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A new Stygarctidae from South Tyrrhenian Sea (Tardigrada, Heterotardigrada)

Susanna DE ZIO GRIMALDI, Maria GALLO D'ADDABBO, Maria Rosaria DE LUCIA MORONE
Dipartimento di Zoologia dell'Università di Bari. Via Orabona, 4 -70125 Bari - Italy.
Fax: 39 80 5443358 ; E-mail s.de.zio@biologia.uniba.it

Abstract: In a coralligenous detritus from the Southern Tyrrhenian Sea, *Pseudostygarctus mirabilis* sp.nov., a new species of Stygarctidae, has been found. The species is here described and its affinities with *P. triungulatus* and *Mesostygarctus intermedius* are discussed.

Résumé : Dans un sédiment provenant de débris de coralligène du Sud de la Mer Tyrrhénienne, une nouvelle espèce de Stygarctidae, P*seudostygarctus mirabilis* sp. nov., a été trouvée. Cette nouvelle espèce est ici décrite et ses affinités avec *P. triungulatus* et *Mesostygarctus intermedius* sont discutées.

Keywords : Stygarctidae, Tardigrada, Heterotardigrada, Tyrrhenian Sea.

Introduction

In 1976 McKirdy, Schmidt and McGinty Bayly, found in the Galapagos the new genus *Pseudostygarcus* of the family Stygarctidae, and described the new species *P. tringulatus*. Successively, in 1979, Renaud Mornant, in Madagascar, found another new species of Stygarctidae, *Mesostygarctus intermedius*, which was closely related to *Pseudostygarctus* and, for some morphological characteristics, intermediate between the two groups of genera *Stygarctus* - *Parastygarctus* and *Pseudostygarctus* - *Megastygarctides*.

In June 1995, in a sample of a coarse organogenous detritus collected in the coralligenous bank "Secca del Capo", at NW of Salina Island (Aeolian Islands) in the Southern Tyrrhenian Sea (38°36'00" N - 14°55'00" E), two adult females of a new species of Stygarctidae, were found together with numerous other species belonging either to Stygarctidae or to Halechiniscidae and Batillipedidae (Matarrese *et al.*, 1995, 1996; Grimaldi de Zio *et al.*, 1998). The new species, which belongs to the genus *Pseudostygarctus*, shares many characters with *P. triungulatus* McKirdy *et al.*, 1976 and *M. intermedius* Renaud-Mornant, 1979 and gave to the authors the opportunity to discuss the affinities between the two genera *Pseudostygarctus* and *Mesostygarctus*.

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Materials and methods

The sample (1000 ml) of coarse organogenous detritus was collected with a grab at 40 m depth from the coralligenous bank named "Secca del Capo" in the Southern Tyrrhenian Sea. Tardigrades were extracted from the sediment by washing in fresh water and seaving through a

45 μm mesh sieve and then fixed in 7% Formalin neutralized with Borax. Permanent mounts were prepared with Hoyer's liquid (Higgins & Thiel, 1988).

Systematics

Family Stygarctidae Schulz, 1951

Diagnosis (emended): Arthrotardigrada with a dorsal cuticle forming dorsal plates and with a complete set of cephalic appendages. Primary clavae either elongated or hemispherical, tertiary clavae often absent. Feet non-digitate; in adults either four claws on each leg the central pair with long filaments or short spurs, or three claws on

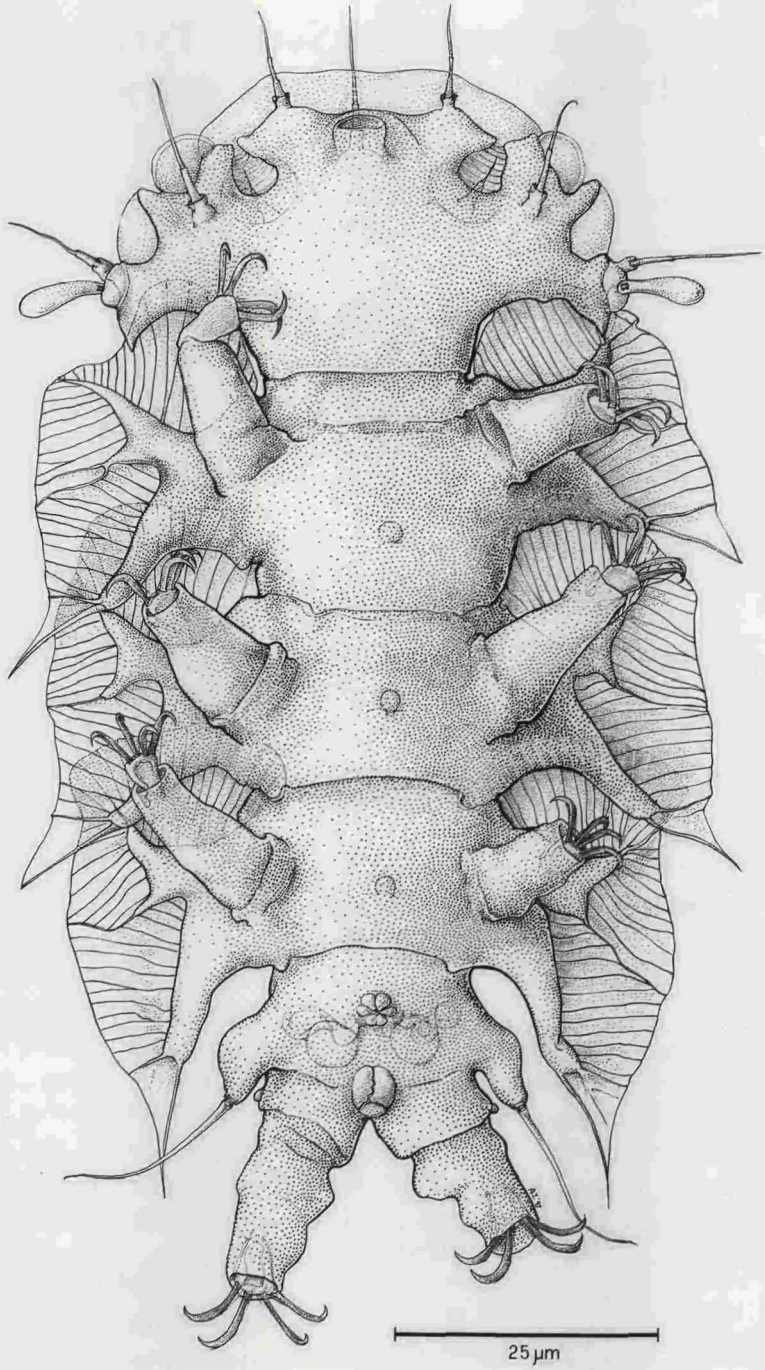

Figure 1. *Pseudostygarctus mirabilis* sp.nov., adult female (ventral view).
Figure 1. *Pseudostygarctus mirabilis* sp.nov., femelle adulte (vue ventrale).

each leg, all with a short dorsal accessory spur, or else four claws on the first three pairs of legs and two claws on the fourth pair leg, all with a short dorsal accessory spur. Claws attached with dorsal basal membrane. Sense organs, present or absent, on the first three pairs of legs. Bulb shaped papilla on the fourth leg (P_4). Seminal receptacles as cuticular pouches with long sinuous ducts close to the female gonopore. Cirrus E with ball and double-socket or thin accordion-plated articulation.

Subfamily Stygarctinae de Zio Grimaldi, D'Addabbo Gallo, Morone De Lucia, 1992

Diagnosis: Dorsal cuticle forming five dorsal thickenings: a cephalic plate, three body plates and a caudal plate; ventral plates sometimes present.

Type genus: *Stygarctus* Schulz, 1951

Pseudostygarctus McKirdy, Schmidt, McGinty-Bayly, 1976 :

Diagnosis: Stygarctidae with body plates tapering into lateral acute processes; cirrus E attached to body by means of a "ball and socket"-type articulation.

Type species: *Pseudostygarctus triungulatus* McKirdy, Schmidt, McGinty-Bayly, 1976

Description of *Pseudostygarctus mirabilis* sp. nov. (Fig. 1-4, Table 1)

Diagnosis: Stygarctidae with elongated primary clavae and semiglobular thick walled secondary clavae. Frontal margin of the medial lobe of the cephalic plate ondulated and covered by a short and smooth cuticular sheet. Three body plates each with two pairs of lateral processes supporting on their edges thin cuticular sheets strengthened by numerous ribs; ventral plates present. Each leg terminating in four claws, the two medial with a dorsal spur. No sense organs on the first three pairs of legs. Bulb shaped papilla on the fourth leg. Cirrus E with ball and double socket articulation.

Holotype: adult female (slide 190 S.C. Eolie 94 in authors' collection) Figs 1-4, Tab. 1.

Body length, from the anterior edge of the cephalic plate to the posterior end of the caudal plate, 102 μm. The exoskeleton organized according to the Stygarctidae scheme: cephalic plate, three body plates and a caudal plate (Fig. 1).

The cephalic plate diameters are: 50 μm between the primary clavae bases and 21 μm at its base (neck level). The cephalic plate is divided in five lobes (one medial, two medio-lateral and two lateral) by four deep incisions. The medial lobe bears dorsally the medial cirrus, 8 μm long, on a basal cone and two internal cirri (12 μm). Its frontal margin is ondulated and is covered by a short and smooth cuticular sheet (5.5 μm) very thin and transparent, extending up to the medio-lateral lobes. The medial and medio-lateral lobes are separated by a deep incision closed by a thin cuticular membrane. A dorsal spike protrudes over the incision (Fig. 2 A, arrow). Each medio-lateral lobe bears on its anterior margin the double walled semiglobular secondary clavae (6.5 μm) and ventrally the external cirri (14 μm); it is connected with the lateral lobe by means of a thin cuticular expansion. Each lateral lobe bears the hemispherical cirrophorus of both club-shaped primary clava (7.7 μm) and lateral cirrus (15 μm). It extends backward with a spike-like process (4 μm). Inside the base of the primary clava, the van der Land's organ is evident. All the cirri arise from a short cirrophorus and consist of a scapus and a long flagellar part (Figs 2A, 3A, 3B). The subterminal mouth opening is protruded; the pharyngeal

Table 1. *Pseudostygarctus mirabilis* sp.nov. Measurements of two adult females (in μm).

Tableau 1. *Pseudostygarctus mirabilis* sp.nov. Mesures effectuées sur deux femelles adultes (en μm).

	holotype	paratype
L	104	96
w	44.5	44.5
nw	21	22
m C	8	11
i C	12	11
eC	14	11
l C	13	16.5
Cl_1	7.7	7.5
Cl_2	6.5	6.5
CE	25-22*	18-22*
P_4	4.4	4.4
A-G	9	9
sR	5	5.5
CL	6.6	6.6

* left and right

Abbreviations

L: Length
w: width
nw: neck width
mC: medial Cirrus
iC: internal Cirrus
eC: external Cirrus
lC: lateral Cirrus
Cl_1: primary Clava
Cl_2: secondary Clava
CE: Cirrus E
P_4: Fourth leg sense organ
A-G: Anus-Gonopore distance
sR: seminal Receptacles diameter
CL: Claw Length

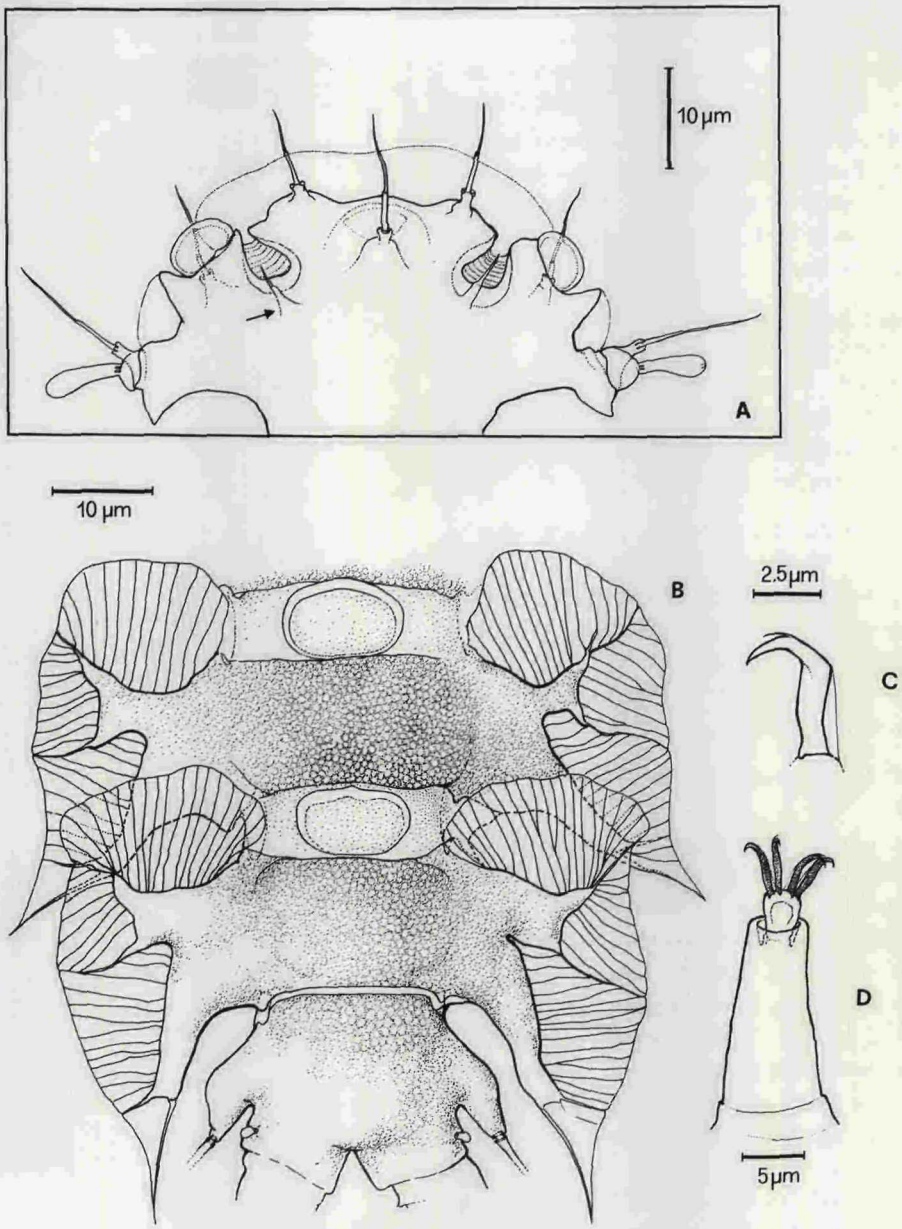

Figure 2. *Pseudostygarctus mirabilis* sp.nov., adult female. (A) cephalic region (dorsal view); (B) dorsal body plates; (C) medial claw; (D) 4th pair leg.

Figure 2. *Pseudostygarctus mirabilis* sp.nov., femelle adulte. (A) région céphalique (vue dorsale) ; (B) plaques dorsales ; (C) griffe médiane ; (D) patte IV.

tube is 25 μm long, whereas the bulb diameter is 9 μm; stilets and placoids as in *Parastygarctus*, *Stygarctus* and *Mesostygarctus*. Eyes are absent.

The three body plates are very similar, but not identical (Fig. 2 B). They are separated from each other by an intermetamerical region where an intersegmental oval plate is located (22 x 8 μm). The body plates extend laterally with two pairs of complex processes. The antero-lateral process is divided in two parts: a stocky anterior one and a spike-like posterior one; the postero-lateral process ends with two spines: a shorter (5 μm) anterior one and a longer (11 μm) posterior one (Figs 1, 2B). Thin cuticular sheets, strengthened by numerous ribs, arise from the edges of the lateral processes (Figs 1, 2B, 3B, C).

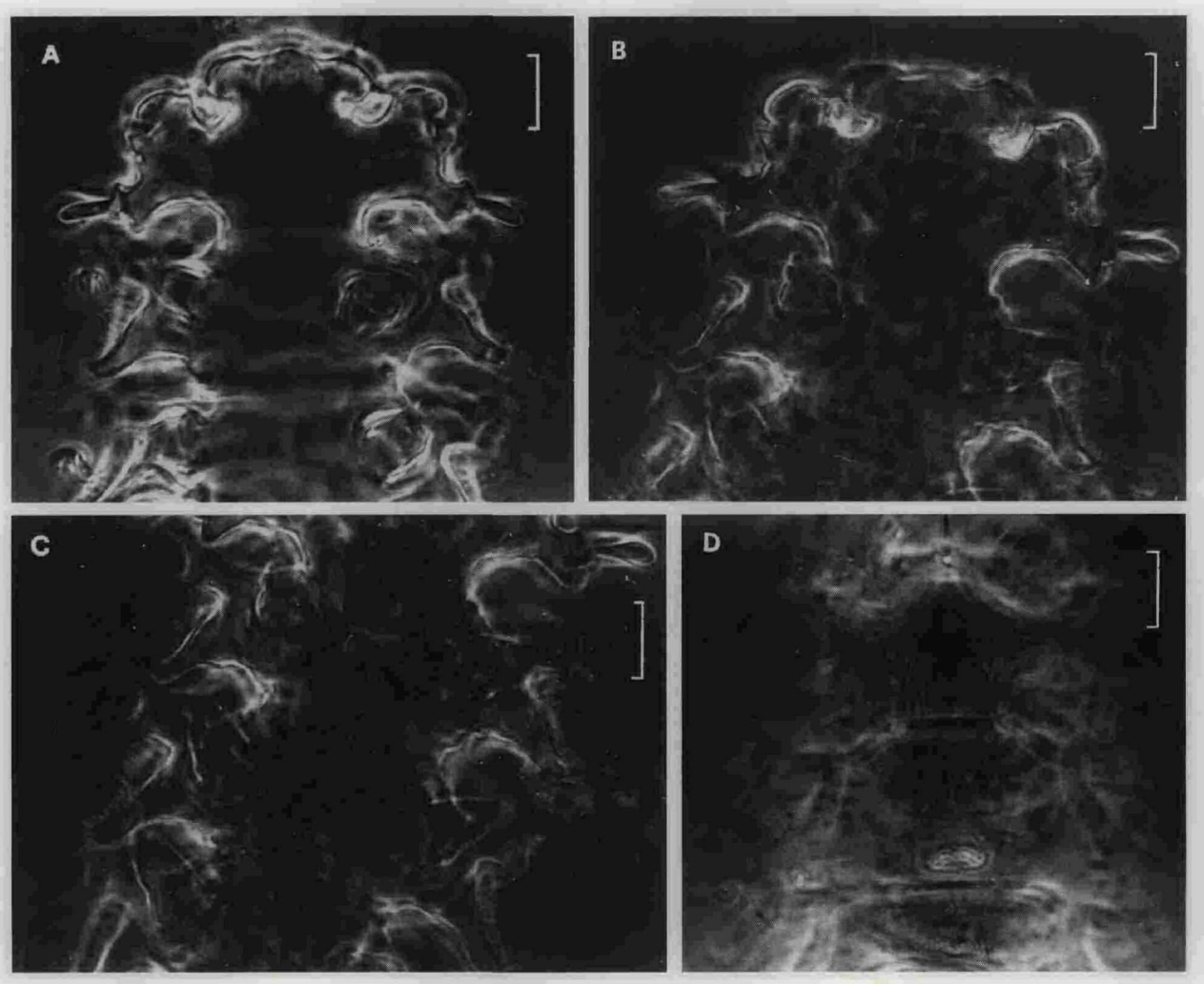

Figure 3. *Pseudostygarctus mirabilis* sp.nov., adult female. Phase contrast microscopy. (A, B) anterior region (ventral view); (C) ventral body plates and lateral expansions; (D) dorsal cuticle sculpture. Bar 10 μm.

Figure 3. *Pseudostygarctus mirabilis* sp.nov., femelle adulte. Microscopie en contraste de phase. (A, B) région antérieure (vue ventrale) ; (C) plaques ventrales et expansions latérales ; (D) sculpture de la cuticule dorsale. Echelle 10 μm.

The caudal plate is 30 μm wide and 15 μm long; it has two backward lateral processes bearing cirri E (25 μm) which have a ball and double socket articulation.

Ventral plates are present. In the first and second ventral body plates, circular muscle scars are evident.

The female gonopore, 9 μm from the anus, is surrounded by six cells the two anteriormost of which are the largest ones (Figs 1, 4A).

Laterally to the gonopore there are the two seminal receptacles which are disk-like pouches with sinuous ducts opening near the genital pore (Figs 1, 4B). The anus is covered by three plates: two large lateral and a small caudal one.

All the legs are telescopic and have the same shape; they end with four claws, the two medial of which have a short and thin dorsal spur. No sense organs on the first three pairs of legs, whereas a bulb shaped papilla (4.4 μm) is located dorsally to the fourth pair base. The dorsal cuticle is sculptured with a thin honeycomb pattern, whereas the ventral cuticle is smooth.

Paratype: adult female, 96 μm long. (slide 174 S.C. Eolie 94).

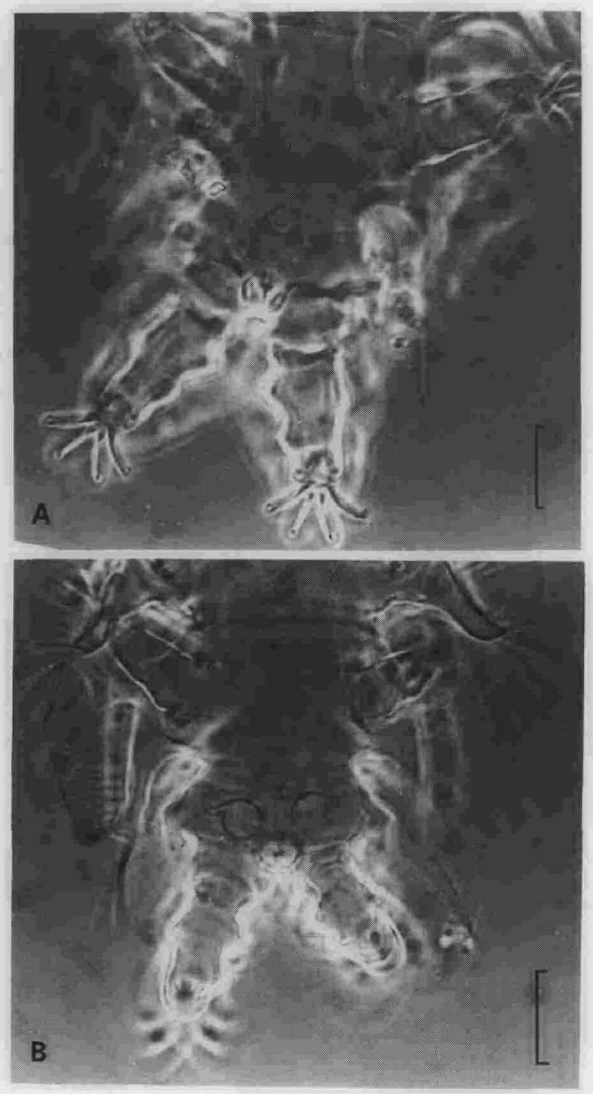

Figure 4. *Pseudostygarctus mirabilis* sp.nov., adult female. Phase contrast microscopy. (A) gonopore; (B) seminal receptacles. Bar = 10 μm.

Figure 4. *Pseudostygarctus mirabilis* sp. nov., femelle adulte. Microscopie en contraste de phase. (A) gonopore ; (B) réceptacles séminaux. Echelle = 10 μm.

Ecology: subtidal, in coarse coralligenous detritus.

Discussion

Pseudostygarctus mirabilis shares many characters with both *P. triungulatus* and *Mesostygarctus intermedius*. The relationship of the new species with the genus *Pseudostygarctus* rests mainly on the morphology of the cephalic region very similar to that of *P. triungulatus* (McKirdy *et al.*, 1976), with the exception of the cuticular sheet present on the frontal ridge of *P. mirabilis*. The lateral processes of the *P. triungulatus* body plates, which have only a short membranous ridge and therefore are much more simple than those of the new species, could be considered an apomorphic character in comparison with the plesiomorphic complicate cuticular sheets of *P. mirabilis*. We observed an analogous situation concerning the exoskeletons of *Neostygarctus* (plesiomorphic) and *Parastygarctus* (apomorphic) (Grimaldi de Zio *et al.*, 1990).

Therefore, the morphological features of the body and caudal plates of the two species are more specific than generic characters, just as the number of claws that in Stygarctidae differentiate species of the same genus (Morone De Lucia *et al.*,1988).

P. mirabilis shares with *Mesostygarctus intermedius* an identical morphology and number of claws and similar shapes of the caudal plates and the seminal receptacles.

P. mirabilis, P. triungulatus and *M. intermedius* have identical cirri E, P_4 and cephalic sense organs, whereas *P. mirabilis* and *M. intermedius* markedly differ in the morphology of the cephalic and body plates which in the latter species, are more simple (apomorphy) and more compact.

A peculiarity of the new species is the fine honey-comb sculpture of the cuticle (Fig. 3D) which, in the two others species, is only finely punctuated. The cuticle sculpture is quite similar to that of *Echiniscoides bruni* (D'Addabbo Gallo *et al.*, 1992).

P. mirabilis shares with *Echiniscoides* a similar morphology of the anal region (Kristensen & Hallas, 1980), since in the new species the anus is covered with three plates. As the same morphology can also be observed in *Neostygarctus acanthophorus* (Grimaldi de Zio *et al.*, 1990), we suggest that this feature, often overlooked because it is difficult to detect, is present in other Stygarctidae.

P. mirabilis emphasizes the evident affinities between *Pseudostygarctus* and *Mesostygarctus* pointed out by Renaud-Mornant (1979) and according to the authors' opinion, the species shortens the distance between the two genera. However at present it is difficult to introduce changes in the current systematics since data and number of species are still far too scarce.

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