

New and little known *Parastenocaris* (Copepoda, Harpacticoida, Parastenocarididae) from cave waters in Northeastern Italy

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ABSTRACT

Four species of *Parastenocaris* were collected from the vadose and epiphreatic zones of caves in northeastern Italy and Slovenia. *P. ranae* n. sp. is described from Lessinian Mountains (Vicenza); its relationship with *P. tumida* Kiefer 1961 is discussed. *P. federici* n.sp. is described from the Karst near Gorizia; the new species shares with the representatives of the *P. minuta*-group the structure of male leg 3 exopod and the armature of male leg 4 basis. *P. italica* Chappuis 1954 and *P. gertrudae* Kiefer 1968 are reported for the first time from the Karst near Trieste and Gorizia; *P. gertrudae*, discovered in a Slovenian cave as well, is redescribed in detail. The taxonomic position of *P. italica* and *P. gertrudae* within the genus *Parastenocaris* is discussed.

Key words: *Parastenocaris*, Harpacticoida, caves, groundwaters.

RIASSUNTO

Parastenocaris (Copepoda, Harpacticoida, Parastenocarididae) poco noti e nuovi dalle grotte dell'Italia nordorientale. – Quattro specie di *Parastenocaris* sono state raccolte nella zona vadosa ed epifreatica di grotte dell'Italia nordorientale e della Slovenia. *P. ranae* n. sp. viene descritta per i Monti Lessini (Vicenza); vengono discusse le sue affinità con *P. tumida* Kiefer 1961. *P. federici* n. sp. è descritta per il Carso Goriziano; la nuova specie condivide con i rappresentanti del gruppo di *P. minuta* la struttura dell'esopodite del terzo paio di arti e l'armatura del basipodite del quarto paio di arti nel maschio. *P. italica* Chappuis 1954 e *P. gertrudae* Kiefer 1968 sono riportate per la prima volta per il Carso triestino e goriziano; *P. gertrudae*, scoperta anche in Slovenia, viene ridescritta in dettaglio. Viene infine discussa la posizione tassonomica di *P. italica* e *P. gertrudae* nell'ambito del genere *Parastenocaris*.

Parole chiave: *Parastenocaris*, Harpacticoida, grotte, acque sotterranee.

INTRODUCTION

Recent investigations of groundwater fauna in North-Italian and Slovenian caves yielded several new species of copepods (Stoch, 1995). Unfortunately, only few specimens of the genus *Parastenocaris* were collected sampling hypogean brooks and large pools of percolating water, despite ten years of intensive sampling effort. Nevertheless, in spring 1996, during a period of heavy rains, the collection of small drops of percolating water in fossil caves yielded a rich material of *Parastenocaris*, which can be ascribed to three different species (*P. italica* Chappuis, 1964; *P. gertrudae* Kiefer, 1968; *P. federici* n. sp.). This material is described herein, together with a further new species (*P. ranae* n. sp.), collected in a cave on Lessinian Mountains.

MATERIALS AND METHODS

The specimens were collected from two main cave habitats:

- vadose zone: small or very small temporary pools of percolating water (sometimes drops or ephemeral trickles of water on stalagmites) were sampled after heavy rains using a little rubber hand pump; water was poured in a vial and fixed with formaldehyde (the amount of water collected in a whole cave ranges from 25 to 100 cc);
 - amphibian zone: the water of hypogean brooks was filtered using a plankton net stirring the substratum upstream; the samples were fixed as explained above.
- Copepods were extracted from detritus under a stereomicroscope (50X) and stored in 70% ethanol with 10% glycerine added. Selected specimens were dissected in glycerine, and permanently mounted on slides in Faure's medium or glycerine sealed using epoxids. A Zeiss Axioskop microscope fitted with a drawing tube was used to study the details at 1000X using an oil immersion lens.

The terminology related to the external morphology follows Huys et Boxshall (1991).

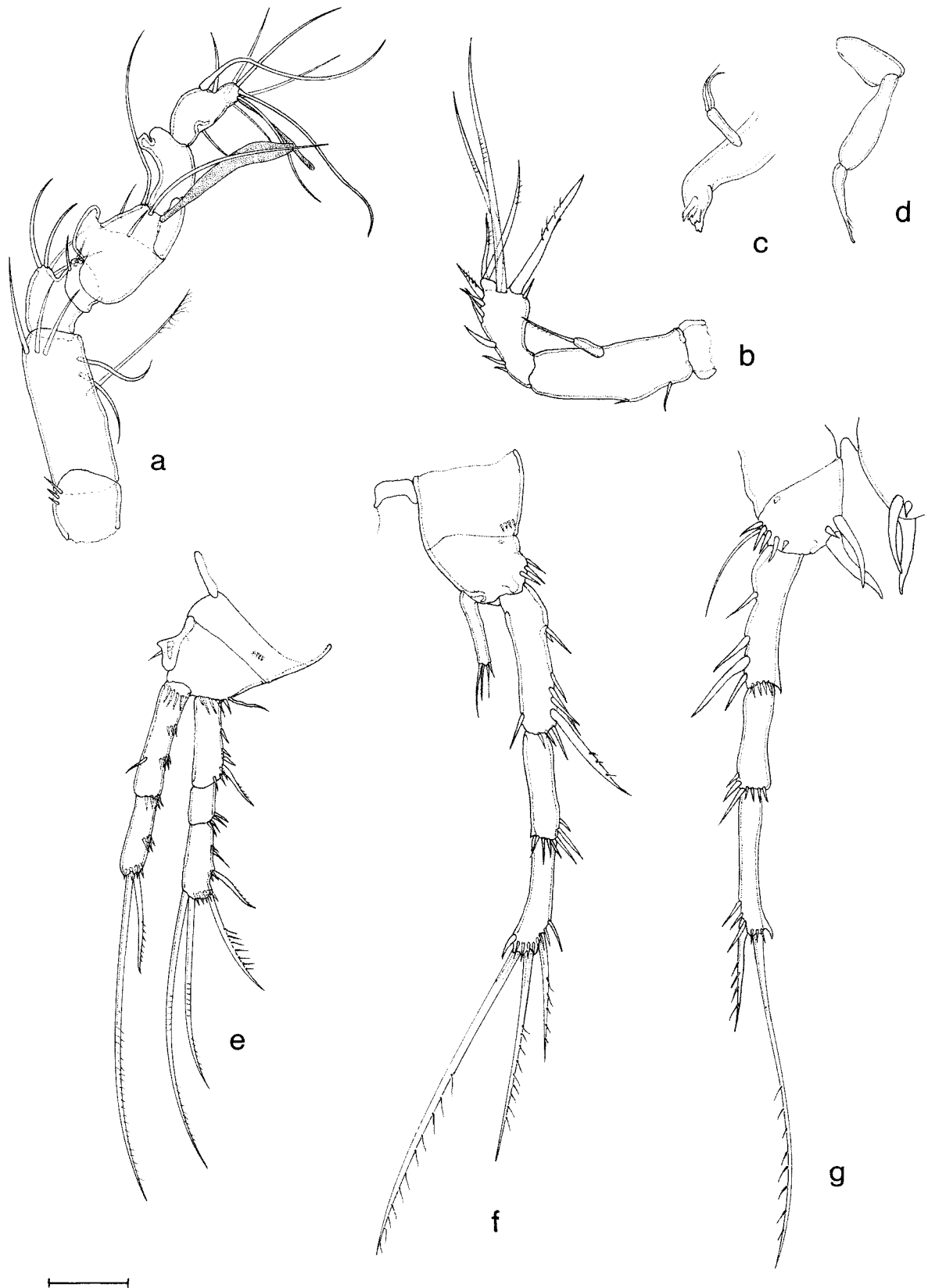


Fig. 1 – *Parastenocaris ranae* n. sp. holotype ♂. a) Antennule; b) antenna; c) mandible; d) maxilliped; e) leg 1; f) leg 2; g) leg 4. Scale bar : 10 μ m.

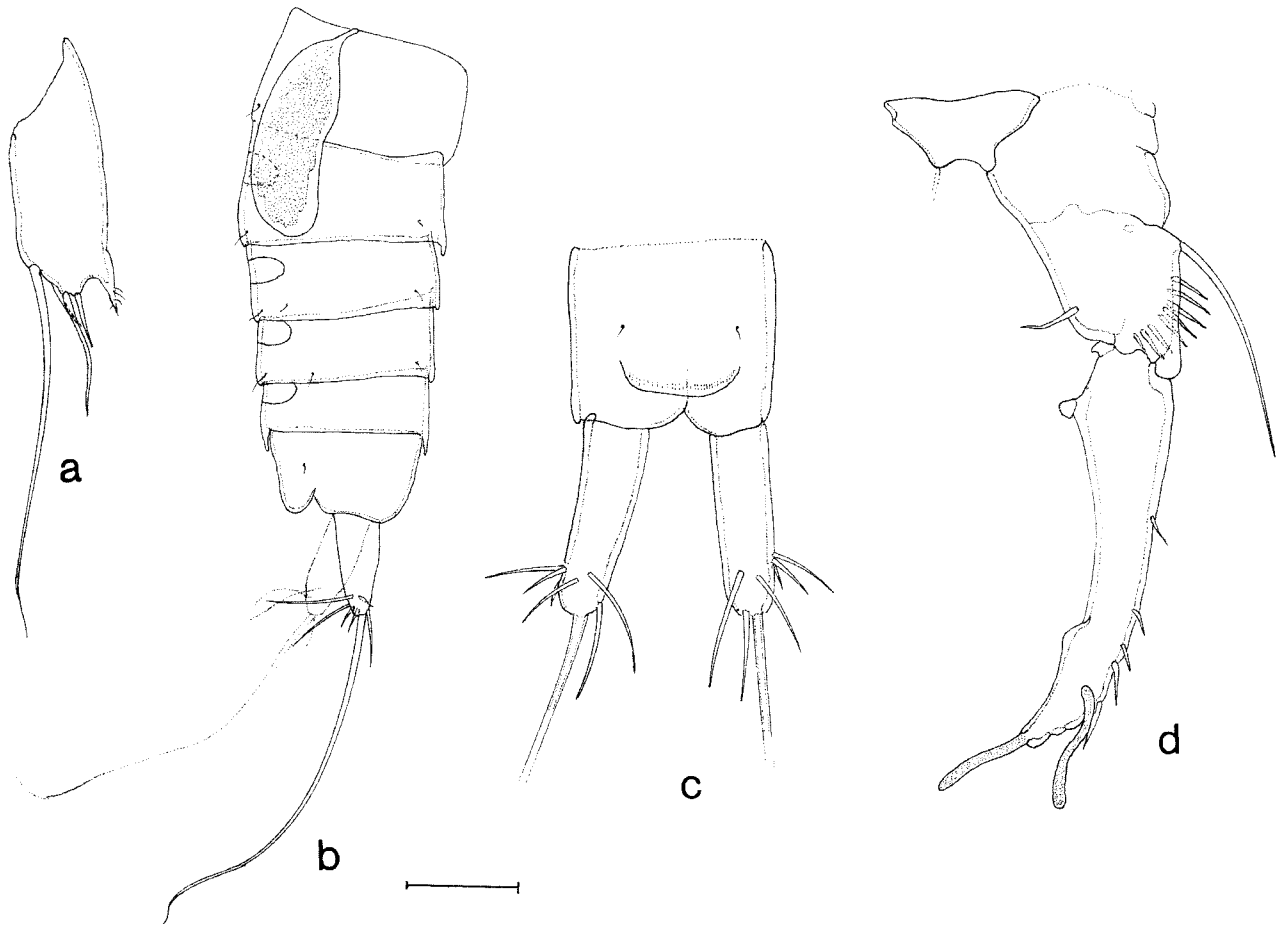


Fig. 2 – *Parastenocaris ranae* n. sp. a, b, d holotype ♂; c paratype ♂. a) Leg 5; b) abdomen and caudal rami, lateral view; c) anal segment and furca, dorsal view; d) leg 3. Scale bar: 10 μ m (a,d); 40 μ m (b,c).

TAXONOMIC ACCOUNT

Family Parastenocarididae Chappuis, 1940
Genus *Parastenocaris* Kessler, 1913

Parastenocaris ranae n. sp.

(Figs. 1-2)

Material examined

Italy: Cave named "Buso della Rana" (cadastre number 40 V/VI), Monte di Malo, Lessini Mountains, province of Vicenza, m 340 a.s.l.; amphibian zone, in large pools, residual of a subterranean brook; water temperature = 10.1°C, pH = 8.3, conductivity = 210 μ S/cm; 17 July 1993, leg. F. Gasparo, E. Piva, F. Stoch, 2 ♂♂.

Type material

Holotype ♂, paratype 1 ♂, completely dissected and mounted on slide in Faure's medium (holotype) and glycerine (paratype). Holotype deposited in the

Museum of Natural History in Verona, paratype in the author's collection.

Etymology

The new taxon is named after the type locality (Buso della Rana = cave of the frog).

Male

Length of the holotype, excluding caudal setae, 300 μ m; length of the paratype 305 μ m. Cephalothorax and abdominal somites 1-4 with dorsal "windows"; anal somite as in Figs. 2b, c; operculum convex. Caudal rami about 3.3 times longer than wide (Fig. 2c), as long as anal somite, with 7 setae. All 3 anterolateral setae inserted in the distal third of caudal ramus; inner terminal seta (V) 5 times longer than caudal ramus (Fig. 2b).

Antennule (Fig. 1a) geniculate, 8-segmented; neocopepodan distal geniculation between segments 6 and 7; segments 5 and 8 bearing aesthetascs; aesthetasc of segment 5 spatulated. Segments with number of setae and aesthetascs (Ae) in brackets: 1 [0], 2 [6], 3 [4], 4 [2], 5 [4 + 1 Ae], 6 [0], 7 [0], 8 [9 + 1 Ae].

Antenna as in Fig. 1b, with 1-segmented exopod bearing 1 seta.

Mandible (Fig. 1c) with 1-segmented palp bearing 2 slender terminal setae; maxillule and maxilla as in *P. federici* n. sp. (see below). Maxilliped (Fig. 1d) prehensile; syncoxa and basis without ornamentation; endopodal claw pinnate.

Swimming legs 1, 2 and 4 with 3-segmented exopods; armature of coxae and exopods as in Figs. 1e, f, g. Leg 1 (Fig. 1e): basis with a stout inner thorn; endopod 2-segmented, with segment 1 bearing 1 inner seta. Leg 2 (Fig. 1f): basis without inner seta, with a row of spinules on outer distal margin; endopod cylindrical, about half length of exopod segment 1, with 1 terminal seta and 3 spinules. Leg 3 (Fig. 2d): basis with a row of spinules along outer margin, 1 long outer seta and a short endopodal seta; exopod inner margin with a proximal sclerotized knob and a distal sclerotized hump; outer margin armed with spinules; distolateral hyaline thumb narrow and blunt, shorter than mediolateral extension of exopod; mediolateral extension with long, narrow and hyaline apophysis. P4 (Fig. 1g): basis with outer margin armed with a row of spinules and 1 seta; exopod segment 3 more than 5.5 times longer than wide, inner terminal seta 2.5 times longer than segment; endopod spiniform, shorter than exopod segment 1, accompanied by 2 spinules, one short and stout, the other long, only slightly shorter than endopod, curved to form a claw. P5 (Fig. 2a): subrectangular, with 1 distomedial thorn and 4 setae.

Female

Unknown.

Remarks

The new species is closely related to *P. tumida* Kiefer, 1961 (recently redescribed by Schminke et Notenboom, 1990) on the basis of the shape of male leg 3 and the structure of leg 4 endopod. Nevertheless, it differs from *P. tumida* in having the following characters:

- caudal rami slightly longer (3.3 against 2.7 times longer than wide)
- distal segments of leg 1, 2 and 4 exopods more elongated; segment 3 of leg 4 exopod 5.5 (against 2.5) times longer than wide
- distal setae of leg 2 and leg 4 exopod segment 3 very long, nearly as long as exopod (in *P. tumida* shorter than the 2 distal segments of the exopod)
- different shape of leg 4 endopod and basal spinules.

P. ranae n. sp., as well as *P. tumida*, can be assigned to the *P. minuta* – group sensu Lang (1948) on the basis of the structure of leg 3 and the armature of leg 4 basis and endopod (see also Schminke et Notenboom, 1990).

Habitat and distribution

P. ranae n. sp. is a cave-dweller discovered in the pools which remain in the cave during Summer when the subterranean brook dries up.

Parastenocaris federici n. sp.

(Figs. 3-4)

Material examined

Italy: Cave named "Caverna dell'Infermeria" (cadastre number 1065 VG), Jamiano, province of Gorizia, m 44 a.s.l.; vadose zone, in drops of percolating water (250 cc collected); 5 May 1996, leg. F. et F. Stoch, 2 ♂♂, 1 ♀ (type material).

War gallery below cave 5388 VG, Bonetti, province of Gorizia, m 130 a.s.l.; vadose zone, in a trickle of water (25 cc collected); water temperature = 12.2°C, pH = 7.7, conductivity = 350 µS/cm; 22 May 1996, leg. F. Stoch, 10 specimens (partly mounted on slides, partly ethanol preserved, coll. F. Stoch).

Type material

Holotype ♂, completely dissected and mounted on slide in Faure's medium; paratypes 1 ♂, 1 ♀ (mounted on slides in glycerine), all from "Caverna dell'Infermeria" (1065 VG), Jamiano, Gorizia, Italy. Holotype deposited in the Museum of Natural History in Verona; paratypes and remaining material in the author's collection.

Etymology

The new species is dedicated to my little son Federico (8 years old when we sampled the caves) who collected in a bottle the small drops of water in the type locality containing *Parastenocaris*.

Male

Length, excluding caudal setae, 335-355 µm (some specimens telescoped). Cephalothorax and abdominal somites 1-4 with dorsal "windows"; anal somite as in Figs. 4b, c; operculum convex. Caudal rami about 3.4 times longer than wide (Fig. 4f), set broadly apart, as long as or slightly shorter than anal somite, bearing 7 setae; a distal sclerotized tooth, wide and blunt, is present on the dorsal side of caudal ramus; anterolateral caudal setae inserted in the distal third of caudal ramus.

Antennule (Fig. 3a) geniculate, 8-segmented; neocopepodan distal geniculation between segments 6 and 7; segments 5 and 8 bearing aesthetascs; aesthetasc of segment 5 spatulated. Segments with number of setae and aesthetascs (Ae) in brackets: 1 [0], 2 [6], 3 [4], 4[2], 5[4 + 1 Ae], 6[0], 7[0], 8[9 + 1 Ae].

Antenna (Fig. 3c) with 1-segmented exopod bearing 1 seta.

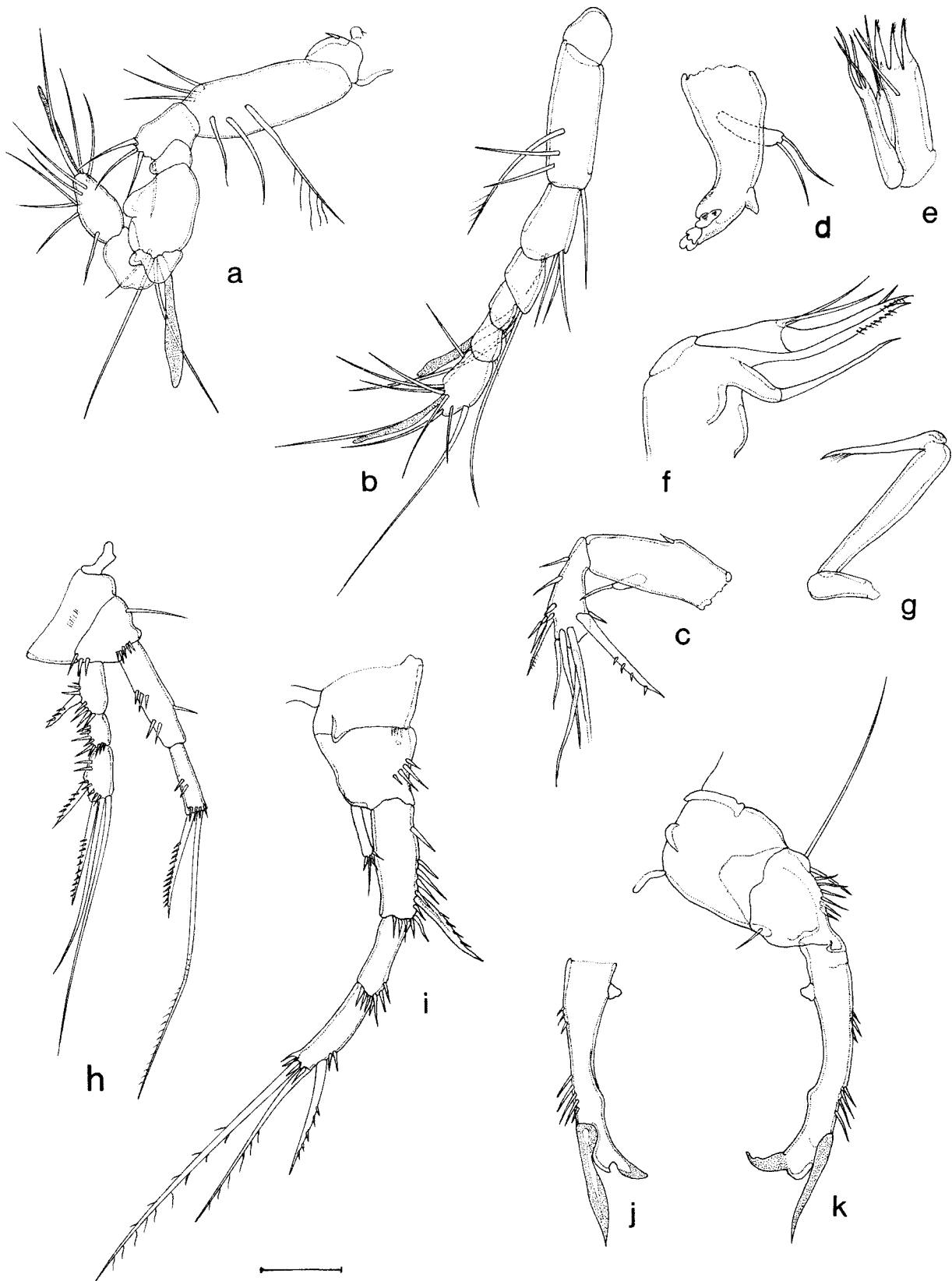


Fig. 3 – *Parastenocaris federici* n. sp. a, c, d, g, h, i, k holotype ♂; b paratype ♀; e, f, j ♂ from war gallery near Bonetti. a) Antennule ♂; b) antennule ♀; c) antenna ♂; d) mandible ♂; e) maxillule ♂; f) maxilla ♂; g) maxilliped ♂; h) leg 1 ♂; i) leg 2 ♂; j) distal part of leg 3 exopod ♂, anterior view; k) leg 3 ♂, slightly rotated. Scale bar: 10 μm (a - c, h-k), 15 μm (d-g).

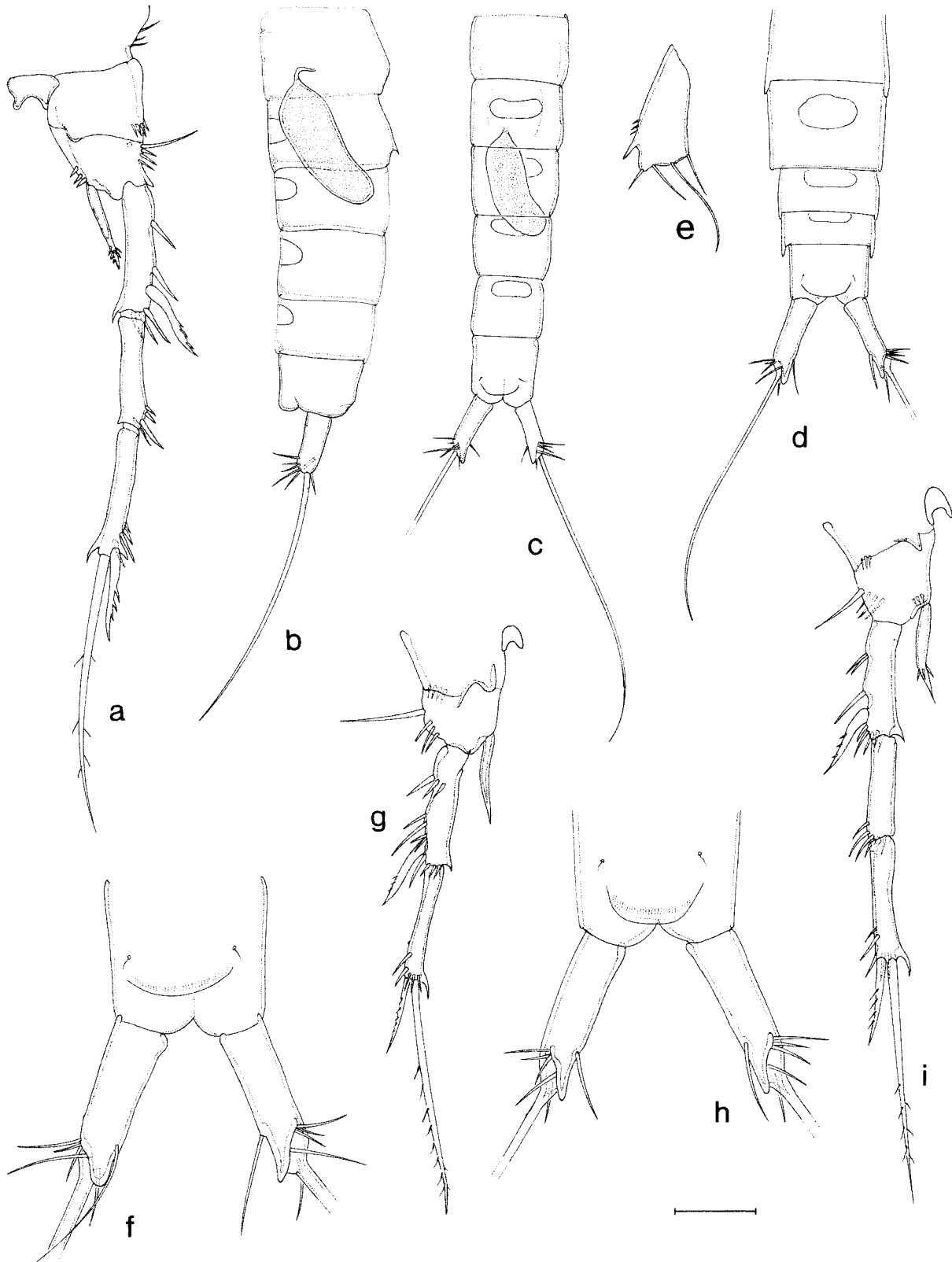


Fig. 4 – *Parastenocaris federici* n. sp. a, b, e holotype ♂; d, g, h, i paratype ♀; c, f ♂ from war gallery of Bonetti. a) Leg 4 ♂; b) abdomen and caudal rami ♀, lateral view; c) abdomen and caudal rami ♂, dorsal view; d) abdomen and caudal rami ♀, dorsal view; e) leg 5 ♂; f) anal segment and caudal rami ♂, dorsal view; g) leg 3 ♀; h) anal segment and caudal rami ♀, dorsal view; i) leg 4 ♀. Scale bar: 10 µm (a, e, g, i); 15 µm (f, h); 40 µm (b – d).

Mandible (Fig. 3d) with 1-segmented palp bearing 2 slender terminal setae; coxa bearing 1 lateral tooth. Maxillule (Fig. 3e) with praecoxal arthrite armed with 4 distal setae (1 slender and 3 claw-like setae) and 1 dorsal seta; coxa with 1 seta, basis with 3 setae. Maxillary syncoxa (Fig. 3f) with proximal endite bearing 1 seta and distal endite bearing 2 setae, one fringed and spiniform, the other one naked; allobasis with an endite transformed in a curved claw; endopod represented by a small hump bearing 2 setae. Maxilliped (Fig. 3g) prehensile and slender; syncoxa and basis without ornamentation; endopodal claw pinnate.

Exopods of swimming legs 1, 2 and 4 3-segmented; ornamentation of coxae and exopods as in Figs. 3h, i and Fig. 4a. Leg 1 (Fig. 3h): basis with inner seta; endopod with segment 1 bearing 1 inner short seta and armed with 2 rows of teeth; segment 2 with some tiny spinules and the usual 2 strong terminal setae. Leg 2 (Fig. 3i): basis without inner seta, armed with a row of tiny spinules; endopod 1-segmented, cylindrical, shorter than half of exopod segment 1, with 3 short terminal spinules and 1 seta. Leg 3 (Fig. 3j, k): coxa unarmed; basis armed with a row of spinules along outer margin, and 1 long outer seta; endopod represented by a tiny seta; exopod elongated: inner margin with a proximal sclerotized knob and a distal hump; outer margin armed with 2 rows of spinules; distolateral hyaline thumb sharp, its length nearly double that of mediolateral hyaline extension of exopod; mediolateral extension with a deep notch on outer margin, visible only in lateral view (Fig. 3j), distal part hyaline and sharp. Leg 4 (Fig. 4a): basis with outer margin armed with 1 row of small spinules and 1 seta; 1 row of tiny spinules is inserted near endopod; endopod 1-segmented, spiniform, shorter than exopod segment 1, with a row of subterminal spinules. Leg 5 (Fig. 4e): subrectangular, bearing 1 distomedial thorn and 4 setae, and with a row of spinules along inner margin.

Female

Length, excluding caudal setae, 250-270 μm (some specimens telescoped). Anal somite and anal operculum as in male (Figs. 4d, h). Caudal rami slightly more slender (3.6 times longer than wide) than in male, with more pointed distal sclerotized tooth (Fig. 4h). Dorsal caudal seta shorter than in male.

Antennule (Fig. 3b) 7-segmented; segments with number of setae and aesthetascs (Ae) in brackets: 1 [0], 2 [4], 3 [4], 4[2 + 1 Ae], 5[1], 6[1], 7[9 + 1 Ae].

Antenna, mouthparts, leg 1, and exopods of leg 2 and 4 as in male.

Leg 3 (Fig. 4g): basis with outer margin bearing 1 seta and a row of spinules; exopod 2-segmented; endopod spiniform, shorter than exopod segment 1. Leg 4

(Fig. 4i): basis with outer margin bearing 1 seta and a row of spinules; another row of tiny spinules is inserted near endopod; endopod 1-segmented, spiniform, slightly shorter than exopod segment 1, with a row of tiny spinules. Leg 5 bearing 1 distomedial spiniform projection and 4 setae as in male.

Remarks

Waiting upon a revision of the genus *Parastenocaris*, *P. federici* n. sp. can be provisionally included in the *P. minuta* – group defined by Lang (1948) (= genus *Minutacaris* Jacobi, 1972). The shape and structure of leg 3 with an inner knob and the presence of a row of spinules on leg 4 basis close to the insertion of the endopod are characters shared with the representatives of this group. Nevertheless, Rouch (1990) pointed out that the endopods of male leg 4 shows a wide interspecific variation within the *P. minuta* – group. Within this group, *P. federici* n. sp. resembles *P. hippuris* Hertzog, 1938, *P. nolli* Kiefer, 1938, and *P. nolli alpina* Kiefer, 1960. However, *P. federici* n. sp. is distinguished from all other members of the *P. minuta* – group, as well as from the sympatric *P. gertrudae* and *P. italica*, by the combination of the following characters:

- caudal ramus of the female with strong, narrow and prominent distal sclerotized tooth
- leg 1 basis with inner seta
- male leg 3 exopod with inner knob and hump, distolateral thumb larger and shorter, mediolateral extension with a deep notch
- male leg 4 basis bearing a row of spinules close to the insertion of the endopod.

Habitat and distribution

The species is known exclusively from the vadose zone of fossil caves in the Karst near Gorizia, where it was found in drops and very small puddles of percolating water; *P. federici* n. sp. probably inhabits small crevices in limestones.

Parastenocaris italica Chappuis, 1954

Parastenocaris italica: Chappuis, 1954: 11

Parastenocaris phyllophora: Noodt, 1955: 79

Italicocaris italica: Jakobi, 1972: 139

Fontinalicaris phyllophora (partim): Jakobi, 1972: 139

Parastenocaris sp. (partim): Gasparo, 1995: 24.

Material examined

Italy: Cave named "Grotta dei Ciclami" (cadastre number 2433 VG), Ferneti, province of Trieste, m 323 a.s.l.; vadose zone, in very small puddles of percolating water on stalagmites (25 cc collected); water temperature = 9.9°C, pH = 8.5,

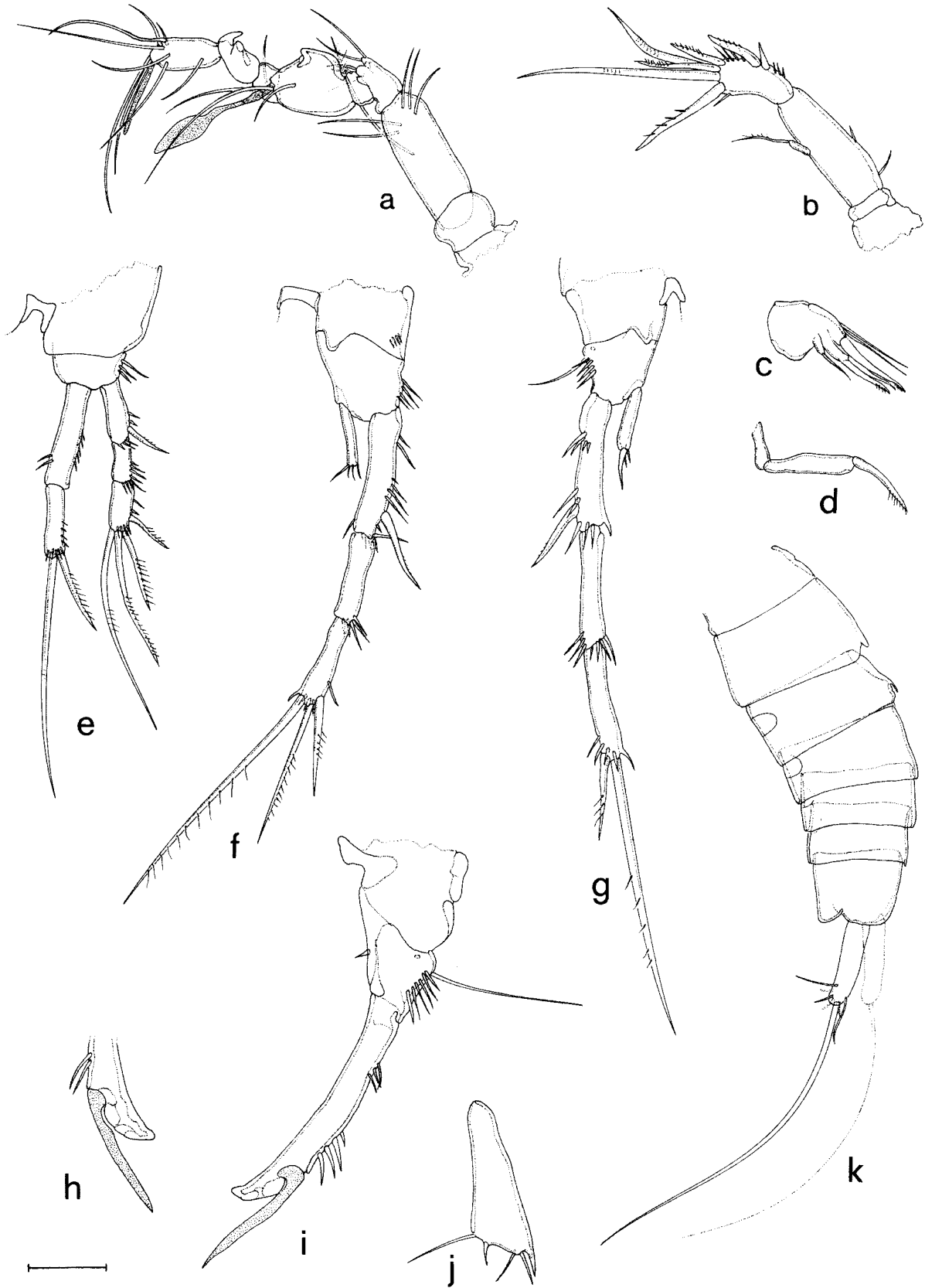


Fig. 5 – *Parastenocaris gertrudae* Kiefer. ♂ from Pajsarjeva Jama, Slovenia. a) Antennule; b) antenna; c) maxilla; d) maxilliped; e) leg 1; f) leg 2; g) leg 4; h) distal part of leg 3 exopod; i) leg 3; j) leg 5; k) abdomen and caudal rami, lateral view. Scale bar: 10 μm (a-j); 40 μm (k).

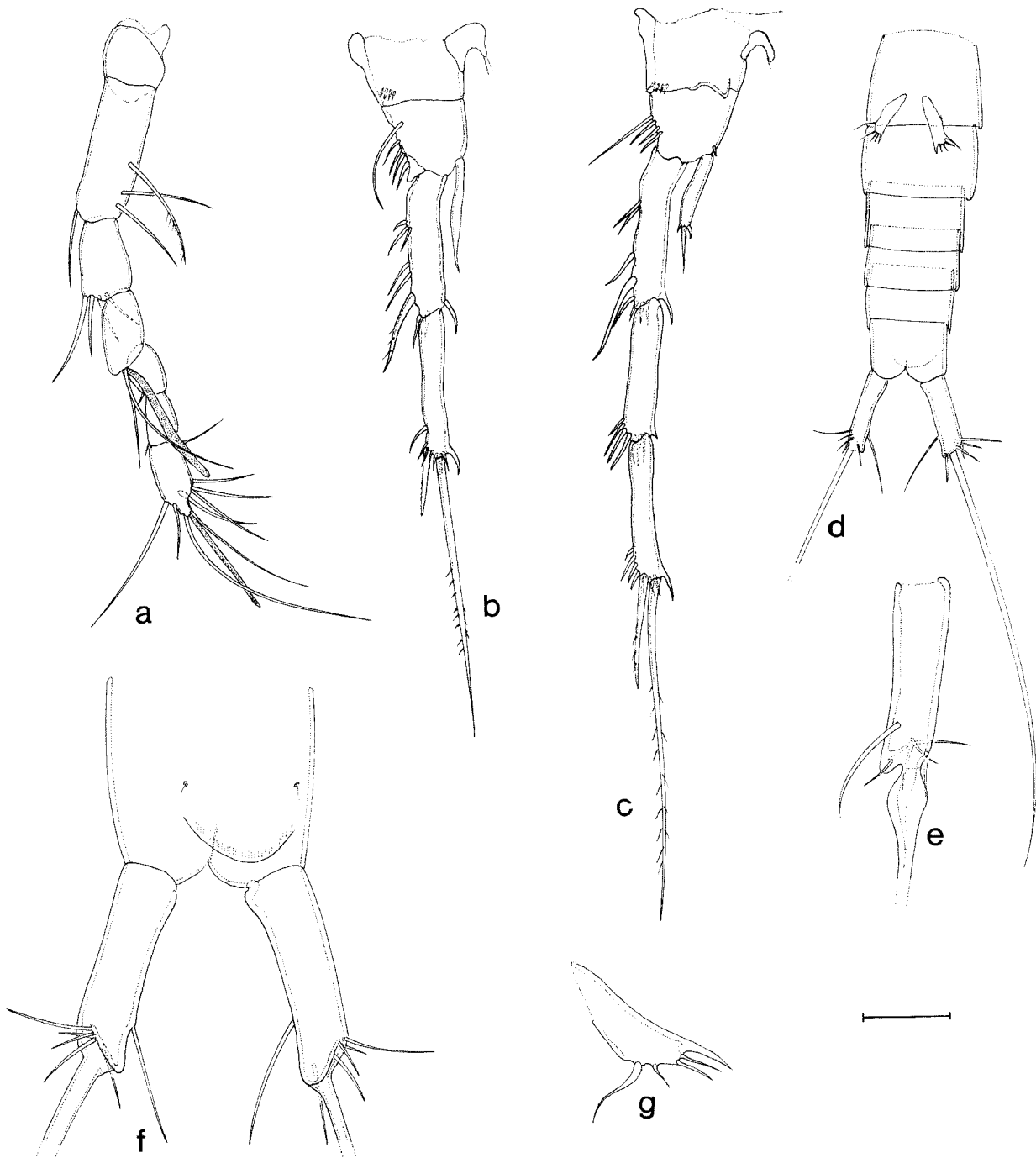


Fig. 6 – *Parastenocaris gertrudae* Kiefer. a, b, c, e, g, h ♀ from Cave Cosmini, Trieste; d, f ♂ from Cave I of Borgnano, Gorizia. a) Antennule ♀; b) leg 3 ♀; c) leg 4 ♀; d) abdomen and caudal rami ♂, ventral view; e) caudal ramus ♀, lateral view; f) anal segment and caudal rami ♂, dorsal view; g) leg 5 ♀. Scale bar: 10 μ m (a-c, g); 15 μ m (e, f); 40 μ m (d).

conductivity = 320 μ S/cm; 2 June 1996, leg. F. et F. Stoch: 1 ♂, 3 ♀♀ (1 ♂ and 1 ♀ dissected and mounted on slide; 2 ♀♀ ethanol-preserved, coll. F. Stoch), together with *P. gertrudae*; Cave "C. Doria" (cadastre number 3875 VG), Borgo Grotta Gigante, province of Trieste, m 275 a.s.l.; in puddles of percolating water; water temperature = 11.4°C,

pH = 8.1, conductivity = 350 μ S/cm; 9 October 1992, leg. S. Dolce et F. Stoch: 1 ♀ (mounted on slide, coll. F. Stoch).

Remarks

The morphology of the specimens in hand agrees perfectly with the description given by Kiefer (1968).

The females from the cave named "Grotta dei Ciclami" have the inner terminal seta of caudal ramus slightly enlarged ("*phyllophora*"-type: see also Kiefer, 1968).

Janetzky, Enderle et Noodt (1996) synonymized *P. phyllophora* Noodt, 1954 with *P. italica*. Unfortunately, Noodt (1954) based his description of *P. phyllophora* on three females collected in a Turkish lake, and the absence of males in the sample prevents any further consideration on the taxonomic status of this species. The same consideration applies to the specimens reported as *P. phyllophora* by Petkovski (1959) and the similar *P. jeanneli* Chappuis, 1924. On the contrary, the Italian material of *P. phyllophora* described by Noodt (1955) should be attributed to *P. italica* (Chappuis, 1957, 1958; Kiefer, 1968; see also Cottarelli, 1972). The discovery of the three females with inner terminal caudal setae of the "*phyllophora*"-type in the cave "Grotta dei Ciclami", together with a typical *P. italica* male, gives further support to this hypothesis.

Jacobi (1972) ascribed *P. phyllophora* to the genus *Fontinalicaris* and *P. italica* to the genus *Italicocaris*. Martínez Arbizu (1997), in his phylogenetic analysis of the *P. fontinalis*-group, suggested that *P. phyllophora* is quite unrelated to this group. Considering that the unique description of the male of *P. phyllophora*, reported by Noodt (1955), should be referred to *P. italica*, Jacobi's (1972) proposal must be rejected.

The affinities of *P. italica* will be discussed together with *P. gertrudae* (see below).

Habitat and distribution

P. italica is fairly common in interstitial groundwaters of Italian rivers and streams, where it is one of the dominant species of meiofaunal assemblages (Chappuis, 1954, 1954a; Kiefer, 1963, 1968; Vesentini, 1960; Ferrarese et Sambugar, 1976; Maiolini et Marchetti, 1978), and in lake shores of Central Italy (Cottarelli, 1972; Cottarelli et Drigo, 1973; Cottarelli et Maiolini, 1980). The discovery of *P. italica* in the Karst near Trieste is the first record of the species from caves.

Parastenocaris gertrudae Kiefer, 1968

(Figs. 2-3)

Parastenocaris gertrudae: Kiefer, 1968: 193

Parastenocaris sp. (partim): Gasparo, 1995: 24.

Material examined

Italy: Cave I near Borgnano (also known as "Grotta di Medea" or "Tane de Volp", cadastre number 36bis Fr), Medea Hill, province of Gorizia, m 63 a.s.l.; vadose zone, in

very small puddles of percolating water (100 cc collected at all); water temperature = 16.9°C, pH = 8.8, conductivity = 360 µS/cm; 29 May 1996, leg. F. Stoch: 3♂♂, 2♀♀ (partly dissected and mounted on slides, partly ethanol preserved, coll. F. Stoch). Cave named "Grotta dei Ciclami" (cadastre number 2433 VG), Ferneti, province of Trieste, m 323 a.s.l.; vadose zone, in very small puddles of percolating water on stalagmites (25 cc collected at all); water temperature = 9.9°C, pH = 8.5, conductivity = 320 µS/cm; 2 June 1996, leg. F. et F. Stoch: 1♀, 1 copepodid♀ (ethanol-preserved, coll. F. Stoch), together with *P. italica*; Cave near Samatorza (also known as "Grotta Cosmini" or "Spelonca del Ferro", cadastre number 561 VG), Samatorza, province of Trieste, m 238 a.s.l.; vadose zone, in small puddles of percolating water; 1 July 1990, leg. F. Gasparo, 1♀ (dissected and mounted on slide in Faure's medium, coll. F. Stoch).

Slovenia: Cave named "Pajzarieva Jama" (Slovenian cadastre number 115), Vrhnika, NW of Ljubljana, m 310 s.l.m.; amphibian zone, subterranean brook; 8 May 1994, leg. F. Gasparo, 1♀ (completely dissected and mounted on slide in Faure's medium, coll. F. Stoch).

Male

Length, excluding caudal setae, 350-370 µm (some specimens telescoped). Cephalothorax and abdominal somites 1-4 with dorsal "windows" (Fig. 5 k); anal somite as in Figs. 5 k and 6 d, f; operculum convex. Caudal rami about 4.1 times longer than wide (Fig. 6f), set broadly apart, as long as or longer than anal somite, bearing 7 setae; a distal sclerotized tooth, wide and blunt, is present on the dorsal side of caudal ramus. The anterolateral caudal setae are inserted in the distal third of caudal ramus; inner terminal seta (V) 5 times longer than caudal ramus (Fig. 6d).

Antennule (Fig. 5a) geniculate, 8-segmented; neocopepodan distal geniculation between segments 6 and 7; segments 5 and 8 bearing aesthetascs; aesthetasc of segment 5 spatulated. Segments with number of setae and aesthetascs (Ae) in brackets: 1 [0], 2 [6], 3 [4], 4 [2], 5 [4 + 1 Ae], 6 [0], 7 [0], 8 [9 + 1 Ae].

Antenna as in Fig. 5b, with 1-segmented exopod bearing 1 seta.

Mandible and maxillule as in *P. federici* n. sp.; maxilla as in Fig. 5c; maxilliped (Fig. 5d) prehensile and slender, syncoxa and basis without ornamentation, endopodal claw with hairs.

Exopods of swimming legs 1, 2 and 4 3-segmented; armature of coxae and exopods as in Figs. 5e, f, g. Leg 1 (Fig. 5e): basis without inner seta; endopod with segment 1 bearing 1 inner seta accompanied by a long spinule; segment 2 with rows of tiny spinules along outer and distal margins. Leg 2 (Fig. 5f): basis without inner seta, with a row of spinules on outer margin; endopod 1-segmented, cylindrical, about 1/2 length of

exopod segment 1, with 3 short terminal spinules and 1 seta. Leg 3 (Fig. 5h, i): coxa unarmed; basis armed with a curved row of spinules along lateral half of distal margin, 1 very long outer seta, and a short, stout endopodal seta; exopod with inner margin smooth, without knobs or humps; outer margin armed with 2 rows of spinules; distolateral hyaline thumb narrow and sharp, 2.3 times longer than mediolateral extension of exopod; mediolateral extension sclerotized, distal part rounded. Leg 4 (Fig. 5g): basis with outer margin armed with a row of spinules and 1 seta; endopod 1-segmented, shorter than exopod segment 1, with 1 terminal seta accompanied by 2 small spinules. Leg 5 (Fig. 5j): subtriangular, with 1 distomedial spiniform projection and 4 setae.

Female

Length, excluding caudal setae, 350-360 μm (some specimens telescoped). Abdominal somites and caudal rami as in Fig. 6d). Anal somite and anal operculum as in male. Caudal rami slender (3.8 times longer than wide), without pointed distal sclerotized tooth. Caudal setae as in male; dorsal seta nearly as long as furcal rami or slightly shorter. Inner terminal seta (V) in some specimens proximally dilated (Fig. 6e).

Antennule (Fig. 6a) 7-segmented; segments with number of setae and aesthetascs (Ae) in brackets: 1 [0], 2 [4], 3 [4], 4[2 + 1 Ae], 5[1], 6[1], 7[9 + 1 Ae].

Antenna, mouthparts, maxilliped, leg 1 and exopods of leg 2 and 4 as in male.

Leg 3 (Fig. 6b): basis with outer margin bearing 1 seta, 1 row of spinules and 1 sclerotized thorn; exopod 2-segmented; endopod 1-segmented, spiniform, shorter than exopod segment 1, without ornamentation. Leg 4 (Fig. 6c): basis with outer margin bearing 1 seta and 1 row of spinules; 1 spinule may be present near endopod articulation; endopod 1-segmented, shorter than exopod segment 1, with 1 terminal seta and a row of spinules. Leg 5 (Fig. 6g) bearing 1 distomedial thorn and 4 setae.

Remarks

The specimens examined agree with the original description given by Kiefer (1968). *P. gertrudae* Kiefer is similar to *P. italica* and *P. entzii* Török, 1935; closely related species are probably *P. similis* Török, 1935 (including *P. similis macedonica* Petkovski, 1959) and *P. banatica* Damian, 1957. *P. gertrudae* and *P. italica* share the structure of male leg 3 (without inner knob and hump) and the absence of the spinulae near the insertion of the endopod on male leg 4 basis; these features are probably similar in *P. entzii*, *P. similis* and *P. banatica* as well, but the drawings accompanying their original descriptions are very poor and some fine morpho-

logical details (such as the absence of the spinular row on leg 4 basis) need to be verified.

The species mentioned above belong to what Martínez Arbizu (1997) calls Parastenocaridinae, in which the anterolateral setae are inserted in the distal third of caudal ramus. However, the inclusion of these species in one of the species-groups established within the genus *Parastenocaris* is quite difficult. Lang (1948) included *P. entzii* and *P. similis* in the *P. fontinalis* - group, but Martínez Arbizu (1997) rejected this hypothesis; Jacobi (1972) attributed *P. italica* to the genus *Italocaris*, *P. entzii* to the genus *Entzicaris* and did not mention *P. gertrudae* and *P. similis*. The apomorphic structure of male leg 3 and leg 4 shared by *P. italica* and *P. gertrudae* suggests that they might form a distinct monophyletic unit within the genus *Parastenocaris*; their inclusion, together with *P. entzii*, *P. similis* and perhaps *P. banatica* in a new species group, requires a careful redescription of all these taxa.

Habitat and distribution

P. gertrudae Kiefer was discovered in the interstitial groundwaters of some Italian rivers and brooks (Kiefer, 1968): river Oglio near Iseo lake; torrent Revolto in the Lessinian Mountains (Dussart et Defaye, 1990, erroneously reported "river Adige near Zevio" as type locality).

With the discovery of *P. gertrudae* in Venezia Giulia and Slovenia the known range of the species is extended significantly eastward. In this karstic areas *P. gertrudae* inhabits small puddles of percolating water and subterranean brooks.

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