Little Known Harpacticoid Copepods From Italy, and Description of Parastenocaris Crenobia N. Sp. (Copepoda, Harpacticoida)

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LITTLE KNOWN HARPACTICOID COPEPODS FROM ITALY, AND DESCRIPTION OF *PARASTENOCARIS CRENOBIA* N. SP. (COPEPODA, HARPACTICOIDA)

BY

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ABSTRACT

Little known harpacticoid copepods are recorded from subterranean habitats of Italy and *Parastenocaris crenobia* n. sp. is described from a rheocrene spring of Abruzzo (central Italy). *Elaphoidella rossellae* Pesce, Galassi & Apostolov, 1987 is herein synonymized with *Elaphoidella plutonis plutonis* Chappuis, 1938. Supplementary descriptions and illustrations are given for *E. plutonis plutonis*, with taxonomic, zoogeographical and ecological remarks.

RIASSUNTO

Una nuova specie di *Parastenocaris*, descritta nel presente lavoro come *Parastenocaris crenobia* n. sp. e altri copepodi arpacticoidi rari o poco noti per l'Italia sono stati raccolti in diversi tipi di ambienti acquatici sotterranei della regione abruzzese (Italia centrale). *Elaphoidella rossellae* Pesce, Galassi & Apostolov, 1987 viene posta in sinonimia con *E. plutonis plutonis* Chappuis, 1938. Vengono inoltre riportate descrizioni supplementari e brevi note tassonomiche, zoogeografiche ed ecologiche delle specie rinvenute.

INTRODUCTION

Collections from various subterranean biotopes of the Sangro River basin (Abruzzo, central Italy) yielded a new species of *Parastenocaris*, described here as *Parastenocaris crenobia* n. sp., a few specimens of *Elaphoidella plutonis plutonis* Chappuis, 1938, and *Bryocamptus* (*Arcticocamptus*) *cuspidatus cuspidatus* (Schmeil, 1893). The opportunity was taken to review the status of *Elaphoidella rossellae* Pesce, Galassi & Apostolov, 1987, here synonymized after comparison with topotypic material of *E. plutonis plutonis*. Supplementary descriptions and taxonomic, zoogeographical, and ecological remarks are given for the above taxa.

Samples were taken with a fine net (100 μm mesh) through which sediment was strained (the Karaman-Chappuis sampling method). Dissected specimens were mounted in polyvinyl lactophenol. Drawings and measurements were made using a Leitz Laborlux phase contrast microscope, with a camera lucida. Observations by CLSM (Confocal Laser Scanning Microscope) corroborated the morphological analyses.

DESCRIPTIONS

Order Harpacticoida G.O. Sars, 1903
Family Parastenocarididae Chappuis, 1933
Parastenocaris Kessler, 1913

Parastenocaris crenobia n. sp. (figs. 1-13)

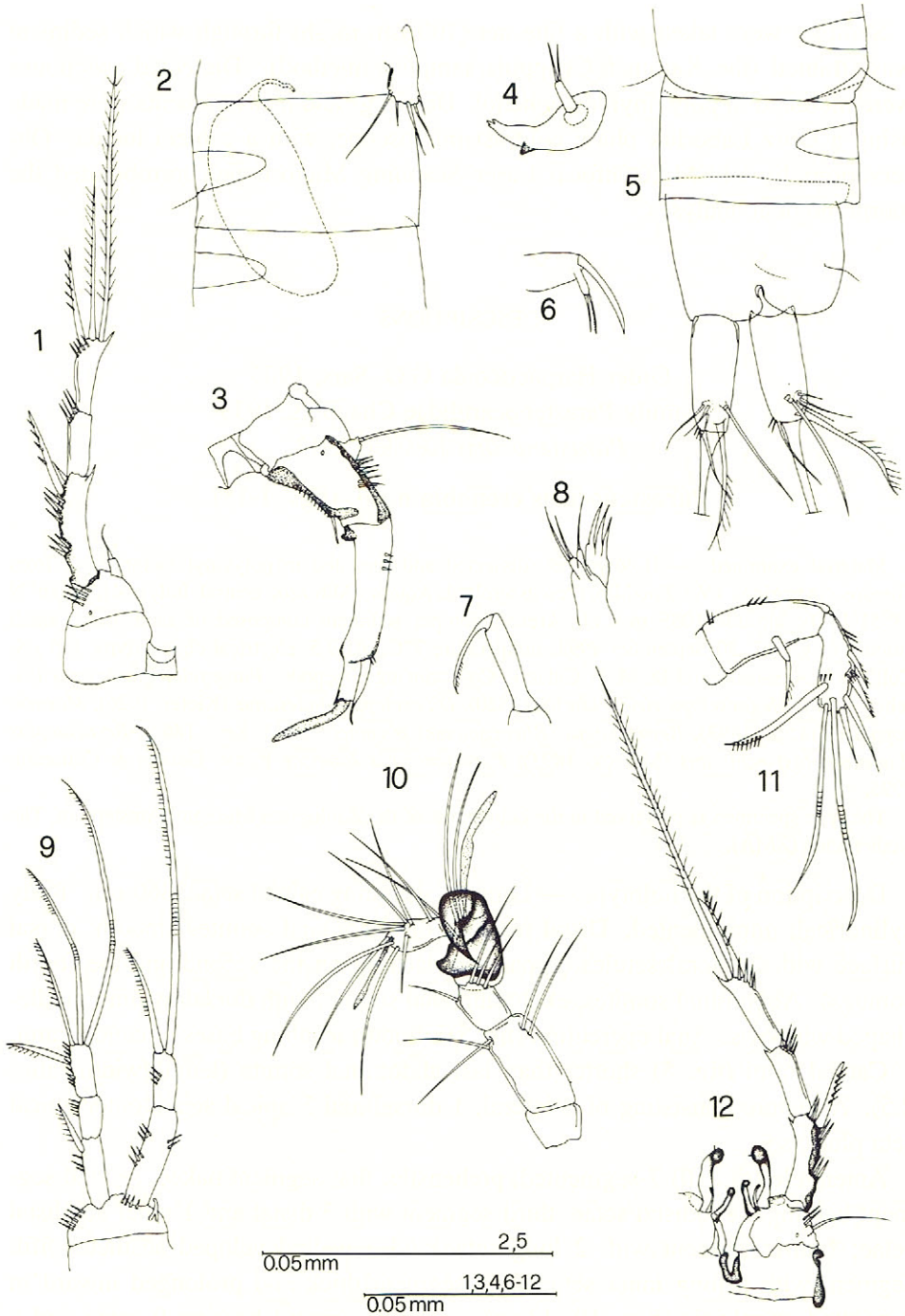
Material examined. — Holotype ♂, dissected and mounted in polyvinyl lactophenol, from Tornareccia springs (Val Fondillo, Pescasseroli, L'Aquila, Abruzzo, central Italy); 41°46′16″N 13°51′19″E; altitude 1085 m a.s.l.; krenal biotope; sediment composed of sand and a small amount of gravel; 30 September 1993; temperature 7°C, pH 7.5, electrical conductivity 195 μS. Coll. R. D'Anastasio and D. M. P. Galassi. Co-occurring copepods: *Paracyclops fimbriatus* (Fischer, 1853), *Megacyclops viridis* (Jurine, 1820), *Diacyclops clandestinus* (Kiefer, 1926), *Moraria poppei* (Mrázek, 1893), *Bryocamptus* (*Rheocamptus*) *pygmaeus* (G.O. Sars, 1863), *Bryocamptus* (*Limocamptus*) *echinatus* (Mrázek, 1893), *Parastenocaris lorenzae* Pesce, Galassi & Cottarelli, 1995.

The type specimen is preserved in the collections of the Zoologisch Museum, Amsterdam, The Netherlands (ZMA).

Description of the holotype. — Length, excluding caudal setae, 360 μm. Body cylindrical, unpigmented. Distal margins of abdominal somites smooth; dorsal surface with 2 lateral setules (apparently lacking on the second and the fourth somites). Abdominal somites, excluding anal somite, with dorsal hyaline saddle-shaped windows. Anal operculum (fig. 5) smooth; reaching bases of caudal rami.

Caudal rami (fig. 5) shorter than last abdominal somite (length/width ratio: 2.5). Armature consisting of 3 lateral, 1 dorsal and 3 apical setae, outer apical seta plumose.

Antennule (fig. 10) 7-segmented, prehensile; first segment naked, second segment bearing 4 subdistal setae; third segment with 3 distal and 1 inner subdistal setae; fourth segment with 2 long setae and a well developed aesthete; fifth segment with a long inner seta; sixth segment thick and prolonged inward in a pointed apophysis (figs. 10, 13c-e); seventh segment bearing 9 setae and a slender apical aesthete.



Figs. 1-12. *Parastenocaris crenobia* n. sp. (male holotype). 1, leg 2; 2, leg 5; 3, leg 3; 4, mandible; 5, abdomen and caudal rami, lateral view; 6, maxilla; 7, maxilliped; 8, maxillule; 9, leg 1; 10, antennule; 11, antenna; 12, leg 4.

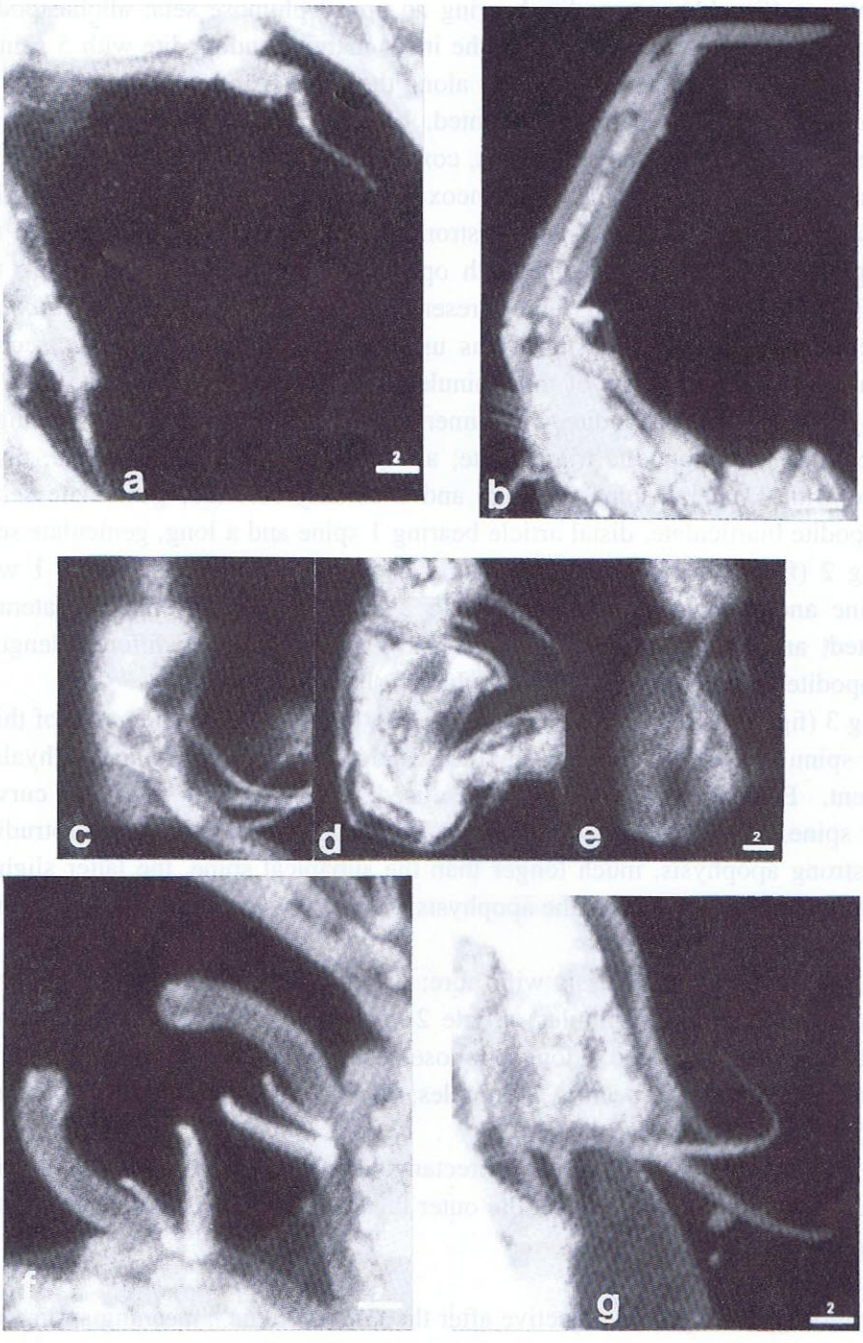


Fig. 13. CLSM integumental analysis of *Parastenocaris crenobia* n. sp. (male holotype). a, leg 2; b, leg 3; c-e, 4th-6th antennular segments from frontal to caudal sides; f, leg 4; g, leg 5. Scale bar in μm.

Antenna (fig. 11): exopodite bearing an apical plumose seta; allobasipodite unarmed, with some spinules along the inner margin; endopodite with 5 spines, 2 geniculate setae and some spinules along the inner margin.

Mandible (fig. 4): palp 1-segmented, bearing 2 setae. Maxillule (fig. 8): praecoxal arthrite with 3 distal spines, coxa bearing a distal seta, basipodite with 2 distal setae. Maxilla (fig. 6): syncoxa apparently with one endite, bearing 2 setae, one pectinate; basis with a strong prolonged element. Apart from the vestigial endopodite, not visible with optical microscopy in our material, the maxilla of *P. crenobia* n. sp. largely resembles that of *P. fontinalis meridionalis* Rouch, 1990. Maxilliped (fig. 7) as usual in congeners, prehensile; second segment armed with a row of thin spinules.

Leg 1 (fig. 9): basipodite with inner medial hook recurved and having a subrounded tip; exopodite triarticulate; about as long as the endopodite; distal article with 1 lateral spine, 1 spine and 2 distally inserted, geniculate setae; endopodite biarticulate, distal article bearing 1 spine and a long, geniculate seta.

Leg 2 (figs. 1, 13a): basis with pore; exopodite triarticulate, article 1 with 1 spine and 2 rows of spinules; article 2 bare, with distal spinules laterally inserted; article 3 with 1 lateral spine and 2 apical setae of different lengths. Endopodite short, bearing 1, "candle flame" shaped, apical seta.

Leg 3 (figs. 3, 13b) slender; basis with pore, long outer seta and a row of thick outer spinules and thinner inner spinules. Endopodite reduced to a short hyaline element. Both segments of exopodite fused: proximal part bearing a curved outer spine, ending distally in a filiform tip; distal part of exopodite protruding in a strong apophysis, much longer than the subapical spine, the latter slightly overreaching the insertion of the apophysis; two groups of spinules inserted along outer edge of exopodite.

Leg 4 (figs. 12, 13f): basis with pore; exopodite triarticulate, article 1 with 1 spine and 3 rows of spinules; article 2 with only 1 row of spinules, article 3 with 1 apical spine and 1 long plumose seta. Endopodite cylindrical, with a stalked spheroidal tip, bearing 2 spinules; 2 curved spinules inserted on inner margin of basipodite.

Leg 5 (figs. 2, 13g): reduced to subrectangular chitinous lamellar plate, bearing 1 long outer seta, 3 apical setae, the outer the shortest, and 1 short seta inserted along inner corner.

Female unknown.

Etymology. — Specific adjective after the Greek "krene", meaning spring, the habitat from which the new species has been collected.

Affinities. — *P. crenobia* n. sp., owing to the construction of the leg 4 endopodite and the ornamentation of the basipodite, fits the *minuta*-group of species

as defined by Lang (1948). Within this group, that author established the existence of minor subdivisions, one of which includes *P. phreatica* Chappuis, 1936, *P. stammeri* Chappuis, 1937, *P. orcina* Chappuis, 1938, and *P. minuta* Chappuis, 1925. Subsequently, Rouch (1990), taking into account the structural complexity of the male leg 4 endopodite, proposed the exclusion of *P. minuta* from the above subgroup, owing to the remarkable simplification of its endopodite. According to Rouch (1990), *P. minuta* could represent a more homogeneous subgroup together with other *Parastenocaris* species and subspecies, such as *P. karamani* Chappuis, 1937, *P. karamani brevicauda* Damian, 1958, *P. dubia* Kiefer, 1933, *P. narentina* Petkovski, 1959, and *P. tumida* Kiefer, 1961, all with two spines on the basipodite of leg 4 and a simplified (digitiform, not spiniform, and more or less spinulose) endopodite. *Parastenocaris crenobia* n. sp., because of its very simple endopodite of leg 4, could fall into the above subgroup. The new species is closely related to *P. karamani*, from springs and phreatic waters near Bankya, Dobruja, and Skopje, to *P. k. brevicauda*, from a water pipe near Bucharest, and to *P. narentina*, from hyporheic waters near Capljina (Yugoslav Macedonia). With all these taxa, *Parastenocaris crenobia* n. sp. shares the same chaetotaxy and armature of the male leg 5, with an inner short seta (instead of an inner thorn possessed by numerous other *Parastenocaris* species) and the general aspect of the endopodite of leg 4. *Parastenocaris crenobia* n. sp. is easily distinguished from the above taxa, as well as from all other congeners, by the peculiar morphology of the male leg 4 and the different combination of other morphological characters such as the armature of the male legs 2, 3, and 5, and the morphology of the sixth article of the antennule, curved inward and prolonged into a strong and pointed apophysis.

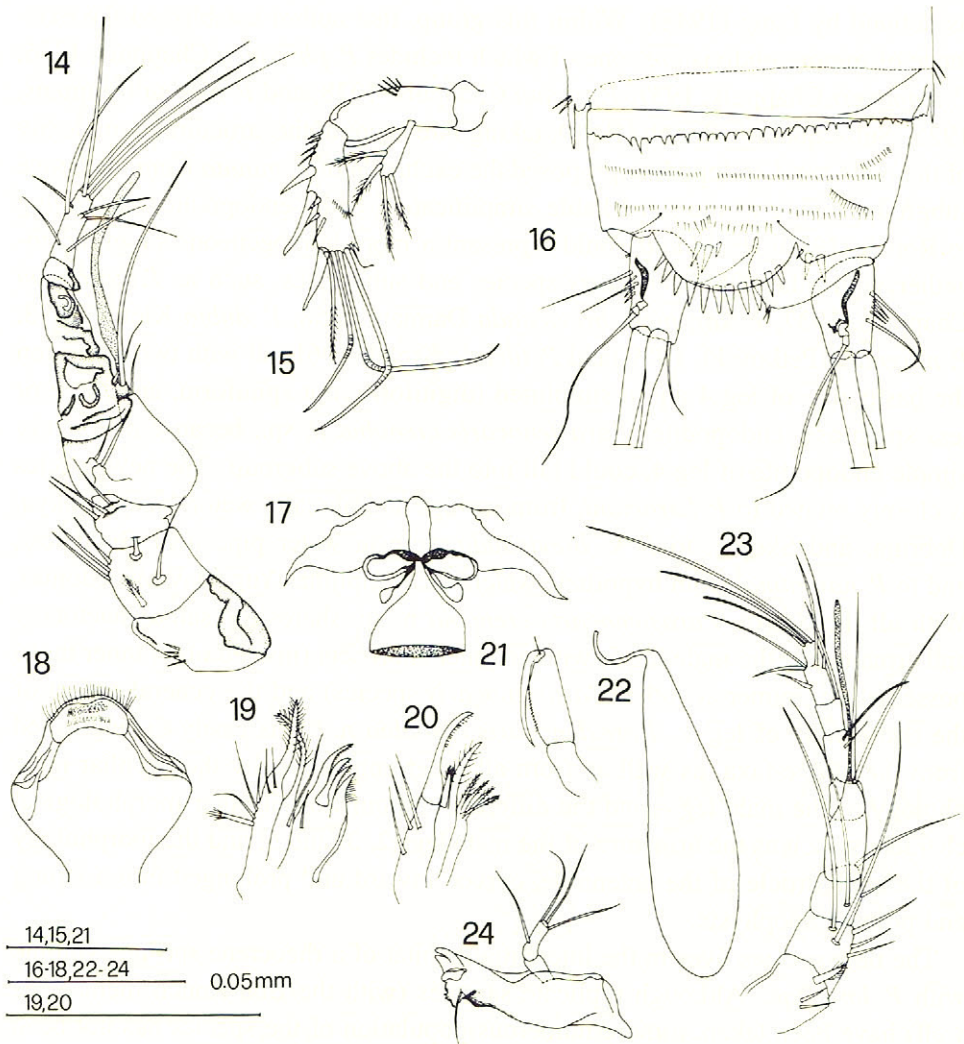
The new species lives in the interstitial habitat of a rheocrene spring, syntopic with *P. lorenzae*. Although replicate samples (with the Bou-Rouch method, as well) have been taken, a more numerous population of the species has not been located. According to Dole & Marmonier (1992), the spatial distribution of some *Parastenocaris* species could be related to phreatic movements in time and space ("species sensitive to water circulation patterns").

Family Canthocamptidae G.O. Sars, 1906; sensu Monard, 1928; Lang, 1948
Elaphoidella Chappuis, 1929; sensu restricto Apostolov, 1985

Elaphoidella plutonis plutonis Chappuis, 1938 (figs. 14-35)

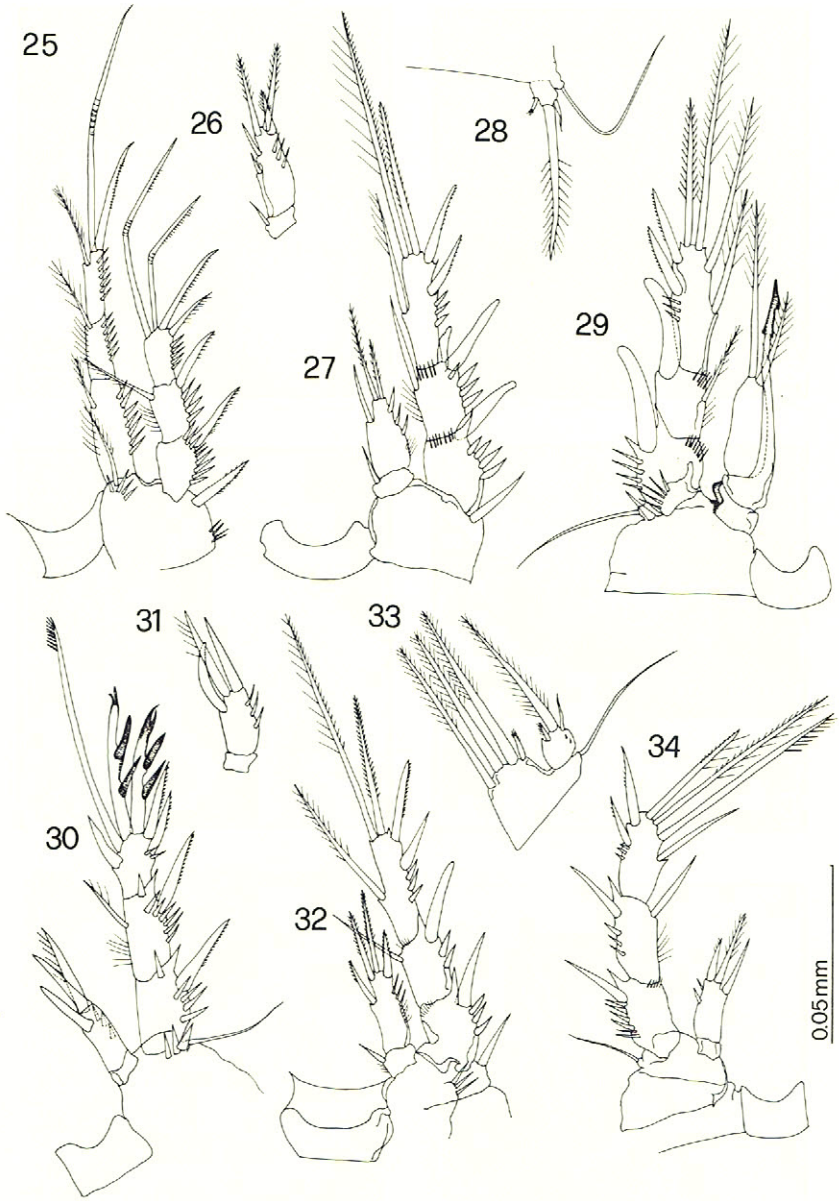
Elaphoidella plutonis Chappuis, 1938: 169, figs. 25-38.
Elaphoidella rossellae Pesce, Galassi & Apostolov, 1987: 181-182, figs. 33-45.

Material examined. — 1 ♀, 1 ♂, dissected and mounted on slides in polyvinyl lactophenol (see locality data given for *P. crenobia*, above); temperature 7°C, pH 7.0, electrical conductivity 190 μS;



Figs. 14-24. *Elaphoidella p. plutonis* Chappuis, 1938. 14, antennule (♂); 15, antenna (♀); 16, caudal rami (♀); 17, receptaculum seminis; 18, labrum; 19, maxillule; 20, maxilla; 21, maxilliped; 22, spermatophore; 23, antennule (♀); 24, mandible.

krenal biotope; 30 September 1993. Coll. R. D'Anastasio and D. M. P. Galassi. Co-occurring copepods: *Paracyclops fimbriatus* (Fischer, 1853), *Attheyella* (*Mrazekiella*) *paranaphtalica* Pesce & Galassi, 1988, *Bryocamptus* (*Rheocamptus*) *pygmaeus* (G.O. Sars, 1863), *Bryocamptus* (*Rheocamptus*) *zschokkei* (Schmeil, 1893), *Bryocamptus* (*Limocamptus*) *echinatus* (Mrázek, 1893). 1 ♀ and 2 copepodites, completely dissected and mounted on slides in polyvinyl lactophenol, interstitial habitat, subterranean lake in Pertosa cave, Salerno (southern Italy); 40°32′8″N 15°27′19″E; altitude 265 m a.s.l.; 23 September 1995. Coll. D. M. P. Galassi and G. Maj. Material preserved in the author's collection at the Dipartimento di Scienze Ambientali, University of L'Aquila, Italy.



Figs. 25-34. *Elaphoidella p. plutonis* Chappuis, 1938. 25, leg 1; 26, leg 3, endopodite (♀); 27, leg 2 (♂); 28, leg 5 (♂); 29, leg 3 (♂); 30, leg 4 (♂); 31, leg 4, endopodite (♂); 32, leg 2 (♀); 33, leg 5 (♀); 34, leg 4 (♀).

Supplementary description. — Female. Body subcylindrical. Length, excluding caudal setae, 0.570 mm (0.565 mm, topotype). Genital double-somite wider than long, suture visible laterally; genital field as in fig. 17. Dorsal surface of

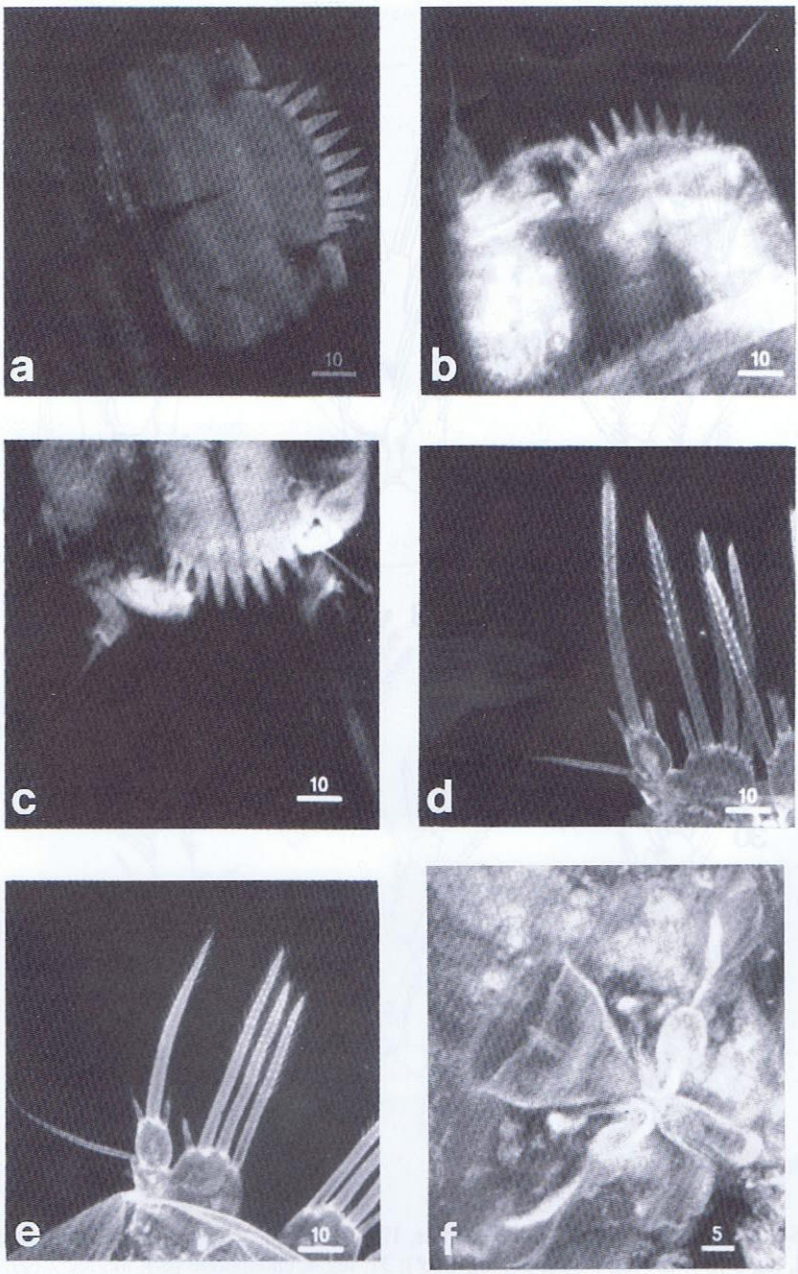


Fig. 35. CLSM integumental analysis of *Elaphoidella p. plutonis* Chappuis, 1938 and *Elaphoidella rossellae* Pesce, Galassi & Apostolov, 1987. a, anal operculum of *E. p. plutonis* (topotype, Pertosa Cave, Italy); b, anal operculum of *E. p. plutonis* (krenal, Sangro River Basin, Italy); c, anal operculum of *E. rossellae* (type material); d, leg 5 of *E. p. plutonis* (krenal, Sangro River Basin, Italy); e, leg 5 of *E. p. plutonis* (topotype); f, receptaculum seminis of *E. p. plutonis*. Scale bar in μm.

abdominal somites with numerous rows of thin cuticular setules; ventral surface of two urosomites posterior to genital segment, each with distal row of spinules. Posterior dorsal and ventral margins of all abdominal somites with faintly indented hyaline lamella. Anal somite with several rows of thin spinules on dorsal side and 3 ventral spines at base of each caudal ramus. Anal operculum strongly convex and armed with 11 strong spines. Caudal ramus longer than wide (length/width ratio: 1.6), subrectangular. Armature as follows: dorsal seta inserted on well-developed dorsal ridge, about three times longer than caudal ramus; 2 lateral setae, inserted on outer surface, and 3 apical setae; remaining armament as in fig. 16.

Antennule 8-segmented, armature as in fig. 23. Antenna as in fig. 15. Labrum as in fig. 18. Mandible (fig. 24) with a biarticulate palp, bearing 3 distal and 1 subdistal setae on segment 2. Maxillule and maxilla as in figs. 19–20. Maxilliped (fig. 21) prehensile, basis without seta.

Legs 1-4 with triarticulate exopodite; endopodite of leg 1 triarticulate; endopodites of legs 2-4 biarticulate. Formula of major armature as follows:

	exp.			enp.		
	1	2	3	1	2	3
Leg 1	0.1	1.1	0.2.2	1.0	1.0	1.2.0
Leg 2	0.1	1.1	1.2.2	1.0	2.1.1	–
Leg 3	0.1	1.1	2.2.2	1.0	2.2.1	–
Leg 4	0.1	1.1	2.2.2	0.0	1.2.0	–

Couplers of all legs without armature.

Leg 5 (fig. 33): baso-endopodite prominent, reaching tip of exopodite, with 4 setae, inner seta very short, remaining 3 setae longer, about same length.

Male. The present description deals with the main differences with respect to the female. Body length 0.530 mm. Antennule of 8 segments, fourth segment enlarged, armature as in fig. 14. Anal operculum with 12 spines. Leg 1 (fig. 25) as in female. Leg 2 (fig. 27) exopodite as in female, distal article of endopodite with 2 distal and 1 inner setae; strong cuticular spinules inserted along outer margin. Leg 3 (fig. 29) exopodite with major lateral spines of articles 1 and 2 large, curved posteriorly, endopodite triarticulate, modified, spiniform process of article 2 long, overreaching tip of article 3. Leg 4 (figs. 30-31) exopodite with 2 spines of article 3 transformed and with 1 inner subapical seta, distally plumose, inner proximal seta strong; endopodite with stronger spines.

Leg 5 (fig. 28): baso-endopodite reduced, lacking armature; exopodite with 1 long distal and 2 short subdistal setae, inner one plumose, outer very tiny, tapering at distal third.

Remarks. — *Elaphoidella plutonis* was described by Chappuis (1938), with the nominal subspecies from Castelcivita and Pertosa Caves (Salerno, southern Italy) and with the subspecies *E. plutonis quadrispinosa* from Pertosa Cave. Subsequently, it was recorded from a freshwater well in Umbria (central Italy) by Pesce & Galassi (1983). On the same occasion, the authors included *E. p. quadrispinosa* in the nominal subspecies, but this proposed synonymy should be better investigated. According to Pesce et al. (1987), *Elaphoidella plutonis plutonis* is closely related to *E. subplutonis* Pesce, Galassi & Apostolov, 1987, from a freshwater well near Perugia (Umbria, Italy) and to *E. rossellae* Pesce, Galassi & Apostolov, 1987, from freshwater wells of Abruzzo and Sicily (Pesce & Galassi, 1987). Although clear differences are recognizable between *E. plutonis* s. str. and *E. subplutonis*, the status of *E. rossellae* requires discussion. The taxonomic validation of *E. rossellae* was argued from questionable diagnostic features, such as the different number of spines on the anal operculum (13-14 in *E. rossellae* vs 8-10 in Chappuis' (1938) description), the morphology of the spines on the basipodite of the female P5 (the two innermost setae spinulose in *E. rossellae* vs naked in Chappuis' (1938) fig. 30), and a few perceived differences in the genital field. Moreover, the type material of *E. plutonis* s. str. has not been re-examined. Given that the location of the type material of *E. plutonis* is still unknown, topotypes have been collected. On the other hand, the type material of *E. rossellae* has been re-examined. The female of *E. plutonis* s. str. from the type locality shows minor differences with respect to the original description (dorsal and ventral margins of abdominal somites with faintly indented lamella, 11 spines on the anal operculum, caudal dorsal seta about 2.5 times longer than caudal ramus) (fig. 35a). Moreover, the morphology of the receptaculum seminis (fig. 35f), the general aspect of the armament of P5 (fig. 35d-e) as well as the number of spines on the anal operculum (no more than 12 spines in the female of *E. rossellae* vs 11 spines in our material) (fig. 35a-b) appear to be quite similar to those of *E. rossellae* (fig. 35c), bridging the gap between the species. These observations indicate that *E. rossellae* is a junior synonym of *E. plutonis* s. str. The specimens from the krenal of Tornareccia Spring agree in nearly all aspects with the original description of the species. Differences of little systematic value are referred to intraspecific variation and to overlooked microcharacters in Chappuis' (1938) figures.

According to the above considerations, *E. plutonis* may have a more or less continuous distributional range in subterranean (cave, phreatic and krenal) freshwater habitats of central and southern Italy.

Bryocamptus Chappuis, 1929
Subgenus *Arcticocamptus* Chappuis, 1929; Lang, 1948

Bryocamptus (Arcticocamptus) cuspidatus cuspidatus (Schmeil, 1893)
(figs. 36-53)

Material examined. — 2 ♀♀, completely dissected and mounted on slides in polyvinyl lactophenol, interstitial habitat, along Rio Fondillo, Sangro River basin, 100 m upstream from the confluence of Tornareccia and Rio Fondillo; 22 April 1993, temperature 11 °C, pH 7.2, electrical conductivity 240 μS. 1 ♀, 1 ♂, mounted as above; same locality; 30 September 1993; temperature 10°C, pH 7.5, electrical conductivity 285 μS. Coll. R. D'Anastasio and D. M. P. Galassi.

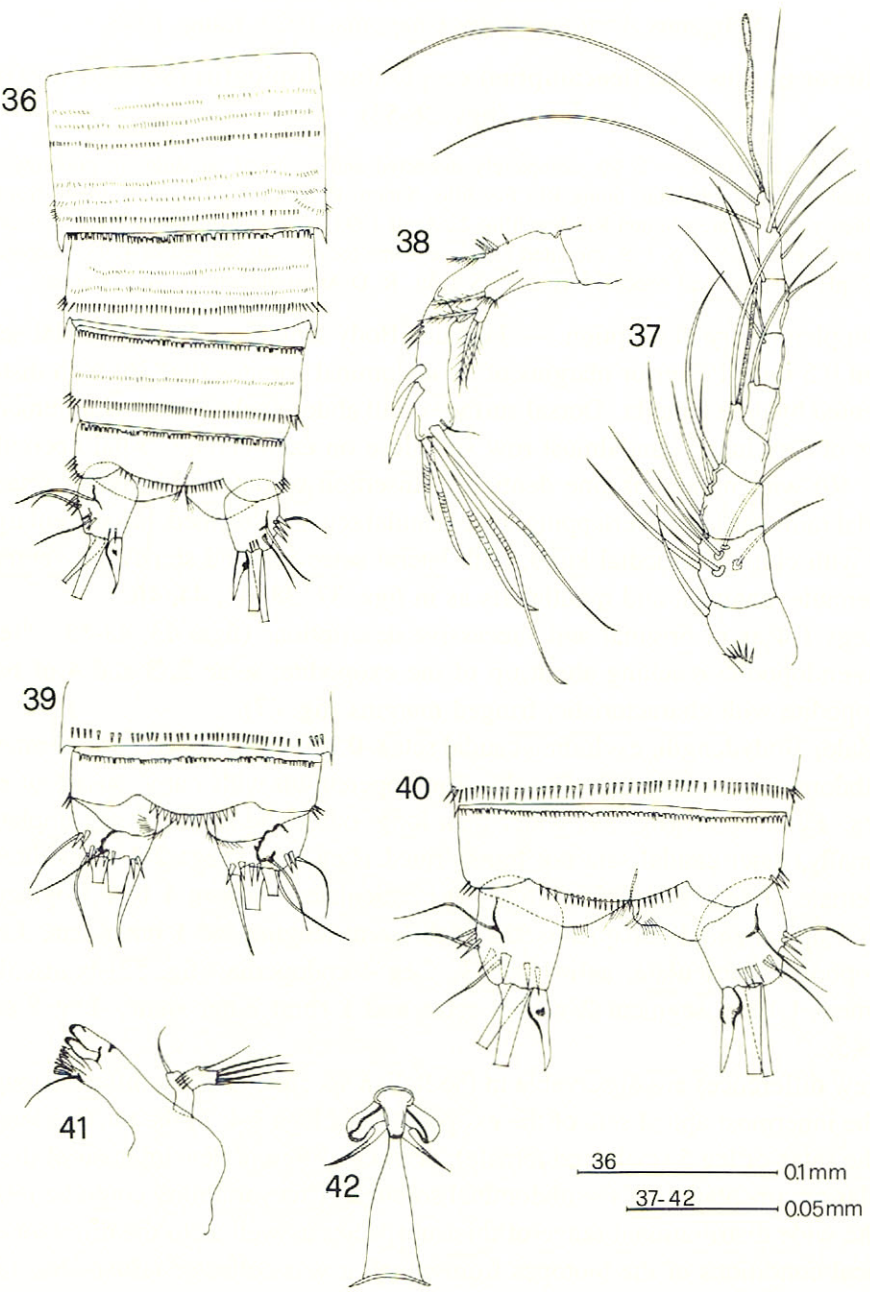
Supplementary description. — Female. Body length, excluding caudal setae, about 0.5 mm. Posterior margins of all abdominal somites (fig. 36) with distally indented hyaline lamella. Dorsal surface of all abdominal somites with numerous rows of tiny hairs; caudalmost row spinulose on each somite. Anal operculum (fig. 40) with numerous fine denticles. Insertion of outer and middle setae of caudal rami partially overlapping, inner caudal seta transformed, basally enlarged, and with chitinous medial knob; both lateral setae inserted somewhat ventrally. Antennule, antenna, and mouthparts as in figs. 37, 38, 41, 44, 46.

Legs 1-4 as in original and successive descriptions (figs. 43, 48-53). Leg 5 baso-endopodite reaching about tip of the exopodite; setae 2, 3 and 4 of baso-endopodite with characteristic, fringed margins (fig. 47).

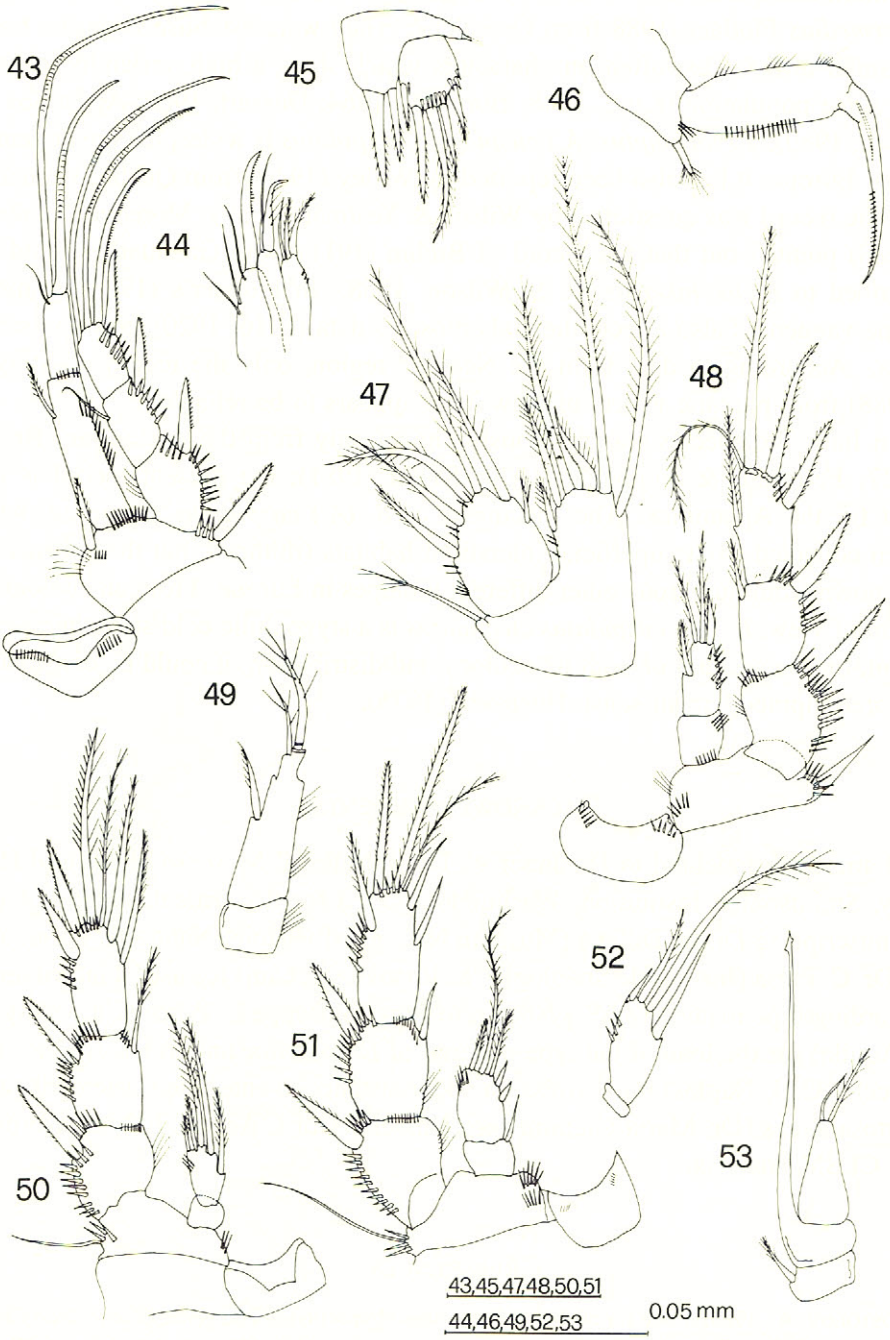
Male. Body length, excluding caudal setae, 0.390 mm. General ornamentation of abdominal somites as in female. Anal operculum with numerous stout denticles. Furcal rami (fig. 39) wider than long; outer and middle setae implanted normally, inner caudal seta not transformed. Leg 1 and legs 2-4 exopodites as in female. Leg 2 endopodite (fig. 49) biarticulate; segment 1 bare, segment 2 with 1 apical and 1 subapical setae of different lengths and 1 inner seta. Leg 3 endopodite triarticulate, as in fig. 53. Leg 4 endopodite (fig. 52) biarticulate; segment 1 bare, segment 2 with 3 setae and 1 short outer spine. Leg 5 as in fig. 45.

Few differences are observable in the Italian specimens in the different lengths of the innermost apical seta of the exopodite 3 of legs 2-4, in the relative lengths of the setae of leg 5 (male and female), or in the different development of the cuticular ornamentation of the abdominal somites. This variability could be related to the wide distributional range of this subspecies as well as to the different ecological conditions of the biotopes from which it was collected (Husmann, 1975; Kulhavy & Noodt, 1968; Apostolov & Pesce, 1989).

Remarks. — *Bryocamptus* (*A.*) *cuspidatus* is known to include 5 subspecies; besides the nominal one, these are: *B.* (*A.*) *c. ekmani* (Kessler, 1913) from numerous localities of central and eastern Europe; *B.* (*A.*) *c. kessleri* Lang, 1931 from



Figs. 36-42. *Bryocamptus* (*Arcticocamptus*) *cuspidatus cuspidatus* (Schmeil, 1893). 36, abdomen and caudal rami, dorsal view (♀); 37, antennule (♀); 38, antenna (♀); 39, operculum and caudal rami (♂); 40, operculum and caudal rami (♀); 41, mandible (♀); 42, receptaculum seminis.



Figs. 43-53. *Bryocamptus* (*Arcticocamptus*) *cuspidatus cuspidatus* (Schmeil, 1893). 43, leg 1 (♀); 44, maxilla (♀); 45, leg 5 (♂); 46, maxilliped (♀); 47, leg 5 (♀); 48, leg 2 (♀); 49, leg 2, endopodite (♂); 50, leg 4 (♀); 51, leg 3 (♀); 52, leg 4, endopodite (♂); 53, leg 3, endopodite (♂).

northern Europe; *B.* (*A.*) *c. harzicus* Gagern, 1938 from Germany; and *B.* (*A.*) *c. intermedius* Floßner, 1988 from Greenland. They were established on the basis of small differences, often on characters which show a high variability within the same population (Lang, 1948; Borutzky, 1964; Dussart, 1967; Apostolov & Pesce, 1989). *Bryocamptus* (*A.*) *cuspidatus cuspidatus* is widespread over nearly all of Europe; it has also been reported by Willey (1934) from Quebec (Canada) but the record was questioned by Wilson & Yeatman (1959). Moreover, Floßner (1988) pointed out that the record of Brehm (1911) from Greenland should be ascribed to *B. tikchikensis* M. S. Wilson, 1958. In Floßner's (1988) opinion, some vagueness also affects the Haberbosch's data (1916, 1920) from the same area. According to data from the Nearctic region, only the record of Strayer (1988) from phreatic waters of New York appears to be reliable.

In Italy, the species was previously known only from the Alpine arc (Brian, 1927; Ferrarese & Sambugar, 1976; Kiefer, 1981); the present record is the first for the Apennines. The specimens of *B.* (*A.*) *cuspidatus cuspidatus* have been collected from superficial interstitial habitats (rhithral), but the subspecies is known from numerous other different biotopes in Europe. From an ecological point of view, *B.* (*A.*) *cuspidatus cuspidatus* is a stygophilic cold-stenotherm element; on the account of both its ecology and distribution, it could be considered a boreo-alpine element sensu Husmann (1975).

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