



Description of *Parastenocaris amalasuntae* n. sp. and new data on *Parastenocaris proserpina* and *Parastenocaris pasquinii* from subterranean waters of central Italy (Copepoda, Harpacticoida)

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ABSTRACT

This work concerns the description of *Parastenocaris amalasuntae* n. sp., the redescription of *Parastenocaris proserpina*, and the addition of new morphological features for *Parastenocaris pasquinii*. The characters have been detected using light and scanning electron microscopy. *Parastenocaris amalasuntae* has been collected in the interstitial psammal of Bolsena Lake (Latium), in hyporheic and groundwaters of northern Latium, and in phreatic habitats of southern Tuscany. The species belongs to the *proserpina* species group Lang, 1948 and shows the closest affinities with *P. proserpina*. This last species had previously been collected in Bolsena Lake, where nowadays it seems to have been substituted by *P. amalasuntae*. Updated information on the distribution and ecology of the three species is also presented and discussed.

KEY WORDS: Parastenocarididae - Psammon - Hyporheos - Systematics - Geonemy.

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INTRODUCTION

Researches concerning species of the genus *Parastenocaris* Kessler 1913, from the subterranean waters of central Italy have led to the discovery and the description of several species new for science (Cottarelli, 1969, 1972; Cottarelli & Drigo, 1972; Cottarelli & Torrisi, 1976; Cottarelli & Maiolini, 1980; Cottarelli *et al.*, 1995; Pesce *et al.*, 1995), and to the study of some aspects of the biology, geonemy, and ecology of these taxa (Bruno *et al.*, 1996). In this work we present and discuss new data from recent field research concerning species of this genus collected in psammolittoral waters of volcanic lakes of Latium and in hyporheic and subterranean waters of northern Latium and southern Tuscany.

We will describe and discuss a new species, *Parastenocaris amalasuntae* n. sp. which is morphologically and taxonomically very close to *P. proserpina* Chappuis, 1938. In this work the latter species is redescribed in detail and, as a result of this analysis, the different populations of *Parastenocaris proserpina* Cottarelli, 1972 have been attributed to this species.

The description of some morphological features of *Parastenocaris pasquinii* Cottarelli, 1972 that have been detected in material collected in Bolsena Lake will be presented in order to correct some mistakes and omissions in the previous description and to give a more precise knowledge of this species.

MATERIAL AND METHODS

Specimens were collected using the Karaman-Chappuis method (Delamare Deboutteville, 1960), fixed in 5% buffered formalin and mounted in permanent slides with Faure's medium. They were drawn at 1250 \times , with an oil immersion lens, using a drawing tube mounted on a Zeiss Axioskop[®] phase contrast microscope.

For scanning electron microscopy, some specimens fixed for 24 hours in 10% formalin were washed twice in cacodylate buffer, pH 7.2, post-fixed in 1% osmium tetroxide in the same buffer, dehydrated in a graded ethanol series, critical-point-dried in a Balzers Union[®] CPD 020 apparatus, and coated with gold in a Balzers Union[®] MED 010 sputter coater. Observations were performed with a 1200 JEOL JEM[®] EX II scanning electron microscope.

The following abbreviations are used, when required, throughout the text and figures: A1 = antennula; A2 = antenna; Bsp = basipodite; Enp = endopodite; Exp = exopodite; Fu = furcal rami; Ga = genital field; Gsg = genital somite; Md = mandible; Mx = maxilla; Mxl = maxillula; Mxp = maxilliped; Op = anal operculum; P1-P5 = thoracic appendages; R = rostrum.

The nomenclature and descriptive terminology follow Dussart & Defaye (1995), Huys & Boxshall (1991), and Giere (1993).

The holotype and one female paratype will be deposited in the collection of the Museo Civico di Storia Naturale G. Doria, Genoa (Italy); the material of the type series is deposited at the "Dipartimento di Scienze Ambientali, Università della Tuscia", Viterbo (collection of the senior author).

TAXONOMIC ACCOUNT

Family PARASTENOCARIDIDAE Chappuis, 1933

Genus *Parastenocaris* Kessler, 1913*Parastenocaris amalasuntae* n. sp.*Material*

Holotype: 1 male, M. C. Bruno leg., 24-05-1994, beach on Bolsena Lake, about 2 km north-west from Capodimonte Village, dissected and mounted on a slide labelled: Capodimonte, Lago di Bolsena - *Parastenocaris amalasuntae* ht. Paratypes: 25 males and 25 females, M. C. Bruno leg., same date and place, mounted on slides labelled: Capodimonte, Lago di Bolsena - *Parastenocaris amalasuntae* pt.; 5 males and 5 females, prepared for scanning electron microscopy, on a stub labelled: Capodimonte, Lago di Bolsena - *Parastenocaris amalasuntae*, males and females pt.

Many more specimens have been collected in different times from January 1995 to June 1996 from the *locus typicus* and in the following sampling stations: Bolsena Lake: near Marta, Bolsena, Capodimonte, psammolittoral habitat (M. C. Bruno leg.); Fiora River, near Sovana (Grosseto) and Vulci (Viterbo), hyporheic and groundwater habitats (V. E. Cottarelli & L. Ciampicali leg.); Manciano-Farnese Road, km 7 (Grosseto), well (V. Cottarelli & A. L. Santacroce leg.).

Description of the holotype

Body cylindrical and elongate, unpigmented, eyeless; length from rostrum to distal apex of furcal rami: 0.404 mm. Cephalosome and first four abdominal somites (Fig. 1B) with dorsal hyaline integumental windows. Spermatophore as in Figure 1F. Anal operculum (Figs 1B, 1D): distal margin smooth and slightly concave, with ventral row of spinules parallel to margin.

Furcal rami (Figs 1B, 1D): shorter than last abdominal somite; length to width ratio: 2.3. Armature consisting of three setae of different lengths inserted at about 1/3 of the lateral outer margin, a pennate and a composite setae subapically on the dorsal margin, and a main long apical seta flanked by a shorter ventral one.

Rostrum and antennule (Fig. 1G): rostrum as in Figure. A1: first segment bare, second segment with six distal setae, one of which is plumose. Third segment with five apical setae. Fourth segment very enlarged, with three distal setae and an aesthetasc. Fifth segment partially merged with the previous one, with no armature, sixth segment also naked. Seventh segment with seven setae and an aesthetasc.

Antenna (Fig. 2E): one-segmented exopodite with an apical seta, allobasipodite with two rows of cuticular spinules. Endopodite bearing distally two geniculate, two normal, and one transformed setae. Remaining ornamentation as in Figure.

Mandible (Fig. 2A): one-segmented palp, with two distal setae.

Maxillule (Fig. 2B): arthrite of the praecoxopodite with five slightly curved apical spines, and curved seta inserted at about half length of arthrite. Coxopodite with a distal seta, basipodite with two apical setae.

Maxilla (Fig. 2C): syncoxopodite with two endites, one bears a normal and a flattened seta, the other one a normal seta. Basipodite prolonged in an apical curved

and spinulose tip accompanied by a seta. Endopodite reduced to a small tubercle with two setae.

Maxilliped (Fig. 2D): slim and elongate; basipodite unarmed, last segment with a long, curved, pennate apical spine.

P1 (Fig. 2I): exopodite three-segmented, as long as the endopodite. Third segment with four distal setae, two of which are geniculate. Endopodite two-segmented, second segment with a long geniculate seta and a barbed simple seta on the apex.

P2 (Fig. 2N): basipodite without outer seta. Exopodite three-segmented, armature shown in Figure. Endopodite reaching 2/3 of exp-1, represented by a small cylindrical segment, with three spinules at about 2/3 of the length, and two apical spines and one apical seta.

P3 (Fig. 1C): squat, basipodite with one seta at about midlength of the lateral margin with a row of spinules near it. Endopodite reduced to a small spine. Exp-1 with two sharpened tubercles about midlength of the medial margin, ending in a finger-like apophysis with a short terminal spine. Exp-2 represented by a leaf-like appendix much longer than the apophysis itself.

P4 (Fig. 3C): exopodite three-segmented, chaetotaxy as shown in Figure. Endopodite as long as the first segment of exp-1, which is represented by an apically acute appendix, with denticles along the lateral margins. Other denticles are inserted near the segment origin. Between the exopodite and the endopodite, a stout curved seta, as long as the endopodite.

P5 (Fig. 2H): elongated, triangular plate, with a row of spines of increasing length on medial margin, and two short and one long setae on the lateral margin. A pore near the proximalmost seta.

Description of the male paratype

Some of the features described for the holotype have been checked in the five male paratypes with SEM:

Habitus as in Figure 7A.

Furcal rami (Fig. 7F): with a pore near the main apical seta.

P1: basipodite with a row of spinules between exopodite and endopodite (Fig. 7C, arrow), a pore near the exopodite insertion on the lateral side (Fig. 7C); similar pores present in the same position on P2, P3 and P4 (Fig. 7E). Near the endopodite insertion of both males and females, on the inner side, a row of spinules (Fig. 7C, asterisk): the sexual dimorphism described for other species of this genus does not exist in this case. Further details on the first segment of endopodite are shown in Figure 8C.

P2: basipodite as in Figure 7D.

P3: outer side of the basipodite as in Figure 7G; distal part of the leg as in Figure 7B.

Description of the female paratype

Length: 0.410 mm. Rostrum (Fig. 1A), antenna, oral appendages, maxilliped, P1, P2 and P4 exopodites, anal operculum (Fig. 1E), cephalic and dorsal windows (Fig. 1E), as in the male.

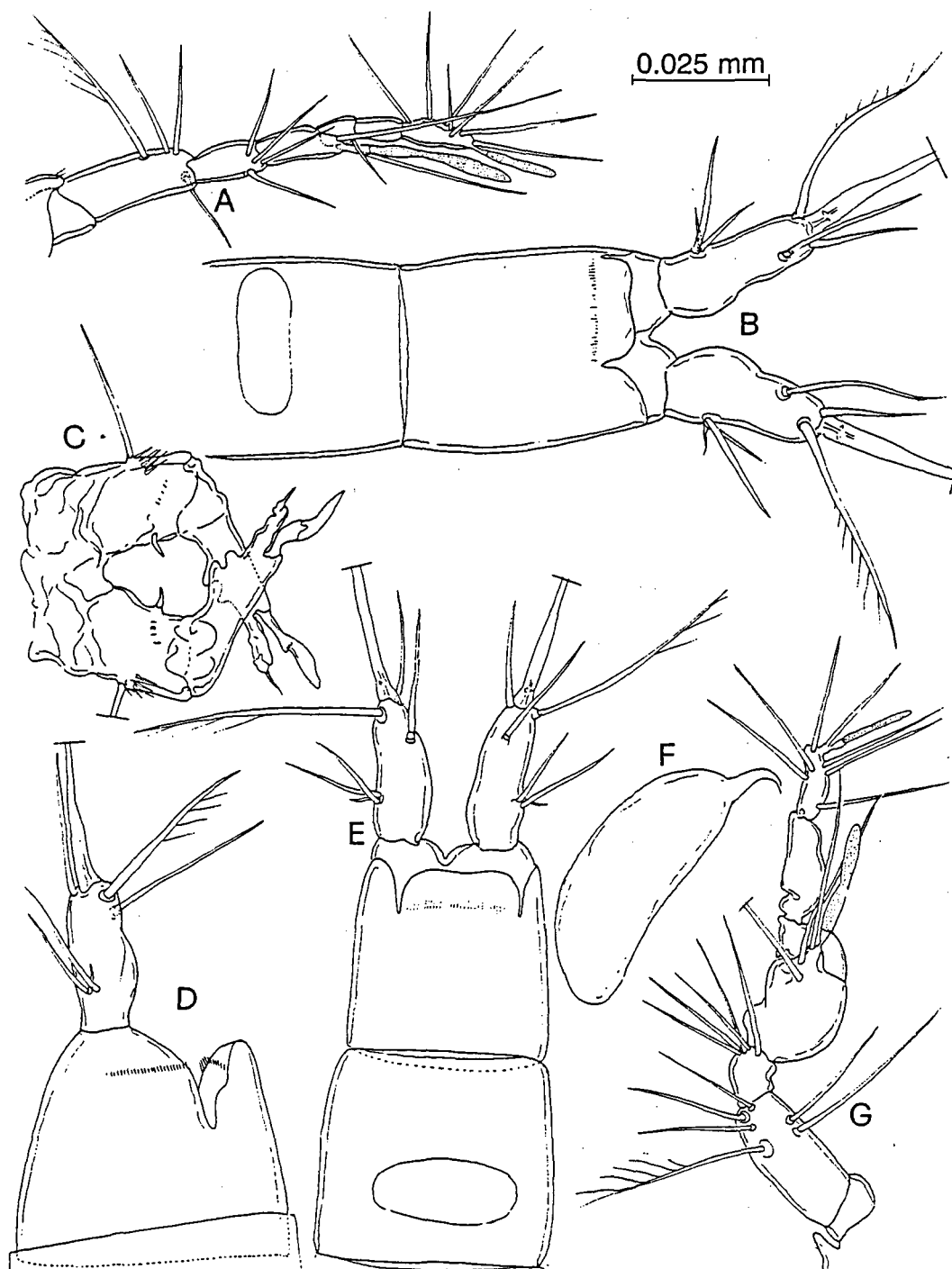


Fig. 1 - *Parastenocaris amalasuntae* n. sp. Holotype: B, Fu and Op, dorsal view, and abdominal somite with dorsal window; C, P3; D, Fu and Op, lateral view; F, spermatophore; G, A1 and R. Paratype female: A, A1 and R; E, Fu and Op, dorsal view, and abdominal somite with dorsal window.

Furcal rami (Fig. 1E): similar to those of the male one but a little longer.

Antennule (Fig. 1A): seven-segmented, segment 2 with four composite, one plumose setae; third segment with four distal setae. Fourth segment with two distal setae and an aesthetasc. Seventh segment with an aesthetasc and seven setae.

P2 endopodite (Fig. 2F): similar to that of the male.

P3 (Fig. 2M): endopodite represented by a small

cylinder with an apical spine, almost as long as $1/3$ of the exp-1, which is armed as in Figure.

P4 (fig 2L): endopodite a little shorter than exp-1, represented by a cylindrical segment with some subapical spinules and a barbed apical seta.

P5 (Fig. 2G): similar to that of the male, but wider and longer and without spines on the inner margin.

Some of the features described for the paratype have been checked in the five female specimens with SEM:



Fig. 2 - *Parastenocaris amalasuntae* n. sp. Holotype: A, Md; B, Mxl; C, Mx; D, Mxp; E, A2; H, P5; I, P1; N, P2. Paratype female: F, Enp P2; G, P5; L, P4; M, P3.

Habitus and cephalic window as in Figure 9E.

Dorsal windows as in Figure 8A.

Genital field as in Figure 9C.

Anal operculum as in Figure 9A.

Furcal rami (Fig. 9D): with a pore near the main apical seta.

Rostrum with one pore on each side (Fig. 8B).

Antennule as in Figure 9B.

P5 as in Figure 8D.

Variability

The features described above appeared to be constant in all the specimens of the type series, with the following exceptions:

– the furcal rami in some female specimens from Bolsena are transformed in a small conical appendix (Fig. 3H), flattened and with fewer and smaller setae; there are also some intermediate shapes between the “normal” furcal rami and the transformed ones (Fig. 8E);

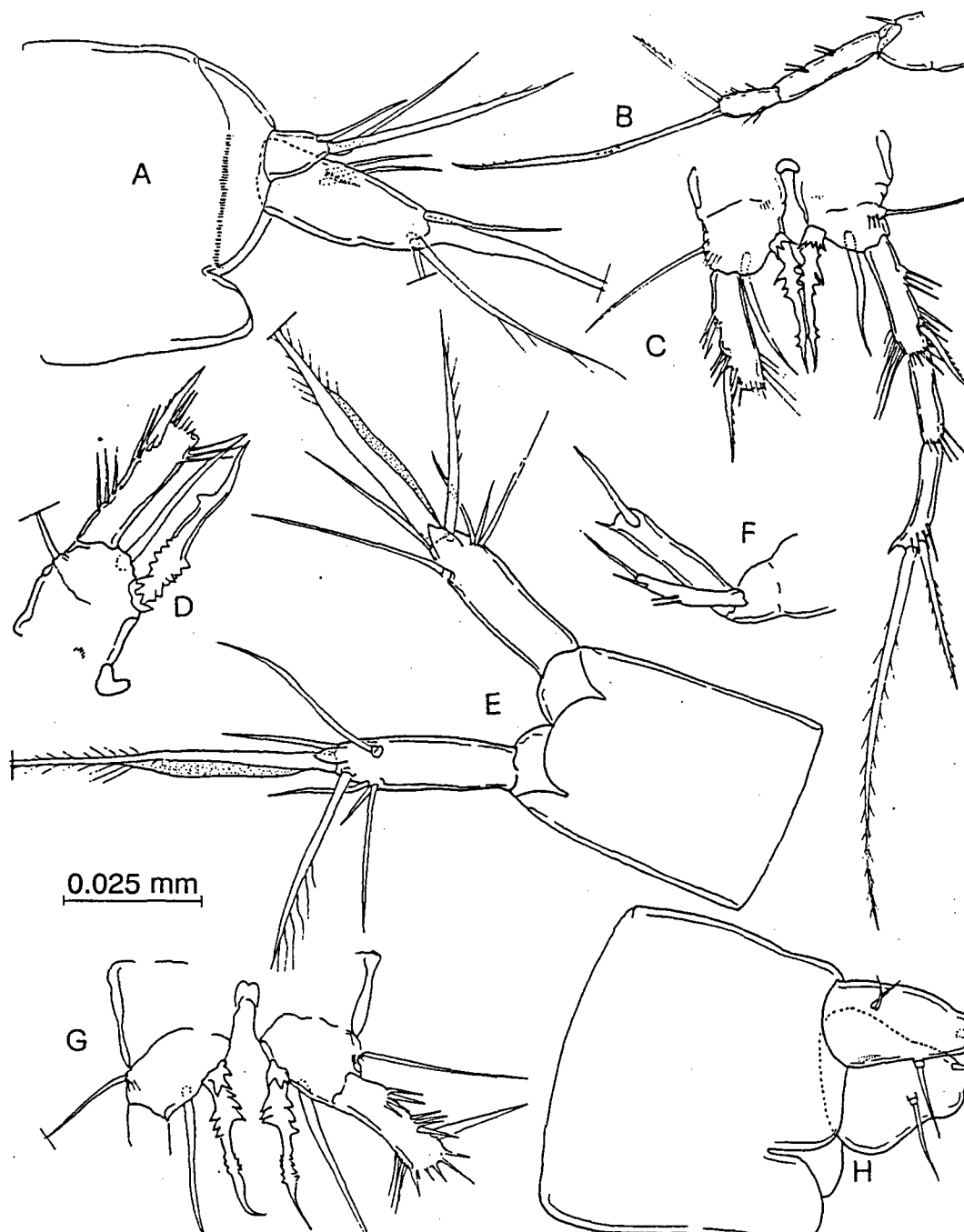


Fig. 3 - *Parastenocaris amalasuntae* n. sp. Holotype: C, P4. Paratype male: A, aberrant Fu, lateral view, Bolsena Lake, Marta; D, Enp P4, Fiora River, Sovana; G, Enp P4, Fiora River, Vulci. Paratype female: F, Enp P2, Fiora River, Vulci; H, Fu, lateral view, Bolsena Lake. *Parastenocaris pasquinii*. Male: B, Enp P1. Female: E, Fu and Op, dorsal view.

a similar kind of transformation was described by Cottarelli *et al.* (1980) for *P. admete* and is also present in *P. proserpina*. In Bolsena Lake (Marta) an aberrant male has also been collected, with the left furcal ramus (Fig. 3A) reduced to a small appendix with three short setae;

– in the P4 endopodite of the male the dimension, number and position of the denticles between the different populations can vary (Fig. 3G, from Vulci), partic-

ularly in the specimens from Sovana, that seem to be larger than the males of other populations (Fig. 3D);

– the P2 endopodite has a variable number of spines: in females the number of apical spines varies from two to four (Fig. 3F from Vulci, Fig. 8G from Bolsena); in males, there are three lateral spines in a specimen from Bolsena (Fig. 9F);

– a female from Bolsena has a P3 endopodite with four distal spines (Fig. 8F).

Taxonomic affinities

Because of the peculiar structure of the P4 endopodite of the male, the new taxon belongs to the species group *proserpina* Kunz, 1938. This group is represented in peninsular Italy by *P. proserpina* Chappuis, 1938, in Sardinia by *P. admete* Cottarelli *et al.*, 1980 and *P. ima* Cottarelli, 1989; and in Sicily by *P. kalypto* Pesce *et al.*, 1988. *Parastenocaris amalasuntae* n. sp. is most similar to *P. proserpina*.

If the morphology and ornamentation of the P3 and P4 endopodite of the male (that are the features used to detect the affinities between the different species of *Parastenocaris*), are considered, the new species P3 resembles that of *P. proserpina*. Nevertheless, this appendix is stouter and larger in *P. proserpina* (see Figs 1C, 4H), the endopodite differs in length and shape, and the tubercles on the inner margin of the exopodite are inserted differently (see Figs 7B, 10B). In *P. amalasuntae* n. sp. the peculiar P4 endopodite of the male, which is long, acute, denticulated and at least as long as the first segment of the corresponding exopod, resembles more to P4 of *P. kalypto*, which differs from the new species in the morphology and ornamentation of P3. The P4 endopodite is very different in *P. ima* and also in *P. proserpina* (see Fig. 4E). It is useful to emphasize that even if *P. amalasuntae* n. sp. and *P. proserpina* are quite similar in several morphological and ecological features and have been collected in neighbouring or even the same sampling stations, they differ in those features related to the mating behaviour of males (P3, P4 endopodite). These apomorphies could be very useful to avoid inbreeding between syntopic species.

The furcal rami are similar to those of *P. proserpina* in both morphology and ornamentation. *P. admete* differs in the shape of both sexes.

As regards other features, all the Italian *Parastenocaris* species belonging to the *proserpina* group are peculiarly convergent, mainly in the morphology of the P5 of both sexes, which is always triangular, with a row of spinules along the internal margin in the males. The P4 endopodite in the females has a different ornamentation but a similar morphology in all these species: it is a long, acute appendix, at least as long as the first segment of the corresponding exopodite.

Derivatio nominis

The species name comes from Gothic Empress Amalasunta, who was killed at Bolsena Lake, on Bisentina Island, near the *locus typicus*.

Parastenocaris proserpina Chappuis, 1938

Material

Many male and female specimens, collected on different dates in May 1996 on Bracciano Lake, near Anguillara, V. Cottarelli leg.

Many other specimens were collected at different dates from 1970 to 1996, at the following localities: Basento River, Apulian, hyporheic habitat; Calore River, Basilicata, hyporheic habitat; Sele River, Campania, groundwater habitat; Varano Lagoon, Apulian, psammolittoral habitat; Volturno River, Campania, groundwater habitat; Garigliano River, Latium, hyporheic and groundwater habitat; Mignone River, Latium, hyporheic habitat; Stream near Sperlonga, Latium, groundwater habitat; Sacco River, Latium, hyporheic habitat; Bracciano Lake, Latium, psammolittoral habitat; Vico Lake, Latium, psammolittoral habitat; Bolsena Lake, Latium, psammolittoral habitat; Cecina River, Tuscany, hyporheic habitat.

Description of the male

A dorsal hyaline integumental window on the cephalosome. A pore near the exopodite insertion on the outer side of P1, P2, P3 (Fig. 10A) and P4.

Anal operculum (Figs 5D, 5G): distal margin slightly concave, with smooth margin.

Furcal rami (Fig. 5D, 5G): shorter than the last abdominal somite; length to width ratio: 0.61. Armature consisting of three setae of different lengths at about 1/3 of the lateral outer margin, a pennate and a composite setae subapically on the dorsal margin, a main long apical seta and a shorter inner one.

Rostrum and antennule (Fig. 5B): rostrum as in Figure. A1: first segment bare, second segment with seven distal setae, one of which is plumose. Third segment with four apical setae. Fourth segment very enlarged, with two setae and a short aesthetasc. Fifth segment partially merged with the previous one, with no armature; sixth segment naked. Seventh segment with six setae and an aesthetasc.

Antenna (Fig. 4D): one-segmented exopodite with a pennate apical seta; allobasipodite with two rows of cuticular spinules on the lateral margin. Endopodite bearing distally two geniculate, two pennate, and one transformed setae. Remaining ornamentation as in Figure.

Mandible (Fig. 4F): one-segmented palp, with two distal setae.

Maxillule (Fig. 4K): arthrite of the praecoxa with four curved distal spines. Coxopodite with a distal seta, basipodite with two apical setae.

Maxilla (Fig. 4J): syncoxopodite with two endites, one with one normal and one leaf-like seta, the other one with one normal seta. Basipodite prolonged in an apically curved, spinulose tip. Endopodite reduced to small tubercle with two setae.

Maxilliped (Fig. 4G): slim and elongate; basipodite unarmed, last segment with a long and slightly curved, pennate apical spine.

P1 (Fig. 4B): basipodite with a narrow outer spine. Exopodite three-segmented, a little shorter than the endopodite. Third segment with four distal setae, two of them are geniculated. Endopodite two-segmented, second segment with two distal setae: one is long, geniculate and one is short and pennate.

P2 (Fig. 4L): basipodite with an outer row of short spinules. Exopodite three-segmented, armature as in Figure. Endopodite reaching 2/3 of exp-1, represented by a small cylindrical segment, with a spinule at about

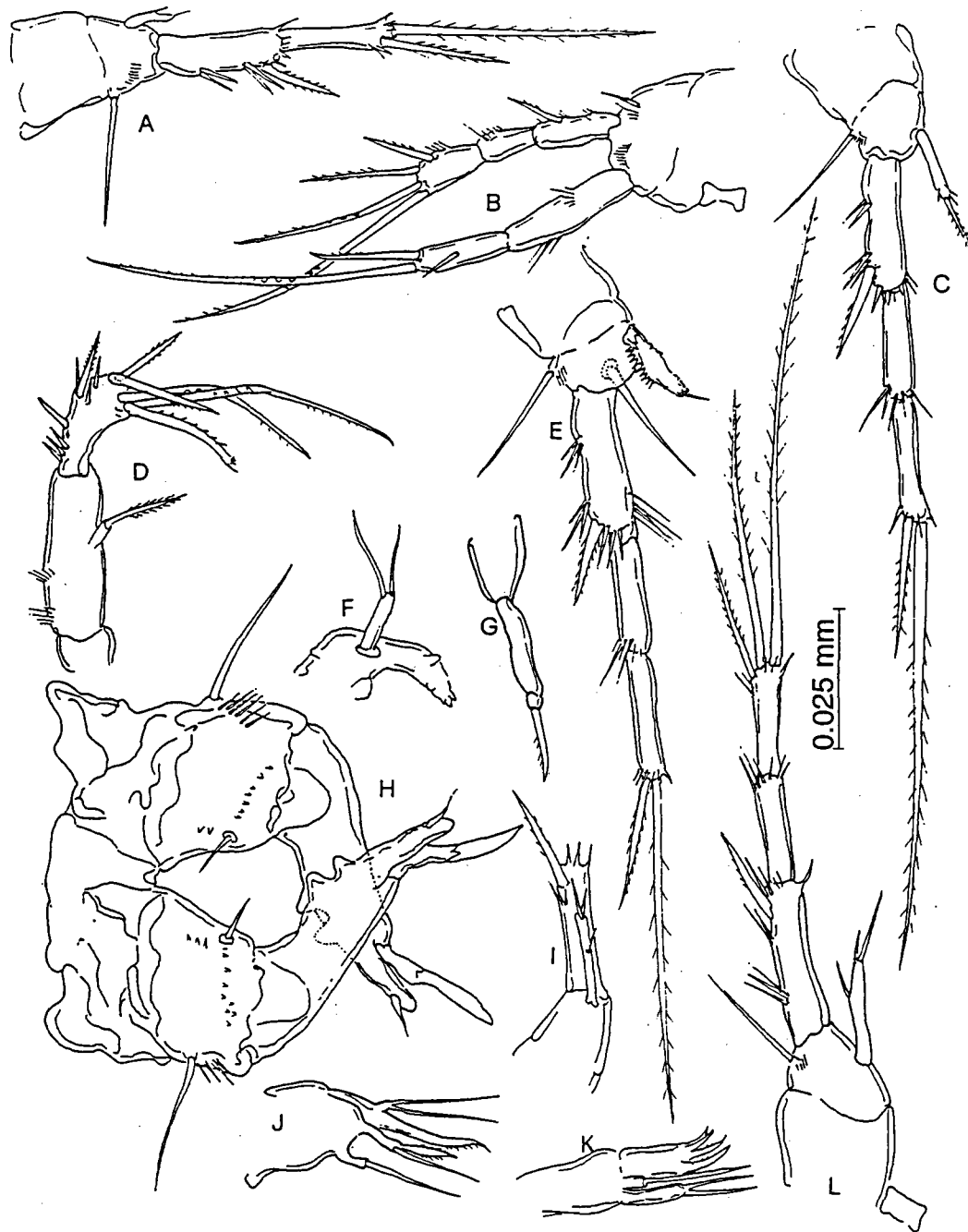


Fig. 4 - *Parastenocaris proserpina*. Male: B, P1; D, A2; E, P4; F, Md; G, Mxp; H, P3; J, Mx; K, Mxl; L, P2. Female: A, P3; C, P4; I, Enp P2.

2/3 of the margin, and a spinule and one seta on the apex.

P3 (Figs 4H, 10A): squat, basipodite with one seta at about midlength of the medial margin and a row of spinules and a pore close to it. Endopodite reduced to a small spine, with a row of small teeth near its insertion. Exp-1 with one sharpened and one rounded teeth, not aligned on about half of the lateral inner margin (Fig. 10B), ending in a distal rounded apophysis, with a terminal short spine.

Exp-2 represented by a distal leaf-like appendix,

longer than the apophysis itself.

P4 (Fig. 4E): exopodite three-segmented, chaetotaxy as in Figure. Endopodite about half length of exp-1, represented by a cylindrical curved segment with rows of short teeth inserted transversely near the origin and along the lateral margins. Other short teeth on the apex, near the origin of a narrow seta. Between the exopodite and the endopodite, a strong curved seta, slightly longer than the first segment of the corresponding endopodite.

P5 (Fig. 5C): a plate of pointed, triangular shape, with a row of spines on the lateral inner margin, two short

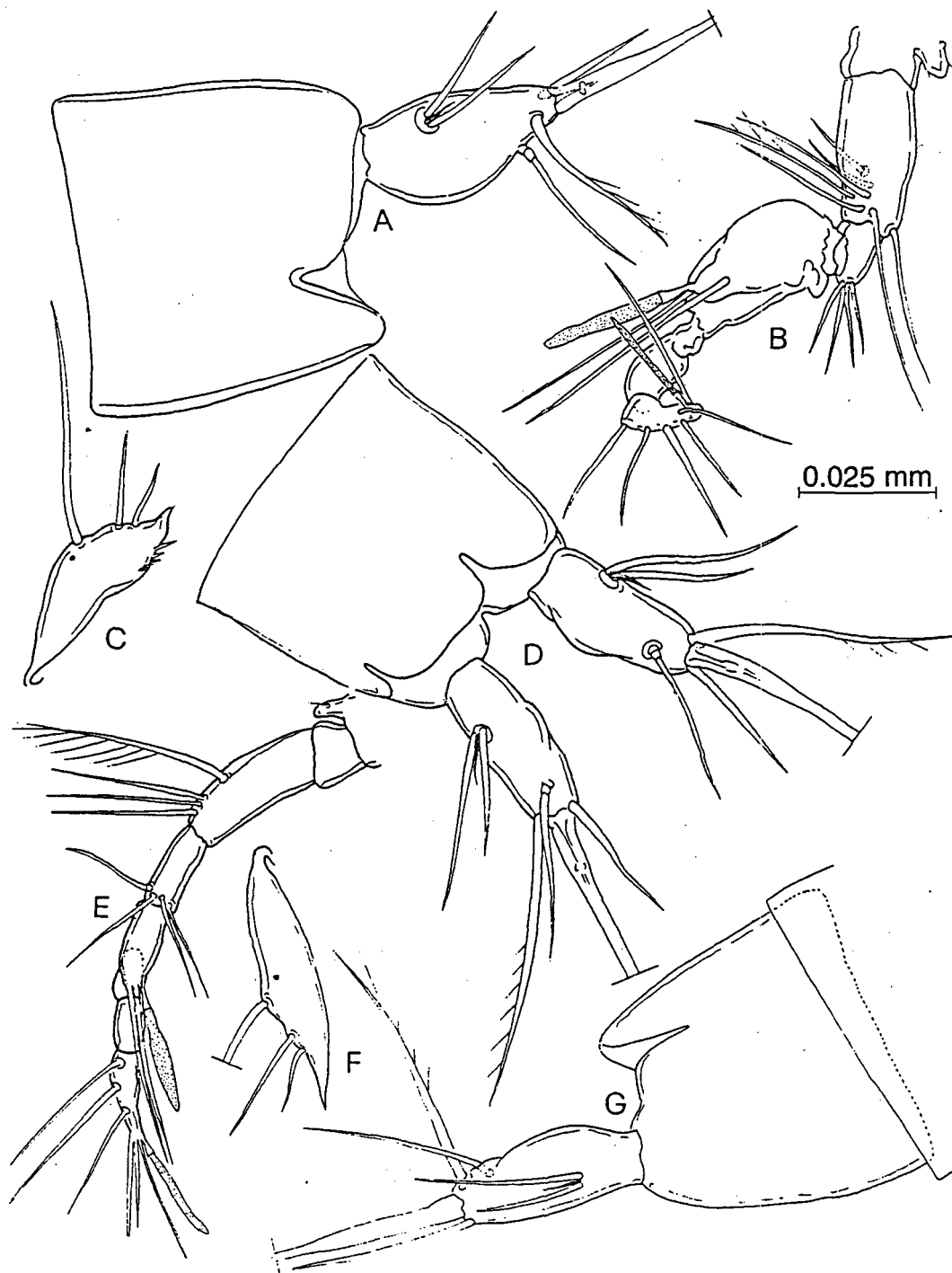


Fig. 5 - *Parastenocaris proserpina*. Male: B, A1 and R; C, P5; D, Fu and Op, dorsal view; G, Fu and Op, lateral view. Female: A, Fu and Op, lateral view; E, A1 and R; F, P5.

and one long seta on the lateral outer margin. A pore near the main seta.

Description of the female

Cephalic window, rostrum (Fig. 5E), antenna, oral appendages, maxilliped, P1, P2 and P4 exopodite, anal operculum (Fig. 5A), as in the male.

Furcal rami (Fig. 5A): shorter and larger than those of

the male, with the same ornamentation; length to width ratio: 1.86.

Antennule (Fig. 5E): seven-segmented, second segment with four composite setae, one plumose; third segment with four distal setae. Fourth segment with two long distal setae and one aesthetasc. Seventh segment with an aesthetasc and six setae.

P2 endopodite (Fig. 4I): similar to that of the male.

P3 (Fig. 4A): endopodite represented by a small cylin-

dricial segment with an apical and a subapical spine, almost as long as 1/4 of exp-1, which is armed as in the Figure.

P4 (Fig. 4C): endopodite almost as long as exp-1, represented by a cylindrical segment with an apical penate spine and small distal spinules.

P5 (Figs 5F, 10F): similar to the that of the male, but thinner and longer and without spines on the inner margin.

Variability

The features described above appeared to be constant in all the specimens examined, with the following exceptions:

- furcal rami of some female specimens from Bracciano Lake are transformed in several ways: they can be flattened, with reduced dimension and ornamentation (Fig. 6F, 6D), or they can be cylindrical (Fig. 10D), or elongated (Fig. 6G);

- in some specimens from Bracciano Lake, endopodite P2 has two spinules and one seta on the apex (Fig. 10C) and two lateral spinules in the male, and two lateral spinules instead of the only one observed by Cottarelli (1972) in the female;

- P3 of the males constant in all the population (Fig. 6A, Cecina River; Fig. 6B, Sele River; Fig. 6C, Volturno River); a female from Bracciano has the endopodite with two apical spines (Fig. 6M);

- in P4 endopodite of the males, the number of the small teeth can vary between the different populations, but this appendix appears different according to the point of view, in any case, the morphology and ornamentation are constant between specimens belonging to the same population (Fig. 6E, Cecina River; Fig. 6H, Sele River; Fig. 6I, Volturno River; Fig. 6L, Calore River).

Taxonomic remarks

Cottarelli (1972) discussed the taxonomic position of the population from Bracciano, Vico and Bolsena Lakes, called *P. prope proserpina*, which needed still to be compared with *P. proserpina* topotypes from Pertosa Cave. Unfortunately, this species has not been collected since in the *locus typicus*, although both Cottarelli and Galassi (pers. comm.) sampled there even recently. The location of the type series is still unknown. In any case the accurate analysis of the many specimens collected in the different sampling stations has allowed us to detect how the main taxonomic features (such as the morphology and ornamentation of P3 and P4 in the males) vary in a continuous way or do not vary at all between the populations and correspond to the description of Chappuis (1938). Some of the differences detected by Cottarelli (1972) (such as the ornamentation of P2 endopodite in both sexes and of P3 and P4 endopodites in the females) are explainable as inter-population variability. Concerning the P5, the description given here corresponds to the original one for the females, while

for males the observation of only one seta on the medial margin by Chappuis could have been an imprecise observation. On the other hand, the number of short setae on this margin seems to vary in a continuous way between and within the populations that we have studied. Chappuis could also have described a specimen with only one seta just by chance. We want to emphasize that all the Italian species belonging to the *proserpina* group have a row of spinules on the medial margin.

Therefore it is possible to state that the main differences between the original and the new descriptions are: the anal operculum, which, according to Chappuis, should have a convex distal margin, while in most of our specimens it has a slightly concave margin; and the furcal rami, which should have five appendages according to Chappuis and which have six appendages in all our specimens. As regards the anal operculum, the shape of the margin for some of our specimens is similar to the description of Chappuis; as regards the furcal rami, the missing seta is the composite one on the dorsal margin and it is always present in all our specimens, except those with reduced furcal rami; this seta is long but thin and fragile and for this reason it can be lost in the manipulation of the specimens. In any case, this difference alone does not seem to us sufficient to discriminate the *Parastenocaris* that we have studied from *Parastenocaris proserpina*.

Parastenocaris pasquinii Cottarelli, 1972

Material

Many specimens, collected on different dates from January 1995 to June 1996 from Bolsena Lake near Marta, Bolsena, Capodimonte, interstitial habitats (M.C. Bruno leg.). Many other specimens have been collected in different dates from 1970 to 1996, at the following localities: Bracciano Lake, Latium, psammolittoral habitat; Bolsena Lake, Latium, psammolittoral habitat.

Additional description of the male

Cephalosome with dorsal hyaline window. Anal operculum (Fig. 10E): with concave distal margin. Furcal rami (Fig. 10E): a secretory pore at the basis of the main apical seta. Maxillule (Fig. 10G): arthrite of the praecoxa with four distally pennate strong spines. Maxilla (Fig. 10G): two endites instead of the one previously reported by Cottarelli (1972). P1 (Figs 3B, 11E): basis with a spine and a hook, both of the same length, near the endopodite insertion, and a secretory pore, also present on the basipodite of all the other pereopods. P4: endopodite as in Figure 11D.

Additional description of the female

Cephalosome with dorsal hyaline window. Anal operculum (Fig. 11A): with straight margin. Furcal rami: (Figs 3E, 11A, 11C): a secretory pore at the basis of the transformed apical seta. Genital field as in Figure 11F.

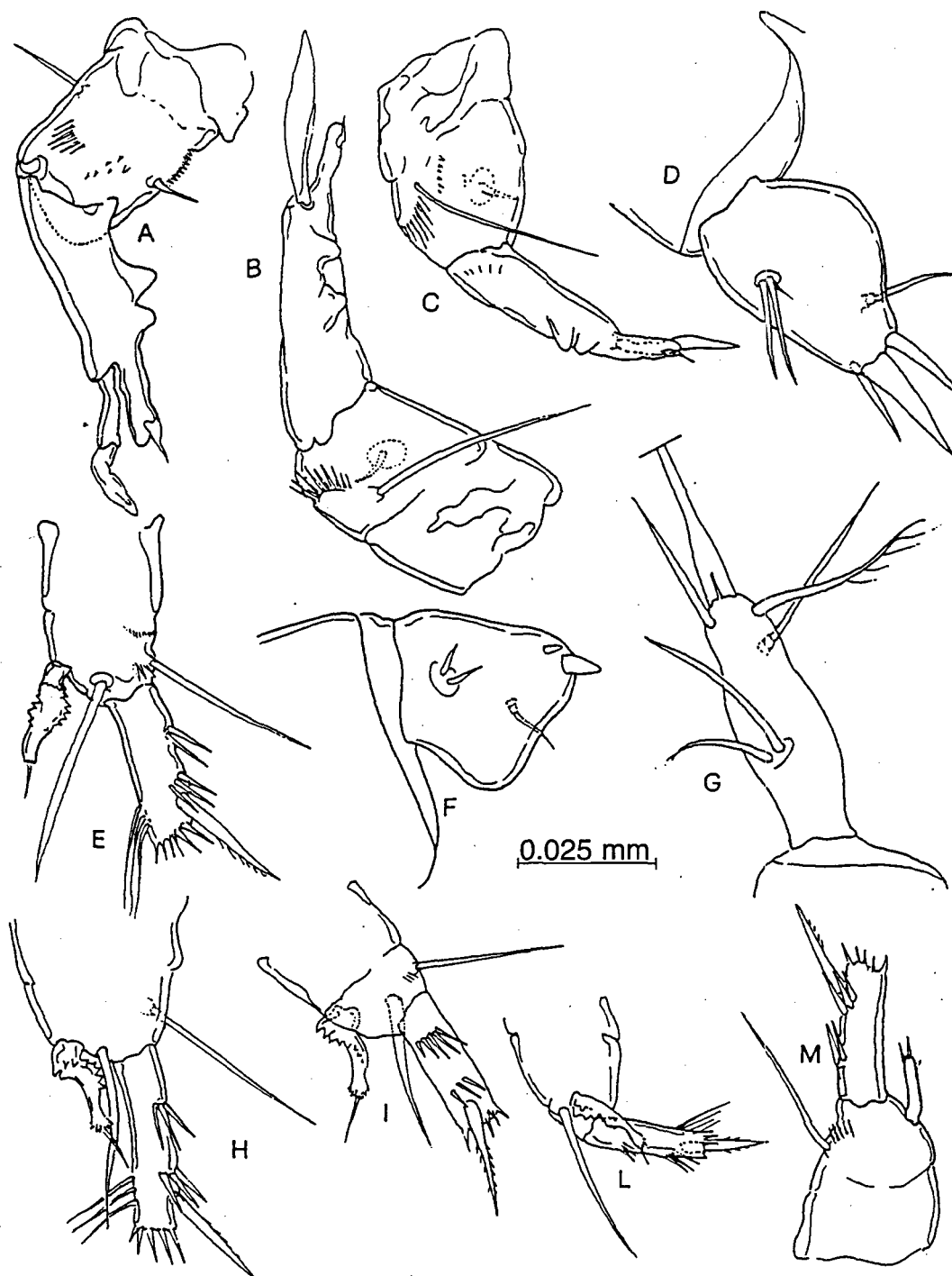


Fig. 6 - *Parastenocaris proserpina*. Male: A, P3, Cecina River; B, P3, Sele River; C, P3, Volturno River; E, Enp P4, Cecina River; H, Enp P4, Sele River; I, Enp P4, Volturno River; L, Enp P4, Calore River. Female: D, Fu, lateral view, Bracciano; F, Fu, lateral view, Bracciano; G, Fu, lateral view, Bracciano; M, Enp P3, Bracciano.

P1: basis (Fig. 11B) with only one spine and a secretory pore, which is also present on the basipodite of all other pereopods. P2: basis (Fig. 11G) with a row of spinules on the external side of the exopod insertion, without the lateral seta previously reported by Cottarelli (1972). P5 (Fig. 11F): a large secretory pore on the inner proximal margin.

CONCLUSIVE REMARKS

Scanning electron microscopy has allowed us to detect new morphological features, in spite of difficulties caused by the small dimensions of the specimens. For example in all the species examined, there are secretory pores on the P5 and furcal rami of both sexes, and this

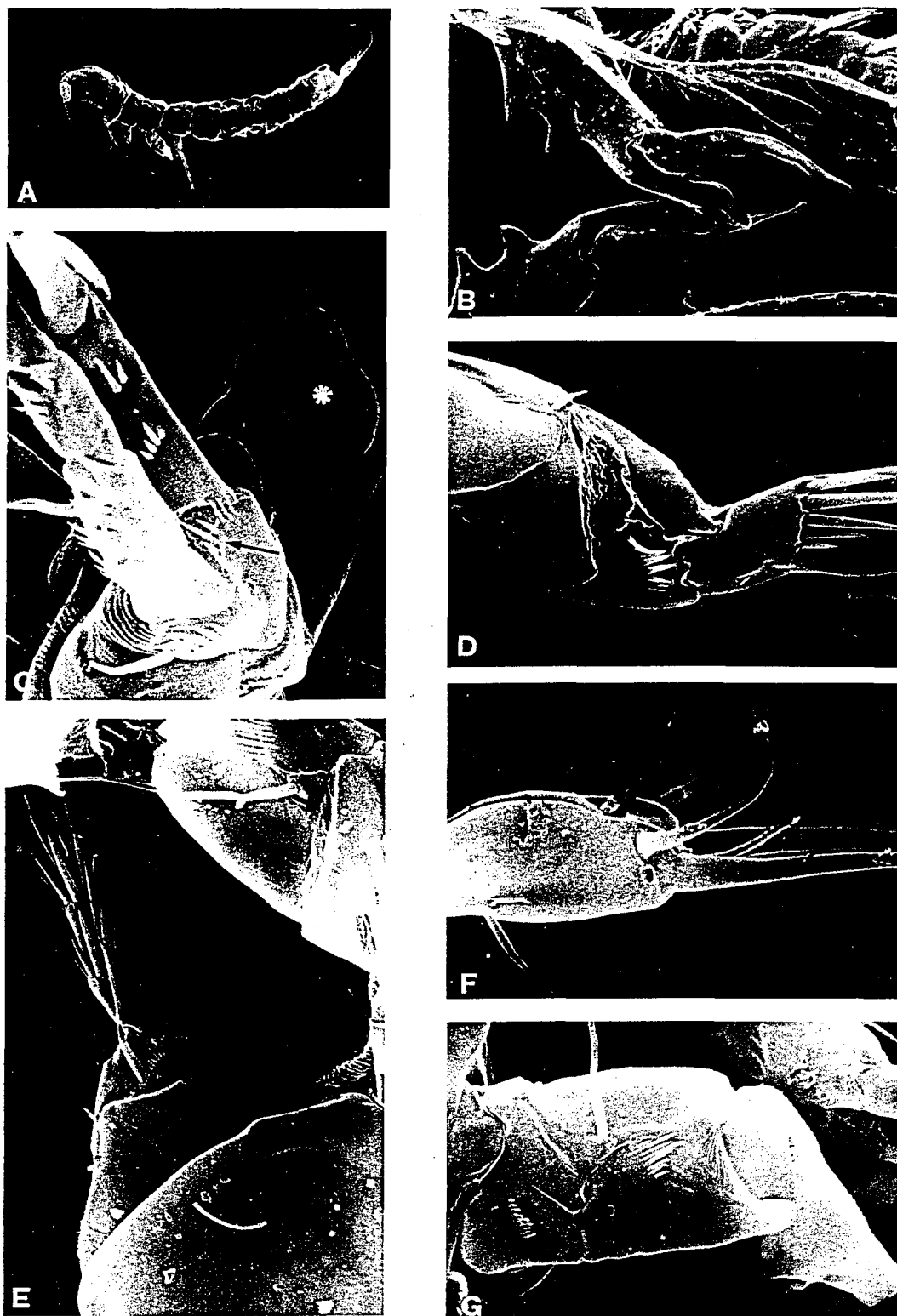


Fig. 7 - *Parastenocaris amalasuntae* n. sp. Paratype male: **A**, habitus, lateral view. $\times 200$; **B**, P3, apical part. $\times 3500$; **C**, Bsp P1. $\times 3500$; **D**, Bsp P2, lateral view. $\times 3500$; **E**, Bsp P3 and P4. $\times 2000$; **F**, Fu. $\times 2000$; **G**, P3, external view. $\times 2000$.

feature may be common to all the species of this genus. We have also confirmed the presence of pores on the P1-P4 basipodites, as already observed in other species

of the genus (Glatzel, 1991; Galassi, manuscript submitted).

Another morphological feature detected for these

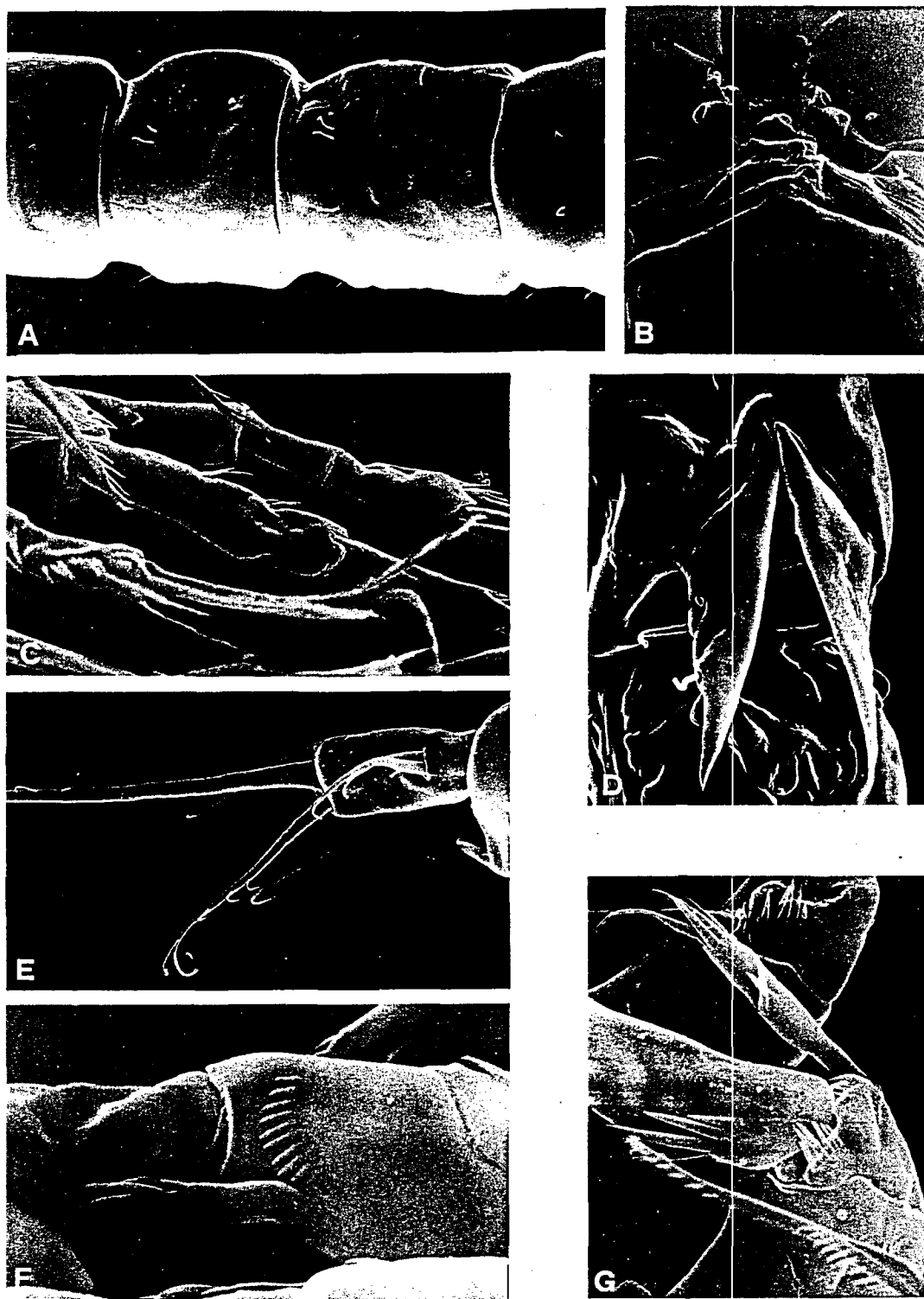


Fig. 8 - *Parastenocaris amalasuntae* n. sp. Paratype male: C, P1. $\times 3500$. Paratype female: A, abdominal somites with dorsal windows. $\times 1000$; B, R. $\times 5000$; D, P5. $\times 2000$; E, Fu and Op. $\times 2000$; F, Enp P3, Bolsena Lake. $\times 7500$; G, Enp P2, Bolsena Lake. $\times 3500$.

species, which could have a taxonomical importance, is the sexual dimorphism of P1 basipodite. In *P. pasquinii* there is a hook near the endopodite insertion of the male, but in *P. amalasuntae* n. sp. and *P. proserpina* from the *proserpina* group, the basipodite is not dimor-

phic. This feature could be useful to distinguish between the different species groups.

Regarding species distributions, *P. amalasuntae* n. sp. was collected for the first time in Bolsena Lake, together with *P. pasquinii*. *Parastenocaris amalasuntae* seems

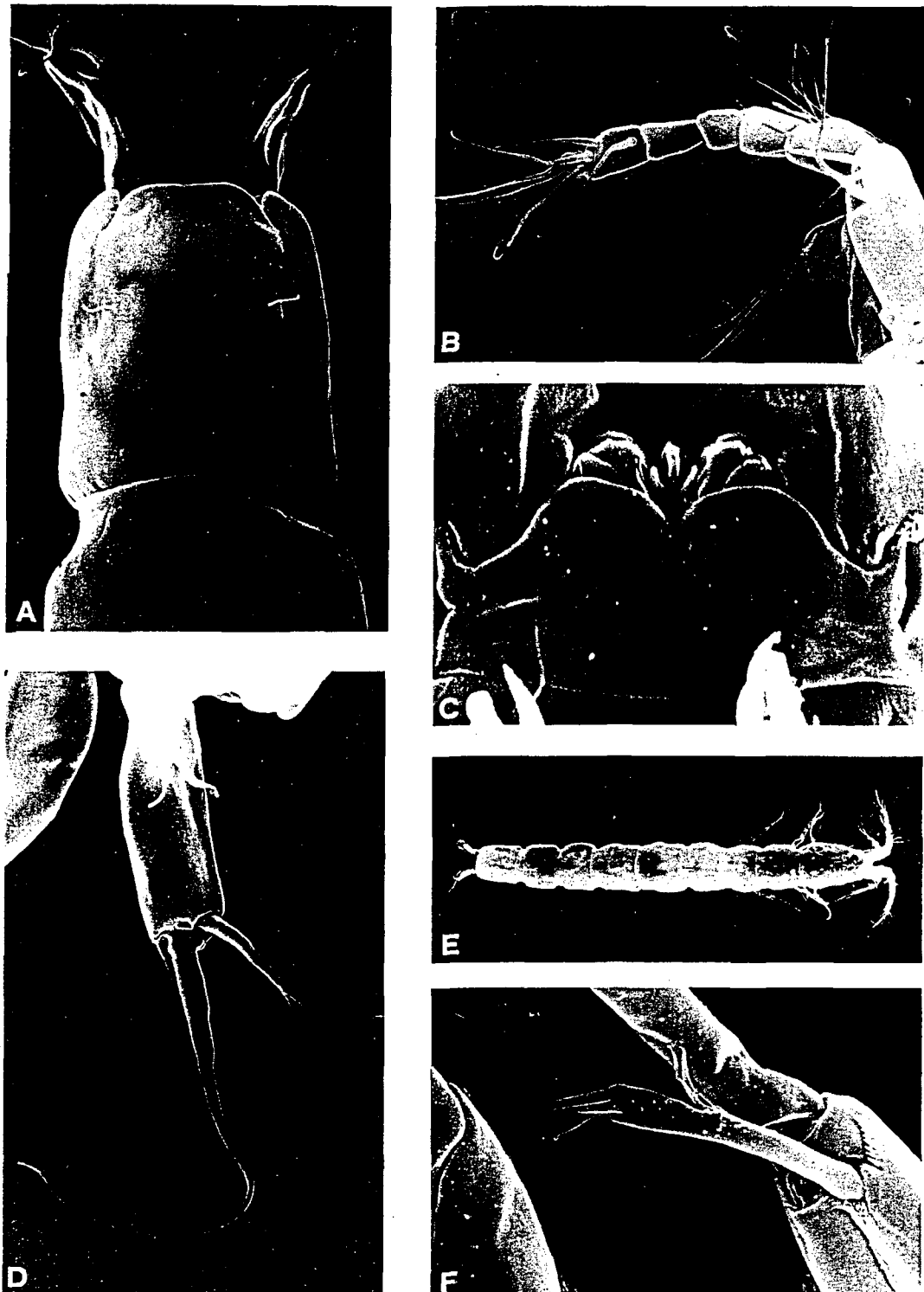


Fig. 9 - *Parastenocaris amalasuntae* n. sp. Paratype male: F, Enp P2, Bolsena Lake. $\times 5000$. Paratype female: A, Fu e Op. $\times 1500$; B, A1. $\times 1500$; C, Ga. $\times 5000$; D, Fu. $\times 2000$; E, habitus, dorsal view. $\times 200$.

to have a quite wide ecological valence, since it has been collected in the hyporheic and groundwaters of Latium and Tuscany and in the phreatic waters of Tuscany. *Parastenocaris amalasuntae* has a narrower distribution than *P. proserpina*, which is widespread in

Italy in all subterranean waters (hyporheic aquifers, phreatic system, karstic caves and lacustrine psammolittoral); *P. proserpina* seems therefore to have a wide ecological valence, as was already noticed by Cottarelli (1972). On the other hand, the discovery of *P. proser-*

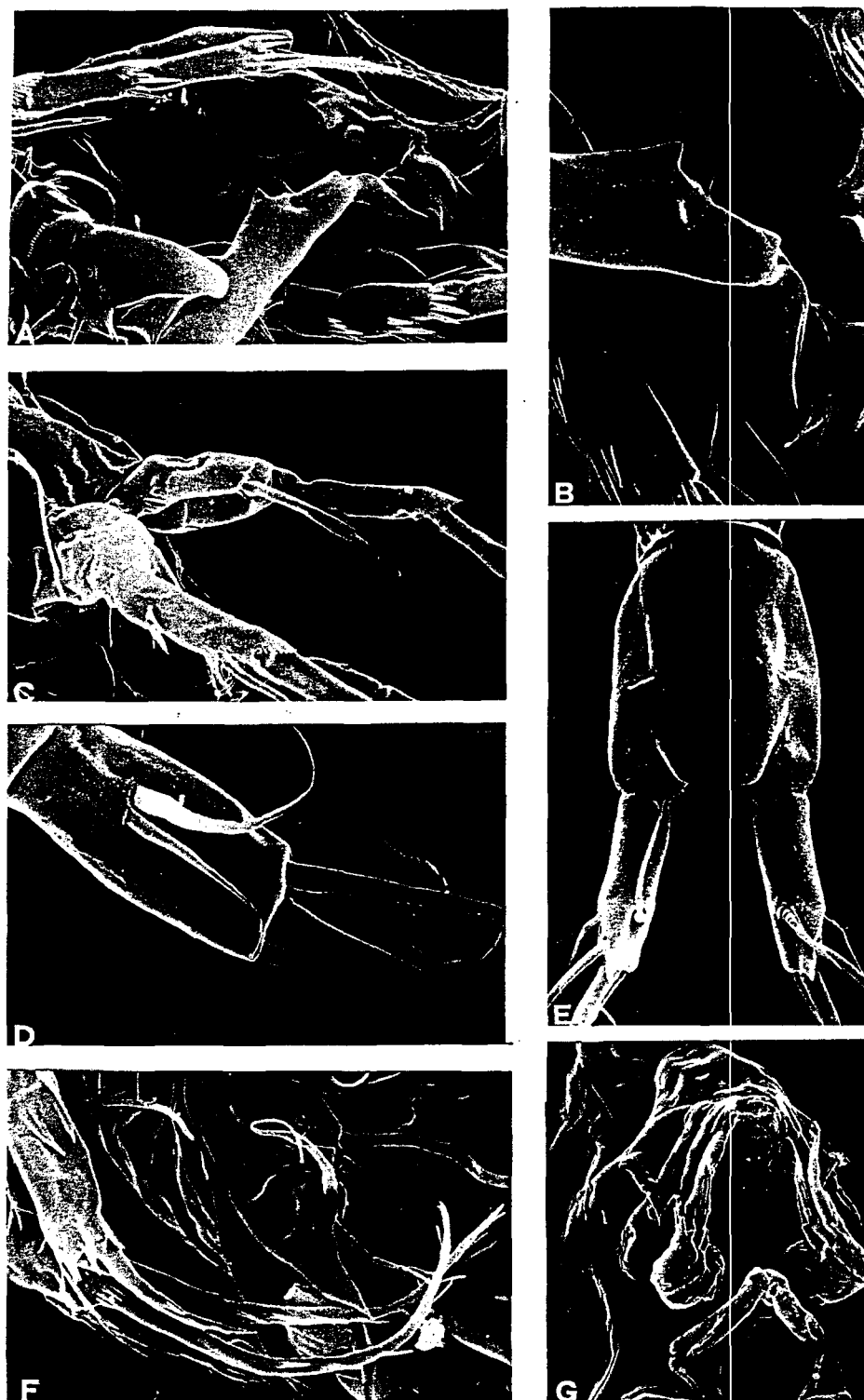


Fig. 10 - *Parastenocaris proserpina*. Male: A, P3. $\times 2000$; B, P3, apical part. $\times 3500$; C, Enp P2, Bracciano Lake. $\times 2000$. Female: D, Fu. $\times 3500$; E, P5. $\times 3500$. *Parastenocaris pasquinii*. Male: E, Fu e Op. $\times 1500$; G, mouth parts. $\times 2000$.

pina in Tuscany in the hyporheos of Cecina River extends northwards its distribution area on the Italian peninsula. This species has also been collected in other European countries (Slovakia, see Dussart & Defaye, 1990). We are of the opinion that the determination of

P. proserpina by Sterba (1965, 1967) in the hyporheos of Laborec and Váh Rivers should be confirmed.

It is interesting to note that the distribution area of *P. proserpina* seems to have become reduced from Bracciano, Vico and Bolsena Lakes (Cottarelli, 1972) to only

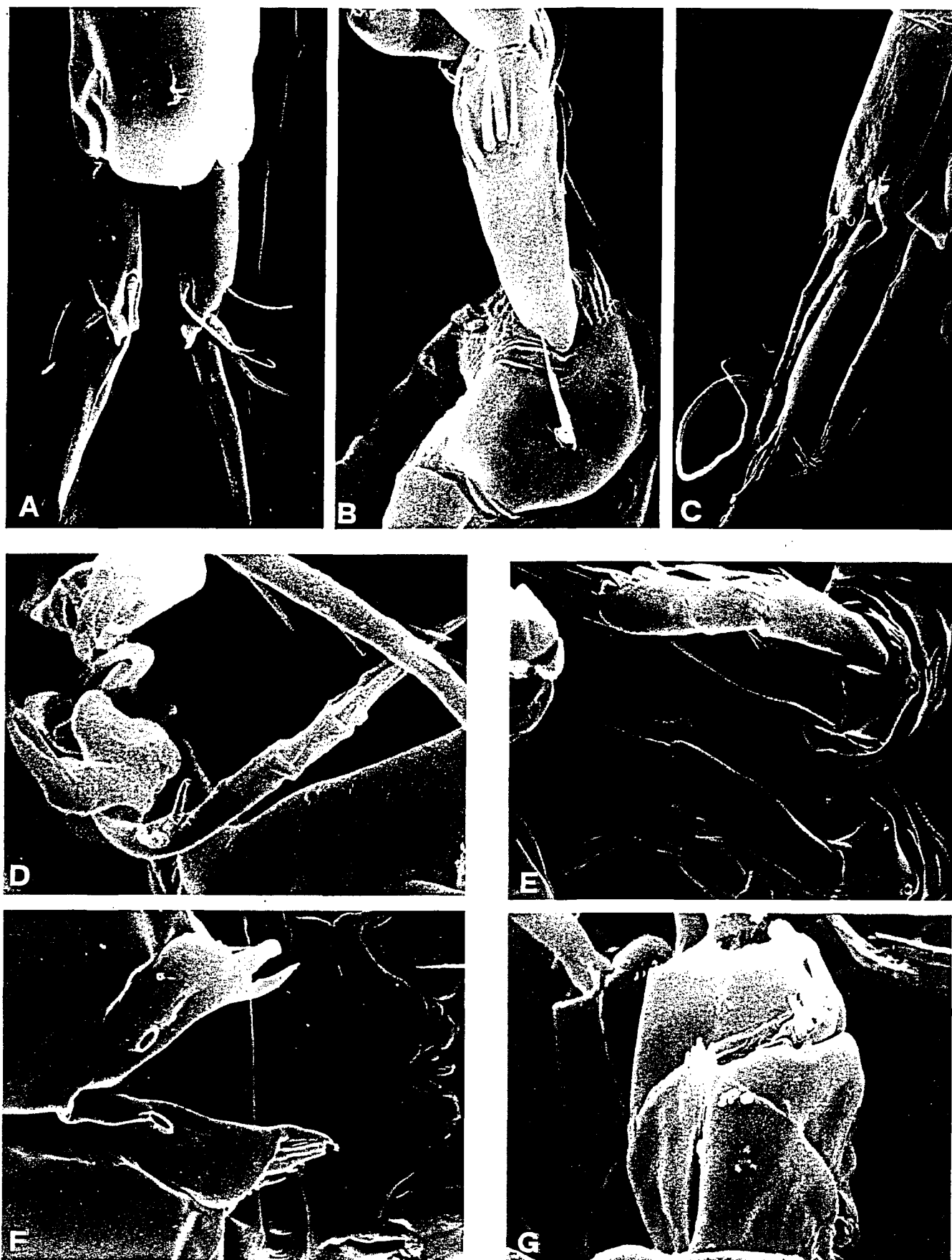


Fig. 11 - *Parastenocaris pasquini*. Male: **D**, Enp P4. $\times 7500$; **E**, Bsp P1. $\times 3500$. Female: **A**, Fu and Op. $\times 2000$; **B**, Bsp P1, lateral view. $\times 5000$; **C**, Fu. $\times 5000$; **F**, P5 and Ga. $\times 3500$; **G**, Bsp P2, lateral view. $\times 5000$.

Bracciano Lake at present. In Vico Lake this species has disappeared together with most of the interstitial copepods, probably because of the intensive use for agricultural purposes of most of the land surrounding the lake (Cottarelli & Bruno, unpublished data). In Bolsena Lake this species seems to have been supplanted by *P. amalasuntae* n. sp. Further investigations will verify this supposition.

Parastenocaris pasquinii was originally discovered in Bolsena Lake (Cottarelli, 1972) and later in one locality near Martignano Village on Bracciano Lake (Cottarelli & Drigo, 1972). The species is nowadays collected, mainly in springtime, at several localities on this lake (Trevignano, Anguillara, Bracciano). In any case, *P. pasquinii* has a more limited distributional area than *P. proserpina*, and it is restricted to the lacustrine psammal of the two volcanic lakes.

Other investigations, some of them still in progress, concern the ecology and biology (Bruno *et al.*, 1996; Bruno, unpubl. data; Bruno *et al.*, manuscript submitted) of *P. amalasuntae* and *P. pasquinii* sympatry. It has been noticed that *P. amalasuntae* seems to be more specialized in resource utilization, since this species is dominant in sampling stations with peculiar physical and chemical conditions and certain levels of nutrients. *Parastenocaris pasquinii* seems to be more generalist and euryoecious, since it has colonized more sampling stations with different ambient conditions (Bruno *et al.*, unpubl. data).

Even the biology of these two species seems different, since *P. amalasuntae* has more adapted reproductive strategies than *P. pasquinii*. These strategies include a seasonal variations of the sex-ratio, biased towards females, and a greater percentage of sexually mature males during the reproductive periods (Bruno *et al.*, unpubl. data).

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