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Pseudectinosoma reductum, a new ectinosomatid harpacticoid from springwaters in Italy (Crustacea: Copepoda)

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Abstract

A few specimens of *Pseudectinosoma reductum* sp.n. were collected from a crenal biotope of the Presciano spring system (Tirino River, Aterno-Pescara Basin) in central Italy, at an altitude of 330 m a.s.l.

This remarkable new species is easily distinguishable from all congeners in the unique shape of the fifth leg, which lacks any trace of armature. This character state as well as the reduced armature of legs 1–4 and the 4-segmented antennule may be considered evolutionary novelties within the genus. Ecological information is given for the species.

Introduction

Recent stygobiological investigations in the Gran Sasso karstic system (Abruzzo, central Italy) have focused on patterns of species diversity in spring waters at different scales, and numerous series of samples from different springs and from different sites in each spring system were examined. One sample from the Presciano spring system (Tirino River, Abruzzo, central Italy) revealed the presence of an ectinosomatid harpacticoid, herein described as *Pseudectinosoma reductum* sp.n.

Habitat

The Presciano spring system is located on the south-eastern part of the Gran Sasso Massif, at 330 m a.s.l., near Capestrano town (L'Aquila). It is one of the three most conspicuous and perennial springs of the Tirino River, with a mean discharge of 1500 l/s (Massoli-Novelli & Petitta, 1997). This spring system shows five large hollows and numerous other small fractures (contact spring). Moreover the whole area (2000 m^2) constitutes an upwelling zone, showing a positive piezometric level, ranging from 40 to 100 cm, depending on site and sampling time. From the perspective of spring biology, the hydrogeology of the Presciano spring occupies an intermediate position between springs fed from porous formations and from cavernous formations (Van Der Kamp, 1995), most probably representing the discharge point from more than one flow systems.

The copepod fauna of these waters appears to be greatly diversified, with important differences in the species composition and in the relative taxa abundance, along fine-scale vertical and horizontal profiles.

Material and methods

Quantitative samples were taken by pumping 20 litres of water with a Bou-Rouch pump at two different depths, below the bottom (-70 cm and -150 cm respectively) and filtering through a 60 μm mesh net. Specimens were preserved in 7% formalin solution. Dissected specimens were mounted in polyvinyl lactophenol. Drawings and measurements were made using a Leitz Laborlux phase contrast microscope, with the aid of a camera lucida. Some details are added to the drawings from confocal laser scanning microscopy (CLSM) analysis, with Sarastro 2000 (MD). The terminology proposed by Huys & Boxshall (1991) is adopted. Abbreviations used in the text are: P1–P5, first to fifth thoracopods.

Description

Order Harpacticoida Sars, 1903
Family Ectinosomatidae Sars, 1903
Genus *Pseudectinosoma* Kunz, 1935
Pseudectinosoma reductum sp.n.

Material. 1 ♀ holotype, completely dissected and mounted in polyvinyl lactophenol; Presciano spring (Capestrano, L'Aquila, central Italy); coordinates: 42°16′05″N 13°46′56″E; altitude: 330 m a.s.l.; interstitial biotope, 70 cm below the bottom; temperature: 10.10 °C, electrical conductivity (25 °): 374 μS cm^{-1}; pH 7.46; sediment composed of a superficial layer of silted sand and a deeper layer of sand on the bedrock; 6 June 1996; coll. A. Marchegiani, P. De Laurentiis & D. Galassi. 2 ♀♀ paratypes, dissected and mounted as above; temperature: 13.3 °C; electrical conductivity (25 °C): 480 μS cm^{-1}; pH 7.8; dissolved oxygen: 6.9 mg l^{-1}; particulate organic matter: 4.1 mg l^{-1}; 22.7.1996; coll. A. Marchegiani & D. Galassi.

Holotype in the Natural History Museum, London; paratypes in Galassi's collection at the Dipartimento di Scienze Ambientali, University of L'Aquila, Italy.

Female length unknown but expected to range, excluding caudal setae, from 275 μm to 290 μm ($n = 3$) (about 280 μm, holotype). Body fusiform, unpigmented. Rostrum hyaline, tapering distally, not fused with cephalosoma, reaching distal third of second segment of antennule on frontal side. Cephalothorax smooth, integumental structures reduced; only 3 pairs of setules on dorsal surface of cephalic shield.

Posterior dorsal margins of abdominal somites, excluding 2 last urosomites, with denticulate hyaline frill; anal somite with 2 sensillae distally on dorsal surface (Figure 1D). Ventral margins of all abdominal somites armed with semi-incised subulate hyaline frill (Figure 1A). Genital double-somite completely fused, without cuticular ornamentation.

Caudal rami (Figure 1A, D) wider than long, hyaline frill of anal somite fully-incised subulate. Armature as follows: anterolateral accessory seta lacking, 1 anterolateral seta inserted somewhat ventrally, 1 posterolateral seta dorsally inserted, 2 terminal setae of different lengths, 1 long terminal accessory seta, 1 dorsal seta on inner knob. Posterior margins of each caudal ramus prolonged into triangular lappets both dorsally and ventrally; dorsal lappet strong (Figure 1D), ventral lappet spiniform, short spinules inserted on mediodistal corner of each caudal ramus.

Antennule (Figure 1B): short, 4-segmented; segment 1 with 1 lateral seta, segment 2 bearing 1 proximal lateral seta, 2 inner setae on caudal surface, 5 setae on frontal ridge, 1 inner lateral seta, 2 distal setae plus 1 aesthetasc; segment 3 short, with 1 seta; segment 4 with 3 setae inserted on the middle of segment, 3 setae plus 1 aesthetasc inserted on tip.

Antenna (Figure 1E): basis unarmed; exopod 2-segmented, segment 1 with 1 lateral seta; segment 2 with 2 long apical setae; endopod 2-segmented, proximal segment naked, second segment with 3 rows of cuticular spinules and 2 spines laterally, 2 strong spinulose setae, 1 geniculate seta plus 2 simple setae distally, one of which slender and located near base of geniculate seta.

Mandible (Figure 1C): coxal gnathobase bearing 3 strong teeth and crenulate chitinous lamella, 1 seta at ventral corner. Mandibular palp: basis with 3 naked setae; exopod bearing 1 subapical short seta and 1 apical long seta; endopod bearing 7 setae, 3 of which along medial margin.

Maxillule (Figure 1F): praecoxal arthrite with 3 terminal setae and 1 curved strong spine, not defined at base. Basis incorporated into endopod, forming laminar plate bearing 9 setae; exopod 1-segmented, with 2 apical plumose setae.

Maxilla (Figure 2F): syncoxa with 4 endites; first and second forming single bilobed protuberance bearing 1 plumose seta on each lobe, third endite represented by medial knob with 1 seta, fourth endite well developed, inserted near articulation with basis, bearing 3 plumose setae. Basis and proximal segments of endopod more or less fused; free endopod apparently 1-segmented with 3 thin setae distally, but 2 rudimentary segments are still recognizable by original boundaries; 2 strong recurved setae and 1 thin seta inserted along fusion line of proximal segment of endopod, 4 setae on free distal margin of basis.

Maxilliped (Figure 2G): slender, not prehensile, 3-segmented; basis lacking armature; endopod 2-segmented: segment 1 with 2 rows of thin spinules along inner and outer margins respectively and 1 row on its surface, segment 2 of endopod with 2 subapical spiniform setae and 2 distal bare setae of different lengths.

P1–P4 with 3-segmented exopods and 2-segmented endopods. Intercoxal sclerites without ornamentation.

P1 (Figure 2A): coxa without ornamentation. Basis with strong inner spine, outer seta lacking, furnished with spinular rows at both inner and outer corners; few spinules on surface. Exopod: segment 1 with 1 outer

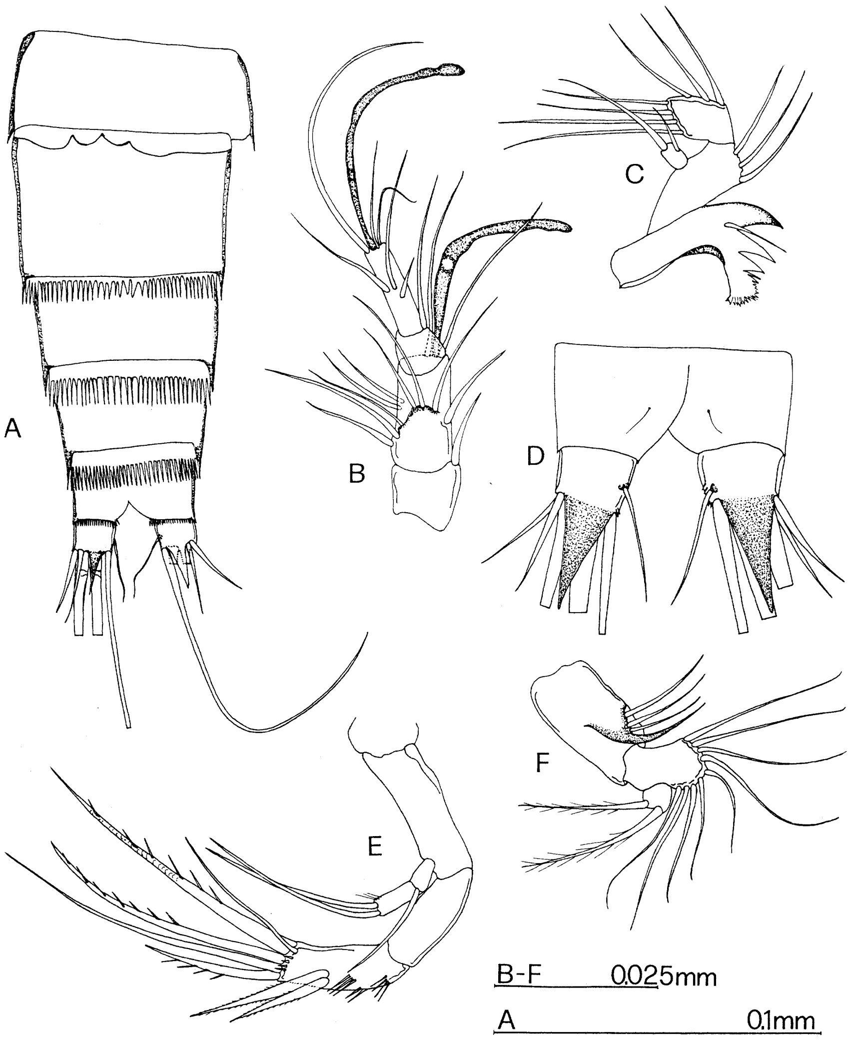

Figure 1. Pseudectinosoma reductum sp.n. Adult female. A, Abdomen and caudal rami, ventral view; B, antennule; C, mandible; D, caudal rami, dorsal view; E, antenna; F, maxillule.

spine and row of spinules; segment 2 with 1 outer spine and 1 long inner plumose seta, segment 3 with 1 outer and 1 subapical spines, 1 apical and 1 inner plumose long setae. Endopod: segment 1 longer than segment 2, fringed with spinules distally, with 1 long inner seta; distal segment with 1 inner plumose seta, 1 apical plumose seta, 1 apical spine with spinulose inner margin and 1 outer spine with spinulose outer margin.

P2 (Figure 2B): basis unarmed, with outer row of tiny spinules. Exopod: segment 1 with 1 outer spine, segment 2 with 1 outer spine and 1 long, bare inner seta, segment 3 with 1 outer spine, 1 apical spine with spinulose outer margin, 2 apical plumose setae and 1 short and bare inner seta. Endopod: segment 1 with 1 long inner plumose seta, segment 2 with 1 inner and 1 apical plumose setae, 1 apical spine with spinulose outer margin and 1 outer spine.

P3 (Figure 2C): basis unarmed, with outer row of tiny spinules. Exopod: segment 1 with 1 outer spine and row of spinules; segment 2 with 1 outer spine and 1 long, bare inner seta, segment 3 with 1 outer spine, 1 apical spine with spinulose outer margin, 2 apical plumose setae and 1 inner short and bare seta. Endopod quite similar to endopod of P2.

P4 (Figure 2D): basis unarmed, with outer row of tiny spinules. Exopod: segment 1 with 1 outer spine and lateral row of spinules, segment 2 with 1 outer spine

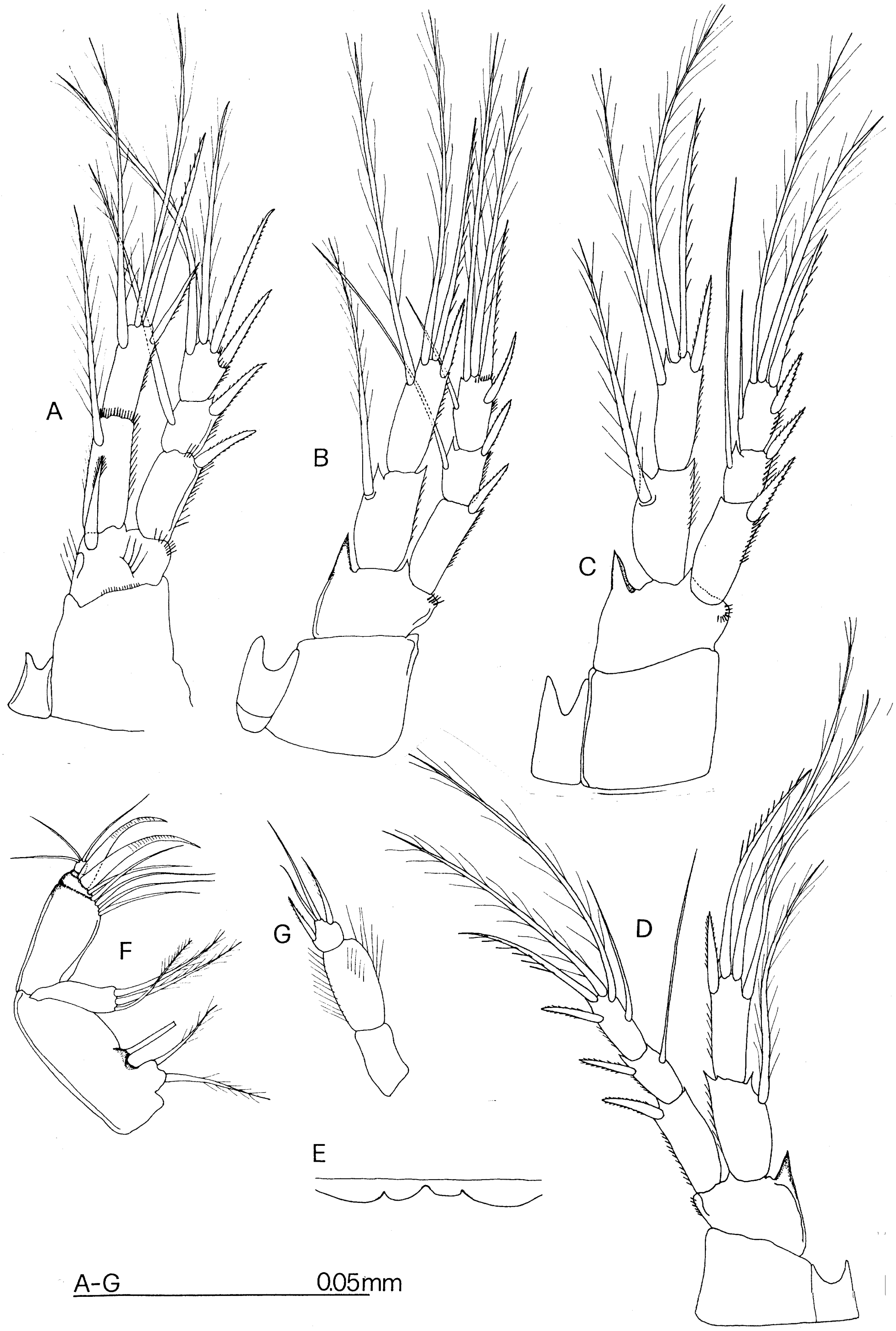

Figure 2. *Pseudectinosoma reductum* sp.n. Adult female. A, Leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5; F, maxilla; G, maxilliped.

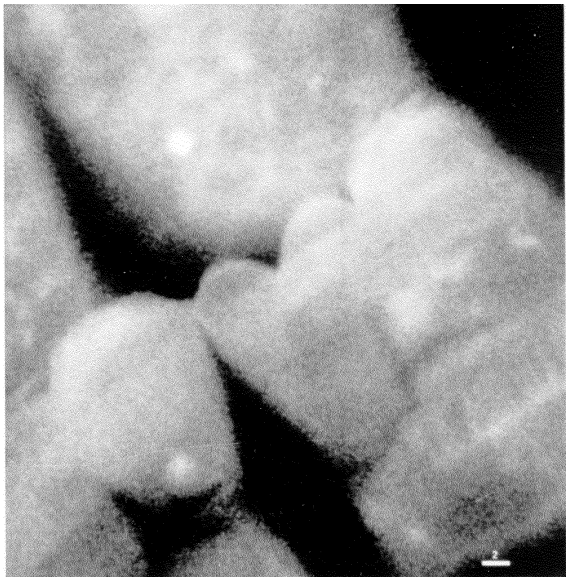

Figure 3. Pseudectinosoma reductum sp.n. Adult female. CLSM integumental analysis of leg 5 (scale bar in μm).

and 1 long, bare inner seta; segment 3 with 1 outer spine, 1 apical spine with spinulose outer margin, 1 apical and 1 subapical plumose setae and 1 inner bare seta. Endopod similar to endopods of P2 and P3.

P5 (Figure 2E, 3): fifth pair of legs confluent, not protruding beyond free ventral edge of P5-bearing somite. Baseoendopod and exopod completely fused and reduced to rounded chitinous lamellar plate, without any trace of armature.

Male unknown.

Etymology. The specific name is derived from the Latin *reductum*, alluding to the extreme simplification of the female leg 5.

Discussion

Until Rouch (1969) described the first stygobiont species of *Pseudectinosoma* Kunz, 1935, from the Cent-Fons karstic system (Herault, France), the genus consisted exclusively of the type-species *P. minor* Kunz, 1935, described from benthic biotopes of Kiel Bay (Germany) and later recorded from the Baltic proper (Schäfer, 1936; Drzycimski 1985, 1993) and from salt marshes of New Jersey, USA (Coull, 1977). Only recently, a third representative of the genus, *Pseudectinosoma kunzi* Galassi 1997, was described from a phreatic lake of Castelcivita Cave (Salerno, south Italy). The discovery of *Pseudectinosoma reductum* sp.n. from the Presciano spring system confirms the presence of the genus in circum-Mediterranean stygohabitats, although the genus is unknown from the Mediterranean Sea (Galassi et al., 1997).

Pseudectinosoma is a poorly diversified genus of the family Ectinosomatidae, chiefly inhabiting marine and brackish water habitats. With the exception of the 'marine' species *Pseudectinosoma minor*, living in the detrital environment (epipsammic, never interstitial) of coastal brackish waters, all the remaining species are known as exclusive freshwater forms, and typically as stygobiont species.

Opinions have varied as to the validity of the genus *Pseudectinosoma* (Schäfer, 1936; Lang, 1948; Rouch, 1969) with respect to the closely related *Sigmatidium* Giesbrecht, 1881. Later, Kunz (1974) confirmed the position of the genus within the group of '*Sigmatidium*-related genera'. Recently, Galassi, 1997 amended the genus *Pseudectinosoma*, including a 4-segmented antennule in the current diagnosis.

Within the genus, the new species is easily distinguishable from its congeners by the unique shape of the rudimentary female P5, lacking any trace of armature: an extreme condition, rarely found in other Harpacticoida genera and species (Huys & Boxshall, 1991).

The new species mostly resembles *P. kunzi* in the segmental pattern of the antennule, consisting of 4 segments, with the last segment derived by fusion between the fourth and the fifth segments of both *P. minor* and *P. vandeli*, in the same P1–P4 armature, and in the number of maxillar endites. Both species differ in the general structure and armature of the P5 (not protruding the ventral margin of P5-bearing somite and naked in *P. reductum* sp.n. vs. protruding and armed with 1 seta in *P. kunzi*), in the setation of the mandibular palp in both exopod (1 apical seta in *P. reductum* sp.n. vs. 2 in *P. kunzi*) and endopod (7 setae in *P. reductum* sp.n. vs. 8 in *P. kunzi*), in the armature of the praecoxal arthrite (3 setae in *P. reductum* sp.n. instead 5 in *P. kunzi*) and of the distal segment of the maxillule (9 setae in *P. reductum* sp.n. vs. 7 in *P. kunzi*), and in the number of setae implanted on the second maxillar endite (1 seta in *P. reductum* sp.n. vs. 2 in *P. kunzi*).

At present, the new species appears to be the most simplified within the genus and in the context of the phylogenetic trends identified by Huys & Boxshall (1991) for copepods, the most apomorphic one. Many distinctive traits of *P. reductum* sp.n. may be considered troglomorphic features, as a result of selection in groundwaters, although the adaptative role of many regressive traits in stygobiont and interstitial copepods is still uncertain (Pesce & Galassi, 1985; 1986; Wells, 1986; Reid, 1991; Reid & Strayer, 1994; Boxshall et al., 1993; Boxshall & Evstigneeva, 1994; Jaume & Boxshall, 1996).

Our studies on the fine-scale distribution of copepods in the Presciano spring system reveal the presence of *P. reductum* sp.n. in only one interstitial site, from a total of 50. Moreover, the new species is uncommon (with only 1–2 specimens collected on each occasion), and it occurs irregularly in the replicate samples taken from the same site (only twice over 12 samples), suggesting that the species is not interstitial, and not directly inhabiting the main circulation pattern of the spring. In particular, a deeper origin may be supported by some hydrogeological evidence (the lowest electrical conductivity recently measured at 2 metres below the bottom: 200 μs cm^{-1} in this site vs a range of 360–500 μS cm^{-1} in the other interstitial sites) of the presence of a conduit, under the alluvial layer of calcareous sediments. In this regard, the presence of the species in the interstitial could be related to drift events during the conduit discharge at this site. As for the other stygobiont species of *Pseudectinosoma, P. reductum* sp.n. appears also to be linked to a karstic environment, although further studies are required to validate this conclusion.

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