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Revision, Phylogeny and Biogeography of the Groundwater Amphipods Salentinellidae. I . Description of *Salentinella anae* nov. sp. from Spain with Remarks on the Genera *Salentinella* and *Parasalentinella*

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ABSTRACT—A new species of the groundwater amphipod *Salentinella* (Crustacea, Salentinellidae), *S. anae,* is described from Spain. This species is characterised by spines on the antennula peduncle, the absence of retinaculae on the pleopods, and the morphology of the coxal plate 1. Different morphological characters are evaluated before a phylogenetic study of the family. *Salentinella prognatha* is assigned as a synonym of *S. petiti*. The description of the genus *Parasalentinella*, as well as the diagnosis of the Salentinellidae are completed.

Key words: amphipoda, Salentinellidae, systematics, groundwater, western Mediterranean

INTRODUCTION

The Salentinellidae are small-sized amphipods (crustaceans) exclusively living in interstitial fresh or slightly brackish groundwaters. Up to now, the family comprizes two genera. *Salentinella* Ruffo, 1947 contains 15 species and subspecies. *Parasalentinella* Bou, 1971 is a monotypic genus. The phylogenetic relationships within this group have never been considered, although several authors suggested that the marine Liljeborgiidae should be the sister group of the Salentinellidae (Coineau, 1963, 1968; Bousfield, 1982, 1983; Barnard and Barnard, 1983; Ruffo, 1986; Notenboom, 1991).

All species of this family occur in the western Mediterranean area, from the Balkanic peninsula and Italy, to Southern France, Spain and Morocco (Karaman, 1979; Karaman and Pesce, 1980; Platvoet, 1987). The family is particularly diversified in Southern France and in Spain.

In this paper, the description of a new species of *Salentinella* is presented together with remarks on *Salentinella prognatha* and *S. petiti.* Additional characters of *Parasalentinella rouchi* and the additional diagnosis of the family are also given. This study aims at giving new details on characters which can be considered evolutionary markers useful for phylogeny studies. As already demonstrated (Boutin *et al.*, 1992; Darlu and Tassy, 1993; Messouli, 1994; Tabacaru and Danielopol, 1999; Koenemann and Holsinger, 1999; Botosaneanu, 2001), such a preliminary analysis of morphological structures should be performed prior to phylogenetic reconstructions. The second part of the work about the Salentinellidae will constitute a forthcomming paper devoted to phylogenic relationships and the historical biogeography within the family Salentinellidae.

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SALENTINELLA ANAE sp.nov.

Material: One male (holotype) and one female (paratype). Type locality: groundwater of a tributary of the Rio Tajo, along the road from Puerto to Peralveche, Guadalajara Prov. Karaman-Chappuis sampling at 20 cm depth, 50 litres water filtered. Preservation in alcohol 70%. A. Camacho and A.G. Valdecasas coll. (12-4-1984).

Description

Description of the male (holotype)

Body length: 1.7 mm. Spermatozoids in the seminal vesicle. Lateral cephalic lobes long and sharp.

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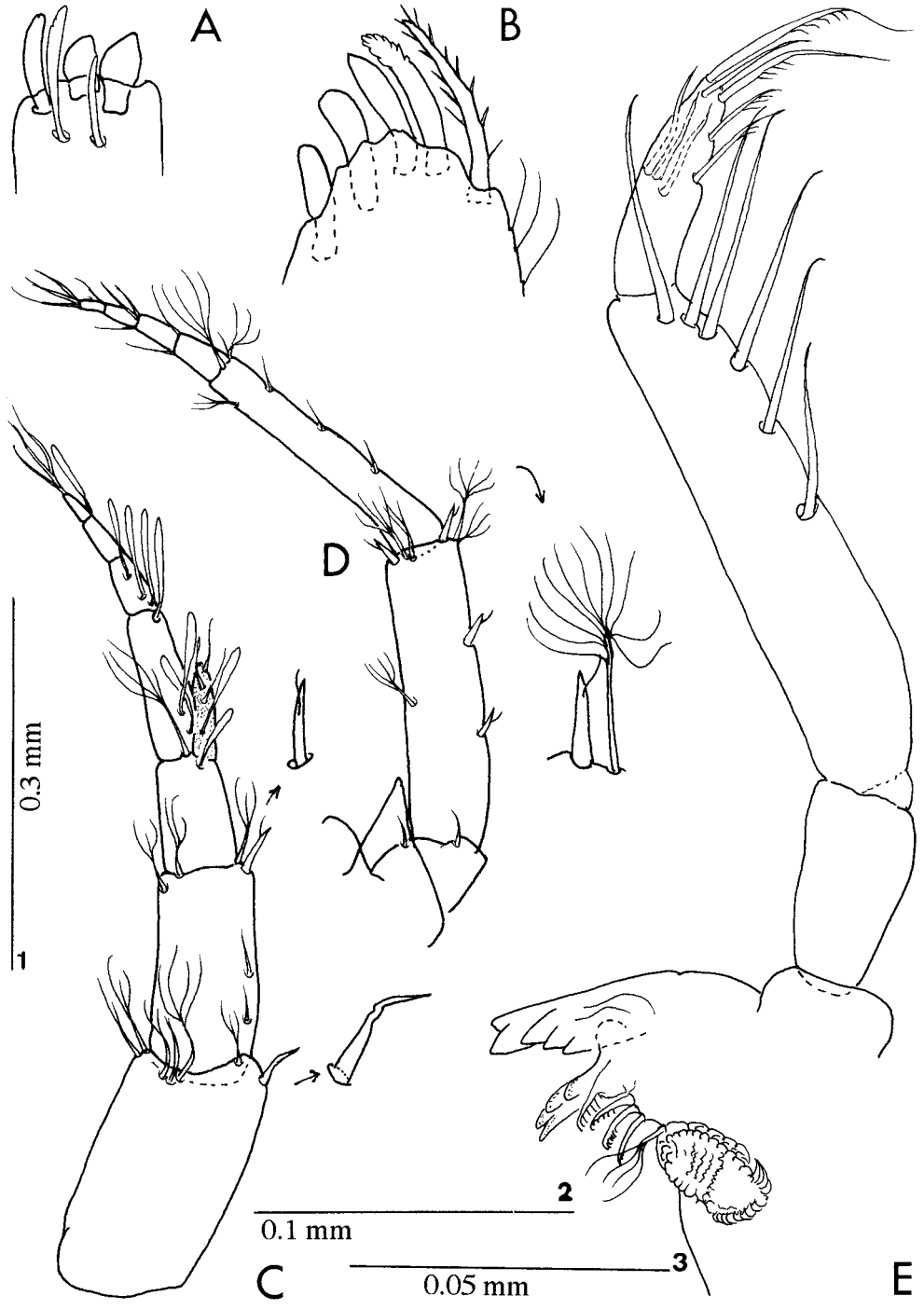


Fig. 1. *Salentinella anae* nov. sp., male. A, detail of the maxilliped inner lobe; B, maxilliped outer lobe; C, antenna 1; D, antenna 2; E, left mandible. A, B: scale 3; C, D: scale 1; E: scale 2.

Antenna 1 (Fig. 1, C). First and second peduncular segments with one distal spine. Flagellum 4-segmented, provided with nine aesthetascs, first segment longer than second, third and fourth together. Accessory flagellum slightly longer than half of primary flagellum segment.

Antenna 2 (Fig. 1, D) as long as the first antenna. Gland cone hardly reaching one-third of the fourth segment, the latter with two lateral spines at one-third and second-third, and two distal spines. Flagellum 4-segmented, slightly longer than half peduncular segment 5.

Mouthparts without special features.

Mandibles (Fig. 1, E). Incisor armed with five teeth. Left lacinia with four teeth. Spine row with one proximal strong comb-shaped tooth (lacking on right mandible), three shorter setae (versus two on right mandible), and one palmate seta. Molar with a triturating surface, without molar

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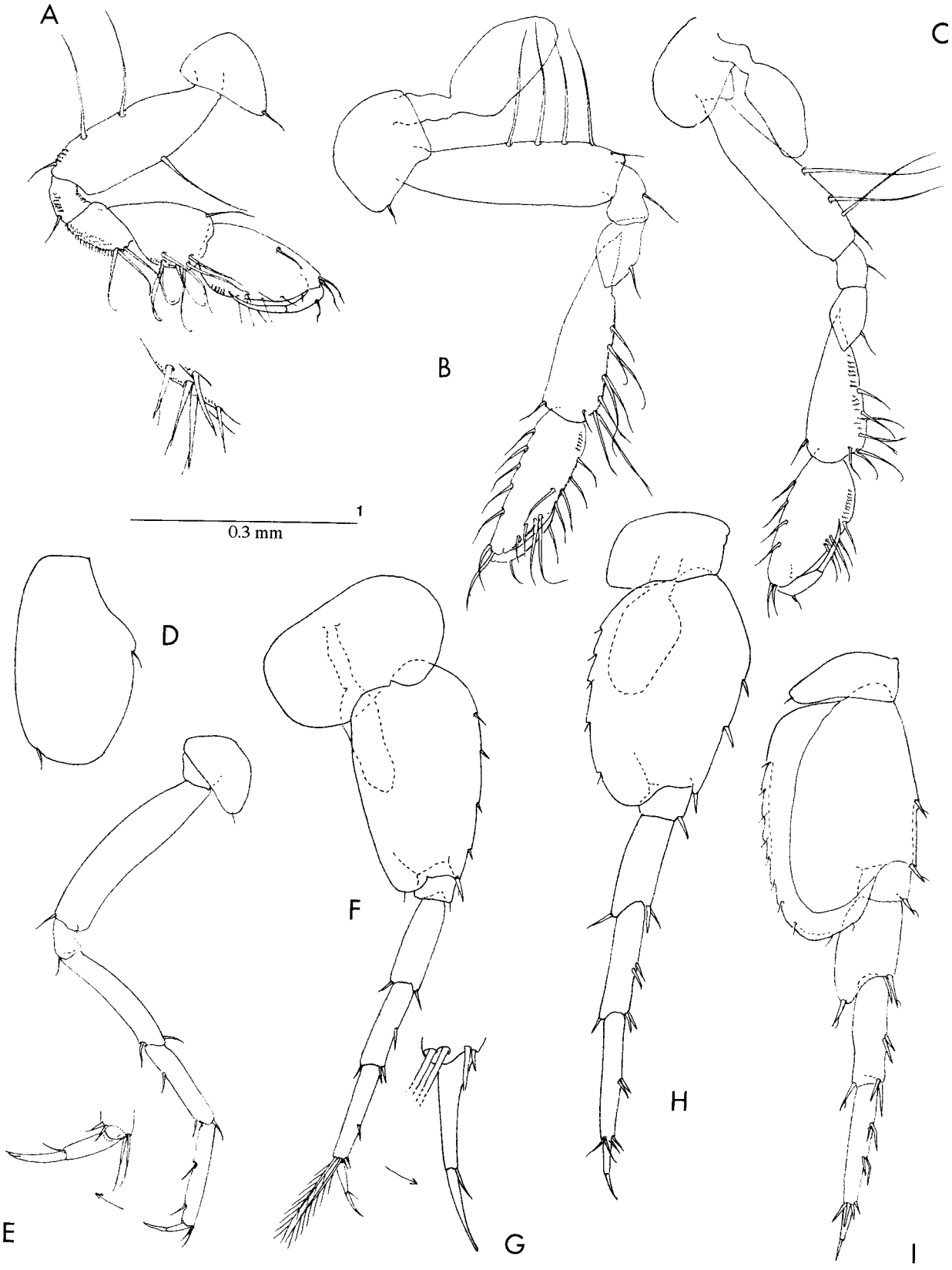


Fig. 2. *Salentinella anae* nov. sp. A, male gnathopod 1; B, female gnathopod 2; C, male gnathopod 2; D, male coxal plate 4; E, male pereiopod 3; F, male pereiopod 5; G, detail of the dactylus of pereiopod 5 (male); H, male pereiopod 6; I, male pereiopod 7. A, B, C: scale 1; D–I: scale 4: 0.3 mm=0.75 of bar 1 length.

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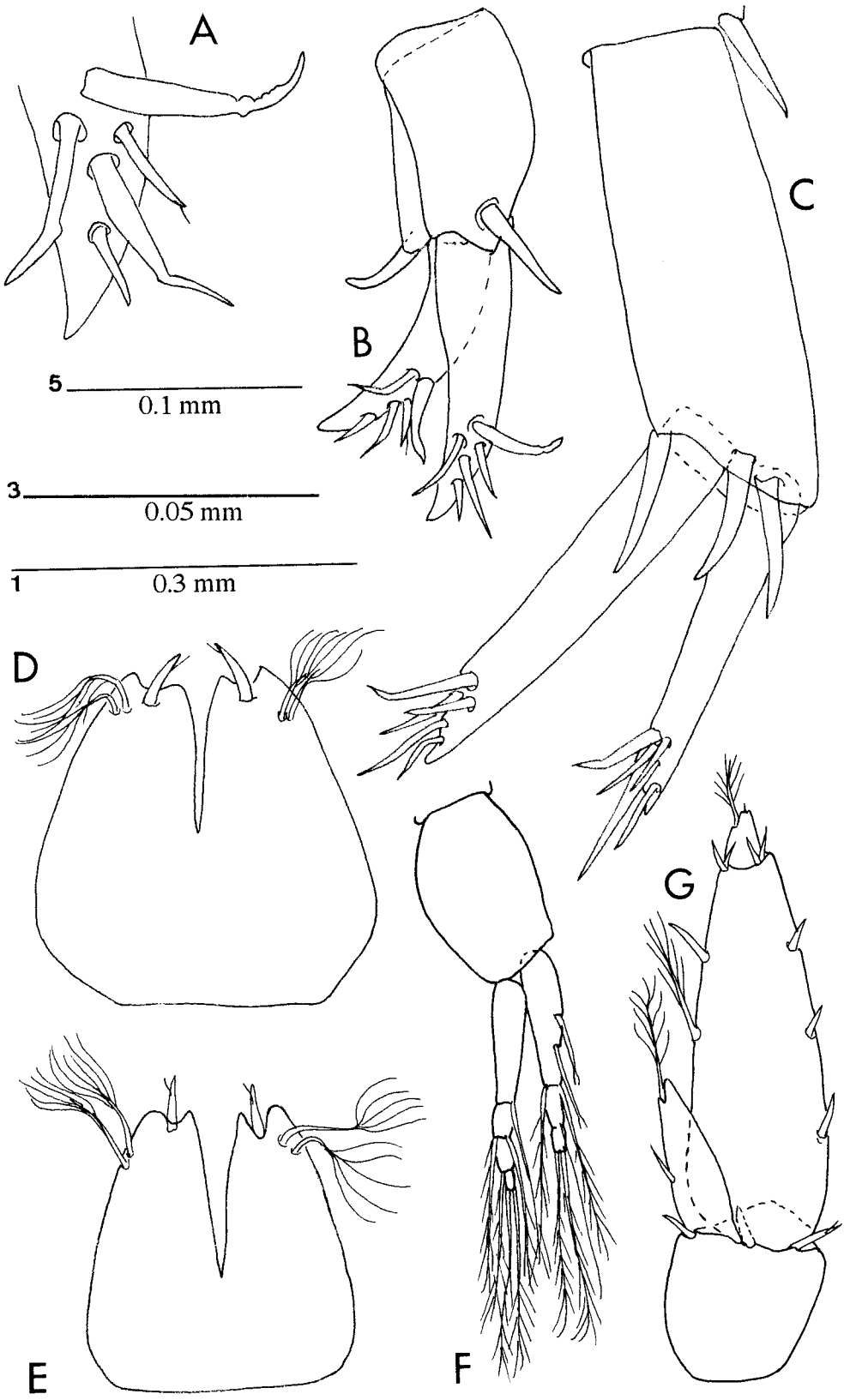


Fig. 3. *Salentinella anae* nov. sp., male. A, distal part of uropod 2; B, uropod 2; C, uropod 1; D, female telson; E, male telson; F, pleopod 1; G, uropod 3. A: scale 3; B–E, G: scale 5; F: scale 1

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seta on left mandible (versus well-developped molar seta on right appendage). First and distal articles of palp sub-equal in length, ca 1/3 as long as the second. Six strong setae getting longer up to apex on inner margin of the second article. Last article with eight setae: two E-setae, three D-setae, one A-seta and two B-setae.

Maxilla 1 and maxilla 2 without special characteristics.

Maxilliped (Fig. 1, A) similar to that of known species. Inner lobe with three lanceolate teeth. Distal part of outer lobe armed with three strong simple lanceolate teeth, one subdistal serrate tooth and one strong plumose subdistal seta.

Gnathopods 1 (Fig. 2, A). Coxal plate small, subtriangular, ventral margin subpointed anteriorly and provided with one long seta. Basis expanded, merus with three strong setae anteriorly. Propodus without special features. Palmar margin armed with long spines (Fig. 2, A), without bifid (bifurcate) teeth. Gnathopods 1 are of weakly pre-amplexing type, as well as gnathopods 2.

Gnathopods 2 (Fig. 2, C) longer than gnathopod 1. Coxal plate small. Basis provided with three long setae on posterior margin. Carpus as long as propodus. Propodus without setae on ventral margin, setae only on palmar margin.

Pereiopods 3 and 4 (Fig. 2, E and D) are similar to each other except the coxal plate which is high in P3, with two setae, and shorter in P4.

Pereiopods 5-7 (Fig. 2, F–I). Coxal plate 5 with the longest coxal gill. P6 and P7 without special features.

Pleopods (Fig. 3, F). Peduncle strong, without retinaculae. Pleopods are all similar, with the same number of segments: inner ramus 3-segmented, outer ramus 4-segmented, the two first segments of each ramus being the longest and of same length.

Urosoma smooth, without spine on dorsal part of third segment.

Uropods 1 (Fig. 3, C). Pre-peduncle ventral part of the body with one ecdysial spine. Basis with three strong distal spines. Outer ramus slightly shorter than inner ramus, both armed with five distal spines.

Uropods 2 (Fig. 3, A and B). Basis strong, shorter than both rami, with two distal spines. Outer and inner rami curved and pointed at the end, provided with five subdistal spines.

Uropods 3 (Fig. 3, G). Proximal part of outer ramus wide, with three spines on lateral margin; second article short, distally obtuse, with a subdistal plumose seta and a tiny spine. Inner ramus relatively short (ca 40 % of outer ramus length), provided with one seta on lateral margin and one subdistal plumose seta.

Telson clearly wider than long, cleft up to slightly more than half its length. Dorsal plumose setae located close to the distal part (Fig. 3, E).

Description of the female (allotype)

Adult length: 2.1 mm. The female is longer than the male. It does not develop oostegites.

The female differs from the male in the following respects: flagellum segments of antenna 1 with six aesthetascs; gnathopods 2 (Fig. 2, B) more slender: a sexual dimorphism is displayed on carpus which is longer than propodus; propodus longer than in male, with series of setae on ventral margin near palmar margin. Telson cleft up to half its length (Fig. 3, D).

Etymology. The species *Salentinella anae* is named after Ana I. Camacho who kindly sent us the material she collected in cooperation with A. G. Valdecassas.

DISCUSSION

Salentinella anae nov. sp. is easily distinguished from the other congeneric species in having distal spines on the peduncle of the antennae 1 and 2 (versus no spine on peduncle in other known species) and in the lack of retinaculae on pleopod peduncles. This latter apomorphic character is also observed in *Parasalentinella rouchi*. The small and pointed coxal plate 1 is characteristic of *S. anae*. The gnathopod 2 is more slender than in other species and the propodus chaetotaxy is similar to those of *S. major* and *S. ruffoi*. The telson, which displays a slight dimorphism, is very short and wider than long; compared to all other species of the genus, it characterises also the new species.

Both the observation of a number of species of the genus *Salentinella* from Spain, France, Italy, Greece, Morocco, and published data show that some of the previous descriptions are only summary diagnoses concerning some parts of the species; data are often compared to *Salentinella angelieri* (Baschieri Salvadori, 1952; Platvoet, 1987; Ruffo, 1953). Traits of uropods 3 and telson have often been used to establish subspecies (Baschieri Salvadori, 1952; Ruffo, 1953) which have been later criticized (Karaman, 1979). Characters do exist which have not retained the attention of authors. Stable characters confirmed within the family are presented hereafter in addition to the diagnosis of the family Salentinellidae. An exhaustive list of characters will be presented in the second part of this work.

New observations of specimens of *Salentinella petiti* from the type locality, and of topotype specimens of *S. prognatha* (Fig. 4) allow to refute the validity of the species *S. prognatha*. Any discriminative characters between the two species have not been shown: therefore *S. prognatha* is the junior synonym of *S. petiti*. The prognathism observed by Barbé (1963) due to the long part of the head between the basis of the two antennae can be, in fact, applied to all species of *Salentinella* and *Parasalentinella*: the lateral cephalic lobes are long, pronounced and acute, so that the implantation of antennae 2 seems more ventral (see Coineau, 1968, Fig. 22A). *S. petiti* has a tendency to have elongate appendages and chaetotaxy reduction. Only this species displays the dactylus of pereiopod 5 as long as or longer than the propodus, as compared to all other species. Furthermore, *S. petiti* resembles *S. meijersae* (Platvoet, 1984) with the elongate third urosomite, but it differs from the latter in the absence of the pre-telsonic two spines on urosomite 3 which

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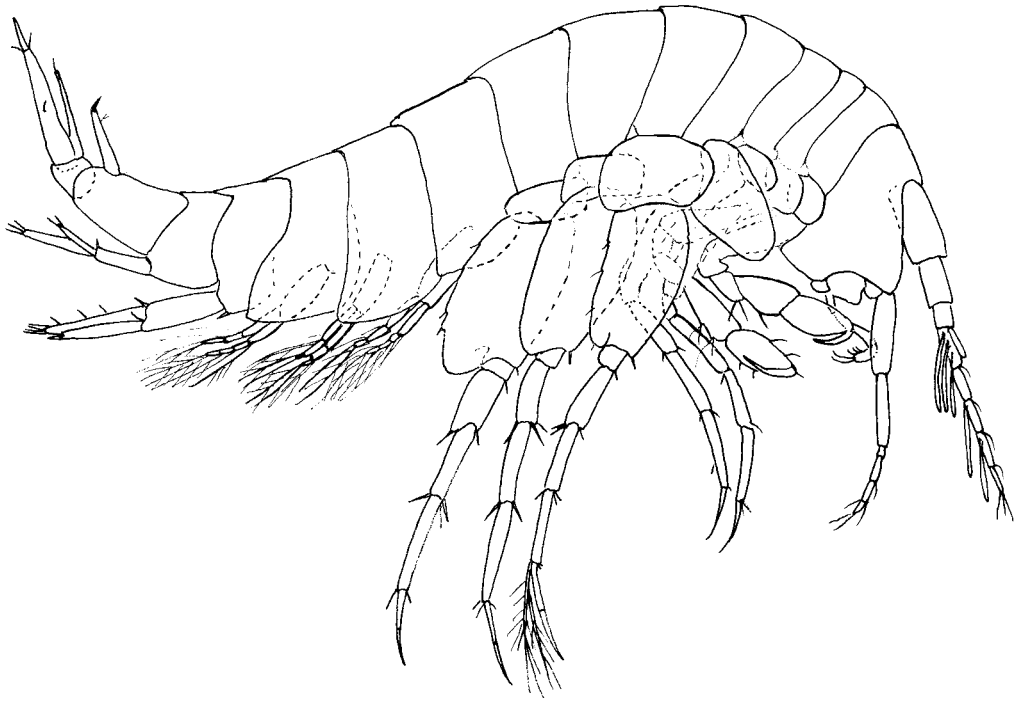


Fig. 4. Habitus of *Salentinella petiti* from Caujolle cave, 1.2 mm in length (leg. C. Bou).

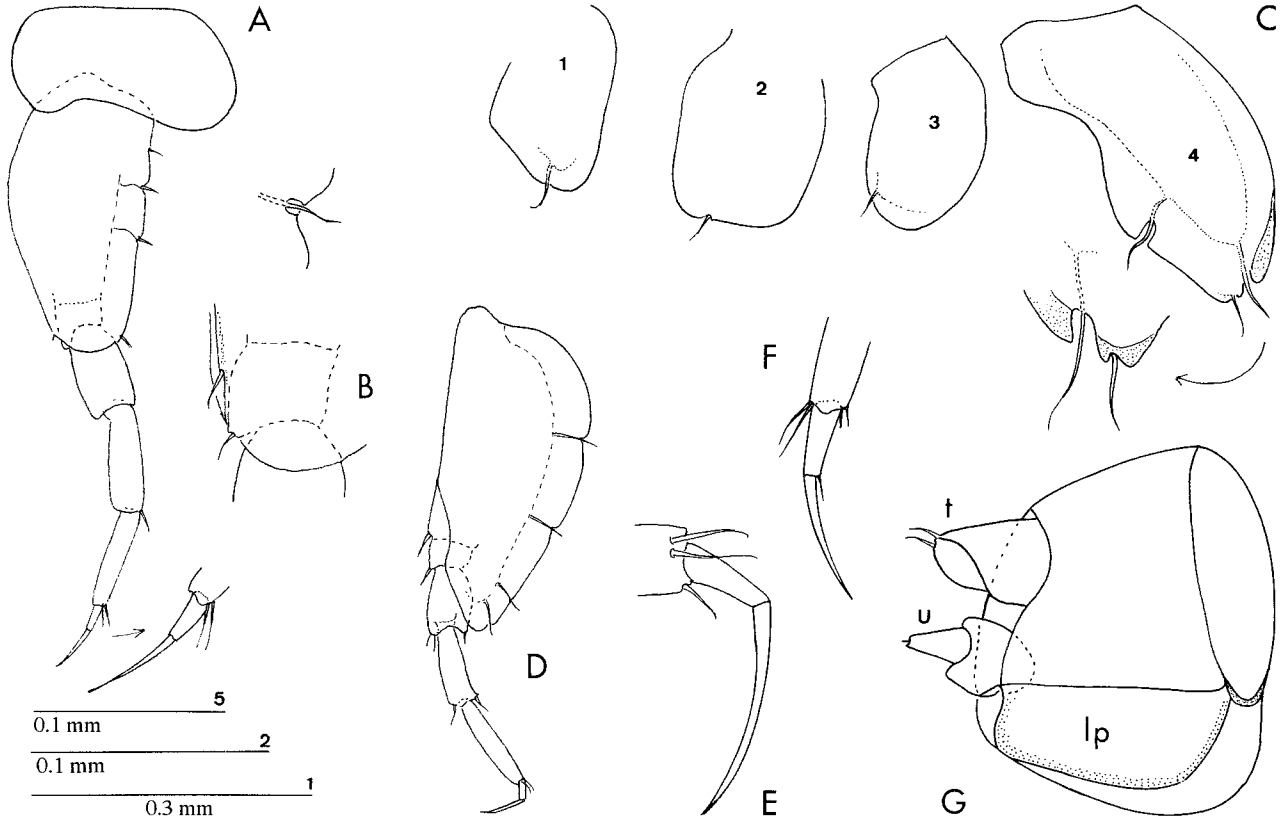


Fig. 5. *Parasalentinella rouchi* from the Lachein river. A, pereiopod 5; B, pereiopod 5, detail of the distal part of the basis and ischium; C, coxal plates 1 to 4; D, pereiopod 7; E, distal part of propodus and dactylus of pereiopod 7; F, distal part of pereiopod 4; G, third urosomite with telson (t), uropod 3 (u) and prolonged lateral plate-like (l p) typical of *Parasalentinella.* A, D: scale 1; B, C, E, F: scale 2; G: scale 5.

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are present in most of the species of the genus *Salentinella*. Uropod rami of *S. petiti* are distinguished in the reduced number of spines, their distal notch provided with three long spines, the medial of which being longer. Only the left mandible displays a molar seta.

REMARKS ON *PARASALENTINELLA ROUCHI*

Material: one male (body length: 1.77 mm, adult with spermatozoids in the vas seminalis) from the type locality: the Lachein river at Alas (Ariège, southern France).

The ability to roll up into a ball, i.e. volvation ability which is total in *Parasalentinella* (see fig 2 in Danielopol *et al*., 1999) results in a number of transformed characters in *P. rouchi*: the species retains plesiomorphic traits such as the posterodistal lobes of the pereiopods 5 to 7 (Fig. 5). In contrast, elaborated characters reach a high degree of apomorphy, i.e. reduction of the three uropods and of the telson, elongate claw of the pereiopod dactylus, reduced antennular gland. The most striking character which has not previously been observed, is the prolonged epimeral parts of urosomites 2 and 3, forming lateral plates. These plates limit a kind of cavity where appendages are introduced during total volvation. It is an autapomorphy in *Parasalentinella rouchi*. In contrast to *Salentinella*, which exhibits uropods 1 longer than uropods 2, uropods 1 of *Parasalentinella* are less developped than uropods 2. This new character which represents an apomorphy, is probably also related to the volvation phenomenon.

The telson is uncleft, like a rounded plate with concave margins (Fig. 5G)

FAMILY SALENTINELLIDAE

additionnal diagnostic characters and states

The Salentinellidae constitutes a well defined group. The diagnosis of the family have been successively completed with the discovering and the description of new species (Ruffo, 1953; Coineau, 1963; Bou, 1971; Barnard and Barnard, 1983; Platvoet, 1987).

The following features are always displayed within members of the family and are to be added to previous diagnosis:

oostegites absent,

peduncle of uropods 1 and 2 without lateral spines, ventroproximal spine always absent,

ecdysial spine on prepeduncle of uropod 1 always present,

pleopods: strong peduncle. Inner ramus 3-or 4-segmented; first segment very long and of similar length; clothespin spines distally cleft and well developed.

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