

Two new members of the family Niphargidae (Gammaridea) from Spain (Contribution to the Knowledge of the Amphipoda 281)

Gordan S. KARAMAN

Montenegrin Academy of Sciences and Arts, Podgorica, Montenegro

Received for Review: 2 June 2015 / Accepted: 30 June 2015

Summary. Two new members of the genus *Niphargus* Schiödte, 1849 (Amphipoda, fam. Niphargidae) from the subterranean waters of Spain are described and figured: *Niphargus notenboomius* sp. n. from wells near Angles (province Gerona) and *Niphargus laisi geronensis* ssp. n. from wells near Garriguella (prov. Gerona). Both taxa are also cited for some other localities of Spain. Taxonomical relations of these two taxa with respect to other members of the genus *Niphargus* from Western Europe are discussed.

Keywords: Amphipoda, description, new taxa, *Niphargus*, Spain.

INTRODUCTION

The subterranean fauna of the genus *Niphargus* Schiödte, 1849 (Amphipoda, Gammaridea, Niphargidae) in Spain remains relatively poorly characterized, although several authors have published a number of papers on this fauna (Margalef 1952; Balazuc 1954, 1957; Margalef 1963, 1970a, 1970b; Morand-Chevat 1972; Ginet 1977; G. Karaman 1986a). On the Iberian Peninsula, subterranean waters are settled mainly with members of the genus *Haploginglymus* Mateus & Mateus 1958, which settled the same ecological niches as the genus *Niphargus*. In this manner, the genus *Haploginglymus* replaced the genus *Niphargus* in Spain and Portugal, and the genus *Niphargus* is present only in subterranean waters near the border with France, and in these localities often both genera can be found in mixed populations (G. Karaman 1986b).

In the present study, two new taxa of the genus *Niphargus* from Spain are established. Specimens of the genus *Niphargus* used in this study were generously provided by Dr. Jos Notenboom of Holland, who collected the samples during fieldwork on subterranean fauna in Spain.

MATERIAL AND METHODS

Specimens were preserved in 70% ethanol. For the present work, specimens were dissected using a WILD M20 microscope and drawn using a camera lucida attachment. All appendages were temporarily submersed in a mixture of glycerin and water for study and drawing. The body length of examined specimens was measured from the tip of the head to the end of the telson using a camera lucida. All illustrations were inked manually. After the end of the study, dissected body parts were submerged in Liquid of Faure on slides and covered by a thin cover glass. Some morphological terminology and seta formulae follow Karaman's terminology (G. Karaman 1969, 1970, 2012).

An advantage of using Liquid of Faure is the possibility to later remove it from dissected body parts in water, enabling further study in various positions under the microscope. The new species is established based on provided morphological and ecological investigations and data.

TAXONOMICAL PART

Family *Niphargidae* Bousfield, 1977

Genus *Niphargus* Schiödte, 1849

Niphargus notenboomius sp. n.

(Figs 1-5)

Material examined

Spain (Province Gerona):

86-8/21. Well near an abandoned farm house just N of the road to Gerona, about 2 km from Angles (16 km WSW of Gerona), alt. 200 m a.s.l. (=about sea level), 12 exp. (holotype and paratypes), 12.8.1986 (leg. J. Notenboom);

86-8/30. Riu Fluvia near a railway bridge SW of Sant Miquel de Fluvia (12 km SSE of Figueras), alt. 50 m a.s.l., 13.8.1986, 10 exp. [mixed with *Niphargus laisi geronensis* ssp. n. and *Niphargus* sp.] (Leg. J. Notenboom);

86-8/40. Well 150 m S. of the road to Peralada, about 2 km from Garriguella (12 km NE of Figueras), alt. 50 m a.s.l. 14.8.1986, 3 juv. exp. mixed with *N. laisi geronensis* ssp. n. and *Niphargus* sp.) (Leg. J. Notenboom);

86-8/27. Well 50 m W of the road La Bisbal d'Emporda-Ullastret, alt. 25 m a.s.l., 13.8.1986, 6 spec. accompanied by *Niphargus* sp. (Leg. J. Notenboom);

86-8/25. Well 70 m E of the main road, SE of Ullastret (20 km ENE of Gerona), alt. 25 m a.s.l., 13.8.1986, 10 juv exp. (Leg. J. Notenboom);

86-8/22. Well near a house, about 200 m W of Celra (5 km NE of Gerona), alt. 100 m a.s.l., 12.8.1986, 1 exp. (Leg. J. Notenboom);

86-8/33. Well in Parets d'Empurda (13 km SSW of Figueras), 300 m E of the road to Orfes, 2.5 km from Bascara, alt. 50 m a.s.l., 14.8.1986, 1 exp. (Leg. J. Notenboom);

86-8/23. Well near a country-house, just N of Bordils (9 km NW of Gerona), alt. 50 m a.s.l., 12.8.1986, 1 exp. (Leg. J. Notenboom).

Spain (Province Elra):

86-8/20. (5 km NE of Gerona), alt. 100 m a.s.l., 12.8.1986, 1 exp. damaged (Leg. J. Notenboom).

Diagnosis

Metasomal segments 1-3 with an elevated number of dorsoposterior marginal setae. Rostrum short, lateral cephalic lobes short, subrounded. Mandible palpus scarcely setose. Maxilla 1 inner plate long, with 2 distal plumose setae, inner and outer plate of maxilliped long. Coxae relatively short; gnathopods 1-2 weak, dissimilar to each other, with elongated article 5 and 1 median seta at outer margin of dactylus. Pereopods 5-7 with lobed ovoid article 2; dactylus of pereopods 3-7 with 1 slender spine at inner margin.

Pleopods with 2 retinacula. Uropods 1-2 slender, spinose, with unequal rami. Uropod 3 strong, with short second article of outer ramus. Telson spinose. Oostegites large.

Description

Female 5.5 mm, with oostegites (Holotype). Body slender, mesosomal segments naked. Metasomal segments 1-3 with an elevated number of long setae along the dorsoposterior margin, and the number of setae increasing towards metasomal segment 3 (17-20-29) (Fig. 1G); several setae attached submarginally.

Epimeral plates 1-3 distinctly acute; sharpness of plates increasing towards the last epimeral plate (Fig. 1G); several setae or spine-like setae attached along posterior margin of plates. Epimeral plate 1 with 1 subventral spine (Fig. 1G), epimeral plate 2 with 2 subventral spines; epimeral plate 3 with 4 subventral spines (Fig. 1G).

Urosomal segment 1 on each dorsolateral side with 5 strong spines (Fig. 3F); urosomal segment 2 with 6 strong spines on each dorsolateral side (Fig. 3F); urosomal segment 3 naked. Urosomal segment 1 on each ventroposterior corner with 2 spines near basis of uropod 1 peduncle (Fig. 3F).

Head with short rostrum and short subrounded lateral cephalic lobes (Fig. 1A); anteroventral sinus present, eyes absent.

Antenna 1 slender, almost reaching the body length (ratio: 52:55); peduncular articles 1-3 progressively shorter (ratio: 67:43:29), scarcely setose (Fig. 1B). Main flagellum scarcely setose, composed of 36 articles (most of them with one aesthetasc) (Fig. 1B, C). Accessory flagellum short, 2-articulated, shorter than the last peduncular article (Fig. 1E).

Antenna 2 relatively slender, remarkably shorter than antenna 1. Peduncular article 3 short, with short distal seta; peduncular article 4 slightly shorter than article 5 (ratio: 60:67), along ventral margin with 1 median long seta and bunch of distal long setae (Fig. 1D), along dorsal margin with 3 groups of short setae; article 5 along ventral margin with one median and 3-4 short setae, along dorsal margin with 7-9 short paired or single setae. Flagellum slender, much longer than last peduncular article (ratio: 119:67), consisting of 13 articles, scarcely setose. Antennal gland cone short (Fig. 1D).

Mouthparts well developed. Labrum broader than long, with entire convex distal margin (Fig. 3A). Labium broader than long, outer lobes with long proximal wings and entire distal part (Fig. 3B); inner plates long and narrow.

Mandibles with triturative molar. Right mandible: molar with one long lateral seta, incisor with 4 teeth, lacinia mobilis serrate (bifurcate) accompanied by 4 rakers. Left mandible: molar without lateral long seta, incisor with 5 teeth, lacinia mobilis with 4 teeth and 4 rakers.

Mandible palpus 3-articulate: first article naked, second article with 4 setae (Fig. 5A); article 3 falciform, longer than article 2 (ratio: 75:65), with 12-13 D-setae and 4-5 distal E-setae, on outer face is attached 1 seta, B-setae absent (Fig. 5A).

Maxilla 1: inner plate long and narrow, with 2 strong distal slightly plumose setae (Fig. 4A); outer plate with 7 strong distal spines bearing 1-5 lateral strong teeth [outer 3 spines with 1 tooth, inner 4 spines with 3-5 lateral teeth]. Palpus 2-articulated, poorly reaching or exceeding the basis of the outer plate spines, bearing 2 distal strong setae (Fig. 4A).

Maxilla 2: both lobes much longer than broad, bearing marginal setae only (Fig. 5B).

Maxilliped: inner plate distinctly exceeding outer tip of palpus article 1, bearing 3 strong pointed distal spines accompanied by several setae (Fig. 1F); outer plate long, reaching or poorly exceeding distal tip of palpus article 2, bearing a row of distal and distolateral pointed spines; palpus article 2 along outer margin with one median seta and one distal bunch of setae, along inner margin with numerous long setae (Fig. 1D); palpus article 3 at outer margin with 1-2 median setae and one bunch of distal setae, along inner margin with many setae; article 4 (dactylus) along outer margin with 1 median seta, along inner margin with 1-2 setae, nail much shorter than pedestal (Fig. 1F).

Coxae relatively short. Coxa 1 longer than broad (ratio: 53:43), with subrounded ventroanterior corner and bearing 6-7 marginal setae (Fig. 2A). Coxa 2 longer than broad (ratio: 65:55), ventral margin subrounded, bearing 9-10 setae (Fig. 2E). Coxa 3 poorly longer than broad (ratio: 68:60), with subrounded ventral corners and bearing 9-10 setae (Fig. 3C). Coxa 4 broader than long (ratio: 75: 64), with subangular ventroposterior lobe, ventral margin bearing 12-13 setae of unequal length (Fig. 3E).

Coxae 5-7 shallow. Coxa 5 broader than long (ratio: 60:33) with anterior lobe bearing 4 setae, posterior lobe with 1-2 short setae (Fig. 4B). Coxa 6 smaller than 5, broader than long (ratio: 55:27), bilobed (Fig. 4D). Coxa 7 entire, with convex ventral margin, broader than long (ratio: 52:23) (Fig. 4F).

Gnathopods 1-2 relatively small, slender, with propodus smaller than corresponding coxa (Fig. 2A, E). Gnathopod 1: article 2 linear, along anterior margin with 2-3 long and 2-4 short setae, along posterior margin with up to 12 long and short setae (Fig. 2A); article 3 at posterior margin with one bunch of setae; article 4 short, with posterior bunch of long setae. Article 5 nearly triangular, nearly as long as propodus, along anterior margin with one distal bunch of setae (Fig. 2A), along posterior margin with 5 transverse rows of setae. Propodus trapezoid, slightly longer than broad (ratio: 75:68), dilated distally, along anterior margin with one median and one distal bunch of long setae (Fig. 2B), along posterior margin with 3 transverse rows of long

setae; palm transverse, finely serrate, poorly convex, defined on the outer face by 1 corner S-spine accompanied laterally by 2-3 slender L-spines and 2-3 long facial M-setae (Fig. 2C, D), on the inner face by one short subcorner R-spine. Dactylus reaching the posterior margin of propodus, along the inner margin with 3-4 submarginal setae, along the outer margin with 1 median seta (Fig. 2B).

Gnathopod 2 longer than gnathopod 1; article 2 linear, along anterior margin with 4-5 very short setae (Fig. 2E), along posterior margin with nearly 10 long simple setae; article 3 at the posterior margin with one bunch of setae; article 4 with 3 groups of posterior marginal setae. Article 5 linear, much longer than broad (ratio: 65:22), along the anterior margin with 2 median and 4 distal setae (Fig. 2E), along the posterior margin with 8 transverse rows of long setae. Propodus trapezoid, *kochianus*-type, longer than broad (ratio: 92:73), slightly dilated distally, along the posterior margin with 9 transverse rows of setae (Fig. 2F). Palm transverse, poorly convex, finely serrate, defined on the outer face by 1 S-spine accompanied laterally by 2 slender L-spines and 3 long facial M-setae (Fig. 2G), on the inner face by 1 subcorner R-spine. Dactylus reaching the posterior margin of propodus, along the inner margin with 3-4 submarginal setae, along the outer margin with one median seta (Fig. 2F).

Pereopods 3-4 rather similar to each other in size, with moderately slender articles. Pereopod 3: article 2 along anterior margin with a row of short setae, along the posterior margin with a row of longer strong setae (Fig. 3C). Articles 4-6 of unequal length (ratio: 63:43:54), scarcely setose, along the posterior margin with setae or spine-like setae not exceeding the diameter of the articles themselves. Dactylus much shorter than article 6 (ratio: 18:54), along the inner margin with one spine near basis of the nail, along the outer margin with one median plumose seta (Fig. 3D), nail shorter than pedestal (ratio: 35:42) (Fig. 3D).

Pereopod 4: article 2 along the anterior margin with row of short setae, along the posterior margin with row of spine-like setae; articles 4-6 of unequal length (ratio: 54:40:51), articles with short setae and spine-like setae (Fig. 3E). Dactylus much shorter than article 6 (ratio: 18:51), along the inner margin with one spine, along the outer margin with one median plumose seta, nail slightly shorter than pedestal.

Pereopods 5-7 of moderate length. Pereopod 5 shorter than pereopods 6 and 7, with article 2 dilated, longer than broad (ratio: 82:48), bearing along the anterior margin row of spine-like setae, along the posterior margin with nearly 15 marginal setae, ventroposterior lobe visible (Fig. 4B). Articles 4-6 of unequal length (ratio: 55:39:44), along margins with setae and spine-like setae, not exceeding the diameter of the articles themselves. Article 6 along the anterior margin with 4 bunches of short spines and 2-3 distal long setae reaching or exceeding the tip of the dactylus (Fig.

4C). Dactylus much shorter than article 6 (ratio: 16:44), relatively slender, along the inner margin with one slender spine, along the outer margin with one median plumose seta; nail shorter than pedestal (ratio: 14:35) (Fig. 4C).

Pereopod 6: article 2 dilated, longer than broad (ratio: 95:58), along anterior slightly convex margin with row of 7-8 short spine-like setae (Fig. 4D), along the posterior margin with 16 short setae, ventroposterior lobe well developed (Fig. 4D). Articles 4-6 of unequal length (ratio: 68:73:87), along both margins with slender spines increasing towards article 6, where the length of the spines exceeds the diameter of the article itself. Dactylus slender, much shorter than article 6 (ratio: 27:87), along the inner margin with one slender spine, along the outer margin with one median plumose seta (Fig. 4E); nail remarkably shorter than pedestal (ratio: 19:59).

Pereopod 7: article 2 longer than broad (ratio: 80:63), along the anterior convex margin with a row of short spines, along the posterior convex margin with 12-13 short setae, ventroposterior lobe well developed. Articles 4-6 of different length (ratio: 60:67:88), along both margins with bunches of spines (Fig. 4F). Dactylus much shorter than article 6 (ratio: 23:88), along the inner margin with one slender spine, along the outer margin with one median plumose seta (Fig. 4G), nail much shorter than pedestal (ratio: 15:52).

Pleopods 1-3 with 2 retinacula each. Peduncle of pleopod 1 along the anterior margin with 1 median seta, along the posterior margin with one proximal seta (Fig. 5C). Peduncle of pleopod 2 at the posterior margin with one proximal seta (Fig. 5D). Peduncle of pleopod 3 along the posterior margin with 3 strong proximal setae (Fig. 5E).

Uropod 1 peduncle slightly shorter than inner ramus (ratio: 70:90), with dorsoexternal and dorsointernal row of strong spines (Fig. 3F); rami slender, outer ramus slightly shorter than inner one; both rami with numerous short strong lateral and distal spines (Fig. 3F).

Uropod 2: peduncle with dorsal median and distal spines; inner ramus poorly longer than outer one, both rami with lateral and distal strong short spines (Fig. 3F).

Uropod 3 relatively short and strong. Peduncle longer than broad, with 3-4 distal spines (Fig. 3G); inner ramus short, scale-like, with 2 distal spines. Outer ramus 2-articulated: first article strong, along outer margin with 5 bunches of short strong spines (Fig. 3G); along inner margin with 7 bunches of slender spines; several single short plumose setae are attached near some of these bunches of spines. Second article of outer ramus short and narrow, shorter than maximal diameter of first article and bearing 2 distal short simple setae (Fig. 3G).

Telson short, as long as broad, incised nearly $\frac{3}{4}$ of telson length; each lobe with 7-8 distal and subdistal slender spines (Fig. 2H), 2-4 spines or spine-like setae and 0-1 facial seta attached along the outer lateral margin; a pair

of short plumose setae attached laterally near the middle of each lobe (Fig. 2H).

Coxal gills on gnathopod 2 and pereopods 3-4 narrowed (Figs. 2E; 3C, E), these on pereopods 5 and 6 small and ovoid (Fig. 4B, D).

Oostegites broad, with short marginal setae (Fig. 2E; 3C, E; 4B) (non ovigerous female).

Adult female, 5.3 mm (Paratype). Oostegites large bearing long marginal setae. Antenna 1 slightly shorter than body (ratio: 41:53), main flagellum with 26 articles; flagellum of antenna 2 with 12 articles. Mesosomal segments smooth, metasomal segments 1-3 with a strongly reduced number of dorsal setae (up to 8 setae on each metasomal segment); urosomal segment 1 on each dorsolateral side with 1 spine, urosomal segment 2 on each dorsolateral side with 3 spines, urosomal segment 3 naked. Urosomal segment 1 on each ventroposterior corner with 1 spine near basis of uropod 1-peduncle.

Shape of epimeral plates 1-3 similar to that in holotype, but the number of subventral spines on the epimeral plates 1-3 is also reduced (no spines on epimeral plate 1; 2 subventral spines on epimeral plates 2 and 3). Mandible palpus with 1-2 A-setae.

Pereopod 7 moderately strong; article 2 slightly longer than broad (ratio: 95:67), almost ovoid, along the anterior margin with a row of 7 spine-like setae, along the posterior margin with 9-10 short setae, ventroposterior lobe well developed (Fig. 5F). Articles 4-6 of unequal length (ratio: 60:69:97), along both margins with strong spines (Fig. 5F); article 2 almost as long as article 6 (ratio: 95:97). Dactylus much shorter than article 6 (ratio: 32:97), at the inner margin with one slender spine near the basis of the nail, along the outer margin with one short plumose seta (Fig. 5G), nail much shorter than pedestal (ratio: 21:63).

Telson is nearly as long as broad, each lobe with 6-7 disto-subdistal spines and one spine-like seta or spine at outer margin, as well as with a single facial spine-like seta (Fig. 5H). Gills on all pereopods larger than those described for the 5.5 mm female above.

Male. Adult male unknown. Juvenile male, 3.3 mm. Uropod 3 similar to that in females, with short second article of outer ramus bearing 3 subdistal short simple setae (Fig. 5I). Telson slightly broader than long, incised $\frac{2}{3}$ of telson length; each lobe with 2 distal and 2 subdistal spines (Fig. 5J); one lateral spine appears along inner margin of right lobe. We suppose that the males are similar to females.

Variability

The figured dactylus of pereopod 7 (Fig. 4G) appears to be slightly deformed. Epimeral plate 1 with or without subventral spine. Number of lateral strong teeth on the outer plate spines of maxilla 1 is rather variable [4 inner spines

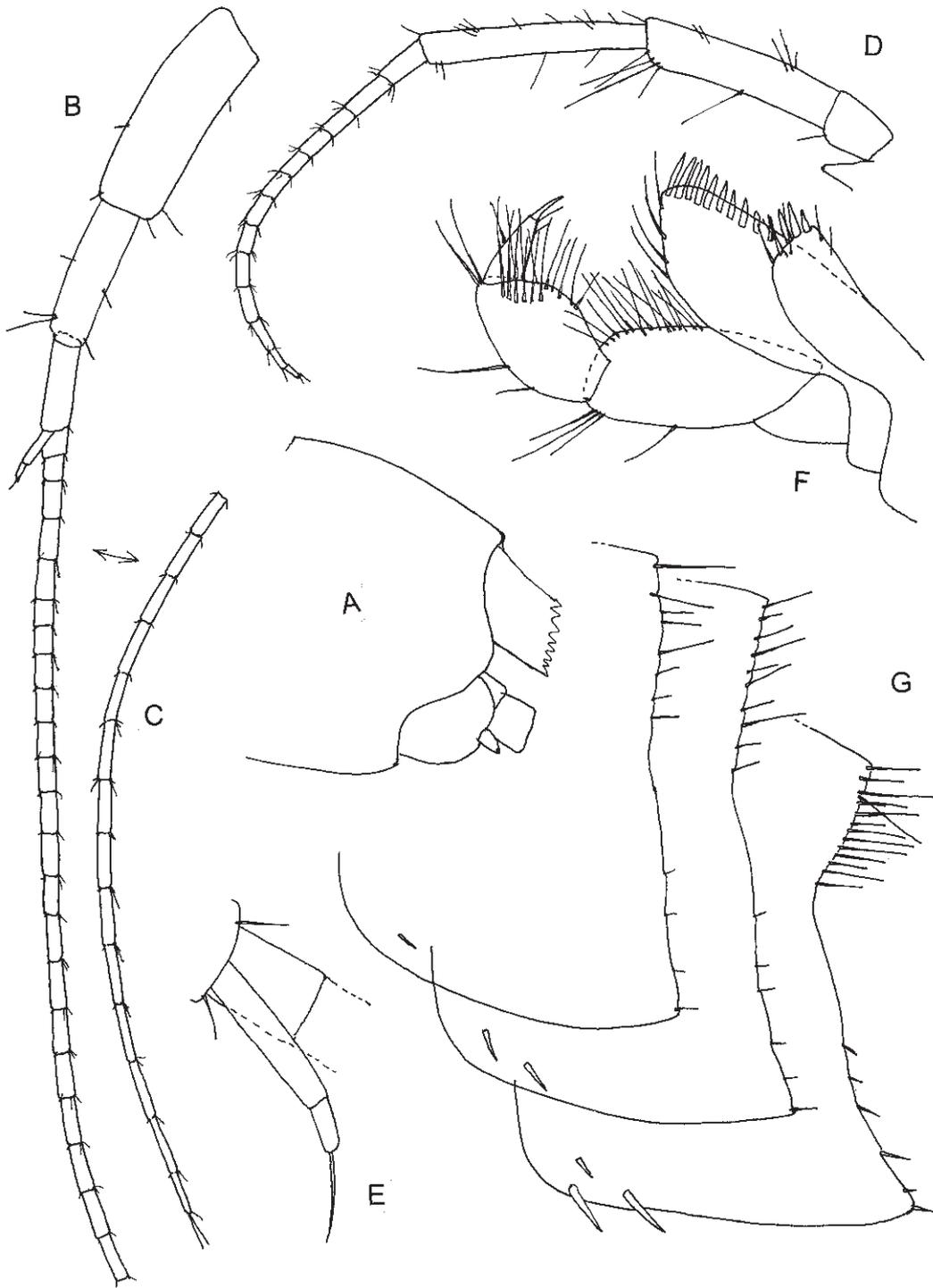


Fig. 1. *Niphargus notenboomius* sp. n., Angles, Gerona, female 5.5 mm. **A**, head; **B-C**, antenna 1; **D**, antenna 2; **E**, accessory flagellum; **F**, maxilliped; **G**, epimeral plates 1-3.

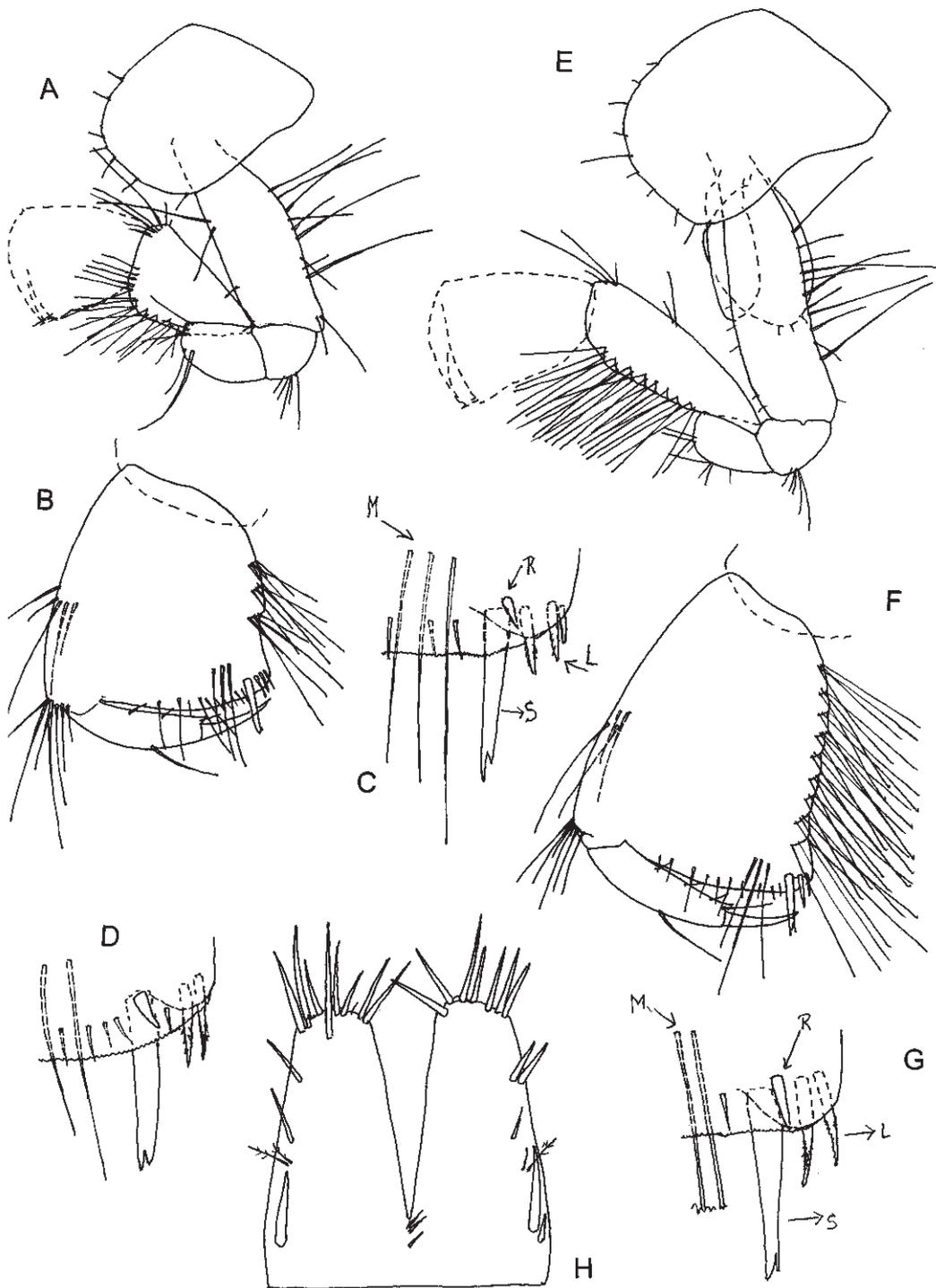


Fig. 2. *Niphargus notenboomius* sp. n., Angles, Gerona, female 5.5 mm. **A-B**, left gnathopod 1, outer face; **C**, distal corner of left gnathopod 1 propodus, inner face (S- corner spine; L- lateral spines; R- subcorner spine; M- facial setae); **D**, distal corner of right gnathopod 1 propodus, inner face; **E-F**, gnathopod 2, outer face; **G**, distal corner of gnathopod 2 propodus, inner face (S- corner spine; L- lateral spines; R- subcorner spine; M- facial setae); **H**, telson.

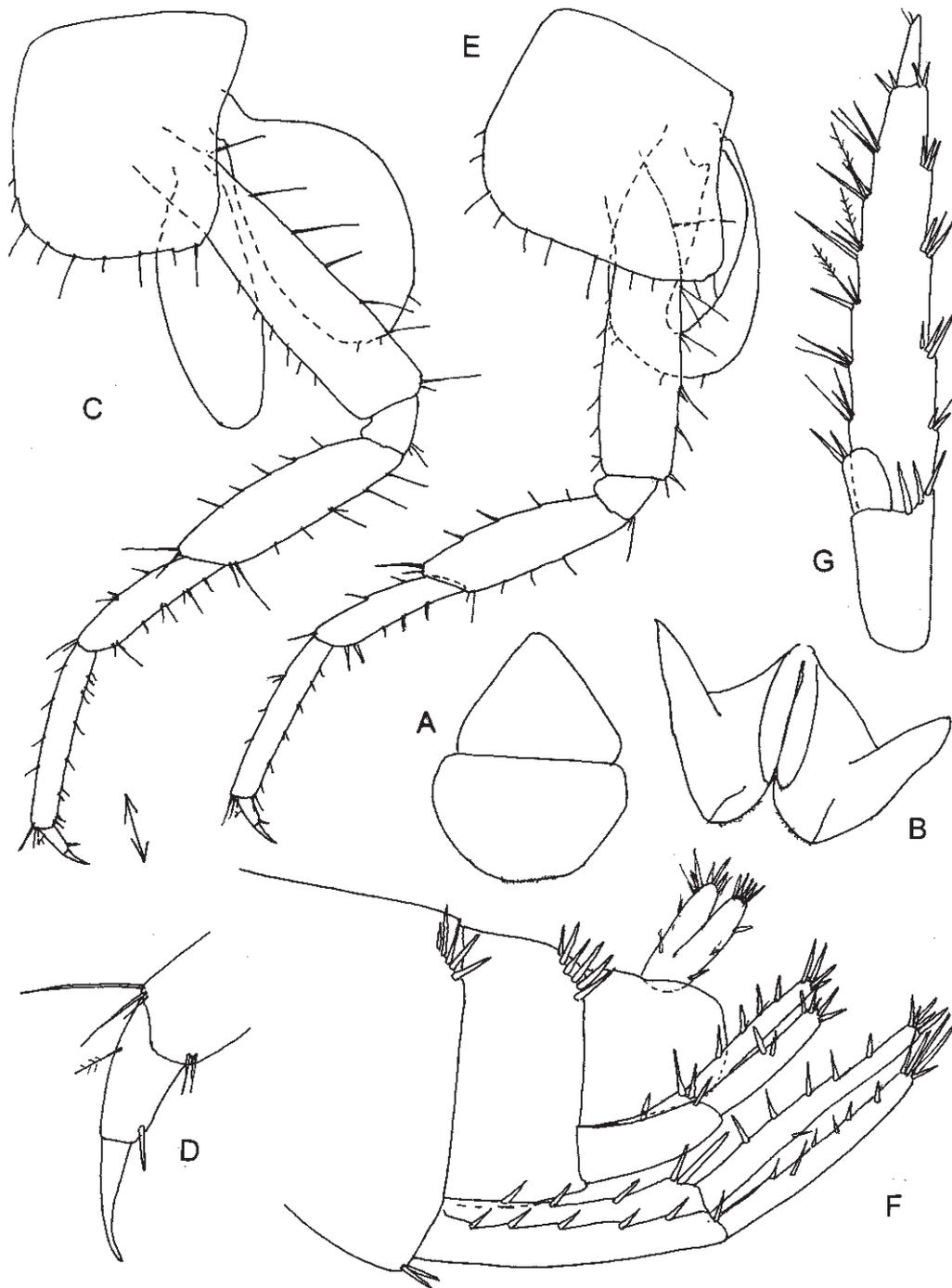


Fig. 3. *Niphargus notenboomius* sp. n., Angles, Gerona, female 5.5 mm. **A**, labrum; **B**, labium; **C-D**, pereopod 3; **E**, pereopod 4; **F**, urosome with uropods 1-2 and telson; **G**, uropod 3.

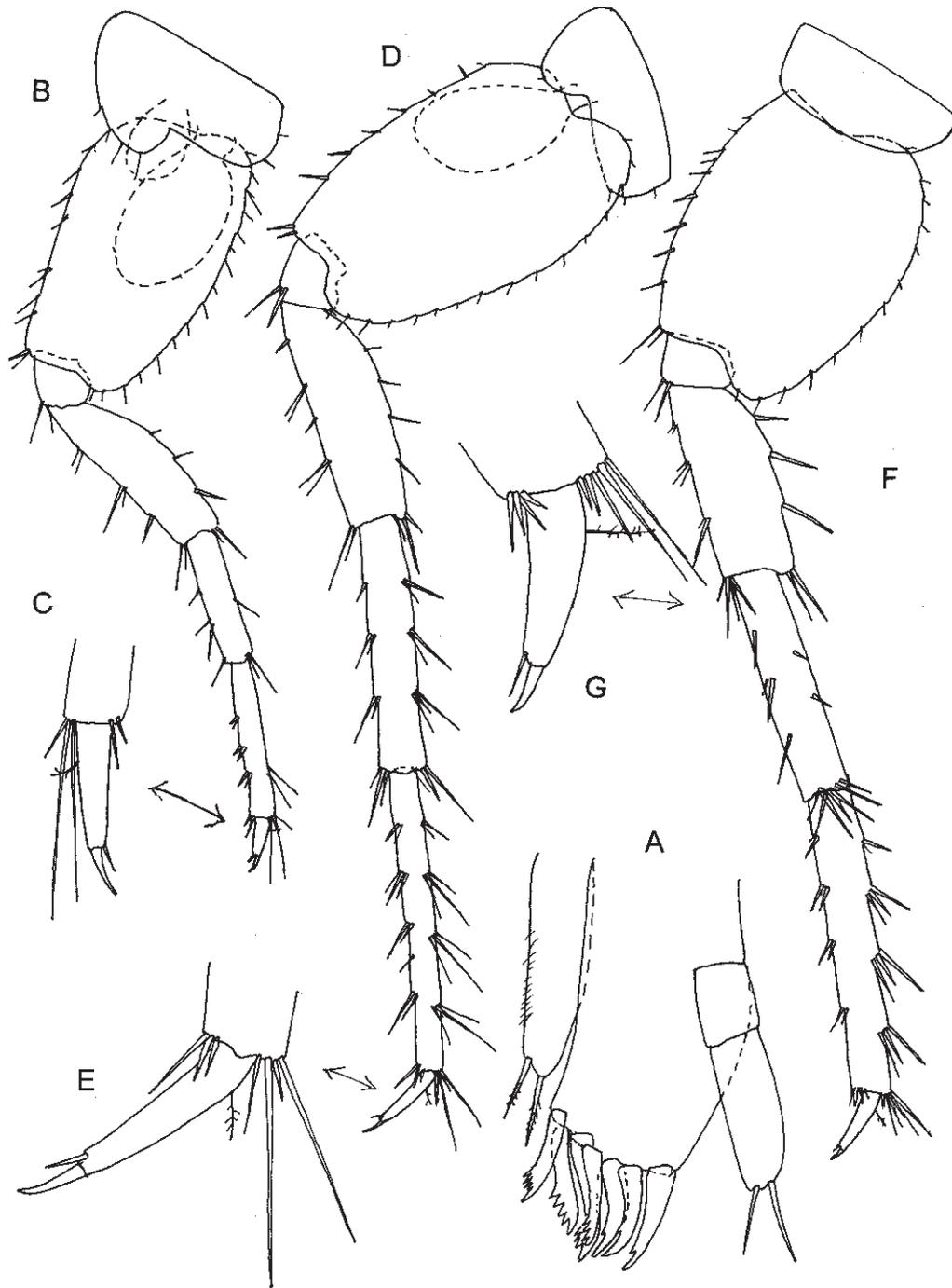


Fig. 4. *Niphargus notenboomius* sp. n., Angles, Gerona, female 5.5 mm. **A**, maxilla 1; **B-C**, pereopod 5; **D-E**, pereopod 6; **F-G**, pereopod 7.

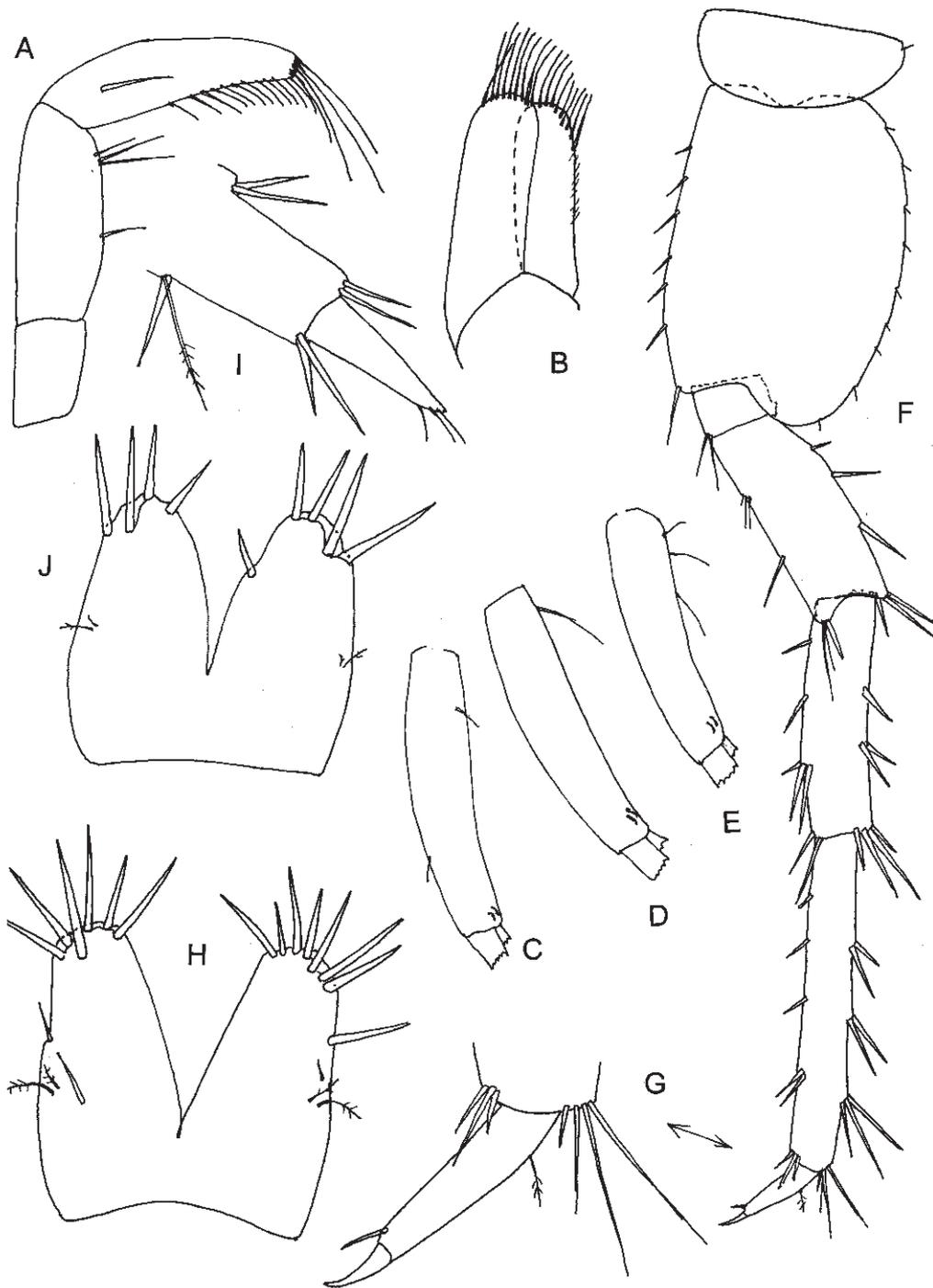


Fig. 5. *Niphargus notenboomius* sp. n., Angles, Gerona, female 5.5 mm. **A**, mandible palpus, outer face; **B**, maxilla 2; **C-E**, peduncle of pleopods 1-3. **F-G**, pereopod 7, female 5.3 mm; **H**, telson, female 5.3 mm. **I**, tip of uropod 3 outer ramus, male 3.3 mm; **J**, telson, male 3.3 mm.

with 2-5 teeth, 3 outer spines with 1 lateral tooth). Along the outer margin of palpus articles 2-3 of maxilliped appear 1-2 median setae, distal setae are always present.

Urosomal segment 1 usually with 2-3, or rarely only 1 spine on each dorsolateral side, urosomal segment 2 with 3-6 spines on each dorsolateral side, but smaller specimens have a lower number of these spines.

Urosomal segment 1 on each ventroposterior corner with 1, exceptionally 2 spines near the basis of uropod 1 peduncle. Inner ramus of uropods 1-2 is slightly longer than the outer ramus, or almost as long as the outer ramus. The number of facial and marginal spines on the telson is rather variable, but the number of distal slender spines is always elevated.

Remarks and affinity

Based on the shape of gnathopods, pereopods, mouthparts and uropods, this species has affinity to the *N. kochianus* group of taxa, although it differs from all other taxa of this group by setose metasomal segments.

In Western Europe, *N. kochianus* Bate, 1859 differs distinctly from *N. notenboomius* by the different shape and armature of the telson. Similar narrowed gnathopods with elongated article 5 appear in several species of Italy: *N. messanai* G. Karaman, 1989 from Caldine, Italy, *N. longidactylus* Ruffo, 1937 from Verona, *N. italicus* G. Karaman, 1976 from Bergamo, *N. danconai* Benedetti, 1942 from Verona, but our species differs from all these taxa by setose metasomal segments 1-3, a long outer plate of maxilliped and by a combination of other taxonomical characters.

Similar species, *Niphargus petrosani* Dobreanu & Manolache, 1933 from Petrosani in Romania, is close to *N. notenboomius* because of scarcely setose mandible palpus, *kochianus*-type gnathopods 1-2 with elongated carpus, acute epimeral plates 1-3, as well as 2 retinacula on pleopods 1-3, lobate basipodites of pereopods 5-7, etc.; however, it differs from *N. notenboomius* by maxilla 1 (inner plate with 1 seta, 6 spines of outer plate spines with 1 lateral tooth), a shorter outer plate of maxilliped, less spinose telson, etc.

Niphargus stygocharis Dudich, 1943, known from Romania, is also very similar to *N. notenboomius* (elongated carpus of gnathopods 1-2, acute epimeral plates, long outer plate of maxilliped, etc.), but differs from *N. notenboomius* by different maxilla 1, narrowed and less spinose telson, as well as by the presence of 3 retinacula on pleopods 1-3, etc.

Stock & Gledhill (1977) studied the *N. kochianus* group of taxa from Western Europe [*kochianus kochianus* Bate, 1959, described from S. England, *N. kochianus irlandicus* Schellenberg 1932 (described from Ireland), *N. kochianus dimorphopus* Stock & Gledhill, 1977 (loc. typ.: Necum, S. of Maastricht, Holland) and *N. pachypus* Schellenberg,

known from France and Holland]; however, all of these taxa differ distinctly from *N. notenboomius* by setose metasomal segments, as well as shape and armature of the telson, etc.

Holotype female (5.5 mm) is provisionally deposited in KARAMAN's Collection in Podgorica, Montenegro.

Locus typicus. Well near an abandoned farm house just N of the road to Gerona, about 2 km from Angles (16 km WSW of Gerona), alt. 200 m a.s.l., Spain.

Derivatio nominis. This species is dedicated to Dr. Jos Notenboom from Holland who collected this species.

Niphargus laisi geronensis ssp. n.

(Figs 6-10)

Material examined

Spain (Province Gerona):

86-8/40. Well 150 m S. of the road to Peralada, about 2 km from Garriguella (12 km NE of Figueras), alt. 50 m a.s.l. 14.8.1986, 14 exp. (holotype and paratypes), mixed with *N. notenboomius* and *Niphargus* sp.) (Leg. J. Notenboom);

86-8/30. Riu Fluvia, near a railway bridge SW of Sant Miguel de Fluvia (12 km SSE of Figueras), alt. 50 m a.s.l., 13.8.1986, 4 exp. mixed with *N. notenboomius* and *Niphargus* sp.) (Leg. J. Notenboom).

Diagnosis

Antenna 1 peduncular articles 1-3 progressively shorter, article 3 elongated. Accessory flagellum 2-articulated. Antenna 2 peduncular article 5 longer than 4, flagellum shorter than peduncular article 5, consisting of 5 articles only. Epimeral plates 1-3 pointed. Urosomal segment 1 with very strong spine on each ventroposterior side near basis of uropod 1 peduncle. Coxae 1-4 longer than broad, coxa 1 rhomboid; coxa 4 with ventroposterior lobe, coxa 5 much shorter than 4.

Mandible palpus article 2 scarcely setose (4 setae), article 3 falciform, with 2 A-setae, B-setae absent.

Maxilla 1 inner plate with 2 setae, outer plate with 7 spines bearing 3-5 lateral teeth each, palpus with 3 setae. Maxilliped inner plate nearly reaching outer tip of first palpus article, bearing 2 distal slender spines.

Gnathopods 1 and 2 dissimilar in size and shape. Gnathopod 1 propodus trapezoid, with palm inclined nearly half of the propodus length. Gnathopod 2 propodus almost egg-shaped, with scarce number of transverse groups of setae along posterior margin, palm inclined $\frac{3}{4}$ of propodus length, with L-spine sitting behind S-spine. Dactylus of gnathopods

1-2 with one median seta along outer margin, inner margin almost naked.

Dactylus of pereopods 3-7 with slender spine or spine-like seta at the inner margin near the basis of the nail. Pereopods 5-7 with ventroposterior lobe on article 2. Pleopods with 2 retinacula, peduncle without setae.

Uropods 1-2 with inner ramus slightly longer than the outer ramus. Uropod 3 short and strong, first article of the outer ramus with lateral plumose setae and spines, second article very short. Telson narrow, deeply incised, lobes with distal spines and one subdistal very long plumose seta.

Description

Female (ovigerous), 4.5 mm (Holotype). Body relatively slender, mesosomal segments naked, metasomal segments 1-3 with 3-4 short dorstoposterior marginal setae each (Fig. 7E). Epimeral plates 1-2 slightly pointed, along posterior scarcely sinusoid margin with 2-5 short setae; epimeral plate 2 with 2 subventral spines. Epimeral plate 3 sharply pointed, with 3 subventral spines and along the posterior concave margin with 4 short setae (Fig. 7E).

Urosomal segment 1 on each dorsolateral side with 1 strong spine; urosomal segment 2 on each dorsolateral side with 3 strong spines; urosomal segment 3 naked (Fig. 8G). Urosomal segment 1 on each ventroposterior corner with very strong spine near the basis of uropod 1 peduncle (Fig. 8G).

Head with short rostrum and short subrounded lateral cephalic lobes, ventroanterior sinus developed (Fig. 6A), eyes absent.

Antenna 1 reaching nearly half of the body length. Peduncle slender, peduncular articles 1-3 progressively shorter (ratio: 80:70:50), scarcely setose (Fig. 6B); article 1 at ventral margin with 1 proximal spine and distal plumose seta; article 2 at ventral margin with 2 distal plumose setae; article 3 with one bunch of median and distal short setae. Flagellum scarcely setose, nearly as long as peduncle, slender, consisting of 12 articles (most of articles with 1 aesthetasc). Accessory flagellum 2-articulated, shorter than last peduncular article (ratio: 20:50) (Fig. 6C).

Antenna 2 slender, shorter than antenna 1. Peduncle much longer than flagellum (ratio: 210:72); peduncular article 3 short, bearing 1 ventral short seta; article 4 at the dorsal margin with one median spine and several short setae, at the ventral margin with one distal spine and bunches of long setae; one median long simple seta is attached at the ventral margin (Fig. 6D). Article 5 is longer and more slender than article 4 (ratio: 107:84), along both margins with short setae; single longer setae appear at the tip of the article. Flagellum very slender, much shorter than the last peduncular article (ratio: 70:107), consisting of 5 elongated articles (Fig. 6D). Antennal gland cone short (Fig. 6D).

Mouthparts well developed. Labrum much broader

than long, with convex distal margin (Fig. 9A). Labium with well developed inner lobes, outer lobes with entire margins (Fig. 8A).

Mandibles with triturative molar, molar of right mandible with one long lateral seta. Left mandible: incisor with 5 teeth and lacinia mobilis with 4 teeth and 5 rakers. Right mandible: incisor with 4 teeth and lacinia mobilis bifurcate, pluritoothed, accompanied by 5 rakers (Fig. 6E). Palpus 3-articulate: first article smooth; second article slightly dilated, with 4 setae (Fig. 6F); article 3 is falciform, longer than article 2 (ratio: 82:66), bearing 12 D-setae, 3 long distal E-setae, on outer face appear 2 A-setae (Fig. 6F), B-setae absent.

Maxilla 1: inner plate with 2 strong distal setae (Fig. 6G), outer plate with 7 distal spines bearing 3-5 lateral teeth each; palpus 2-articulated, reaching the tip of the outer plate spines, provided with 3 distal setae (Fig. 6G).

Maxilla 2: inner plate is slightly smaller than the outer one, both plates with distal setae only (Fig. 8B).

Maxilliped: inner plate nearly reaching the outer tip of first palpus article, bearing 2 distal slender spines and several setae (Fig. 8C); outer plate not or almost reaching the outer distal tip of palpus article 2, bearing 11-12 strong distolateral spines. Palpus article 2 at the inner margin with 10-11 setae. Palpus article 3 with numerous distal setae; palpus article 4 (dactylus) at the inner margin with 2 distal short setae near the basis of the nail, at the outer margin with one median seta (Fig. 8C), nail much shorter than pedestal.

Coxae 1-4 moderately long, scarcely setose, much longer than coxae 5-7. Coxa 1 longer than broad (ratio: 56:37), with nearly parallel lateral margins and subrounded ventroanterior corner (Fig. 7A). Coxa 2 longer than broad (ratio: 77:50), bearing 6 ventromarginal short setae (Fig. 7C). Coxa 3 longer than broad (ratio: 80:53), bearing 5-6 ventromarginal setae (Fig. 8D). Coxa 4 slightly longer than broad (ratio: 90:70), with well developed ventroposterior lobe and provided with 7-8 marginal setae (Fig. 8F).

Coxa 5 much shorter than coxa 4, much broader than long (ratio: 67:45), with anterior lobe subrounded ventrally (Fig. 9B).

Coxa 6 shorter than coxa 5, but of similar shape, with subrounded anterior lobe (Fig. 9D).

Coxa 7 is entire, broader than long (ratio: 62:26), with a convex ventral margin, subrounded anterior margin and almost acute proximoposterior corner (Fig. 9F).

Gnathopods 1-2 moderately large, of different shape, gnathopod 2 much larger than gnathopod 1 (Fig. 7A, C).

Gnathopod 1: article 2 along the anterior margin with a row of 5 long and 2 short setae, along the posterior margin with 2 long and 3 short setae (Fig. 7A); article 3 at the posterior margin with one bunch of 3 short setae. Article 5 slightly shorter than propodus (ratio: 43:50 or 53:64), along the posterior margin with 2 transverse rows of long setae. Propodus trapezoid, nearly as long as broad, along the posterior margin with 6 transverse rows of setae (Fig. 7B). Palm

slightly convex, inclined nearly half of propodus length, defined on the outer face by 1 corner S-spine, accompanied laterally by 2 short serrate L-spines and one facial M-seta, on the inner face by 1 subcorner R-spine. Dactylus slender, reaching the posterior margin of the propodus, bearing at the outer margin one median short seta (Fig. 7B), along the inner margin setae are absent.

Gnathopod 2: article 2 along the anterior margin with several short setae, along the posterior margin with 6-7 long proximal setae and 2-3 short distal setae (Fig. 7C); article 3 at the posterior margin with one bunch of 1-2 setae. Article 5 slightly elongated, shorter than article 6 (propodus) (ratio: 55:80 or 76:109), bearing numerous setae at the posterior margin. Propodus large, almost egg-shaped, longer than broad (ratio: 109:72), along the posterior margin with 4 transverse rows of a scarce number of setae (Fig. 7D). Palm convex, strongly inclined nearly $\frac{3}{4}$ of propodus-length, defined on the outer face by one strong S-spine and 1 short serrate L-spine sitting behind the S-spine, and one facial M-seta, on the inner face by 1 short subcorner R-spine (Fig. 7D). Dactylus reaching the posterior margin of propodus, with one short median seta at the outer margin (Fig. 7D), setae at the inner margin are absent.

Pereopods 3-4 relatively slender, very scarcely setose. Pereopod 3: article 2 long, along the anterior margin with one short distal seta only, along the posterior margin with 2 long proximal and 2 short distal setae (Fig. 8D). Articles 4-6 of unequal length (ratio: 55:38:42), along both margins with several very short setae (Fig. 8D). Dactylus much shorter than article 6 (ratio: 19:42), relatively slender, along the inner margin with one spine-like seta near basis of the nail, along the outer margin with one median plumose seta (Fig. 8E); nail is long, shorter than pedestal (ratio: 30:44).

Pereopod 4: article 2 along the anterior margin with 3 short setae, along the posterior margin with 2 long setae in proximal part and 3 short setae in distal part of article. Articles 4-6 of unequal length (ratio: 47:36:44), along both margins with several short setae (Fig. 8F). Dactylus relatively slender, much shorter than article 6 (ratio: 15:44), like that of pereopod 3, with one spine-like seta at the inner margin and one plumose median seta at the outer margin.

Pereopods 5-7 of moderate length. Pereopod 5 slightly shorter than pereopods 6-7, with article 2 dilated, much longer than broad (ratio: 93:57), slightly tapering distally; along the convex anterior margin with a row of 12 short spines (Fig. 9B), along the posterior slightly convex margin with 7 short setae, ventroposterior lobe shallow. Articles 4-6 of unequal length (ratio: 52:60:68), along both margins with strong spines (Fig. 9B); article 2 is longer than article 6 (ratio: 93:68). Dactylus much shorter than article 6 (ratio: 28:68), along the inner margin with one slender spine, along the outer margin with one long median plumose seta (Fig. 9C), nail much shorter than pedestal (ratio: 20:49).

Pereopod 6: article 2 much longer than broad (ratio:

117:67), along the anterior margin with a row of 7 short slender spines, along the posterior margin with 9 short setae, ventroposterior lobe developed (Fig. 9D); articles 4-6 of unequal length (ratio: 65:67:95), along both margins with slender spine-like setae or spines; the longest setae on article 6 slightly longer than the diameter of the article itself. Article 2 slightly longer than article 6 (ratio: 117:95). Dactylus relatively slender, much shorter than article 6 (ratio: 33:95), along the inner margin with 1 slender spine, along the outer margin with one median plumose seta (Fig. 9E); nail much shorter than pedestal (ratio: 17:53).

Pereopod 7: article 2 ovoid, longer than broad (ratio: 98:67), along the anterior convex margin with 6-7 short spines, along the posterior convex margin with 9-10 short setae, ventroposterior lobe well developed (Fig. 9F); article 4 along both margins with spines (Fig. 9F); articles 5-7 missing.

Pleopods 1-3 with 2 retinacula each. Peduncle of all pleopods naked.

Uropods 1-2 relatively stout. Uropod 1: peduncle with dorsoexternal and dorsointernal row of spines (Fig. 8G); inner ramus slightly longer than the outer ramus, both rami bearing lateral and distal short strong spines (Fig. 8G).

Uropod 2: outer ramus shorter than inner, both rami with lateral and distal short strong spines (Fig. 8G).

Uropod 3: short and strong. Peduncle slightly longer than broad, with 2-3 distal spines. Inner ramus short, scale-like, with distal spine and plumose seta (Fig. 9G). Outer ramus 2-articulated: first article strong, along outer margin with 4 bunches of strong spines, along inner margin with 4-5 spines accompanied by single strong setae and long plumose setae; second article very short, with 2 short subdistal simple setae only (Fig. 9G).

Telson relatively long, tapering distally, deeply incised, much longer than broad (ratio: 85:65), each lobe with 3 distal slender unequal spines; along the outer margin one very long and one short plumose seta are attached in a subdistal position (Fig. 10H).

Coxal gills 2-6 relatively short (Figs. 7C; 8D, F; 9B, D). Oostegites very large, with marginal setae (Figs. 7C; 8D, F; 9B).

Female, 3.5 mm (Paratype). Similar mainly to holotype. Pereopods 6 and 7 of nearly equal length. Pereopod 7 relatively strong: article 2 ovoid, longer than broad (ratio: 95:65), along the anterior margin with 7-8 short spine-like setae or spines, along the posterior margin with 9 short setae; ventroposterior lobe well developed (Fig. 10J); articles 4-6 of unequal length (ratio: 55:60:89), along both margins with strong spines (Fig. 10J). Article 2 slightly longer than article 6 (ratio: 95:89). Dactylus much shorter than article 6 (ratio: 30:89), at the inner margin with one slender spine, at the outer margin with one median long plumose seta (Fig. 10K); nail much shorter than pedestal (ratio: 18:57).

Variability

Male, 5.0 mm. Similar to females, character present also in many taxa of the *N. jovanovici* complex [subgenus *Jovaniphargus* S. Karaman, 1960, type species: *Niphargus jovanovici* S. Karaman, 1931]. Mouthparts similar to those in females.

Coxae 1-4 slightly elongated, with a scarce number of short marginal setae. Coxa 1 longer than broad (ratio: 52:36), with straight anterior margin and subrounded ventroanterior corner (Fig. 10A). Coxa 2 remarkably longer than broad (ratio: 70:44), with 5 marginal setae (Fig. 10B). Coxa 3 much longer than broad (ratio: 82:43), with 4-5 short distal setae (Fig. 10C). Coxa 4 slightly longer than broad (ratio: 90:80), with developed ventroposterior dilatation and bearing 10 short marginal setae (Fig. 10D). Coxae 5-7 similar to those in females.

Gnathopods 1 and 2 are dissimilar in shape and size. Gnathopod 1: article 3 at the posterior margin with one bunch of setae; article 5 shorter than article 6 (ratio: 49:65) (Fig. 10E). Propodus trapezoid, slightly broader than long (ratio: 70:65), along the posterior margin with 6 transverse rows of setae (Fig. 10E). Palm convex, inclined nearly half of the propodus length, defined on the outer face by 1 corner S-spine, accompanied laterally by 2 slender serrate L-spines and one facial M-seta, on the inner face by one subcorner short R-spine (Fig. 10F). Dactylus reaching the posterior margin of propodus, along the outer margin with 1 median short seta (Fig. 10E).

Gnathopod 2 much larger than gnathopod 1, with article 3 bearing along the posterior margin one bunch of setae. Article 5 shorter than article 6 (ratio: 75:105), without setae at the anterior margin (Fig. 10G). Propodus large, egg-shaped, longer than broad (ratio: 105:87), along the posterior margin with 2 transverse scarce rows of setae (Fig. 10G). Palm convex, defined on outer face by 1 strong corner S-spine accompanied by one L-spine sitting behind S-spine, and with 1 facial M-seta (Fig. 5G); one subcorner R-spine moved more laterally (Fig. 10H). Dactylus slender, not reaching the posterior margin of propodus, with long nail reaching nearly half of pedestal length and bearing at the outer margin one median short simple seta (Fig. 10G), inner margin naked. Pereopods and uropods 1-3 like those in females.

Telson longer than broad, tapering distally, deeply incised (Fig. 10I); much longer than broad (ratio: 76:65); each lobe with 3 short distal spines and 1 short seta (on one lobe); one very long and one short plumose seta appear in subdistal external part of each lobe (Fig. 10I).

Male, 4.0 mm. Mouthparts like those in the 5 mm male. Maxilliped inner plate almost reaching the outer tip of the palpus article 1, bearing 2 distal slender spines and several setae, outer plate nearly reaching the distal tip of palpus article 2. Gnathopods 1-2 with elongated article 5. Gnathopod 1 propodus along the posterior margin with 4 transverse

groups of scarce number of setae, palm with 1-2 L-spines. Palm of gnathopod 2 propodus with S, L and R spines like those in the 5 mm male specimen.

Urosomal segment 1 with 2 spines on each dorsolateral side, metasomal segments 1-3 with 4-5 setae each.

Remarks and affinity

The specimens from Spain described in the present study are very similar (after the description and Figures) to *Niphargus laisi* Schellenberg, 1936, described from Germany (Gunglingen, Feldkirch, Ringsheim, Grezhausen und Leben [Baden region]). Schellenberg mentioned this species later (1942) for "oberrheinische" Ebene, Freiburg region in Germany. Barnard and Barnard (1983) and G. Karaman and Ruffo (1986) cited this species, but without any new data or localities. Later no new data of this species were cited.

Schellenberg described and Figured *N. laisi* based on a female of 7.0 mm, and our specimens (up to 5.0 mm) agree by numerous characters with Schellenberg's description: dissimilar gnathopods 1-2, maxilla 1, lobed coxa 4, lobed article 2 of pereopod 7, dactylus of pereopods with slender spine at inner margin, short strong uropod 3 with plumose setae along inner margin of outer ramus, acute epimeral plates, narrowed and deeply incised telson bearing distal spines only and provided with one very long plumose subdistal seta.

The specimens from Spain differ from the description and Figures of *N. laisi* (Schellenberg, 1936, 1942) by an elongated carpus of gnathopod 2 (which is not elongated in *N. laisi*), by a trapezoid propodus of gnathopod 1 (nearly *kochianus*-type of propodus in *N. laisi*), by rhomboid coxa 1 (almost quadrate in *N. laisi*); by the presence of 1-2 spines on each dorsolateral side of urosomal segment 1 in females (1 seta in females, and 1 spine in males of *N. laisi*), by an inner plate of maxilliped not exceeding the tip of the first palpus article (distinctly exceeding in *N. laisi*), the posterior margin of gnathopod 2- propodus bearing 2-4 scarce transverse bunches of setae (3-5 in *N. laisi*). Thus, we consider the populations from Spain described in the present study to be a distinct subspecies, *Niphargus laisi geronensis*, ssp. n.

As the description of *N. laisi* made by Schellenberg is rather scarce and numerous taxonomical characters are unknown (shape of antennae 1 and 2, shape of uropod 1, some mouthparts, etc.), it is not possible to establish other possible taxonomical differences between the German and Spanish populations. For this reason, we cannot exclude the possibility that the differences mentioned for populations from Spain will drop within the limits of the variability of *N. laisi*, despite the distance of over 700 km between them.

Holotype female (4.5 mm) is provisionally deposited in the "Karaman's" Collection in Podgorica, Montenegro.

Derivatio nominis. The name "*geronensis*" is derived

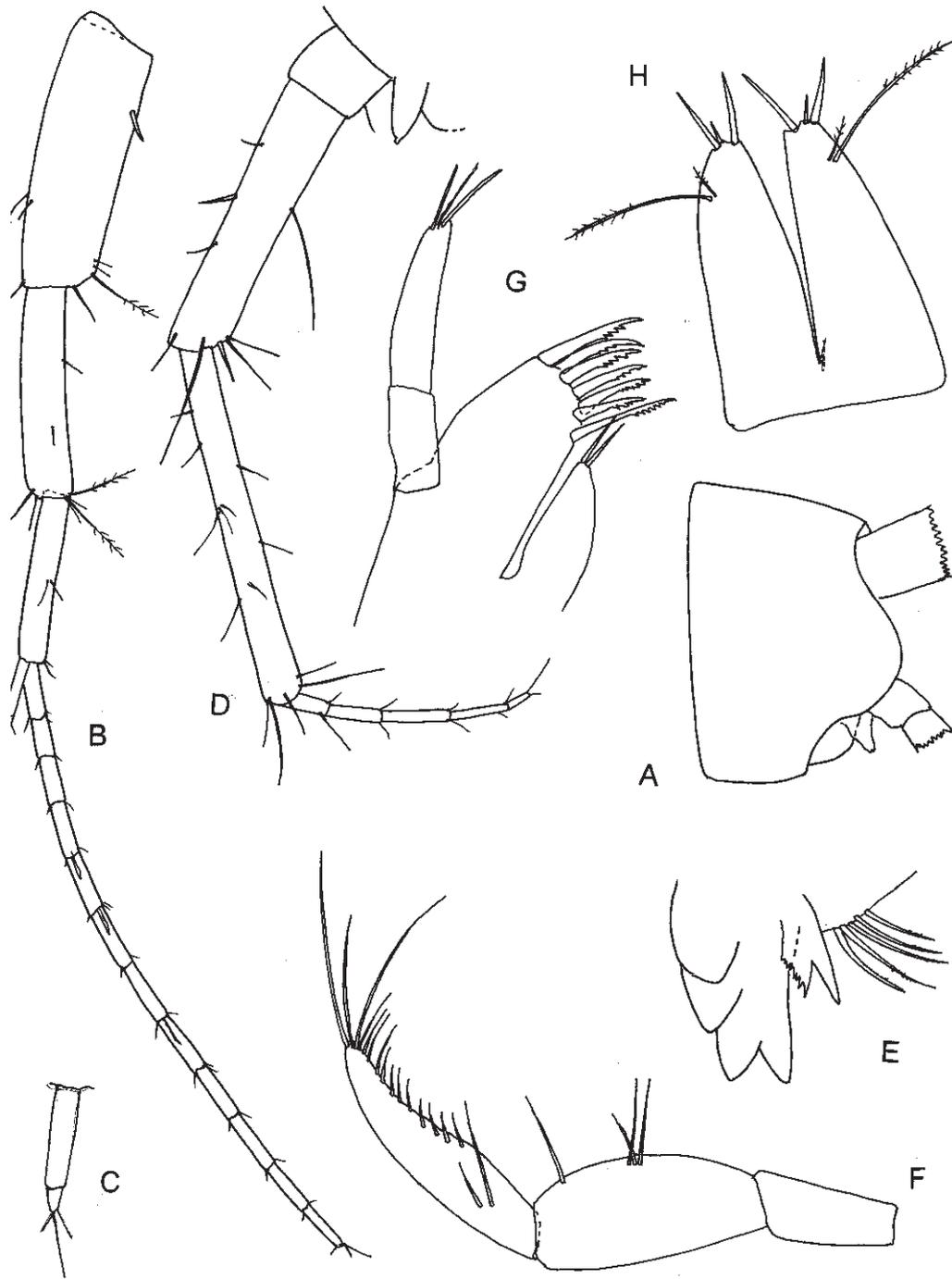


Fig. 6. *Niphargus laisi geronensis* ssp. n., Garriguella, Figueras, female 4.5 mm. **A,** head; **B,** antenna 1; **C,** accessory flagellum; **D,** antenna 2; **E,** right mandible, incisor, lacinia mobilis and rakers; **F,** mandible palpus, outer face; **G,** maxilla 1; **H,** telson.

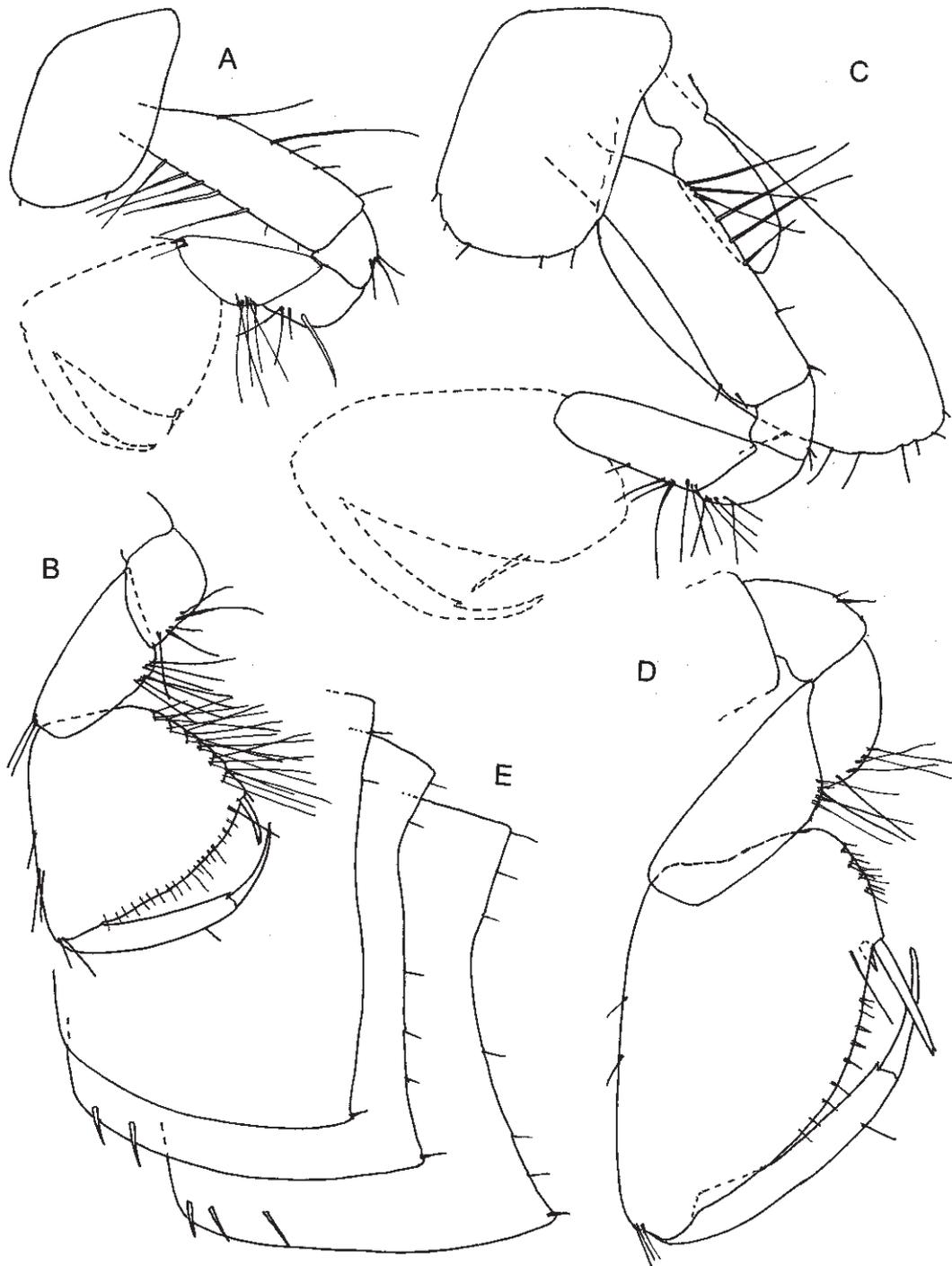


Fig. 7. *Niphargus laisi geronensis* ssp. n., Garriguella, Figueras, female 4.5 mm. **A**, gnathopod 1, outer face; **B**, distal part of gnathopod 1, outer face; **C**, gnathopod 2, outer face; **D**, carpus and propodus of gnathopod 2, outer face; **E**, epimeral plates 1-3.

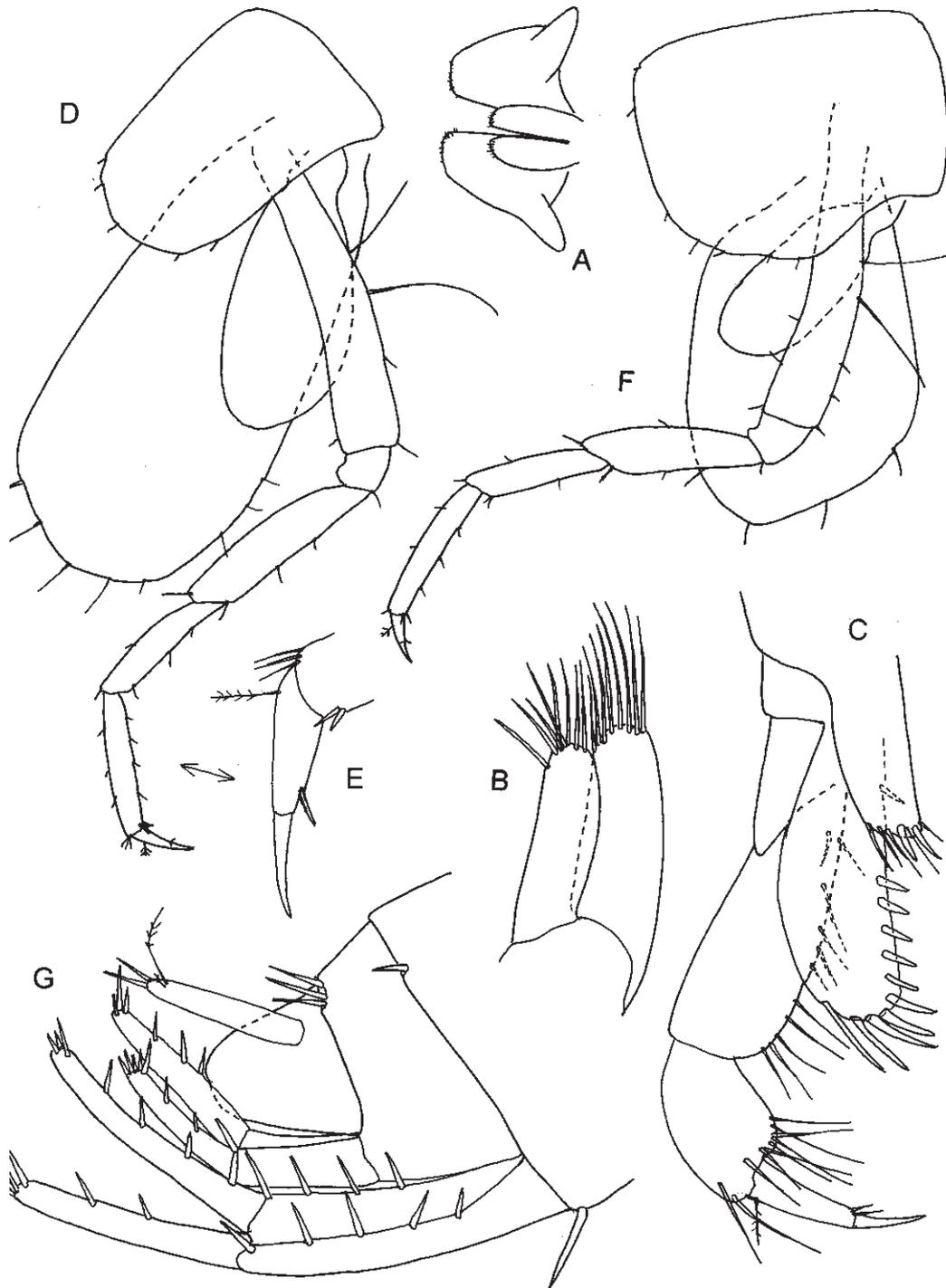


Fig. 8. *Niphargus laisi geronensis* ssp. n., Garriguella, Figueras, female 4.5 mm. **A**, labium; **B**, maxilla 2; **C**, maxilliped; **D-E**, pereopod 3; **F**, pereopod 4; **G**, urosome with uropods 1-2.

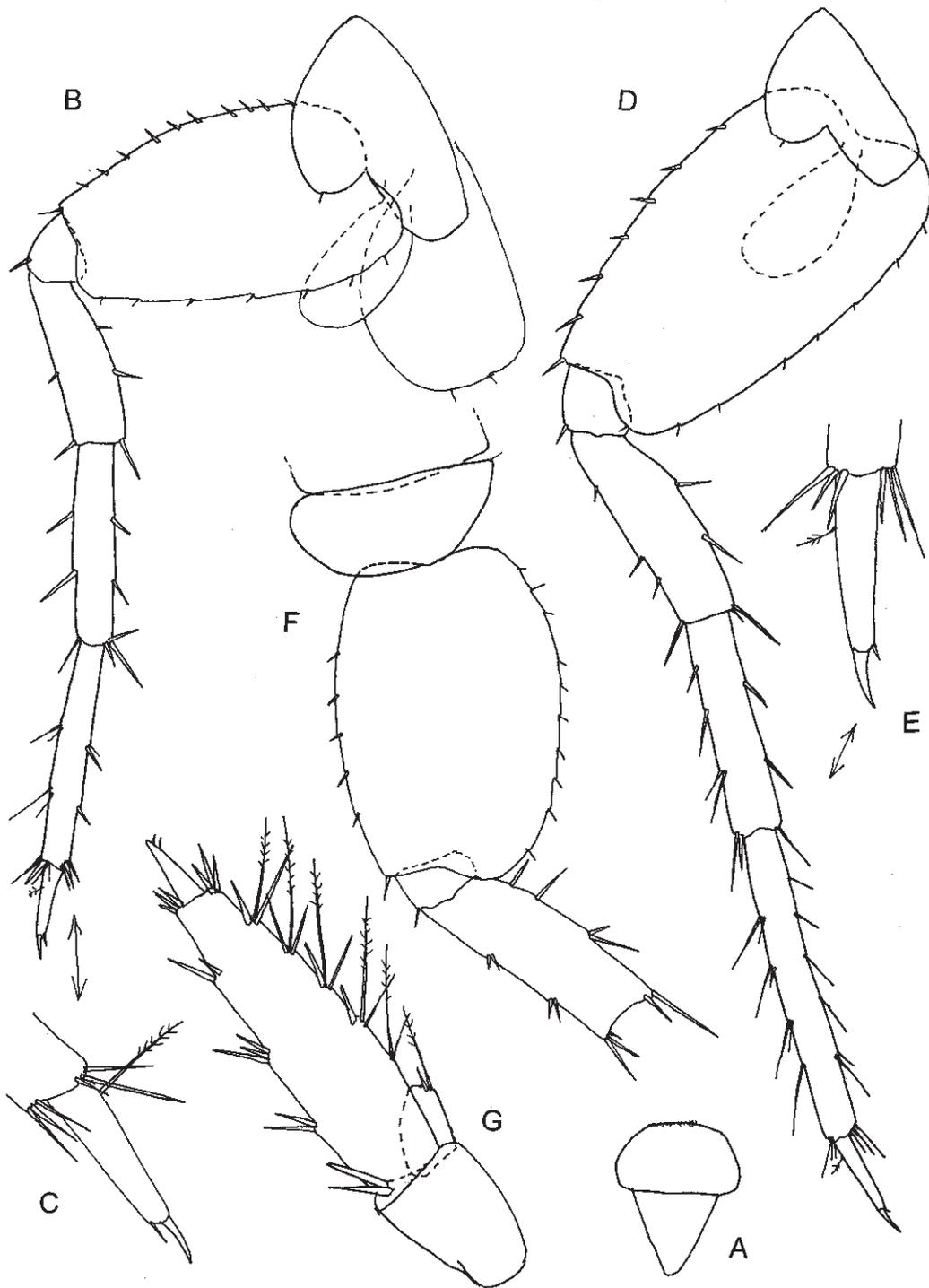


Fig. 9. *Niphargus laisi geronensis* ssp. n., Garriguella, Figueras, female 4.5 mm. **A**, labrum; **B-C**, pereopod 5; **D-E**, pereopod 6; **F**, pereopod 7 (missing distal part); **G**, uropod 3.

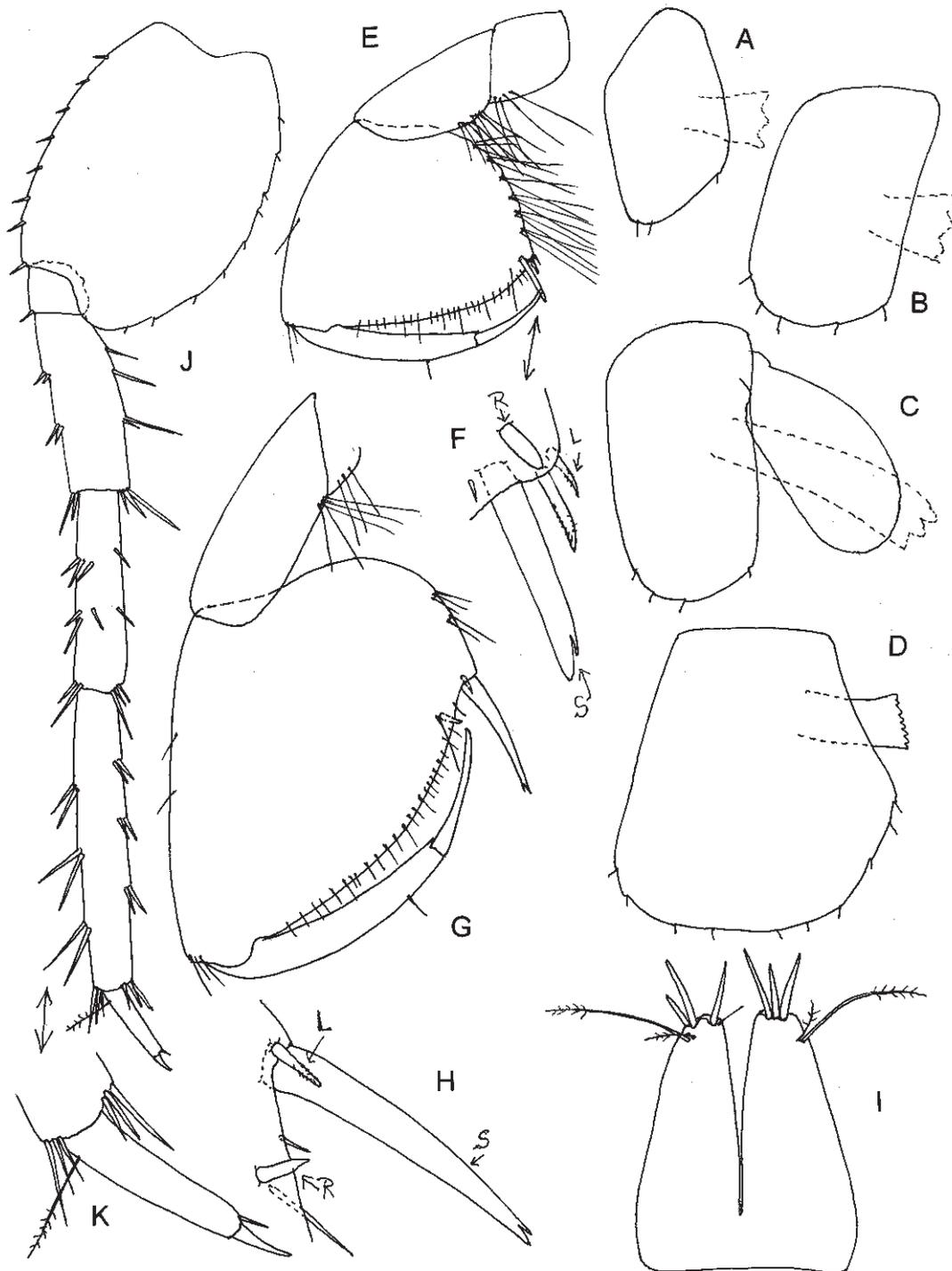


Fig. 10. *Niphargus laisi geronensis* ssp. n., Garriguella, Figueras, male 5.0 mm. **A**, coxa 1; **B**, coxa 2; **C**, coxa 3; **D**, coxa 4; **E**, distal part of gnathopod 1, outer face; **F**, distal corner of gnathopod 1 propodus, inner face (S- corner spine; L- lateral spine; R- subcorner spine); **G**, propodus and carpus of gnathopod 2, outer face; **H**, distal corner of gnathopod 2 propodus, inner face (S- corner spine; L- lateral spine; R- subcorner spine); **I**, telson; **J-K**, pereopod 7 (female 3.5 mm).

from the name of the region of Spain “Gerona”, where this species has been collected.

CONCLUSIONS

Fauna of the subterranean genus *Niphargus* Schiödte, 1849 (Amphipoda, fam. Niphargidae) has only been partially studied in Spain and remains poorly known, although in Spain’s subterranean waters the genus *Haploginglymus* Mateus & Mateus, 1958 has replaced the genus *Niphargus*. Because of this, species of the genus *Niphargus* have settled only in regions of Spain near the French border, represented only by several known species. Our discovery of new taxa in Spain shows the evident connections between *Niphargus* fauna of Spain with that from France, and suggests that more taxa of this genus could be discovered in the future in this region.

ACKNOWLEDGMENTS

I am thankful to Dr. Jos Notenboom from Holland for the loan of material used in the present study.

REFERENCES

- Balazuc J. 1954. Les amphipodes troglobies et phreatobies de la faune gallo-rhénane. Archives de Zoologie Expérimentale et Générale. 91(1):153–193.
- Balazuc J. 1957. Notes sur les Amphipodes souterraines. II. Additions a la faune gallo-rhénane. Notes Biospéologiques. 12:67–80.
- Barnard JL, Barnard CM. 1983. Freshwater amphipods of the World. I. Evolutionary patterns. II. Handbook and bibliography. Hayfield Associates: Mt. Vernon (Va).
- Bate CS. 1859. On the genus *Niphargus* Schiödte. Proceedings of the Dublin University Zoological and Botanical Association. 1:237–244.
- Benedetti GB. 1942. Prime osservazioni sopra i *Niphargus* della Venezia Euganea. Atti e Memorie della Regia Accademia di Scienze, Lettere ed Arti in Padova (n. s.). 58:175–186.
- Dobreanu E, Manolache C. 1933. Beitrag zur Kenntnis der Amphipodenfauna Rumäniens. Notationes Biologicae, Bucharest. 1(3):103–108.
- Dudich E. 1943. Neue *Niphargus*-Arten aus Siebenbürgischen Grundwässern. Annales historico-naturales Musei nationalis hungarici, Pars zoologica. 36:47–66.
- Ginet R. 1977. Amphipodes troglobies d’Espagne. Crustaceana Suppl. 4:173–176.
- Karaman G. 1969. XXVII. Beitrag zur Kenntnis der Amphipoden. Arten der Genera *Echinogammarus* Stebb. und *Chaetogammarus* Mart. an der jugoslawischer Adriaküste. Glasnik Republičkog zavoda za zaštitu prirode i Prirodnjačke zbirke u Titogradu. 2:59–84.
- Karaman G. 1970. XXV. Beitrag zur Kenntnis der Amphipoden. Kritische Bemerkungen über *Echinogammarus acarinatus* (S. Kar., 1931) und *Echinogammarus stocki* n. sp. Poljoprivreda i šumarstvo, Titograd. 16(1–2):45–66.
- Karaman G. 1976. Contribution to the Knowledge of the Amphipoda 72. Four new *Niphargus* species from Italy, *N. duplus*, *N. stygoharis italicus*, *N. ruffoi* and *N. canui* (Gammaridae). Vie Milieu, ser. C. 26(1):21–50.
- Karaman G. 1986a. Discovery of *Niphargus delamarei* Ruffo 1954 in Spain, with first description of females (Gammaridea: Niphargidae) (Contribution to the Knowledge of the Amphipoda 154). Poljoprivreda i šumarstvo, Titograd. 33(2–3):29–42.
- Karaman G. 1986b. Description of *Haploginglymus mateusi*, new species of subterranean Gammaridea from Iberian Peninsula with remarks to other taxa of this genus (Fam. Niphargidae) (Contribution to the Knowledge of the Amphipoda 157). Poljoprivreda i šumarstvo, Titograd. 32(1):75–90.
- Karaman G. 2012. Further investigations of the subterranean genus *Niphargus* Schiödte, 1849 (fam. Niphargidae) in Serbia. (Contribution to the Knowledge of the Amphipoda 264). Agriculture and Forestry, Podgorica. 58(2):45–64.
- Karaman G, Ruffo S. 1986. Amphipoda: *Niphargus*-Group (Niphargidae sensu Bousfield, 1982). In: Botosaneanu L, editor. Stygofauna Mundi, A Faunistic, Distributional, and Ecological Synthesis of the World Fauna inhabiting Subterranean Waters (including the Marine Interstitial). Leiden: E.J. Brill/Dr. W. Backhuys. p. 514–534.
- Karaman S. 1931. 4. Beitrag zur Kenntnis der Süßwasser-Amphipoden. Glasnik Skopskog Naučnog Društva, Odeljenje Prirodnih Nauka, Skoplje. 9(3):93–107.
- Karaman S. 1960. Weitere Beiträge zur Kenntnis der Jugoslawischen Niphargiden. Glasnik Prirodnjačkog Muzeja Beograd, Ser. B. 15:75–90.
- Margalef R. 1952. La vida en las aguas dulces de los alrededores del Santuario de Nuestra Señora de Aránzazu (Guipúzcoa). Munibe, Suplemento de Ciencias Naturales del Boletín de la Real Sociedad Vascongada de los Amigos del País. 4(2–3):73–108.
- Margalef R. 1963. Un *Supraniphargus* interesante de Vizcaya (Amphipoda Gammaridae). Miscelanea Zoologica, Museo de Zoología Barcelona. 1:33–34.
- Margalef R. 1970a. Anfipodos recolectados en aguas subterráneas del País Vasco. Munibe (San Sebastián), Sociedad de Ciencias Naturales Aranzadi. 22(3–4):169–174.
- Margalef R. 1970b. Anfipodes recolectados en aguas subterráneas ibéricas. Speleon. 17:63–65.
- Mateus A, Mateus EO. 1958. Un nouveau genre et une nouvelle espèce d’Amphipode troglobie du Portugal. Publicações do Instituto de Zoologia “Dr. Augusto Nobre” (Fac. Ciências Porto). 59:1–15.
- Morand-Chevat Chr. 1972. Bilan actuel du genre *Niphargus* en France et en Espagne. Actes I. Col. Int. *Niphargus* Verona 1969. Museo Civico di Storia Naturale di Verona, Memorie fuori serie. 5:25–31.
- Ruffo S. 1937. Studi sui Crostacei Anfipodi VI. Un nuovo *Niphargus* delle acque sotterranee del Veneto. Bollettino dell’Istituto di Entomologia della Reale Università di Bologna. 10:24–30.
- Schellenberg A. 1936. Bemerkungen zu meinem *Niphargus*-Schlüssel und zur Verbreitung und Variabilität der Arten, nebst Beschreibung neuer *Niphargus*-Formen. Mitteilungen aus dem Zoologischen Museum in Berlin. 22(1):1–30.
- Schellenberg A. 1942. 40. Teil. Krebstiere oder Crustacea. IV: Flohkrebse oder Amphipoda, In: Dahl F, editor. Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise. Jena: Gustav Fischer. p. 1–252.
- Stock JH, Gledhill T. 1977. The *Niphargus kochianus*-group in North-Western Europe. Crustaceana, Suppl. 4:212–242.