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ELAPHOIDELLA UVA N. SP. (CRUSTACEA, COPEPODA) AND TWO OTHER INTERESTING SPECIES OF THE GENUS *ELAPHOIDELLA* FROM MONTENEGRO (SE EUROPE)

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ABSTRACT

Three species of the genus *Elaphoidella* Chappuis, 1929 (Copepoda, Harpacticoida), from Montenegro are presented. *E. uva* n.sp., which belongs to the 'gracilis' group of species, is described from two subterranean localities in Montenegro, and is most closely related to *E. bidens* (Schmeil, 1894). *E. phreatica* (Chappuis, 1925) is reported from several localities, and new synonyms of this species are established. For *E. denticulata* Chappuis, 1929 this is the most western locality from which it has been recorded, and one new synonym of this species is established.

RÉSUMÉ

Trois espèces du genre *Elaphoidella* Chappuis, 1929 (Copépoda, Harpacticoida) du Monténégro sont étudiées. *E. uva* n.sp. est décrite des deux localités souterraines du Monténégro, appartient au groupe 'gracilis', et elle est très proche d'*E. bidens* (Schmeil, 1894). *E. phreatica* (Chappuis, 1925) a été recoltée dans plusieurs localités, et nouveaux synonymes sont établis. Pour *E. denticulata* Chappuis, 1929 ce est la dernière occidentale localité et un nouveau synonyme est établi.

INTRODUCTION

The genus *Elaphoidella*, which was established by Chappuis (1929), currently contains just over 200 described species and subspecies. Unfortunately, many of these are synonyms, but the genus is still the second largest copepod genus, after *Parastenocaris* Kessler, 1913. Although very speciose, *Elaphoidella* is relatively homogenous, and attempts to split it up into different genera

(Apostolov, 1985), or returning it to the subgeneric status (Hamond, 1988) of the genus *Canthocamptus* Westwood, 1836 have been unsuccessful. At present the majority of copepodologists support the generic status of *Elaphoidella*, as well as its separation into species groups, which was created by Lang (1948) and supplemented by Petkovski & Brancelj (1988). In fact, the separation into ten groups by Lang (1948), was so good that only one species described since then (despite almost 150

species and subspecies have been described) could not be placed within this system: *E. serbica* Petkovski & Brancelj, 1988. The only problem with the classification of species into groups is the necessity of both sexes, while some species have been described and are known from just one sex (usually female).

Two subterranean and endemic species of the genus *Elaphoidella* are already known from Montenegro. *Elaphoidella montenegrina* Karanovic, 1997 is known from several caves in southern Montenegro (Karanovic, 1997), and belongs to the II.-group of species. *E. gordani* Karanovic, 1998 belongs to the III.-group, and is known from southern and central Montenegro (Karanovic, 1998). Together with the description of the latter species a brief review of the III.-group (although not a key to species) was given (Karanovic, 1998). In this paper a new species, *E. uva*, belonging to the II.-group is described and a key to the species of this group presented. Two other interesting species are also redescribed herein: *E. phreatica* (Chappuis, 1925) from the V.-group (now the only remaining species in that group), and *E. denticulata* Chappuis, 1929, probably belonging to the II.-group. These two species are interesting from both a taxonomic and zoogeographic point of view.

METHODS

For this study samples were taken with different methods. From wells they were taken with phreatic net constructed following the instructions given by Cvetkov (1968). From springs, streams and rivers samples were taken by the Karaman-Chappuis method or by phreatic pump similar to that of Bou & Rouch (1967). Also, different types of hand nets were used. The material was preserved by adding several drops of 36% formaldehyde. Copepods were separated with a Wild-M5 stereomicroscope and moved to 70% ethanol. Specimens were dissected in a mixture of equal parts of distilled water and glycerol, with fine entomological needles (mark 000). Dissected appendages were placed on a slide, in the same distilled water and glycerol mixture, and covered with a coverslip. For larger parts (urosome, etc.) two human hairs were mounted between slide and coverslip, so the parts could not be squashed.

By moving the coverslip carefully by hand, the whole animal or a particular appendage could be positioned in different aspects, making possible the observation of morphological details. During examination water slowly evaporated, and after some time appendages remained in pure glycerol. All drawings have been prepared using a drawing attachment (tube) on Leica-DMLS microscope, with C-PLAN achromatic objectives. Dissected appendages were preserved in Faure's medium, which was prepared following the old procedure recently discussed by Stock & Vaupel Klein (1996). Non-dissected specimens, after examination, were again preserved in 70% ethanol.

SYSTEMATICS

Elaphoidella uva n.sp.

Figs. 1-29

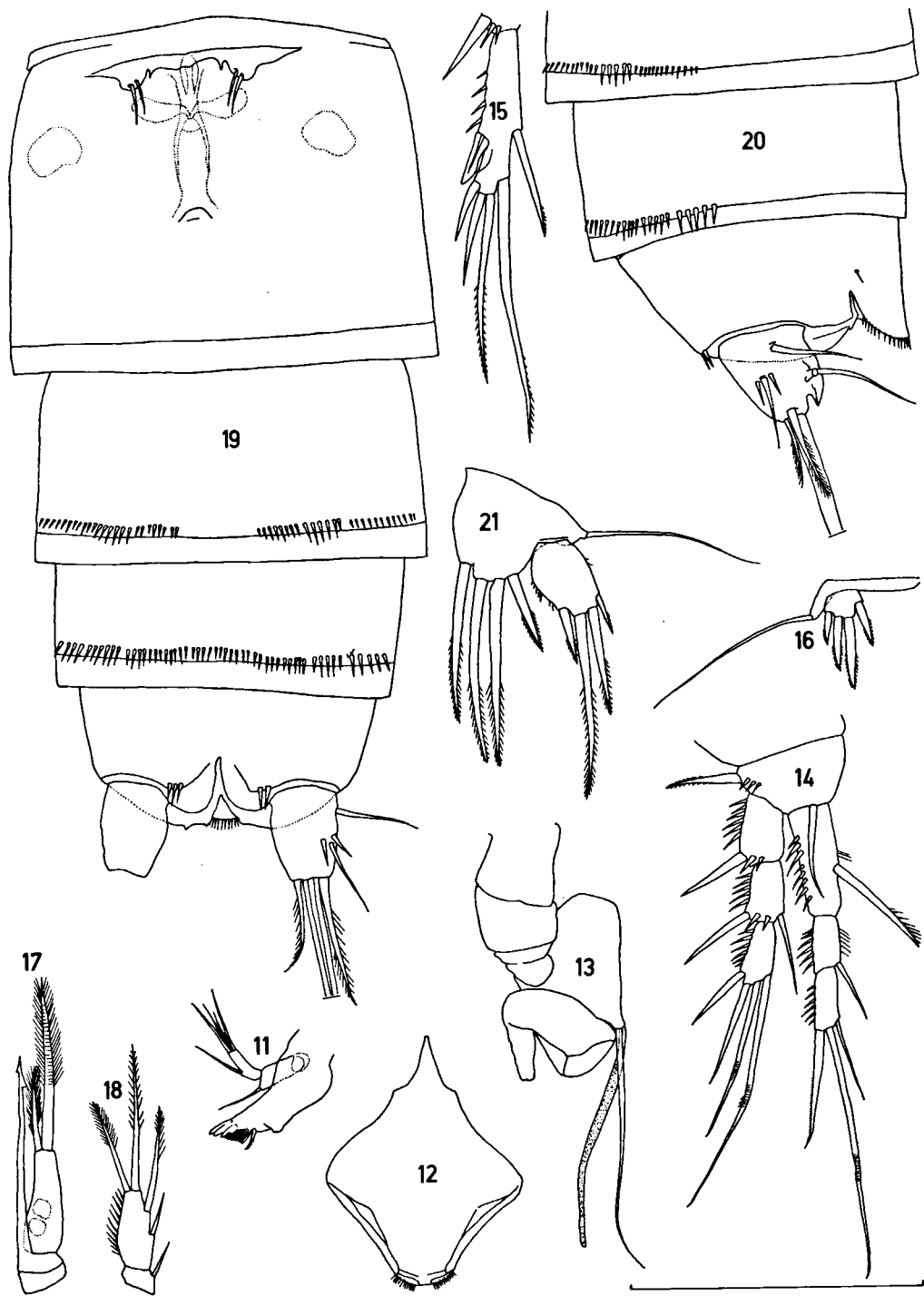
MATERIAL. - 1) Holotype (male 0.58 mm), allotype (female 0.623 mm), and 14 paratypes (5 males, 7 females and 2 copepodids) from a well in the village Spuz (type locality), near the town of Podgorica, central Montenegro, 26VI-1997, collected by T. Karanovic; 2) 1 male (0.68 mm) from the spring Mareza in the village Tolosi near the town of Podgorica, central Montenegro, 26-X-1996, collected by T. Karanovic.

Holotype, allotype, 2 paratypes (male and female) and male from the spring Mareza were completely dissected and mounted on slides in Faure's medium. They are held in the author's working collection in Australia as well as 10 paratypes (3 males, 5 females and 2 copepodids) that were preserved in 70% ethanol. Two paratypes (male and female), preserved as non-dissected animals in Faure's medium, are deposited in the Zoological Museum Amsterdam (ZMA Co. 204.921).

DESCRIPTION. - Male (holotype): body length, excluding furcal setae, 0.58 mm. Habitus elongate and cylindrical. Body colourless and nauplius eye absent. Prosoma comprising cephalothorax (incorporating first pedigerous somite) and three free pedigerous somites. Surface of cephalothoracic shield and three free pedigerous somites with only a few pore and sensillae. Their hind margins smooth. Urosome comprising fifth pedigerous somite and five free abdominal somites. First urosomal somite (genital somite) about 1.5 times broader than long, without ornamentation. Second, third and fourth urosomal somites with transverse rows of spinules ventrally; with smooth hind margins both ventrally and



Figs. 1-10. *Elaphoidella uva* n.sp., holotype (male 0.58 mm). 1, anal somite and furcal rami, dorsal view. 2, last two abdominal somites and right furcal ramus, lateral view. 3, abdomen, ventral view. 4, fifth legs. 5, maxilla. 6, fourth swimming leg. 7, third swimming leg. 8, second swimming leg. 9, antenna. 10, maxilliped (scale = 0.1 mm).



Figs. 11-21. *Elaphoidella uva* n.sp. 11-14, holotype (male 0.58 mm). 15-18, spring Mareza (male 0.68 mm). 19-21, allotype (female 0.623 mm). 11, mandibula. 12, labrum. 13, antennula, without complete armature. 14, first swimming leg. 15, third exopodite segment of fourth swimming leg. 16, fifth leg. 17, endopodite of third swimming leg. 18, endopodite of second swimming leg. 19, abdomen, ventral view. 20, last two abdominal somites and left furcal ramus, lateral view. 21, fifth leg (scale = 0.1 mm).

dorsally (Figs. 2 and 3). Anal somite (last urosomal somite) ornamented with pair of sensillae dorsally, with one short transverse row of spinules laterally, and with two large spinules at base of furcal rami ventrally (Figs. 1, 2 and 3). Anal operculum convex, not reaching beyond limit of anal somite; with many spinules along its margin (Fig. 1). Anal sinus smooth. Furcal rami slightly divergent, about 1.5 times longer than wide, with six armature elements (two lateral, one dorsal and three apical setae). There are two strong spinules at base of distal lateral seta, which inserts ventrolaterally, in distal third of furcal ramus (Fig. 2). Proximal lateral seta inserted in proximal third of furcal ramus. Dorsal seta biarticulate at base, attached behind well developed, posteriorly produced chitinous ridge, just to midlength of ramus (Fig. 1). Inner apical seta smooth and shorter than ramus, while outer apical seta very strong and plumose, about 2.9 times longer than ramus (Fig. 3). Middle apical seta somewhat longer than abdomen, and also plumose.

Antennula 8-segmented, strongly geniculate, with relatively short and slender aesthetasc on fourth segment (Fig. 13).

Antenna comprising small coxa, allobasis, 1-segmented endopodite, and 1-segmented exopodite (Fig. 9). Exopodite armed with four setae, while endopodite armed with two lateral and five apical armature elements.

Labrum rhomboidal, with two groups of pinules along its short cutting edge (Fig. 12).

Mandibula with very strong teeth along distal end of coxal gnathobase, and with 2-segmented palp (Fig. 11). Proximal segment of mandibular palp armed with one subapical seta, while distal segment bearing one lateral and four apical setae.

Arthrite of praecoxa of maxillula with five naked spines and one plumose seta; coxa with one strong and one fine seta; basipodite with one very strong distal seta and six lateral setae.

Syncoxa of maxilla with two endites of which proximal bearing three, while distal bearing two setae (Fig. 5).

Syncoxa of maxilliped without seta on distal-inner corner (just a few spinules); basis with row of spinules on inner margin; endopodite drawn out into strong, recurved claw with one smooth seta (Fig. 10).

All swimming legs with 3-segmented exopod-

ites, as well as endopodites of first and third swimming legs, while endopodites of second and fourth swimming legs 2-segmented (Figs. 6, 7, 8 and 14). Endopodite of first swimming leg longer than corresponding exopodite for length of almost whole distal segment; bearing one seta on proximal, one on median, and three setae on distal segment respectively (Fig. 14). Endopodite of second swimming leg with one inner seta on proximal, and four setae on distal segment (Fig. 8). Distal exopodite segment of that leg with five spines and setae. Proximal endopodite segment of third swimming leg without armature; median with long inner apophysis; distal with two apical plumose setae, outer one 1.3 times longer than inner seta (Fig. 7). Distal exopodite segment of that leg with six spines and setae. Proximal endopodite segment of fourth swimming leg very small and without armature; distal with inner spine and two apical setae (inner one twice as long as outer, and plumose). Distal exopodite segment of that leg elongate and armed with six elements, of which proximal outer spine stout, characteristically modified, thumb-like in shape (Fig. 6). Couplers (intercoxal sclerites) of all swimming legs concave and without surface ornamentation. Coxae of all swimming legs with one row of (three or four) spinules on outer-distal margin (Figs. 6, 7 and 8). Bases of first and second swimming legs with outer spines, while on third and fourth legs it bearing an outer seta (each swimming leg with a few spinules around their bases).

Fifth leg with reduced basiendopodite, without armature (Fig. 4). Exopodite subquadrangular, almost twice as broad as long, armed with four stout and spiniform pinnate setae.

Sixth leg consisting of membranous lamella, without armature (Fig. 3).

Female (allotype): body length 0.623 mm. General body appearance similar to male, just slightly less slender. Urosome comprising fifth pedigerous somite, genital double-somite (representing fused genital and first abdominal somites), and three free abdominal somites. Genital double-somite about 1.2 times as broad as long; with two short and smooth setae on its fused sixth leg; without any rows of spinules (Fig. 19). Genital field with copulatory pore just after midlength of genital somite; copulatory duct concealed in middle; receptacles elongate, bottle-like. First free



Figs. 22-29. *Elaphoidella uva* n.sp., allotype (female 0.623 mm). 22, last two abdominal somites and furcal rami, dorsal view. 23, third swimming leg. 24, fourth swimming leg. 25, first swimming leg. 26, second swimming leg. 27, antennula. 28, mandibular palp. 29, antenna (scale = 0.1 mm).

abdominal somite with one row of spinules ventrally, which interrupted medially. Second free abdominal somite with one uninterrupted row of spinules ventrally (Fig. 19). Anal somite similar to male, but without lateral row of spinules (Fig. 20). Furcal rami somewhat broader than in male; dorsal chitinous ridge produced to hind margin of ramus (Figs. 20 and 22). Inner apical seta plumose and as long as ramus, while outer apical seta much shorter than in male (just about 1.5 times longer than ramus).

Antennula 8-segmented, with one slender aesthetasc on apical segment, one long aesthetasc on fourth segment (reaching little beyond top of appendage), and with setal formula as follows: 1.8.4.2.1.3.2.8 (Fig. 27). All setae on antennula naked.

Antenna (Fig. 29), labrum, mandibula (Fig. 28), maxillula, maxilla, maxilliped, first swimming leg (Fig. 25), exopodite of second swimming leg (Fig. 26), and exopodite of third swimming leg (Fig. 23) very similar to those of male. Outer spines on proximal and median exopodite segments of third swimming leg much stouter than their equivalents on other swimming legs. Swimming leg armature formula as follows (legend: inner / outer spine or seta; inner/terminal/outer):

Segments	Exopodite			Endopodite		
	1	2	3	1	2	3
First leg	0/1	1/1	0/2/2	1/0	1/0	1/2/0
Second leg	0/1	1/1	1/2/2	1/0	2/2/1	-
Third leg	0/1	1/1	2/2/2	1/0	3/2/1	-
Fourth leg	0/1	1/1	2/2/2	1/0	2/2/0	-

Distal segment of endopodite on second swimming leg bearing five setae, on third leg bearing six setae, and on fourth leg bearing four setae (Figs. 23, 24 and 26). Distal exopodite segment of fourth swimming leg similar to that of male, but proximal-outer spine not modified and proximal-inner seta longer.

Basiendopodite of fifth leg extending to proximal third of exopodite; with four very strong, long and pinnate setae, outermost of which twice as short as other three setae (Fig. 21). Exopodite subquadrangular, about 1.36 times as long as wide, armed with four setae of which two in the middle like those on basiendopodite; inner and

outer setae much shorter.

VARIABILITY. - Seventeen specimens (15 adults) of *Elaphoidella uva* n.sp., from two localities were found and examined. All specimens are very similar in most morphological characteristics. Body length of males ranges from 0.56 mm to 0.69 mm, while in females it ranges from 0.61 mm to 0.72 mm. The single male from the spring Mareza has: 1) a squarer fifth leg exopodite with slightly shorter setae (Fig. 16); 2) somewhat longer inner-proximal seta on distal exopodite segment of fourth swimming leg (Fig. 15); 3) distal segment on endopodite of second swimming leg slightly shorter and stouter (Fig. 18); and 4) inner-apical seta on distal segment of third leg endopodite considerably shorter than in holotype (Fig. 17). The number of spinules ventrally at the base of the furcal rami in females can be two or three, but one specimen was observed with two and three on each side respectively (Fig. 19).

DISTRIBUTION. - At present *Elaphoidella uva* n.sp. is found only at two localities in central Montenegro (see above). It is presumed that it inhabits a wide area of the south Dinaric Alps.

ETYMOLOGY. - The specific name is from the Latin noun *uva*, which means bunch of grapes, agreeing in gender with the feminine generic name.

DISCUSSION. - From the shape of female's fifth leg and from the distal exopodite segment of fourth swimming leg in the male, *E. uva* n.sp. fits well into II. ('*gracilis*')-group within the genus *Elaphoidella* sensu Lang (1948), and further supplemented by Petkovski & Brancelj (1988). This group now includes 17 species, although three species, *E. californica* Wilson, 1975; *E. kodiakensis* Wilson, 1975; and *E. denticulata* (Chappuis, 1929) are still only known from females, and their placement in the II.-group is questionable. *E. petrovae* Apostolov, 1987 is obviously a synonym of *E. valkanovi* Basamakov, 1973, both described from Bulgaria (Basamakov, 1973; Apostolov, 1986). Presented below is a key to species for females only of the II.-group:

KEY TO SPECIES OF II. ('GRACILIS')-
GROUP OF THE GENUS *ELAPHOIDELLA*
(females)

- 1a. Antennula 9-segmented 2
- b. Antennula 8-segmented 3
- 2a. Distal endopodite segment of second swimming leg with 5 setae *E. neotropica* Petkovski, 1973
- b. That segment with only 3 setae *E. parvifurcata* Petkovski, 1980
- 3a. Distal endopodite segment of second swimming leg with 4 setae 4
- b. That segment with 5 setae 5
- 4a. Exopodite of fifth leg with 4 setae *E. subgracilis* Willey, 1934)
- b. Exopodite of fifth leg with 5 setae *E. denticulata* Chappuis, 1929)
- 5a. Anal operculum with hyaline membrane on hind margin *E. intermedia* Chappuis, 1931
- b. Anal operculum without hyaline membrane, with row of spinules along its margin 6
- 6a. Hind margins of abdominal somites serrated 7
- b. Hind margins of abdominal somites smooth 8
- 7a. Exopodite of fifth leg with 4 setae *E. montenegrina* Karanovic, 1997
- b. Exopodite of fifth leg with 5 setae *E. bidens* Schmeil, 1894)
- 8a. Anal operculum produced posteriorly *E. grandidieri* Guerne & Richard, 1893)
- b. Anal operculum slightly shorter than anal somite 9
- 9a. Distal endopodite segment of third swimming leg with 5 setae *E. californica* Wilson, 1975
- b. That segment with 6 setae 10
- 10a. Furcal ramus with two digitiform and flexible processes apically *E. kodiakensis* Wilson, 1975
- b. Furcal ramus without these processes 11
- 11a. Outer-apical seta on furcal ramus shorter than ramus; inner-apical seta very plump *E. valkanovi* Basamakov, 1973
[syn. *E. petrovae* Apostolov, 1987]
- b. Outer apical seta on furcal ramus longer than ramus; inner-apical seta with normal appearance 12
- 12a. Exopodite of fifth leg with 4 setae..... *E. uva* n.sp.
- b. Exopodite of fifth leg with 5 setae 13
- 13a. Exopodite of fifth leg elongate, more than 3 times as long as wide 14

- b. That segment less than twice as long as wide 15
- 14a. Furcal ramus as long as wide *E. wilsoni* Hunt, 1979
- b. Furcal ramus about twice as long as wide *E. reedi* Nilson, 1975
- 15a. Exopodite of fifth leg as long as wide; furcal rami with very narrow posterior end, and inner-apical seta displaced to ventral side *E. bryophila* (Chappuis, 1928)
- b. Exopodite of fifth leg almost twice as long as wide; furcal rami with normal appearance 16
- 16a. Innermost apical seta on fifth leg basienpodite almost as long as outermost one; dorsal seta on furcal ramus inserted just at midlength of ramus *E. gracilis* Sars, 1862)
- b. Innermost apical seta on fifth leg basienpodite considerably longer than outermost one; dorsal seta on furcal ramus inserted in distal third of ramus *E. pescei* Apostolov, 1986

REMARKS. - This group of species is quite homogenous, although its representatives are distributed all over the world. In this sense 12 of the 17 species have identical armature formula on the swimming legs. Different armature formula is exhibited by the following five species: *E. californica*, *E. neotropica*, *E. parvifurcata*, *E. subgracilis*, and *E. denticulata*. Also, the fifth leg in this group is very similar in all species. In females the basienpodite bears four setae and the exopodite bears five or four setae. The exopodite of the female fifth leg with only four setae occurs only in the following four species: *E. montenegrina*, *E. neotropica*, *E. subgracilis*, and *E. uva* n.sp. Fifth leg exopodite in males always bears four setae, with the single exception of *E. montenegrina* which bears three setae. The most important difference among species in the II.-group is the shape of furcal rami. *E. uva* n.sp. differs from all known species by its well-developed, posteriorly directed, pointed, chitinous ridge on the female's furcal rami. A similar chitinous process is present only in *E. bidens* (although not so well developed), but this species differs in: the shape of fifth legs in both sexes, the serrated hind margins of body somites, and in the length of some setae on swimming legs. The chitinous process on male's furcal rami of *E. uva* n.sp. are not as well developed as in the female, but sexual dimorphism in furcal rami shape is an important character of the II.-group of species, and this phenomenon is known in some other harpacticoid genera (Schminke, 1991). *E. uva*

n.sp. is the second representative of this group from subterranean waters of Montenegro, the first being *E. montenegrina*. These two species differ in many characteristics, such as furcal rami shape, fifth legs in both sexes, ornamentation of abdominal somites, etc. (Karanovic, 1997).

***Elaphoidella phreatica* (Chappuis, 1925)**

Figs. 30-65

SYNONYMY

Canthocamptus phreaticus Chappuis, 1925: 169, figs. 19-27.

Elaphoidella phreatica (Chappuis); Lang, 1948: 1145, fig. 456/1; Borutzky, 1952: 301, fig. 84/36-44; Damian-Georgescu, 1970: 182, fig. 84; Petkovski, 1972: 30, figs. 22-32; Pesce & Galassi, 1985: 141, figs. 40-48; Pesce et al., 1987: 183, figs. 69-82; Brancelj, 1988: 9, figs. 6 and 7.

Canthocamptus pseudophreaticus Chappuis, 1928: 24.

Elaphoidella pseudophreatica (Chappuis); Lang, 1948: 1146; Borutzky, 1952: 302; Chappuis, 1954: 8, figs. 19, 20 and 25; Dussart, 1967: 386, fig. 167 (female).

Elaphoidella phreatica var. *pseudophreatica* (Chappuis); Sterba, 1956: 395, figs. 19-33; Kulhavy, 1969: 6, figs. 1a, b.

Elaphoidella pseudojeanneli Ponyi, 1956: 41, figs. 1-14; Ponyi, 1958: 74, figs. 2, 4, 6, 8, 10 and 12.

Elaphoidella pseudojeanneli aggtelekiensis Ponyi, 1958: 73, figs. 1, 3, 5, 7, 9 and 11.

Elaphoidella cavatica Chappuis, 1957: 45, figs. 1-9.

Elaphoidella croatica Petkovski, 1959: 111, figs. 44-56.

Elaphoidella oglasae Cottarelli & Torrisoni, 1976: 361, figs. 1 and 2.

Elaphoidella italica Pesce, et al. 1987: 179, figs. 15-20.

Non: *Elaphoidella pseudophreatica* (Chappuis); Chappuis, 1954: 8, figs. 21-24; Dussart, 1967: 386, fig. 167 (male).

MATERIAL. - 1) 1 male and 2 females from a nameless stream in the village Fundina, Kuci Region, eastern Montenegro, 2-V-1997, collected by T. Karanovic; 2) 1 male and 6 females from the Suvi Potok stream, Kuci Region, eastern Montenegro, 2-V-1997, collected by T. Karanovic; 3) 1 female from a nameless spring near the village Fundina, Kuci Region, eastern Montenegro, 2-V-1997, collected by T. Karanovic; 4) 3 males and 1 female from the Sitnica river in

the village Beri near the town of Podgorica, central Montenegro, 24-V-1997, collected by T. Karanovic; 5) 1 female from a nameless spring in the village Tunjevo near the town of Danilovgrad, central Montenegro, 11-IV-1997, collected by T. Karanovic; 6) 1 male and 1 female from the Glava Zete spring, central Montenegro, 1-V-1997, collected by T. Karanovic; 7) 14 males, 37 females and 9 copepodids from the Gračanica river near the town of Niksic, central Montenegro, 12-VI-1997, collected by T. Karanovic.

Four specimens (2 males and 2 females) from the last locality (7), preserved as non-dissected animals in Faure's medium, are deposited in the Zoological Museum Amsterdam (ZMA Co. 204.922). All other specimens are held in the author's working collection in Australia. Twelve specimens (5 males and 7 females) from different localities were completely dissected and mounted on microscope slides in Faure's medium, while the remaining specimens are preserved in 70% ethanol.

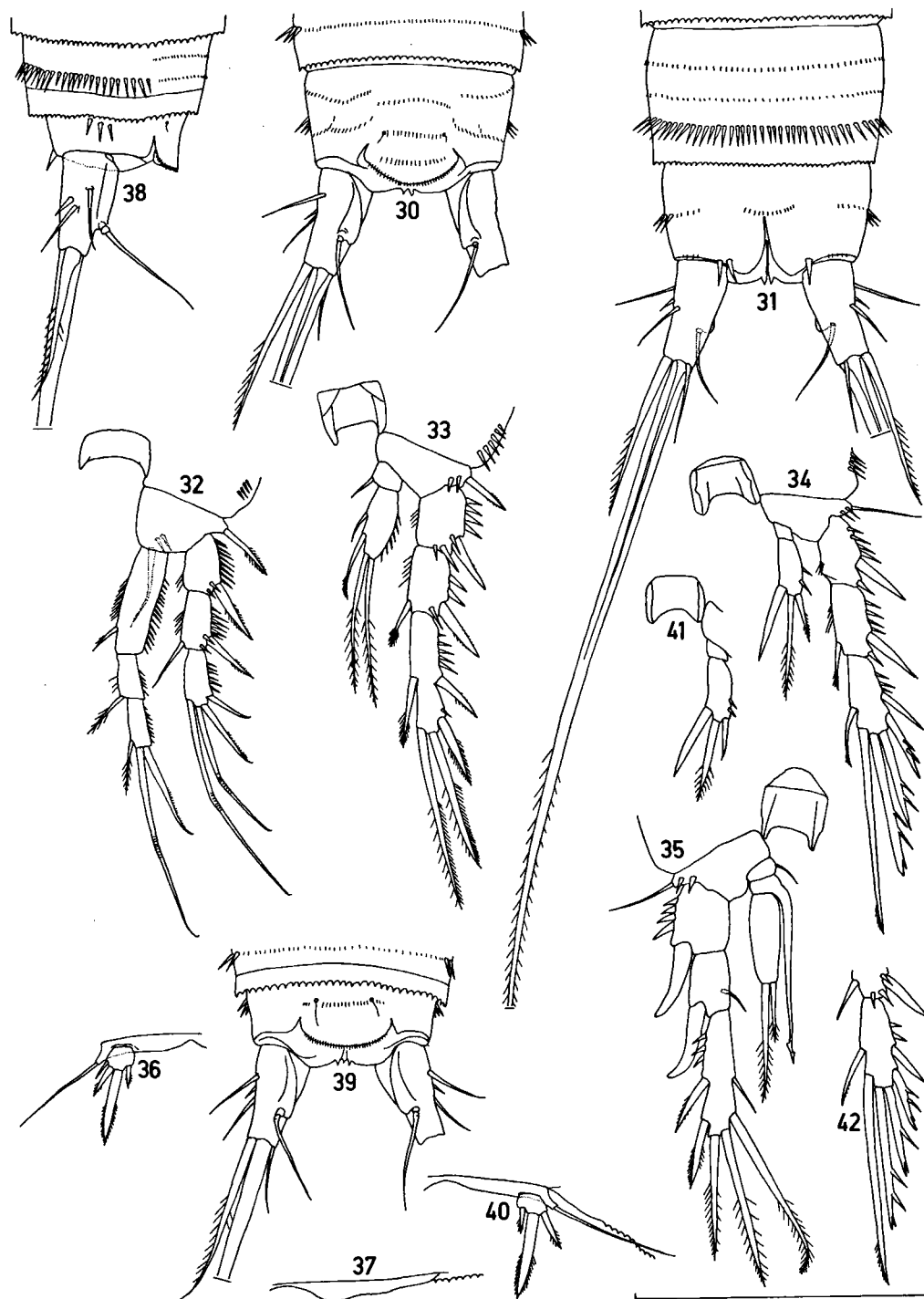
REDESCRIPTION. - Male: body elongated, cylindrical, light brown in colour. Surface of cephalothoracic shield and three free pedigerous somites with many sensillae. Second, third, and fourth abdominal somites with transverse row of large spinules ventrally, and with serrated hind margins both ventrally and dorsally (Figs. 30 and 31). Also they bear transverse rows of minute spinules. Anal somite ornamented with pair of sensillae dorsally, with one short transverse row of large spinules laterally, with several rows of minute spinules dorsally, and with one or two large spinules at base of furcal rami ventrally. Anal operculum convex, not reaching beyond limit of anal somite; with many spinules along its margin (Figs. 30 and 39). Furcal rami slightly divergent, about twice as long as wide, and with six armature elements (two lateral, one dorsal, and three apical setae). There is one strong spinule at base of distal lateral seta (Fig. 38). Dorsal seta biarticulate at base, attached behind well developed chitinous ridge, in distal third of furcal ramus. Inner apical seta smooth and shorter than ramus, while outer apical seta very strong, pinnate and longer than ramus. Middle apical seta longer than abdomen, plumose.

Antennula 8-segmented, strongly geniculate.

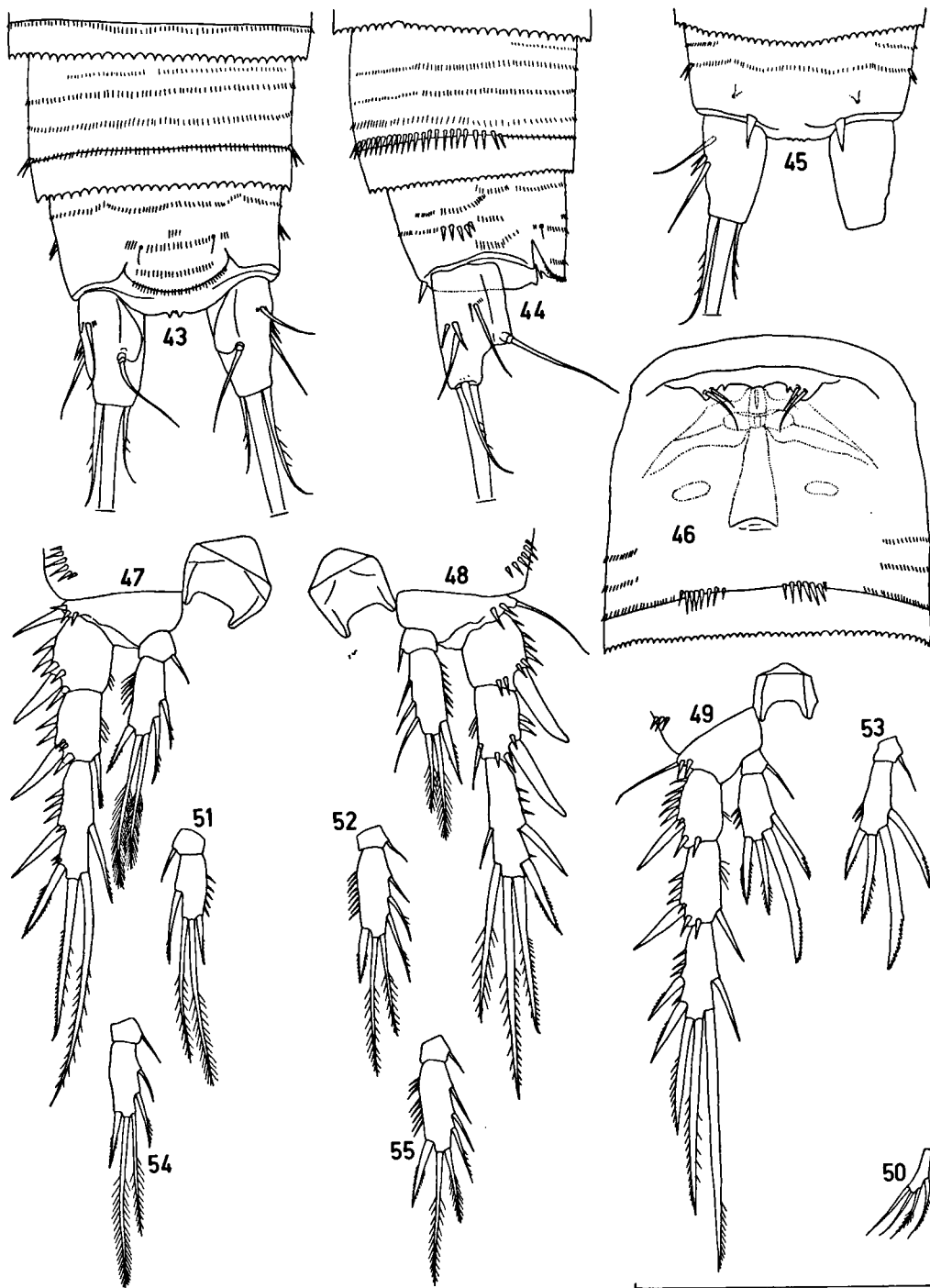
Antenna with 1-segmented exopodite, bearing 4 setae.

Mandibula, maxillula, maxilla and maxilliped similar to those of previous species.

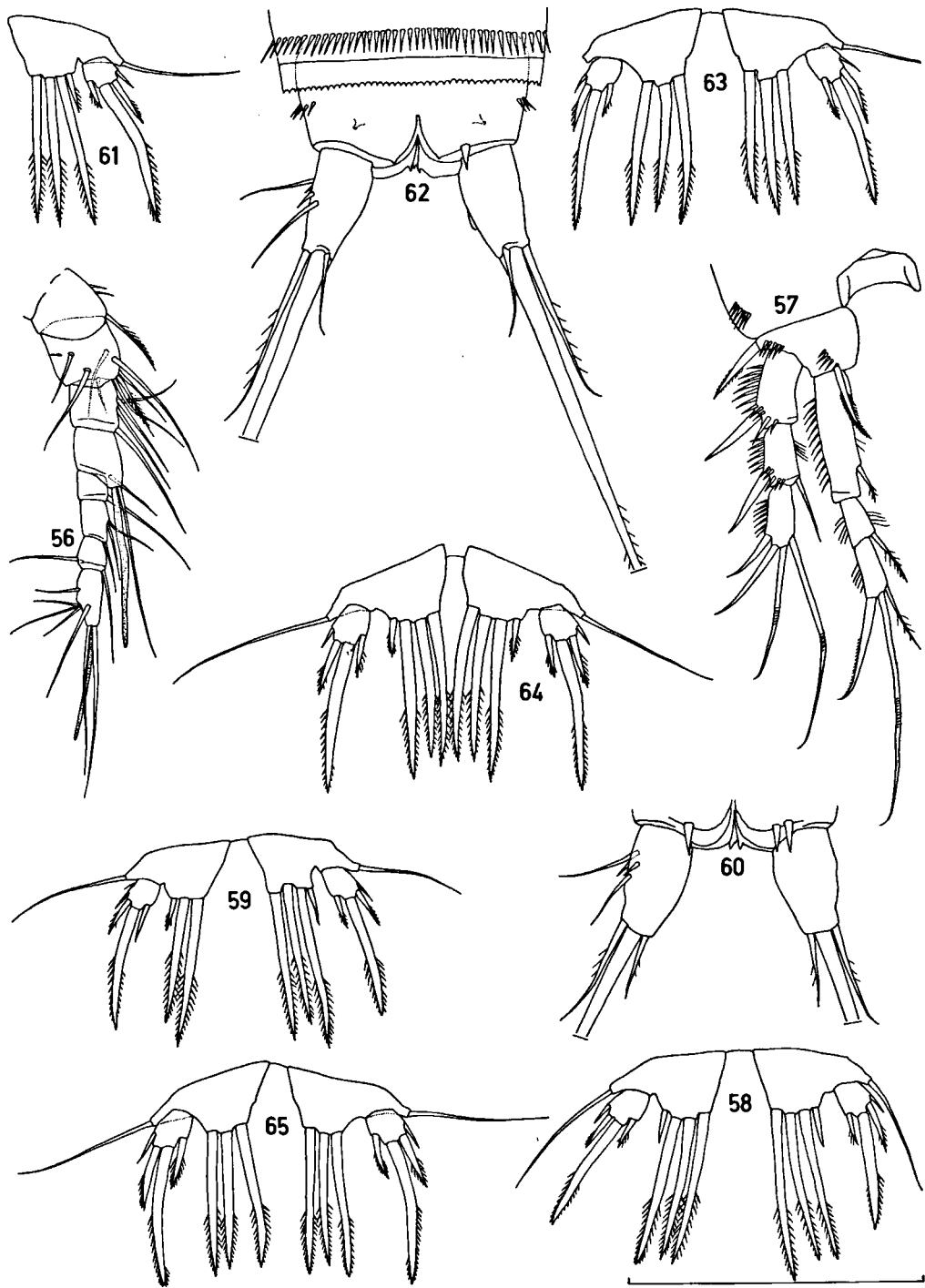
All swimming legs with 3-segmented exopodites, as well as endopodites of first and third swimming legs, while endopodites of second



Figs. 30-42. *Elaphoidella phreatica* (Chappuis, 1925). 30-37, stream in the village Fundina (male 0.427 mm). 38-42, Sitnica river (male 0.546 mm). 30, anal somite and furcal rami, dorsal view. 31, last two abdominal somites and furcal rami, ventral view. 32, first swimming leg. 33, second swimming leg. 34, fourth swimming leg. 35, third swimming leg. 36, fifth leg. 37, sixth leg. 38, last two abdominal somites and left furcal ramus, lateral view. 39, anal somite and furcal rami, dorsal view. 40, fifth leg. 41, endopodite of fourth swimming leg. 42, third exopodite segment of fourth swimming leg (scale = 0.1 mm).



Figs. 43-55. *Elaphoidella phreatica* (Chappuis, 1925). 43-50, stream in the village Fundina (female 0.556 mm). 51-52, Suvi Potok stream (female 0.575 mm). 53-55, Glava Zete spring (female 0.498 mm). 43, last two abdominal somites and furcal rami, dorsal view. 44, last two abdominal somites and left furcal ramus, lateral view. 45, anal somite and furcal rami, ventral view. 46, genital double-somite. 47, second swimming leg. 48, third swimming leg. 49, fourth swimming leg. 50, exopodite of antenna. 51, endopodite of second swimming leg. 52, endopodite of third swimming leg. 53, endopodite of fourth swimming leg. 54, endopodite of second swimming leg. 55, endopodite of third swimming leg (scale = 0.1 mm).



Figs. 56-65. *Elaphoidella phreatica* (Chappuis, 1925). 56-58, stream in the village Fundina (female 0.556 mm). 59-60, Suvi Potok stream (female 0.575 mm). 61-62, Glava Zete spring (female 0.498 mm). 63, Gracanica river (female 0.582). 64, Gracanica river (female 0.568 mm). 65, Gracanica river (female 0.594 mm). 56, antenna. 57, first swimming leg. 58, fifth legs. 59, fifth legs. 60, furcal rami, ventral view. 61, fifth leg. 62, anal somite and furcal rami, ventral view. 63, fifth legs. 64, fifth legs. 65, fifth legs (scale = 0.1 mm).

and fourth legs 2-segmented. Endopodite of first swimming leg longer than corresponding exopodite for length of distal segment; bearing one seta on proximal, one on median, and three setae on distal segment (Fig. 32). Endopodite of second swimming leg with one inner seta on proximal, and four setae on distal segment (Fig. 33). Distal exopodite segment of that leg with five spines and setae. Proximal endopodite segment of third swimming leg with one smooth thin seta; median with long inner apophysis; terminal with two apical plumose setae, outer one twice as long as inner seta (Fig. 35). Distal exopodite segment of that leg with six spines and setae. Proximal endopodite segment of fourth swimming leg very small and without armature; distal with three setae (Figs. 34 and 41). Distal exopodite segment of that leg about 2.5 times longer than wide, armed with six setae and spines, three of which (distal-lateral one and two apical spines) transformed like antlers (Figs. 34 and 42). Couplers of all swimming legs concave and without surface ornamentation. Coxae of first, second and fourth swimming legs with one row of spinules along outer margin (Figs. 32, 33 and 34).

Fifth leg with reduced basiendopodite, without armature. Exopodite subquadrangular, armed with four or three setae of which apicalmost longest (Figs. 36 and 40).

Sixth leg consisting of membranous lamella, without armature (Fig. 37).

Female: body similar to male, as well as ornamentation of free abdominal somites. Genital double-somite with one short row of large spinules ventrally, which interrupted medially, with several rows of minute spinules, and with two short and smooth setae on its fused sixth leg (Fig. 46). Genital field with big copulatory pore in distal third of genital somite; copulatory duct conical; receptacles short, elliptical. Anal somite similar to male. Furcal rami somewhat broader than in male, with two large spinules at base of distal lateral seta, and with shorter outer apical seta (Figs. 43, 44, 45, and 62).

Antennula 8-segmented, with one slender aesthetasc on apical segment, one long aesthetasc on fourth segment (reaching little beyond top of appendage), and with setal formula as follows: 1.8.4.2.1.3.2.7 (Fig. 56). Only seta on first segment, and one seta on second segment plumose.

Antenna (Fig. 50), mandibula, maxillula, maxilla, maxilliped, first swimming leg (Fig. 57), endopodite of second swimming leg (Fig. 47), and exopodite of third swimming leg (Fig. 48) very similar to those of male. Outer spines on proximal and median exopodite segments of third swimming leg somewhat stouter than their equivalents on other swimming legs, but not as those of previous species. Swimming legs armature formula as follows (legend: inner/outer spine or seta; inner/terminal/outer):

Segments	Exopodite			Endopodite		
	1	2	3	1	2	3
First leg	0/1	1/1	0/2/2	1/0	1/0	1/2/0
Second leg	0/1	1/1	1/2/2	1/0	2(1)/2/1	-
Third leg	0/1	1/1	2/2/2	1/0	3/2/1	-
Fourth leg	0/1	1/1	2/2/2	1/0	2/1/1	-

Lateral setae on distal segment of fourth swimming leg characteristically serrated (Figs. 49 and 53). Distal exopodite segment of fourth swimming leg without transformed setae or spines.

Basiendopodite of fifth leg little protruding and armed with different number of setae (Figs. 58, 59, 61, 63, 64 and 65). Most frequent case: four setae, outermost of which very small, other three long, stout and pinnate (Fig. 64). Exopodite subquadrangular, almost as broad as long, armed with four setae, of which second from inner side very long, stout, spiniform, curved and pinnate.

VARIABILITY. - Seventy-eight specimens (69 adults) of *Elaphoidella phreatica* (Chappuis, 1925), from seven different localities in Montenegro, were examined. This species is very variable in several morphological characteristics, and the most important examples of its variability noticed in specimens from Montenegro we already included in the description. Body length of examined males ranges from 0.427 mm to 0.57 mm, while in females it ranges from 0.49 mm to 0.61 mm. Variability of this species has already been discussed by Petkovski (1972) and by Brancelj (1988). Summarized below are all the important variable morphological characteristics that have been recorded for this species as a whole, including the examined material: 1) body length, excluding furcal setae, ranging from 0.49 mm to 0.7 mm in females, and from 0.427 mm to

0.685 mm in males; the data recorded by Pesce & Galassi (1985) is surprisingly long and could possibly be due to the measurements including the furcal setae (0.85 mm for female, and even 0.87 mm for male); 2) variability in ornamentation of abdominal somites; 3) length/width ratio of furcal rami ranges from 1.5 to 3.3; 4) sometimes inner apical seta can be displaced to the ventral surface (Figs. 31 and 62); 5) proportional lengths between outer and inner apical furcal setae ranges from 1.2 (Petkovski, 1959) to 2.7 (Pesce & Galassi, 1985) in females, while in males it is never less than 2; 6) proximal endopodite segment of second swimming leg in female with or without seta; distal segment usually with five setae, sometimes with four (Fig. 51); 7) proximal endopodite segment of third swimming leg in male with or without seta; 8) proximal endopodite segment of third swimming leg in female with or without seta; distal segment with six or five setae; 9) proximal endopodite segment of fourth swimming leg in female with or without seta; distal segment with four or three setae (Petkovski, 1959); 10) exopodite of male's fifth leg with four or three setae (Figs. 36 and 40); 11) basiendopodite of female's fifth leg usually with four setae, sometimes with three (Fig. 59), or even with two (Kulhavy, 1969); 12) exopodite of female's fifth leg with four or sometimes with three setae (Kulhavy, 1969); 13) type and relative length of many setae also very variable: for example distal inner seta on distal exopodite segment of fourth swimming leg in male can be longer than apical spines (Figs. 34 and 42), almost equal (Chappuis, 1925), or considerably shorter (Petkovski, 1972; Pesce et al., 1987).

DISTRIBUTION. - At present *Elaphoidella phreatica* (Chappuis, 1925) is known from the French Perenees, Italy (the whole Apenine Peninsula), Slovenia, Croatia, Montenegro, Romania, Hungary, and from Slovakia.

DISCUSSION. - Petkovski (1972) studied some populations of *E. phreatica* from Romania and noticed a great degree of variability in that species. With it he synonymized three other taxa: *E. pseudophreatica*, *E. pseudojeanneli*, and *E. pseudojeanneli aggtelekiensis*. However, he left as a valid species *E. croatica*, which he had previously described from

Croatia (Petkovski, 1959), and *E. cavatica*, which Chappuis (1957) described from the French Perenees, despite their similarity with *E. phreatica*. Furthermore, Cottarelli & Torrisi (1976) described *E. oglasae* in the same group, and Pesce et al. (1987) described *E. italica*, both from Italy. After the examination of *E. phreatica* from Montenegro it has become clear that these four species should be synonymized with *E. phreatica*, because they fit within the range of variability of the later species. Petkovski (1972) tried to explain the great variability of *E. phreatica* with phenomenon translated here as rally-species ('Sammel-species' in German). However, this variability probably has a simpler explanation. It is postulated here that *E. phreatica* survived the last ice age in two or more refugial centres (in Apenine and Balkan Peninsula), where the isolated populations developed some differential morphological characters, but not reproductive isolation. As the glaciers subside, these populations expanded their distribution, and hybridization began. The consequence of this phenomenon being the great variability in some morphological characters of *E. phreatica*, which is currently the only species in the V.('phreatica')-group. In Montenegro this species lives in the thin border between the surface and underground waters, represented interstitially in the first few centimeters. Despite having collected over 300 samples from all types of water biotopes in Montenegro, *E. phreatica* was never found from deep underground waters (pers. obs.), although other authors have found it in several caves. Almost certainly, the presence of this species in deep underground waters depends on the intensity of competition in that habitat, which is very high in Montenegrin underground waters.

Elaphoidella denticulata Chappuis, 1929
Figs. 66-75

SYNONYMY

Elaphoidella denticulata Chappuis, 1929a: 104, figs. 11-15.

Elaphoidella denticulata Chappuis; Lang, 1948: 1154, fig. 458/4; Borutzky, 1952: 296, fig. 81/18-21; Petkovski, 1959a: 168, figs. 3-8; Damian-Georgescu, 1970: 187, fig. 87; Kiefer, 1978: 221.

Elaphoidella pani Por, 1984: 116, figs. 13-23.

MATERIAL. - Single female from a marsh near the old salt-works in the town of Tivat, southern Montenegro, 19-II-1995, collected by T. Karanovic.

The specimen was completely dissected and mounted on a slide in Faure's medium, and it is held in the author's working collection in Australia.

REDESCRIPTION. - Female: body length, excluding furcal setae, 0.524 mm. Habitus elongate, cylindrical. Body light brown in colour, and nauplius eye present. Prosome comprising cephalothorax (incorporating first pedigerous somite) and three free pedigerous somites. Surface of dorsal shield covering cephalothorax, as well as of free pedigerous somites, with many rows of fine spinules and with several sensillae. Their hind margins clearly serrated. Urosome comprising fifth pedigerous somite, genital double-somite, and three free abdominal somites. Genital double-somite about 1.5 times as broad as long, with one short row of large spinules ventrally which interrupted medially, with several rows of minute spinules and with two plumose setae on its fused sixth leg. Next two abdominal somites with uninterrupted row of large spinules ventrally, and several rows of minute spinules, both dorsally and ventrally (Figs. 66 and 68). Anal somite (last abdominal) ornamented with pair of sensillae dorsally, with one short transverse row of large spinules laterally, with several rows of minute spinules, and with three large spinules at base of furcal rami ventrally. Anal operculum convex, not reaching beyond limit of anal somite; with many minute spinules along its margin (Fig. 68). Furcal rami slightly divergent, about 1.5 times longer than wide, with six armature elements. There is one strong spinule at base of distal lateral seta, which inserts just to midlength of ramus (Fig. 67). Dorsal seta biarticulate at base, also attached almost at midlength of ramus, behind well developed chitinous ridge. Inner apical seta smooth, about as long as furcal ramus, while outer apical seta plumose on outer side and about 2.3 times longer than ramus. Middle apical seta as long as abdomen, plumose.

Antennula 8-segmented, short, with one slender aesthetasc on apical segment, one long aesthetasc on fourth segment (reaching a little beyond top of appendage), and with setal formula as follows: 1.8.4.2.1.2.1.7 (Fig. 75). Only seta on first segment plumose.

Antenna, labrum, mandibula, maxillula, maxilla, and maxilliped very similar to those of *E. uva* n.sp.

All swimming legs with 3-segmented exopodites, as well as endopodite of first leg, while endopodites of second, third and fourth swimming legs 2-segmented (Figs 69, 70, 71 and 72). Swimming legs armature formula as follows (legend: inner/outer spine or seta; inner/terminal/outer):

Segments	Exopodite			Endopodite		
	1	2	3	1	2	3
First leg	0/1	1/1	0/2/2	1/0	1/0	1/2/0
Second leg	0/1	1/1	1/2/2	1/0	2/1/1	-
Third leg	0/1	1/1	2/2/2	1/0	3/1/1	-
Fourth leg	0/1	1/1	2/2/2	0/0	2/1/1	-

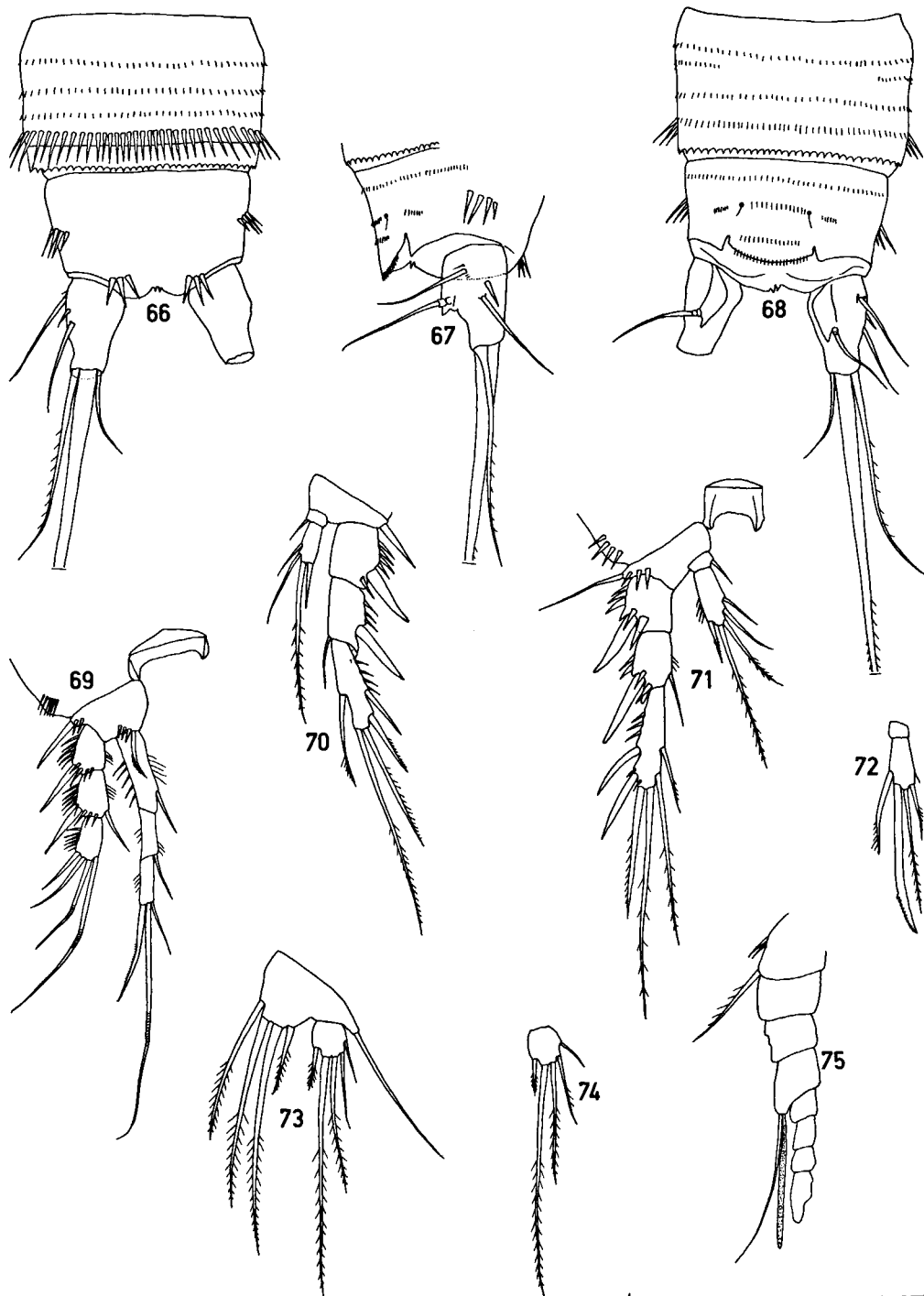
Distal lateral seta on distal endopodite segment of fourth swimming leg characteristically serrated (Fig. 72).

Basiendopodite of fifth leg extending to proximal third of exopodite; with four slender and plumose setae, outermost of which shortest (Fig. 73). Exopodite subquadrangular, about as long as wide, armed with five setae of which second from inner side longest one (Figs. 73 and 74). Basipodite seta on that leg smooth and long.

Male: unknown.

VARIABILITY. - It is incredible that *E. denticulata* Chappuis, 1929 displays virtually no any important form of variability. Even the relative length of setae on swimming legs is more or less identical in all reported specimens. Moreover all illustrated specimens share the same minute details, for example: the tiny spinule on inner side of distal endopodite segment of fourth swimming leg (Fig. 72). Body length ranges from 0.5 to 0.524 mm. The only variation observed in the single female specimen examined here was the proportional length of the innermost seta of the left and right exopodites of the fifth leg.

DISTRIBUTION. - At present *E. denticulata* Chappuis, 1929 is known from Greece (Crete), Romania, Bulgaria, Israel and Montenegro. This is the furthest west the species has been recorded thus far.



Figs. 66-75. *Elaphoidella denticulata* (Chappuis, 1929), female (0.524 mm). 66, last two abdominal somites and furcal rami, ventral view. 67, anal somite and right furcal ramus, lateral view. 68, last two abdominal somites and furcal rami, dorsal view. 69, first swimming leg. 70, second swimming leg. 71, third swimming leg. 72, endopodite of fourth swimming leg. 73, left fifth leg. 74, exopodite of right fifth leg. 75, antennula without complete armature (scale = 0.1 mm).

DISCUSSION. - Por (1984) described *E. pani* from Israel as a new species, although the description and the illustrations he provided showed close similarities to *E. denticulata*. Most surprising is Por's (1984) placement of this species in Lang's VIII.-group, because Lang (1948) provided excellent reproductions of Chappuis's (1929a) original illustrations of *E. denticulata*. It was already said in the first part of this paper that *E. denticulata* probably belongs to the II.-group of species. This is a surface dwelling species that prefers swampy habitats, and is very rare. Because males have never been discovered the possibility that *E. denticulata* lives in parthenogenetic populations can not be excluded, but such a small level of variability usually is not a characteristic of parthenogenetic species.

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