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Pseudomoraria triglavensis gen. n., sp. n. (Copepoda, Harpacticoida) from a high-alpine reservoir in Slovenia

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Abstract

Numerous specimens of *Pseudomoraria triglavensis* gen.n., sp.n. were collected from small, high-alpine, reservoir Močilec. The reservoir is situated in the centre of Triglav national park (NW Slovenia) at an altitude of 1690 m. The new genus differs from related genera *Moraria*, *Morariopsis* and *Paramorariopsis* by the reduced articulation of exopodites and endopodites in both sexes. It also differs from *Moraria* by possessing sexually dimorphic furcal rami. Detail taxonomic differences between these related genera and their ecology are discussed.

Introduction

The Julian Alps are situated in NW part of Slovenia. This is a high-alpine region with an altitude mainly over 1500 m. Most of the region is included in the Triglav national park (TNP). There are also glacial lakes. The best known are seven lakes in Dolina Sedmerih Triglavskih Jezer. They are small lakes, between 20 and 150 m long and with a depth between 1 and 14 m (Gams, 1962). Prior to 1990, few studies on aquatic fauna and flora of these lakes had been carried out (Pevalek, 1925; Rejic, 1962a, 1962b, 1962c; Lazar, 1969; Brancelj, 1988; Krušnik, 1988; Blaženčič *et al.*, 1990). The Park's lakes are now exposed to severe eutrophication due to increased tourism. In September 1991, and June and September 1992, intensive faunistic and floristic surveys, plus measurements of physical and chemical parameters of the water in these lakes were carried out to evaluate the degree of eutrophication. Zoologically the most interesting discovery was a previously unknown taxon of Harpacticoida (Copepoda, Crustacea) described below as *Pseudomoraria triglavensis* gen. n., sp. n. Numerous specimens were found in reservoir Močilec in low water near the shore only in June 1992. On sampling in Sept. 1992 no specimens of this taxon were found.

The biodiversity of Slovenian high-alpine lakes is rich (Brancelj, in prep.) and nine harpacticoids were previously known from TNP (Brancelj, 1988; unpubl. data). They belong to *Attheyella* Brady, 1880, *Maraenobiotus* Mrazek, 1893, *Epactophanes* Mrazek, 1893, *Moraria* T. & A. Scott, 1893, *Bryocamptus* Chappuis, 1928, *Elaphoidella* Chappuis, 1928 and *Paracamptus* Chappuis, 1929. The most common harpacticoid in all the lakes is *Bryocamptus (Arcticocamptus) rhaeticus* (Schmeil, 1893). Some additional and interesting finds in TNP can be expected in other habitats, for example, high-alpine swamps, small springs and wet moss pillows.

Material and methods

The bottom dwelling fauna from a shallow high-alpine reservoir was collected by hand net with 0.06 mm mesh size. Material was fixed in 4% formaldehyde solution and later preserved in 70% alcohol. Dissection of specimens was done under an Olympus stereo-microscope. Drawings were made using an Olympus microscope with a camera lucida. 5 females were prepared for SEM microscopy and examined under a JEOL JSM-840 Scanning microscope.

Description

Pseudomoraria gen. n.

Diagnosis

Female: medium sized and cylindrical harpacticoid with short antennulae. Antennula 8-segmented. Antenna with 1-segmented exopodite with 4 setae. Posterior edges of somites without spinules dorsally. Exopodites of P1 and P2 2-segmented, of P3 and P4 3-segmented. Endopodites of P1-P4 2-segmented. No setae on inner side of 1st or 2nd segments of exopodites or basal segment of endopodites. Anal operculum rounded with fine spinules on posterior margin. Furcal ramus as long as wide and depressed, differing from that of male.

Male: smaller than female, cylindrical. Posterior edge of abdominal segments with row of spinules dorsally or dorsolaterally. Exopodites of P1-P4 2-segmented, endopodites of P1-P3 2-segmented, of P4 1-segmented. No setae on inner side of proximal segment of exopodites or endopodites. Anal operculum rounded with 16–17 spinules on posterior margin. Furcal ramus 1.5 times as long as wide, cylindrical, slightly diverging.

Pseudomoraria triglavensis sp. n.

Material

Type locality: reservoir Močilec in Triglav national park, altitude 1690 m, Bohinj, Slovenia, June 1992;

Type series: all the specimens examined (3 males, 120 ovigerous females, 60 adult females without eggs) collected in June 1992 in reservoir.

Holotype: adult female, completely dissected and mounted in glycerol; length from tip of rostrum to end of furcal rami 0.64 mm. Paratypes: 3 males, 10 ovigerous females, 15 adult females without eggs. 2 males, 10 ovigerous females and 10 females without eggs preserved in 70% ethanol. 1 male and 3 females completely dissected and mounted in glycerol and sealed with glyceel, 5 females prepared for SEM microscopy.

Material deposition

The holotype, 1 completely dissected male and 3 females and 5 females prepared for SEM microscopy, all of them designated as paratypes are deposited at the author's collection at the Institute of Biology in Ljubljana. 11 paratypes (1 male, 5 ovigerous females and 5 adult females without eggs) are deposited at the British Museum (Natural History); registration numbers: BM(NH) 1993.16–31. 11 paratypes (1 male, 5 ovigerous females and 5 adult females without eggs) are deposited at the Smithsonian Institution (Washington); catalog number: 259485. The rest of material is deposited in the author's collection at the Institute of Biology in Ljubljana.

Etymology

Pseudo - false, pretended, *i.e.* resembling to *Moraria* . Specific name *triglavensis* is derived from the Triglav mountain, the highest mountain in Slovenia (2864 m).

Description

Female:

Length (including furcal rami): mean total length 0.58 mm, range: 0.54–0.63 mm.

Colour: more or less pale green, transparent.

Body: cylindrical, elongated (Fig. 1A). Rostrum small and pointed. Cephalothorax as long as wide. Posterior edges of all thoracic somites free of spinules (Fig. 4A). Thoracic and genital somites ornamented with few rows of small spinules (Fig. 4B). Genital somite (fused genital somite and 1st urosomite) wider than long, laterally with row of spinules (Figs 1A, 2D). Receptaculum seminis as in Fig. 2E. 2nd urosomite ventrolaterally with row of spinules. 3rd urosomite laterally and ventrolaterally with row of spinules. 4th urosomite dorsolaterally and laterally with row of spinules. An additional row of small spinules at the base of furca (Figs 2G, 4E).

Operculum: rounded with numerous fine denticles on posterior margin (Figs 2F, 4C).

Furcal rami: as long as wide (Figs 2F, 2G, 4C), parallel and characteristically depressed in dorso-medial and ventro-lateral direction (Fig. 4F). Armature comprising: one seta dorsally, two laterally with 5–6 small spinules at base (Figs 1J, 4D). Outer terminal seta slightly longer than ramus, median seta long, inner seta as long as ramus, twisted upward (Fig. 1J). Dorsally no hyaline membrane. Ventral part of ramus with 3 transverse rows of strong setules distally (Figs 2G, 4D).

Antennula: 8-segmented, short and stout (Fig. 1B). 4th segment with slender aesthetasc not reaching the tip of antennula.

Antenna: endopodite 2-segmented, exopodite 1-segmented with 2 apical and 2 lateral setae (Fig. 1C).

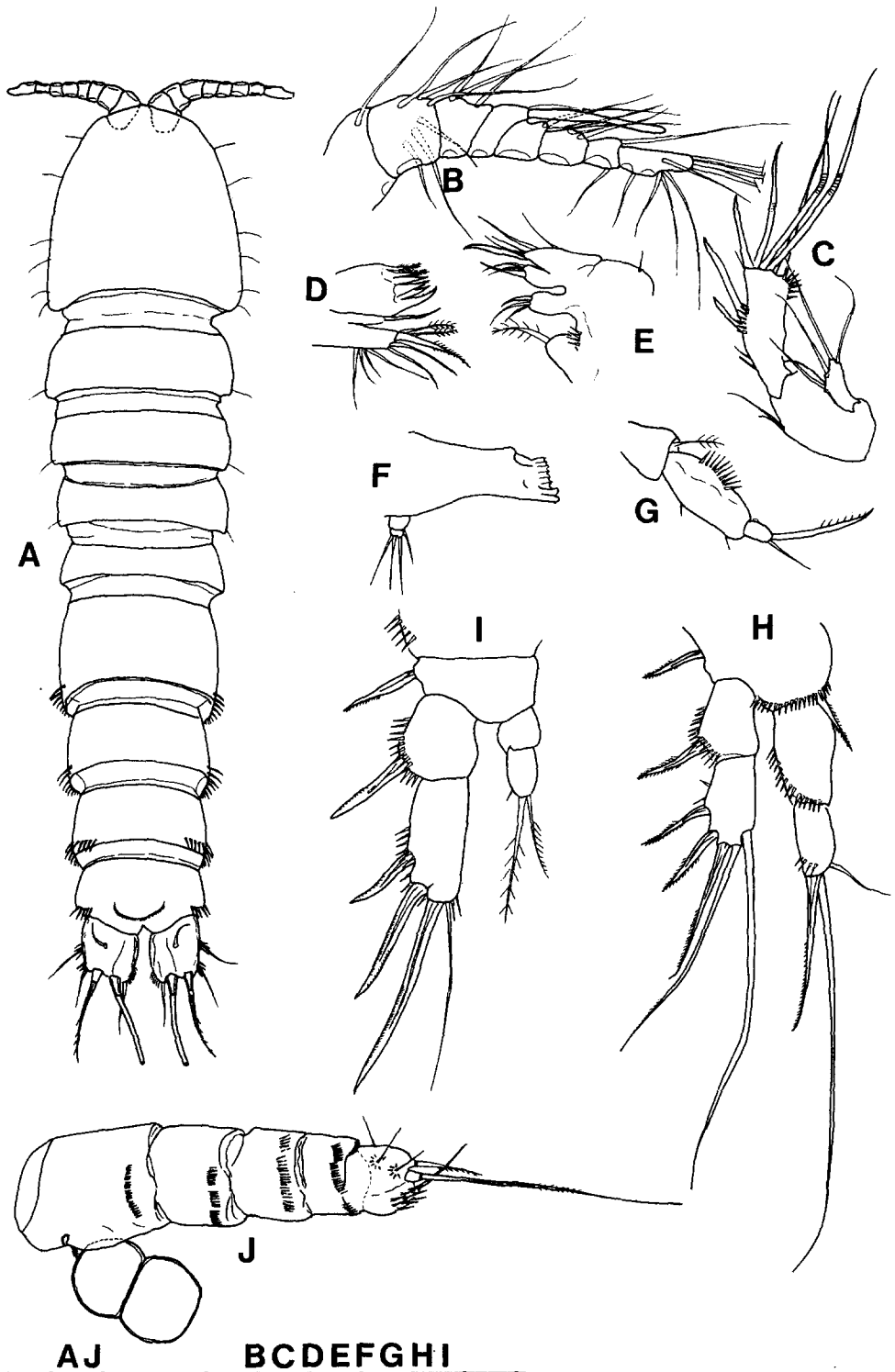

Fig. 1. *Pseudomoraria triglavensis* gen.n., sp.n. – female: reservoir Močilec, Triglav national park, Slovenia. A: habitus of adult female (paratype); B: antennula; C: antenna; D: mandibulaf; E: maxillula; F: maxilla; G: maxilliped; H: P1; I: P2; J: urosome with egg-sac – laterally; Scale bar: 0.1 mm

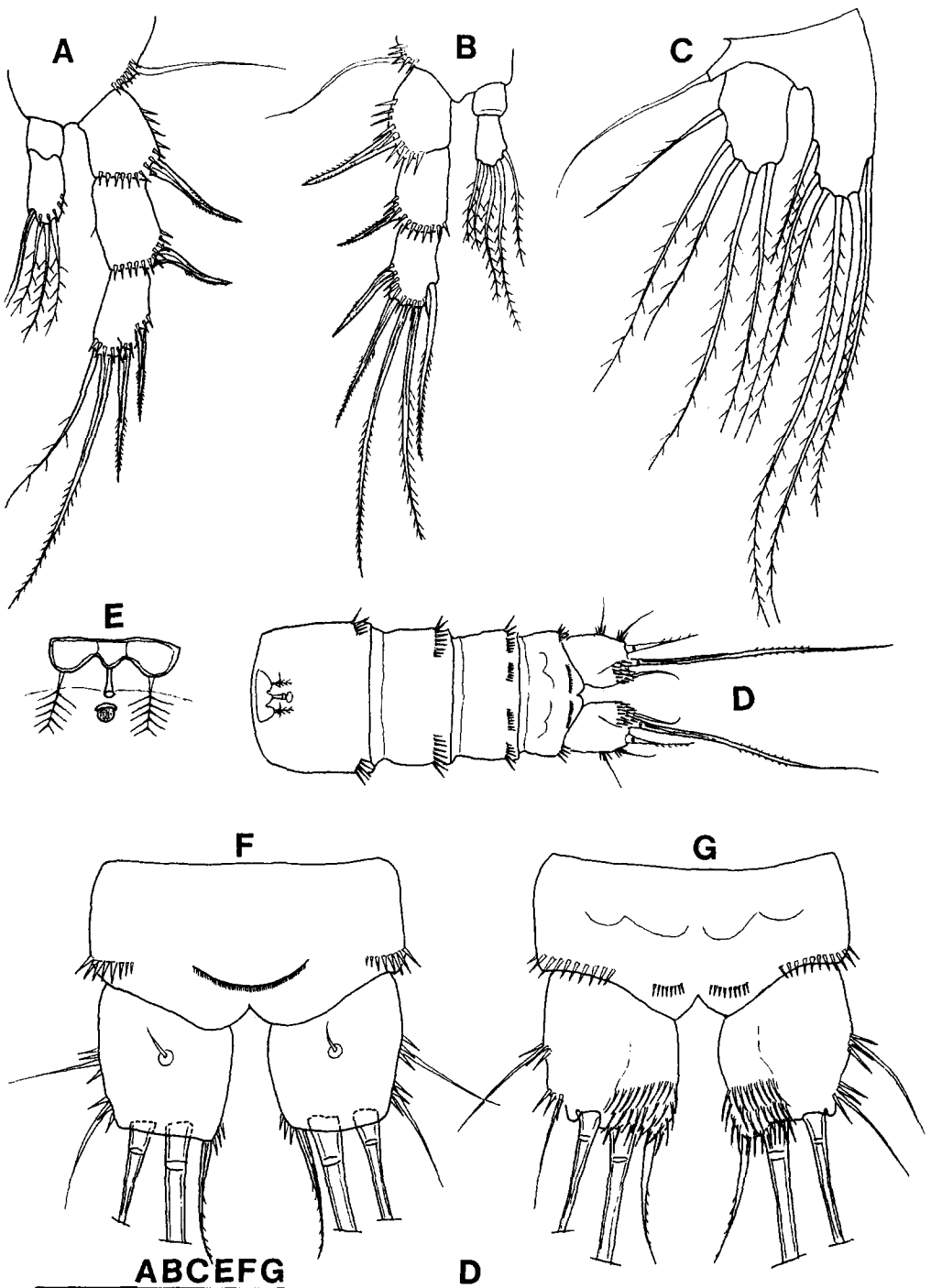

Fig. 2. Pseudomoraria triglavensis gen.n., sp.n. – female: reservoir Močilec, Triglav national park, Slovenia. A: P3; B: P4; C: P5; D: urosome – ventrally; E: receptaculum seminis; F: furcal rami and anal operculum – dorsally; G: furcal rami – ventrally; Scale bar: 0.1 mm

Mandibula, maxillula, maxilla and maxilliped as in Figs 1D-1G).

Swimming legs: P1 and P2 2-segmented exo- and endopodite (Figs 1H, 1I). Endopodite of P1 slightly longer than exopodite. Inner edges of exopodite with no spines or setae. Distal segment of exopodite P2 terminally with long and strong spine and seta, as long as spine. Terminal segment of endopodite P2 with 2 unequal setae. P3 and P4 with 3-segmented exopodite and 2-segmented endopodite (Figs 2A, 2B). Distal segment of exopodite P3 with 2 spines and 2 strong setae. Terminal segment of endopodite P3 with 5 setae, 2 of them very thin (Fig. 2A). Distal segment of exopodite P4 with 2 spines laterally and 3 strong setae terminally. Endopodite of P4 similar to endopodite of P3.

P5 2-segmented (Fig. 2C). Baseoendopodite longer than exopodite bearing 6 unequal setae. Exopodite slightly longer than wide with 5 unequal setae.

Setation formula of P1–P4 as follows:

	Exopodite			Endopodite		
Segment	1	2	3	1	2	3
P1	–	01	122	–	00	111
P2	–	01	022	–	00	020
P3	01	01	022	–	00	221
P4	01	01	122	–	00	221

Number of eggs: ovigerous females with 2 relatively large eggs in egg-sac, arranged longitudinally (Fig. 1J)

Male:

Length (including furcal rami): mean total length 0.50 mm, range: 0.49–0.51 mm. Shape of toracic part with no particular characteristics. Genital segment with row of spinules laterally and dorsolaterally (Fig. 3A). 1st urosomite with row of spinules all round the segment with short interruption dorsally. 2nd urosomite with row of spinules all round the segment. 3rd urosomite similar to the 1st but with wider interruption dorsally. 4th urosomite with only a laterally row of spinules. An additional row of spinules at base of furcal rami.

Anal operculum: rounded, with 16–17 spinules on the posterior margin (Fig. 3C).

Furcal rami: cylindrical, 1.5 times as long as wide, slightly diverging (Fig. 3C). Apical seta situated mediolaterally, at the 2/3 of distance along ramus. Two outer lateral setae at the 1/2 and 3/4 of length from the ramus base. Inner terminal seta about 1.5 times as long as furcal ramus, the outer seta about 4 times as long as ramus. Median terminal seta about 2.2 times as long as outer one.

Swimming legs: P1 and P2 similar in structure to female's (Figs 3D–3G). Spines on exopodite P2 strong with rounded tips. Exopodite and endopodite of P3 2-segmented. Endopodite with strong lateral spine and slender apical one (Fig. 3F). Exopodite of P4 2-segmented and endopodite with one segment bearing 2 setae.

Baseoendopodite of P5 shorter than exopodite, armed with 2 or exceptionally 1 long spine (Fig. 3H). Exopodite slightly longer than wide with 2 setae. Outer seta shorter than spine on baseoendopodite, inner seta about 3 times as long as outer one. Setation formula of P1-P4 as follows:

	Exopodite			Endopodite		
Segment	1	2	3	1	2	3
P1	–	01	122	–	00	111
P2	–	01	022	–	00	020
P3	–	01	022	–	00	110
P4	–	01	122	–	–	020

Relationships

The new species cannot be placed in any currently known genus. According to the shape and number of setae on the P5 in both sexes, it is most closely related to the genus *Moraria* T. & A. Scott, 1893. But the new genus differs from *Moraria* by the reduced segmentation of the rami of P1-P4 in both sexes and by sexually dimorphic furca. Comparing the diagnosis of *Moraria* (Dussart, 1967) with that of the new genus we find additional significant differences between the two genera.

In Table 1 are compared four closely related genera within *Moraria*-group found in Slovenia (Brancelj, 1986, 1991). Comparing the new taxon to other three, *Pseudomoraria* gen. n. appears to be intermediate between *Moraria* A. & T. Scott, 1893 and *Paramorariopsis* Brancelj, 1991. Males and females of *Moraria*, the most primitive genus in *Moraria*-group, has the constant number of segments in both rami of P1-P4 and similar furca in both sexes. Females and males of three other genera from *Moraria*-group have reduced

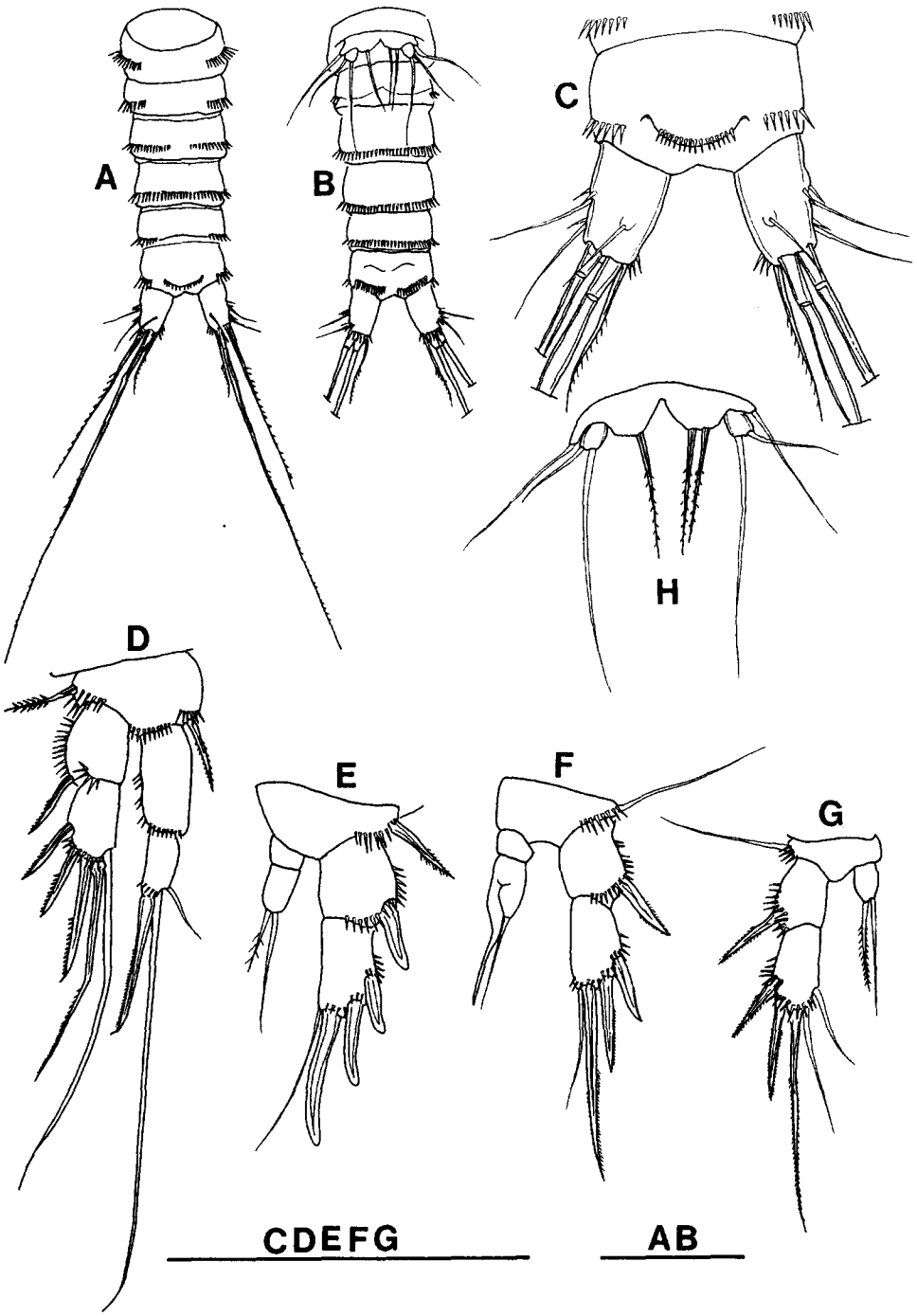

Fig. 3. Pseudimoraria triglavensis gen.n., sp.n. – male: reservoir Močilec, Triglav national park, Slovenia. A: urosome – dorsally; B: urosome – ventarlly; C: furcal rami – dorsally; D: P1; E: P2; F: P3; G: P4; H: P5; Scale bar: 0.1 mm

number of segments in both rami of P1-P4. They have also reduced number of spines and setae on P5. *Pseudomoraria* is the only genus in the group with 2-segmented exopodites: P1-P2 in female and P1-P4 in male. It is also the only genus with sexually dimorphic furcal rami. Hyaline mebrane, characteristic for *Moraria* and *Morariopsis*, is absent in *Pseudomoraria*.

Reduction of segments in legs, number of setae, reduction of eye apparatus, depigmentation, etc., is common in animals, living in different marginal aquat-

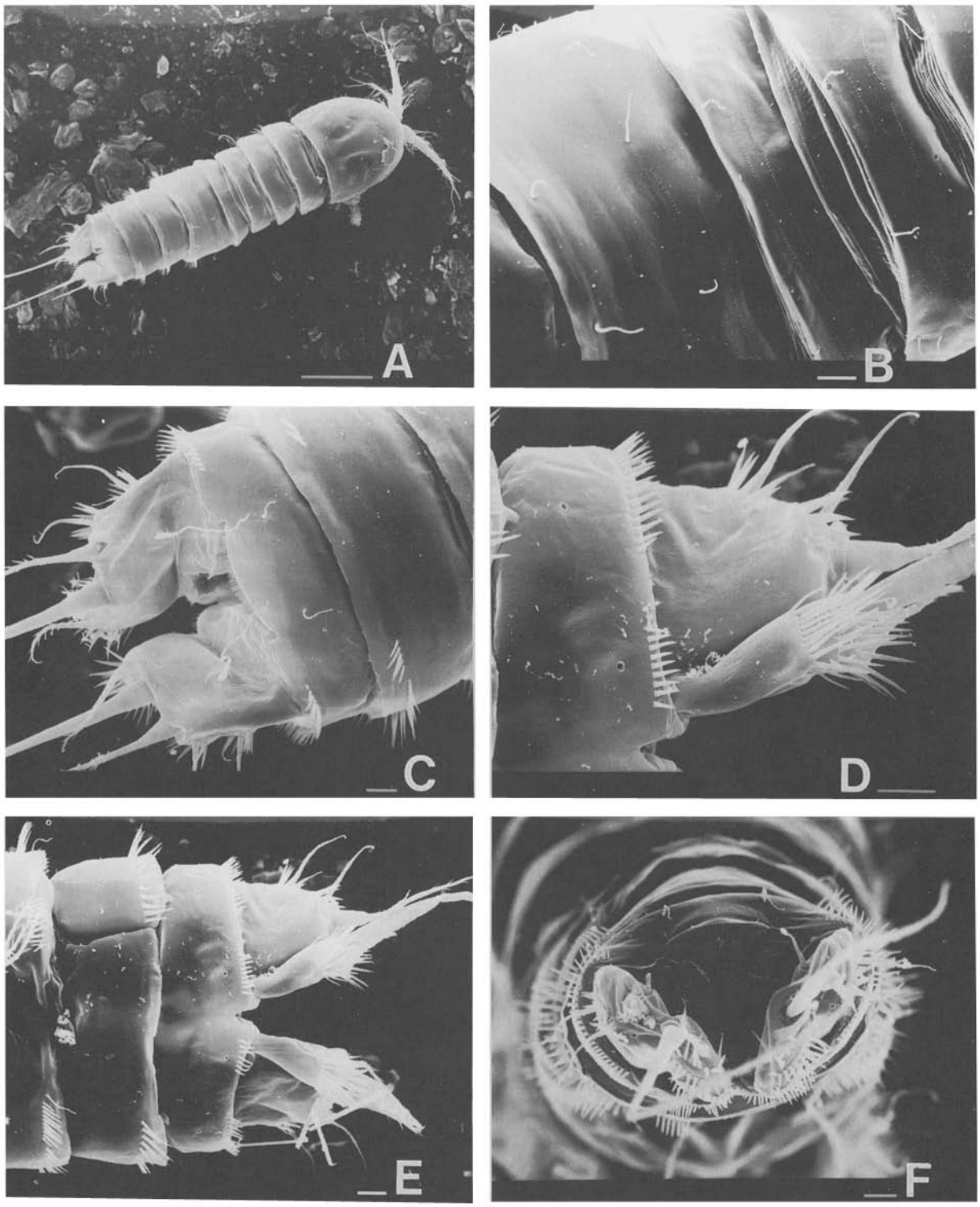

Fig. 4. Pseudomoraria triglavensis gen.n., sp.n. – female: reservoir Močilec, Triglav national park, Slovenia. A: habitus; B: ornamentation of thoracic and genital somites; C: furcal rami and anal operculum – dorsally; D: furcal ramus – laterally; E: urosome and furcal rami – ventrally; F: furcal rami – caudally; Scale bar: A: 0.1 mm; B–F: 0.01 mm

Table 1. Differences in articulation and setation in P1–P5 and shape of furca in four related genera in *Moraria*-group.

Females	*Moraria*	*Pseudo-moraria*	*Paramora-riopsis*	*Mora-riopsis*
- No of segm.:				
P1-P4 exp.	3,3,3,3	2,2,3,3	3,3,3,3	3,3,3,3
P1-P4 enp.	2,2,2,2	2,2,2,2	2,1,1,2	2,1,1,1
- No of setae:				
exp. P5	5	5	2	3–4
baseoend. P5	5–7	6	3	3–6
- setae: inner side of exp. P2-P4	absent	absent	present	absent
- furca similar in both sexes	yes	no	yes	?
- hyaline membrane on furcal rami	present	absent	absent	present
Males	*Moraria*	*Pseudo-moraria*	*Paramora-riopsis*	*Mora-riopsis*
- No of segm.:				
P1-P4 exp.	3,3,3,3	2,2,2,2	3,3,3,3	?,?,?,?
P1-P4 enp.	2,2,2,2	2,2,2,1	2,2,3,2	?,?,?,?
- No of setae:				
exp. P5	5	2	2	?
baseoend. P5	1–2	1–2	0	?
- setae: inner side of exp. P2-P4	absent	absent	present	?
- antler-like tranformed spine on exp. P3 or P4	absent	absent	present	?

ic habitats or in habitats poor in food, like caves or springs. The degree of reduction of segments in P1-P4 in *Moraria*-group is related to habitats. *Moraria*, genus with 3-segmented exopodites of P1-P4 and 2-segmented enopodites of P1-P4, is common in many epigeic, energetically rich habitats. Springs are habitats with reduced availability of food. *Pseudomoraria*, with reductions on exoposites and endopodites, is inhabitant of such type of habitat. *Morariopsis* and *Pseudomorariopsis* with the most intensive reduction on endopodites of P1-P4 inhabit the habitats with the smallest amount of food, *i.e.* wet moss pillows and crevices filled by percolating water near the entrances of caves. The intensity of body pigmentation also decreases from epigeic habitats toward caves and crevices filled by percolating water.

Discussion

Seven high-alpine lakes, two temporary puddles and one man made reservoir are situated in Dolina Sedmerih Triglavskih Jezer. The lakes are situated in the center of the park in the NW part of Slovenia. They have a glacial origin and have no surface connections.

A small permanent spring (Lazar, 1969) was damed creating a small reservoir to provide water supply for nearby alpine cottages. Reservoir is situated at elevation of 1690 m and it is about 150 m from the natural lake Dvojno Jezero (1670 m). Water level in the reservoir varied during the year but when full it is about 40 m long, 15 m wide and 3 m deep. When it is empty only the stream of about 5 ls^{-1} flow remains. Approximately half of bottom is covered by stones (5–20 cm in diameter) with a few large rocks (up to

Table 2. Physical and chemical parameters, measured in reservoir Močilec in June and September 1992.

	June	September
max. water depth (m)	3.1	0.5
temperature (°C)	7.0	7.4
pH	8.1	not measured
conductivity (μs)	163.0	180.4
TDS (mg l^{-1})	109.0	119.7
oxygen conc. (mg l^{-1})	15.3	9.8
COD (mg l^{-1})	2.37	2.84
sulphate (mg l^{-1})	12.96	35.52
tot. phosphorus (mg l^{-1})	0.019	0.002
Chlorophyll *a* (μg l^{-1})	not measured	0.06

Table 3. List of flora and fauna found in reservoir Močilec in June and September 1992 (1: rare, 3: common, -: not found).

	15.07.92	22.09.92
FLORA		
Cyanobacteria		
Aphanocapsa sp.	–	1
Calotrix parietina	–	3
Chroococcus westii	–	1
Clastidium rivulare	1	–
Leptochaete rivularis	1	3
Lyngbya maior	–	1
Oscillatoria sp.	1	–
Oscillatoria subtilissima	–	3
Pleurocapsa minor	1	1
Phormidium corium	1	3
Phormidium favosum	1	–
Rivularia haematites	–	1
Chrysophyta		
Malomonas sp.	–	1
Bacillariophyta		
Achnanthes sp.	1	–
Cymbella cesatii	–	1
Cymbella microcephala	–	1
Cymbella ventricosa	1	1
Denticula tennuis	–	1
Comphonema intricatum	1	1
Navicula sp.	1	1
Nitzschia dissipata	–	1
Stauroneis anceps	–	1
Chlorophyta		
Cosmarium ochthodes	–	1

Continued on p. 98

0.5 m in diameter). The rest of bottom is covered by fine sand (>1 mm in diameter) or soil. Organic material is deposited mostly in the deepest part, mainly as twigs, cones or needles of *Pinus mughi* and *Larex decidua*. Water enters the reservoir among boulders at the upper part and leaves it either over the dam or through cracks in the dam. When water is low it sinks into numerous small holes in the bottom of the stream bed 20–30 m after outlet. During high water part of water from reservoir flow into lake Dvojno Jezero as a temporary stream. Some physical and chemical data measured in the reservoir Močilec in June and September 1992 are listed in Table 2. A list of accompanying fauna and flora is presented in Table 3.

Pseudomoraria is the fourth genus of the *Moraria* group known from Slovenia. Except for *Moraria*, the three other genera are either endemic to Slovenia (*Paramorariopsis* Brancelj, 1991 and *Pseudomoraria* gen. n., sp.n.) (Brancelj, 1991; this paper) or have a very scattered distributions (*Morariopsis* Kiefer, 1930) (Kiefer, 1930; Borutskii, 1952; Petkovski, 1959).

The reason why all genera, with exception of *Moraria*, are considered to be rare can be found in their ecology. Although at present all specimens of *Paramorariopsis* and *Morariopsis* from Slovenia have been found in small puddles near cave entrances (Kiefer, 1930; Brancelj, 1986, 1991) that were relatively rich with organic debris, the most probable original habitats are wet moss pillows and crevices filled by percolating water near the entrances of caves (Brancelj, *ibid.*). Both microhabitats are in Slovenia very poor known but they are considered to be oligotrophic. This agrees with Kikuchi (1984) and Dumont & Maas (1988) who considered that many harpacticoid copepods occur in different marginal aquatic and semi-aquatic habitats (see also Lang, 1948; Dussart, 1967).

Specimens of *P. triglavensis* also inhabit water poor in organic matter (see Table 1). It is most likely that the original habitat is the surroundings of high-alpine springs. Adaptation to extreme habitats, *i.e.* those with low temperature and poor food resources is expressed in *P. triglavensis* by reduced number of eggs, although each has an increased volume, which may increase the surviviorship of the juveniles, as is common in many cave-dwelling taxa (Vandel, 1964; Rouch, 1968). On the other hand such reduction of eggs was also observed in *Bryocamptus (Arcticocamptus)*

Table 3 (cont.).

	15.07.92	22.09.92
FAUNA		
Oligochaeta		
Haplotaxidae gen. sp.	–	1
Lumbriculidae gen. sp.	1	1
Cladocera		
Biapertura affinis	–	1
Chydorus sphaericus	–	3
Copepoda		
Acanthocyclops vernalis	–	1
Bryocamptus dacicus	–	1
Bryocamptus rhaeticus	–	1
Cyclops abyssorum tatricus	–	1
Eucyclops serrulatus	3	3
Paracyclops fimbriatus	1	3
Pseudomoraria triglavensis	3	–
Ostracoda		
gen. sp.	1	3
Amphipoda		
Niphargus sp.	–	1
Ephemeroptera		
Ecdyonurus sp.	–	1
Siphlonurus lacustris	1	1
Plecoptera		
Leuctra sp.	–	1
Nemoura cinerea	1	3
Trichoptera		
Limnephilidae gen. sp.	3	1
Metanoea rhaetica	1	–
Rhyacophila vulgaris	1	1
Diptera		
Chironomidae gen. sp.	1	1
Coleoptera		
Dytiscidae gen. sp.	–	1

rhaeticus, an inhabitant of high-alpine lakes (Dussart, 1967) and very common in lakes in TNP. However, this taxon is more common in late summer than at the end of spring. Beside numerous specimens of *Bryocamptus* in late summer we can find specimens of two other, bottom dwelling taxa, *Eucyclops* and *Paracyclops*, to be quite common (Table 2). The relationship of specimens of *P. triglavensis* to specimens of three listed taxa is unknown.

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