central claws as a percentage of total body length (R_1) is 4.5 %, whereas the shortest claw length as a percentage of the longest claw length (R_2) is between 62 % and 68 % (Tab. V). All the claws are without spurs.

Leg appendages are present on the first, third and fourth pair.

The first leg appendage (P_1) is 10 μm long ; it is like the lateral cirrus, the P_3 (7 μm long) is like the P_1 , whereas the P_4 (3 x 4 μm) is like the primary clava with the terminal opening and a Van der Land's body (Fig. 7 C).

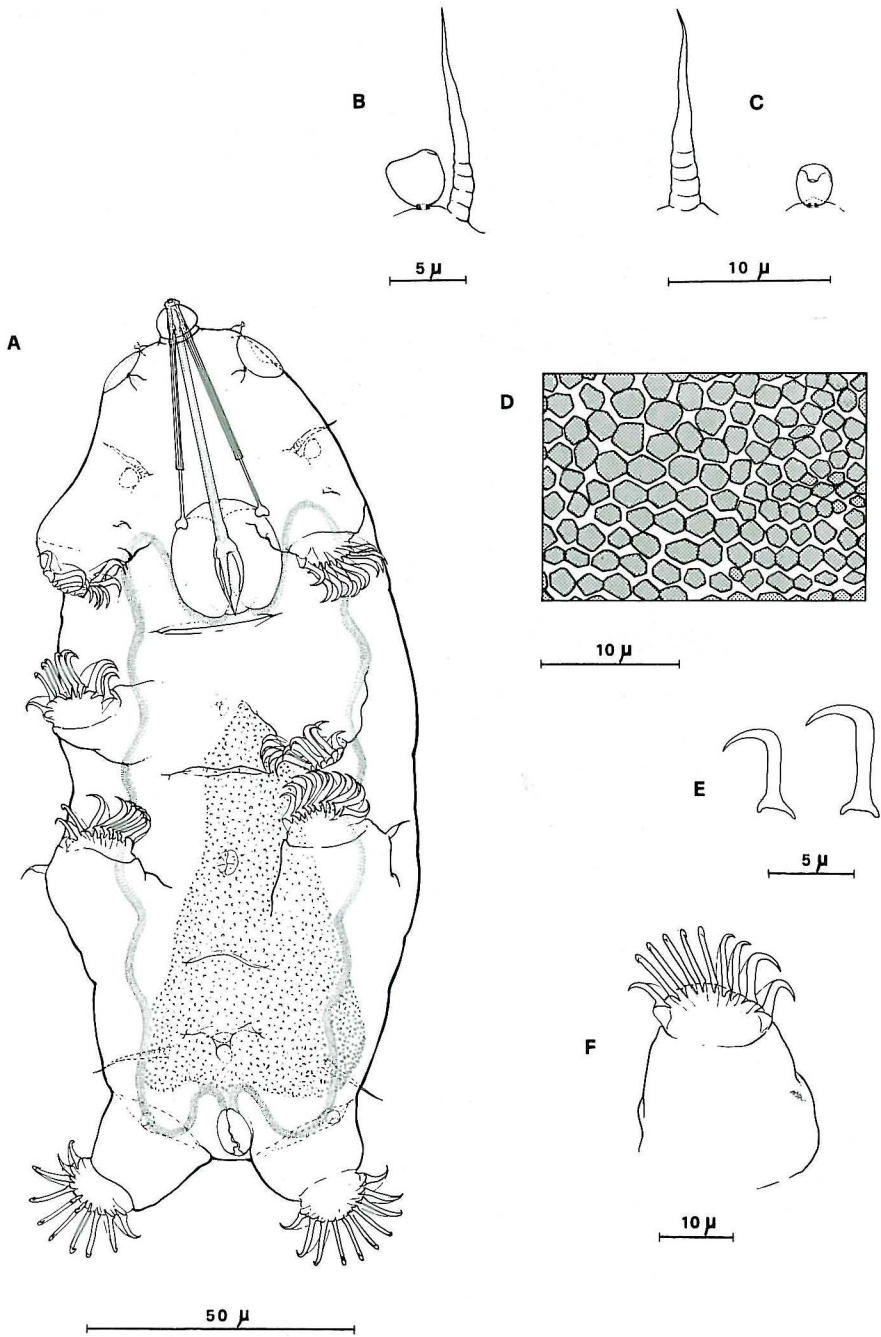


Fig. 7 : *Echiniscoides bruni*, n.sp. A - Adult male ventral view. B - Primary clava and lateral cirrus. C - Cirrus E and P₄ ; D - Cuticular sculpture. E - External and internal claws. F - Second pair leg.

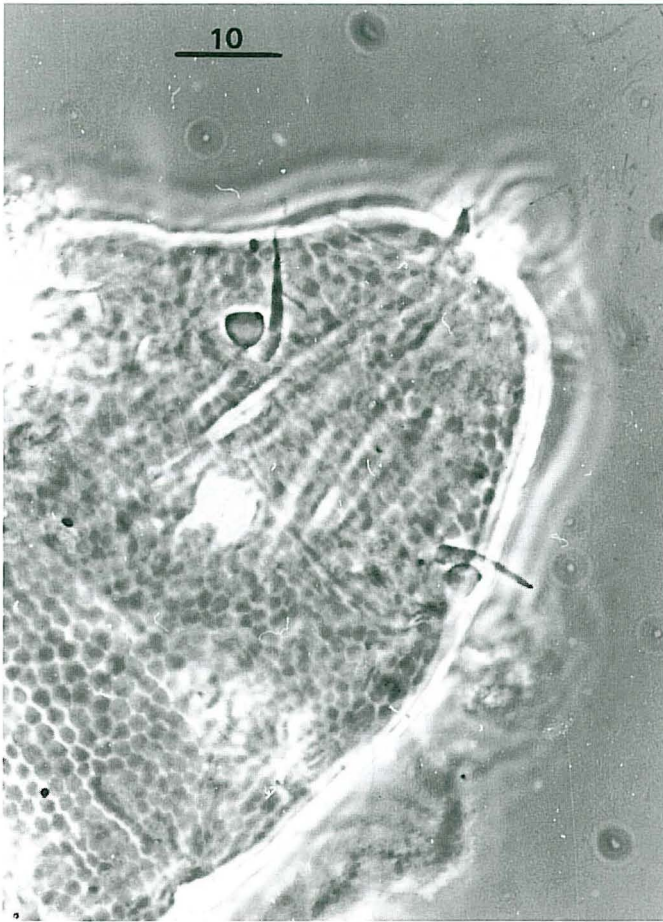


Fig. 8 : *Echiniscoides bruni*, n.sp. Cephalic region with primary clava and lateral cirrus. Clearly visible the cuticular sculpture (Scale bar = 10 μ m).

The cirri E, which are 14 μ m long, have the same shape as the lateral cirri with an evident basal annulation.

The dorsal cuticle is strongly sculptured with polygonal smooth plates arranged in parallel lines. No pillars are evident in the cuticular plates (Fig. 7 D).

The anal opening is covered by two large lateral plates and a very small caudal one. The rosette-like gonopore is surrounded by 6 units so thick and inflated that the gonopore protrudes from the ventral cuticle (Fig. 6).

In the ventral region there are three asterisk-like medial holes, at the same level as the first three pairs of legs. They could be the external marks of internal apodemes. Type locality : Orosei Gulf, Sardinia (Sample 13D) collected in September 1985.

TABLE IV

Measurements (in μm) of *Echiniscoides bruni* n. sp.

	Adults		Larva
	holotype female	allotype male	paratype 1st stage
L	183	158	93
W	75	65	39
iC	3.2	3	4
eC	2.5	2.4	3.3
IC	12	10.2	5
Cl ₁	4	2	3
Cl ₂	11	9	6.6
pt	46	44	31
ph	23	22	10
pI	14	12	7
P ₁	2.5	*	2.6
P ₃	7	6.5	4.6
P ₄	2	3	1.5
CE	14	14	10
CW	5/9	5/10	3/5

*observed, but not measured

Ecology : subtidale, - 30, - 40 m of depth, in coralligenous detritus.

Allotype : adult male 158 μm long and 65 μm wide. No evident sexual dimorphism has been observed. Only the ratios, R_1 and R_2 are different from those of the female : R_2 is between 50 % and 71 % and R_1 is 5.5 % because of the shorter body length and the greater claw length (Tab. V). The gonopore is circular and covered by a crescent fold.

Type locality : Orosei Gulf, Sardinia (Sample S. F.) collected in September 1985.

Ecology : subtidale, - 38 m of depth, in sandy detritus covered with green algae.

Paratype : a first stage larva from the same locality as the allotype. In the first stage larva the cuticle is like that of the adult, whereas the claw formula (8, 7, 7, 8) is different. Furthermore there is neither anus nor gonopore.

Type material : holotype, slide 13 D 309010 ; allotype slide SF. 15 309008, paratype slide SF. 24 309009 in authors' collection.

Discussion

Because of its length, *E. bruni*, can be classified as a small sized *Echiniscoides*, the two adults found (a male and a female) do not reach 200 μm . Its most evident peculiarities are :

- the same claw number (ten) on each leg, in the adults, whereas in the first stage larva the claw formula is 8, 7, 7, 8 ;

- the cuticle morphology, which is the same all round the body, with polygonal and smooth plates arranged in trasverse lines ; no pillars are evident in the cuticular plates ;

TABLE V

Echiniscoides bruni n.sp. Measurements in μm of the claw length in the I, II, III and IV pair of legs and ratios R_1 (mean length of two or three central claws as a percentage of total body length) and R_2 (shortest claw length as a percentage of the longest claw length).

FEMALE					
	I	II	III	IV	IV
1	5	5			6
2	7	7			7
3	7	7			8
4	8	8	5	8	9
5	8	8	8	9	9
6	8	8	8	9	9
7	8	8	8	9	9
8	7	8	8	8	9
9	7	7	7	7	7
10	5	6	5	6	6
$R_1 : 4.5$					
$R_2 :$	62.5	68			66
MALE					
	I	II	III	IV	IV
1	5	5	5	4	5
2	7	7	7		7
3	7	8	7	8	9
4	7	8	7	10	10
5	8	8	7	10	10
6		9	7	10	10
7		8	8	10	9
8		7	8	9	9
9	7	7	8	8	8
10	5	5	5	6	5
$R_1 : 5.5$					
$R_2 :$	62.5	58.8	71	50	50
LARVA					
	I	I	II	III	IV
1	3	3	3	4	3
2	4	4	4	4	4
3	4	4	4	4	4
4	4	4	4	5	4
5	4	4	4	5	4
6	4		4	5	4
7	4		3	4	4
8	3				3
$R_1 : 4.5$					
$R_2 :$	75	75	75	88	74

- the P_1 and P_3 which are setae as the internal and external cephalic cirri, whereas the P_4 is like the primary clava.

The claw formula of the adults of *Echiniscoides bruni* does not occur in other species of the genus, even though ten claws are present in some pairs of legs in other species of

Echiniscoides such as *E. sigismundi sigismundi*, *E. s. galliensi*, *E. s. groenlandicus*, *E. s. mediterranicus* (Kristensen & Hallas, 1980) and *E. travei*.

The same number on all the legs is present in *E. higginsi* (Hallas and Kristensen 1982), but in this species the claw formula is 6, 6, 6, 6 and this low number reveals that *E. bruni* is phylogenetically quite distant from *E. higginsi*. The presence of the leg appendages P₁, P₃ and P₄ is unique in the genus *Echiniscoides* and, furthermore, P₁ and P₃ are both setae like the internal and external cephalic cirri, representing another peculiarity of the new species. It is interesting to consider the morphology of the lateral and E cirri which, as in *E. sigismundi polynesiensis*, *E. higginsi* and *E. pollocki*, have clearly annulated bases (Renaud-Mornant, 1976). They are very similar to the somatic cirri of some species of Coronartidae and this peculiar shape must be considered a plesiomorphic characteristic which, as suggested by Renaud-Mornant (1987 b), is frequently present in the Arthrotardigrada.

Only three specimens (two of which are adults) have been found and observed. Nevertheless, considering the above mentioned peculiarity, we can conclude that the sardinian *Echiniscoides* is a new species.

ABBREVIATIONS :

L	Total body length	P ₁	1st leg spine
W	Body width	P ₃	3rd leg spine
pt	pharyngeal tube	P ₄	4th leg spine
ph	pharyngeal bulb	CE	Cirrus E
mC	medial Cirrus	A-G	Distance anus-gonopore
iC	internal Cirrus	Cw	Claw length
eC	external Cirrus	1De	First pair of leg external digit
lP	lateral Process	1Di	First pair of leg internal digit
lC	lateral Cirrus	4De	Fourth pair of leg external digit
Cl ₁	primary Clava	4Di	Fourth pair of leg internal digit
Cl ₂	secondary Clava		

REFERENCES

- BELLIDO, A. & M. BERTRAND, 1981. *Echiniscoides travei* n. sp., un Tardigrade marin des îles Kerguelen (Heterotardigrada). *Bull. Mus. natn. Hist. nat. Paris*, 3 : 789-798.
- D'ADDABBO GALLO, M., S. GRIMALDI DE ZIO & M.R. MORONE DE LUCIA, 1984. *Styraconyx testudo* n. sp., a new Styraconyxinae of the Mediterranean sea (Arthrotardigrada: Halechiniscidae). *Oebalia*, X n. s.: 95-103.
- D'ADDABBO GALLO, M., M.R. MORONE DE LUCIA & S. GRIMALDI DE ZIO, 1989. Two new species of the genus *Styraconyx* (Tardigrada : Heterotardigrada). *Cah. Biol. Mar.* 30 : 17-33.
- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO 1987. *Archechiniscus minutus* n. sp. and its systematic position within Arthrotardigrada (Tardigrada : Heterotardigrada). In : R. Bertolani (ed.) *Biology of Tardigrades. Selected Symposia Monographs U.Z. I. Mucchi Modena*. 1 : 253-260.

- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO & M.R. MORONE DE LUCIA, 1988. Two new Mediterranean species of the *Halechiniscus* genus (Tardigrada, Heterotardigrada). *Boll. Zool.* 3 : 205-211.
- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO & M.R. MORONE DE LUCIA, 1990a. Revision of the genus *Halechiniscus* (Halechiniscidae, Arthrotardigrada). *Cah. Biol. Mar.* 31 : 271-279.
- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO & M.R. MORONE DE LUCIA & A. TROCCOLI, 1990b. New description of *Neostygarctus acanthophorus* (Tardigrada, Arthrotardigrada). *Cah. Biol. Mar.* 31 : 409-416.
- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO, R.M. MORONE DE LUCIA, R. VACCARELLA, & P. GRIMALDI, 1982. Quattro nuove specie di Halechiniscidae rinvenute in due grotte sottomarine dell'Italia meridionale. *Cah. Biol. Mar.* 23 : 415-426.
- GRIMALDI DE ZIO, S., M. D'ADDABBO GALLO & M.R. MORONE DE LUCIA, 1991. *Neoarctus primigenius*, n. g., n. sp. a new Stygarctidae of the Tyrrhenian Sea (Tardigrada : Arthrotardigrada). *Boll. Zool.* In press.
- HALLAS, T. E. & R. M. KRISTENSEN, 1982. Two new species of the tidal genus *Echiniscoides* from Rhode Island, U. S. A. (Echiniscoididae, Heterotardigrada). In : D. R. Nelson (ed.), Proc. third Int. Symp. Tardigrada, Johnson City, Tennessee, USA, 1980, *East Tenn. Univ. Press*, 179-192.
- KRISTENSEN, R. M. & T. E. HALLAS, 1980. The tidal genus *Echiniscoides* and its variability, with erection of Echiniscoididae fam. n. (Tardigrada). *Zoologica Scripta.* 9 : 113-127.
- KRISTENSEN, R. M., & R.P. HIGGINS, 1984. Revision of *Styraconyx* (Tardigrada ; Halechiniscidae), with descriptions of two new species from Disko Bay, West Greenland. *Smithson. Contr. Zool.* 391 : 1-40.
- KRISTENSEN, R. M. & J. RENAUD-MORNANT, 1983. Existence d'Arthrotardigrades semi-benthiques de genres nouveaux de la sous-famille des Styraconyxinae subfam. nov. *Cah. Biol. Mar.* 24 : 337-353.
- LINDGREN, E.W., 1971. Psammolittoral marine Tardigrades from North Carolina and their conformity to worldwide zonation patterns. *Cah. Biol. Mar.* 12 : 481-496.
- MARCUS, E. 1927. Zur Anatomie und ökologie, einer mariner Tardigraden. *Zool. Jahrb. Syst.* 53 : 487-588.
- Mc KIRDY, D.J., P. SCHMIDT & M. Mc GINTY-BAILY, 1976. Interstitielle Fauna von Galapagos. XVI. Tardigrada. Mikrofauna d. Meeresboden, Mainz., 58 : 1-43.
- PLATE, L. H. 1889. Beitrage zur Naturgeschichte der Tardigraden. *Zool. Jb. Anat.* 3 : 487-550.
- POLLOCK, L. W. 1975. Observations on marine Heterotardigrada including a new genus from the western Atlantic Ocean. *Cah. Biol. Mar.* 16 : 121-132.
- RENAUD-MORNANT, J., 1976. Tardigrades marins de Polynésie. *Cah. Pacif.* 19 : 289-297.
- RENAUD-MORNANT, J., 1980. Description de trois espèces nouvelles du genre *Tanarctus* Renaud-Debyser, 1959 et création de la sous-famille des Tanarctinae, subfam. nov. (Tardigrada : Heterotardigrada). *Bull. Mus. natn. Hist. nat.* Paris, 2 : 129-141.
- RENAUD-MORNANT, J., 1984. Nouveaux Arthrotardigrades des Antilles. *Bull. Mus. natn. Hist. nat. Paris*, 4 : 975-988.
- RENAUD-MORNANT, J., 1987a. Halechiniscidae nouveaux de sables coralliens tropicaux (Tardigrada, Arthrotardigrada). *Bull. Mus. natn. Hist. nat. Paris*, 2 : 353-373.
- RENAUD-MORNANT, J., 1987b. Bathyal and abyssal Coronarctidae (Tardigrada), descriptions of new species and phylogenetical significance. In : R. Bertolani (ed.) *Biology of Tardigrades. Selected Symposia Monographs U.Z.I. I Mucchi Modena* : 229-252.
- SCHULTZE, M. 1865. *Echiniscus sigismundi*, ein Arctiscoide der Nordsee. *Arch. Mikrosk. Anat.* 1 : 428-437.
- THULIN, G., 1928. Über die Phylogenie und das System der Tardigraden. *Hereditas Genetiskt Arkiv.* (Lund), 11 : 207-266.