THREE NEW SPECIES OF *PSEUDONIPHARGUS* (CRUSTACEA: AMPHIPODA) FROM THE MADEIRA ARCHIPELAGO

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With 11 figures

SUMMARY. The amphipod genus *Pseudoniphargus* was once recorded before from the Madeira Archipelago, but the single available specimen remained unidentified at species level. Recent studies of the groundwater fauna of the islands have revealed the presence oh three species, all new, viz. two on Madeira and one on Porto Santo, which are described in the present paper. One of these species was collected in interstitia of the intertidal zone: it is only the second amongst the fifty-odd species of *Pseudoniphargus* to become known from this type of habitat, all others are known from inland ground waters.

SUMÁRIO. TRÊS NOVAS ESPÉCIES DE *PSEUDONIPHARGUS* DO ARQUIPÉLAGO DA MADEIRA. A única referência à presença do género *Pseudoniphargus* no Arquipélago da Madeira resumia-se, até à data, a um único espécime não identificado ao nível específico.

Recentes estudos faunísticos das águas subterrâneas do arquipélago da Madeira proporcionaram a descoberta de três novas espécies, duas das quais na Madeira e uma em Porto Santo, as quais são descritas no presente trabalho. Uma destas espécies foi colhida na zona intertidal sendo a segunda de entre cinquenta espécies de *Pseudoniphargus* a ocupar este tipo de habitat.

INTRODUCTION

Pseudoniphargus is a genus of gammaridean Amphipoda, containing exclusively blind, unpigmented species, living almost exclusively in inland ground waters of varying salinity (only one species is also recorded from marine littoral interstices of coarse sediments).

Until recently, it was believed that *Pseudoniphargus* contained only one species, *Ps. africanus* CHEVREUX, 1901, known from a large area on the north side of the Mediterranean (from Jugoslavia to France), from the Iberian peninsula and Algeria, and from a number of insular areas (Balearic Islands, Corsica, Faial in the Azores, Madeira).

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Bol. Mus. Mun. Funchal, ~~43~~ (241): 131 - 155, 1992 ISSN 0870-3876

G. KARAMAN (1978) was the first to distinguish two species in the genus. STOCK (1980) reviewed the older literature and re-examined many of the older samples. He distinguished 9 named and several unnamed species.

In the last 10 years, no less than 47 new taxa were added to this list. These species were discovered in the Canary islands (STOCK, 1988; SÁNCHEZ, 1989, 1990, 1991), the Balearic Islands (PRETUS, 1988, 1990; JAUME, 1991), Bermuda (SKET, 1979; SKET & ILIFFE, 1980; STOCK *et al.*, 1986), Sicily (KARAMAN & RUFFO, 1989), and in particular in the Iberian peninsula (NOTENBOOM, 1986, 1987a, b, 1988).

From the Madeira archipelago, a single female specimen has been recorded from the main island, Madeira, viz. from the cistern of the Seminary of Funchal, collected in June 1933 by J. GOUVEIA BARRETO (SCHELLENBERG, 1939). This small-sized specimen (body length 3 mm), unfortunately of the female sex, is unidentifiable (STOCK, 1980). The present authors have tried to take new samples in the cistern of the Seminário of Funchal, however in vain. Nowadays, the garden of the Seminário harbours a huge open cistern, fed exclusively by rain-water, which is inhabited by epigean organisms only (duckweed, ducks (!), green unicellular algae, Cladocera) but certainly not by subterranean amphipods like *Pseudoniphargus*. However, as we were informed by Padre M. NÓBREGA (Quinta Grande, Madeira), in the year of 1933 the Seminário was not housed in its present building, but in the centre of Funchal in a street called (evidently) Rua do Seminário. The old building is in use nowadays by a public laboratory for chemical analyses, but during our visit it became clear that the cistern which used to be in the central court of the building, has disappeared. Thus, it proved impossible to procure any new *Pseudoniphargus* material from the original locality.

However, we were fortunate enough to collect considerable numbers of *Pseudoniphargus* from some other localities in the Madeira archipelago, viz. on the main island, Madeira, and on the island of Porto Santo. The latter is a small island (3.3 x 10.2 km) situated some 50 km NE of Madeira, but separated from it by deep waters (> 2000 m). Porto Santo is partly calcareous (MITCHEL -THOMÉ, 1976) and consequently that its waters have a high conductivity (usually between 3 and 8 mS/cm, own obs.), whereas Madeira is volcanic with low-conductivity waters (0.1-0.2 mS/cm, own obs.). Since several authors (e.g., NOTENBOOM,1988; STOCK, 1988) have stressed the –extremely– small ranges and high degree of endemicity in this genus, it is not surprising that the material collected belongs to three different species, all new, which are described in the sequel.

DESCRIPTIVE PART

Genus *Pseudoniphargus* CHEVREUX, 1901

A) Taxon from Porto Santo
Pseudoniphargus portosancti n. sp.

Material (all from Ilha de Porto Santo, Madeira archipelago): 1 male (holotype), 1 female (allotype), and 41 paratypes, Stn. 91-520, Fonte do Tanque (on left bank of Ribeiro do Tanque); UTM coordinates CB ^{3}7514 x ^{36}5920; slowly running captured spring, connected with a number of open basins; conductivity 4.5 mS/cm; water temperature 22.0° C; altitude *c.* 40 m; distance (in direct line) to the sea *c.* 1200 m; 12 Oct. 1991. (Holotype, allotype and 36 paratypes in Zoölogisch Museum, Amsterdam, ZMA cat. nr. Amph. 108.956; 5 paratypes in Museu Municipal do Funchal, MMF 25127.)

2 fragmentary specimens, Stn. 91-525, Chafariz do Baião; UTM coordinates CB ^{3}7820 x ^{36}6098; tap fed by spring; conductivity 3.3 mS/cm; water temperature 22.7° C; altitude *c.* 50 m; distance (in direct line) to the sea *c.* 820 m; 12 Oct. 1991. (ZMA Amph. 108.957.)

Description.- Body length 3.8-4.7 mm (female) or 3.7-3.9 mm (male). Live colour ivory white to grayish white; no eyes. Body and appendages not very slender (fig. 1a). None of the females in the collection is ovigerous, but many carry setose oostegites. Lateral head lobe prominent, rounded (fig. 1d); infra-antennal sinus very shallow. Dorsum of pereionites, pleonites, and urosomite 1 with a few minute setules only.

Antenna 1 (fig. 1b) short (1.3 in length in a female with body length 4.7 mm); peduncle segments rather slender; flagellum with up to 11 segments, armed with short setae only; flagellum segments 3 through 9 moreover with 1 long aesthetasc; accessory flagellum 2-segmented, shorter than flagellum segment 1 of main flagellum.

Antenna 2 (fig. 1c) about 75% of length of antenna 1; gland cone plump, rounded; peduncle segments 4 and 5 with some long and some short setae; flagellum 6-segmented; no calceoli.

Labrum (fig. 1e) with narrow, rounded proximal part, and wider, roughly trapezoidal, distal part.

Mandible (fig. 2a): pars incisiva 5-dentate; lacinia mobilis 4-dentate (left), or bifid, finely serrate (right) (fig. 2b); 5 incisor setae left, 4 right; molar small, finely toothed; molar seta present on both sides. Palp 3-segmented; segment 1 naked; segment 2 with 2 ventral and 1 to 3 distal setae; segment 3 not slender, with 1 A-seta,

8 D-setae, and 3 E-setae (B- and C-setae absent).

Labium (fig. 2c) with strongly developed inner lobes.

Maxilla 1 (fig. 1f): palp 2-segmented, longer than outer lobe, distally armed with 6 (left) or 7 setae; outer lobe with 7 distal spines, the medial margin of which armed with (from lateral to medial) 1, 1, 0, 2, 0, 2, and 3 teeth, respectively; inner lobe thump-shaped, with 2 long distal setae.

Maxilla 2 and maxilliped resembling those of *Ps. grandimanus* (see STOCK *et al.*, 1986, figs. 3h and 4d).

Gnathopod 1 (fig. 2d) not sexually dimorphic. Coxal plate slightly less than 1.5 times as long as wide; ventral margin convex, armed with 2 or 3 setules on anterior and posterior corners. Basis: anterior margin with some short setules only; posterior margin with 4 or 5 long, curved setae. Carpus: trapezoidal with 4 posterior and 1 distoposterior rows of setae. Propodus (fig. 2e) with 2 groups of setae on posterior margin; palma transverse; 3 or 4 bifid palmar angle spines (one of which long); palmar margin with some spinules and 4 long setae. Dactylus and unguis well-demarcated; inner margin of dactylus with 3 setules, distal margin with 2 longer setae.

Gnathopod 2 (fig. 3a) larger than gnathopod 1. Coxal plate 1.25 times as long as wide , with 2 to 3 stetules on both posteroventral and anteroventral corner. Basis with 5 long setae on posterior margin, 5 long + 5 short setae on anterior margin. Carpus short, trapezoidal, with 2 groups of setae on posterior margin. Propodus rather large, subovoid; with 4 or 5 groups of setae on posterior margin; palm oblique; palmar margin about as long as free posterior margin, slightly convex, with 10 to 13 short elements and 5 longer setae; 3 setules-tipped palmar angle spines. Dactylus and unguis well-demarcated; dactylus with 4 endal setules and 2 distal setae. Slightly sexual dimorphism in shape of propodus: width/length ratio in female 0.62, in male 0.67 (cf. figs. 3a, b).

Pereiopod 3 (fig. 3c): coxal plate almost 1.5 times as long as wide; basis with 4 long and 4 short setae on anterior margin, 6 long setae on posterior margin. Dactylus much longer than unguis. Pereiopod 4 similar to P3, except for coxal plate, which is slightly longer than wide, with shallow posterior excavation (fig. 3d).

Pereiopod 5 (fig. 4a) with anterolobate coxal plate. Basis 1.37 times as long as greatest diameter; posterior margin almost straight, with some 7 setules; posterodistal corner lobate, weakly overhanging. Merus relatively short. Claw not very slender.

Pereiopod 6 (fig. 4b) with aequilobate coxal plate. Basis almost 1.5 times as long as wide; posterior margin almost straight, with 9 to 12 setules; posterodistal corner lobate, slightly overhanging. Merus relatively short. Dactylus slightly longer than unguis, rather slender.

Pereiopod 7 (figs. 4c, d) with non-lobate coxal plate; merus, carpus and in particular propodus longer than in P6.

No sexual dimorphism observed in the pereiopods.

Coxal gills pedunculate, on gnathopod 2 and pereiopods 3 through 6. Oostegites of female linear, provided with long setae (fig. 2f), on gnathopod 2 and pereiopods 3 through 5.

Epimeral plates (fig. 2g) with rounded posteroventral corners; posterior margin strongly convex, armed with 3 setules; ventral margin with 0/2/2 spines, respectively.

Pleopods. Peduncle with rounded-triangular distolateral projection; 2 retinacula, each with 4 teeth. Exopodite of pleopod 1 8-segmented, of pleopods 2 and 3 7-segmented. Endopodite of pleopod 1 6-segmented, of pleopods 2 and 3 5-segmented (in adults). Male pleopods not modified.

Uropod 1 (fig. 4e). Peduncle without proximoventral spine; dorsolateral ridge with 3 spines; distolateral corner with 2 short spines; distomedial corner with 1 short spine. Exopodite slightly shorter than endopodite; both rami without dorsal armature.

Uropod 2 (fig. 4f). Peduncle with 1 dorsal and 1 terminal spine; rami without dorsal armature.

Uropod 3 (figs. 4g, h) not very long (*ca.* 18% of body length), not sexually dimorphic. Peduncle distinctly less than twice as long as wide. Exopodite tapering, with 2 or 3 groups of lateral spines, 3 groups of medial spines, and 4 terminal spines. Endopodite scale-like, with 1 terminal spine and 1 dorsal setule.

Telson (figs. 3e, f) *ca.* 1.4 times as wide as long; distal margin very slightly concave. Distolateral armature consisting of 1 long spine, or 1 long lateral + 1 short medial spine. Sensory setules plumose, located distad of the middle near the lateral margin.

Etymology.- The specific name is derived from the Latinized form of the type locality, the island of Porto Santo.

Remarks.- The differences between the various species of *Pseudoniphargus* are of subtle nature. This holds also true for the present species from Porto Santo, which shows close relationships with a cluster of species called the Lusitanian-Atlantic group by NOTENBOOM (1988). This group includes, amongst others, *Ps. brevipedunculatus* STOCK, 1980 (from Faial, Azores), *Ps. mateusorum* STOCK, 1980 (from the Setubal area, Portugal), *Ps. unispinosus* STOCK, 1988 (from Tenerife, Canary Islands), and *Ps. fontinalis* STOCK, 1988 (likewise from Tenerife). A less close phenetic resemblance exists with the other members of this group, two species

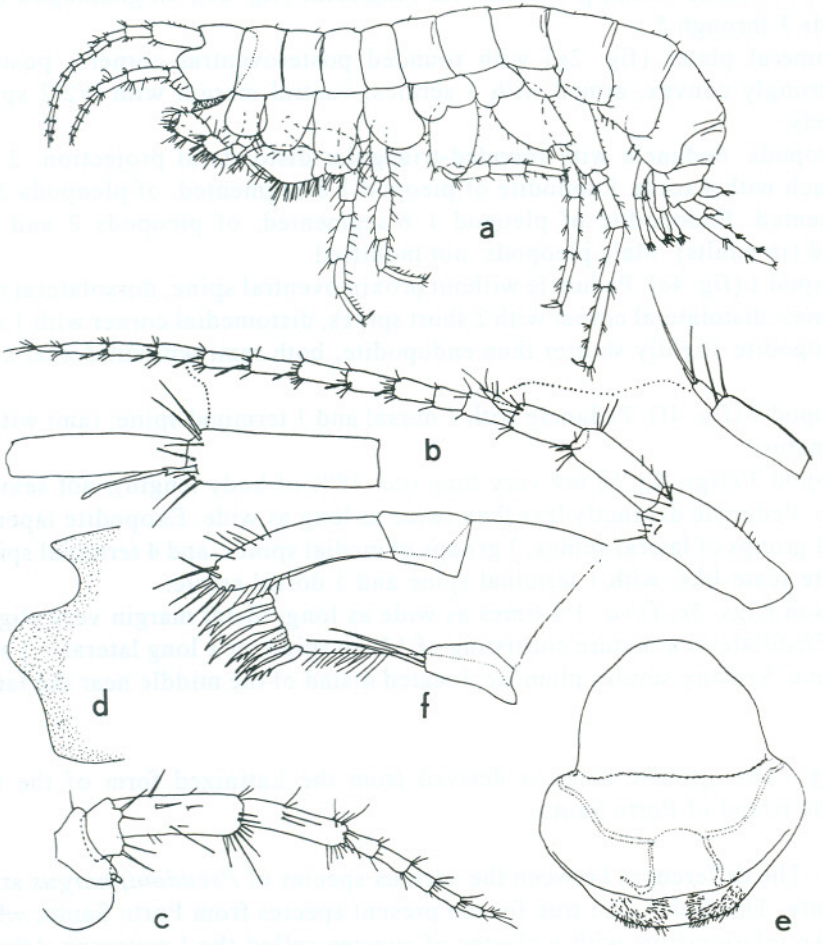

Fig. 1. *Pseudoniphargus portosancti* n. sp. (a, female allotype; b-f, female paratype). a) entire animal, from the left, pleopods omitted (actual body length 4.7 mm); b) antenna 1 (scale A); c) antenna 2 (A); d) frontal margin of cephalic segment, from the left (A); e) labrum (B); f) maxilla 1 (C). Scales on fig. 2.

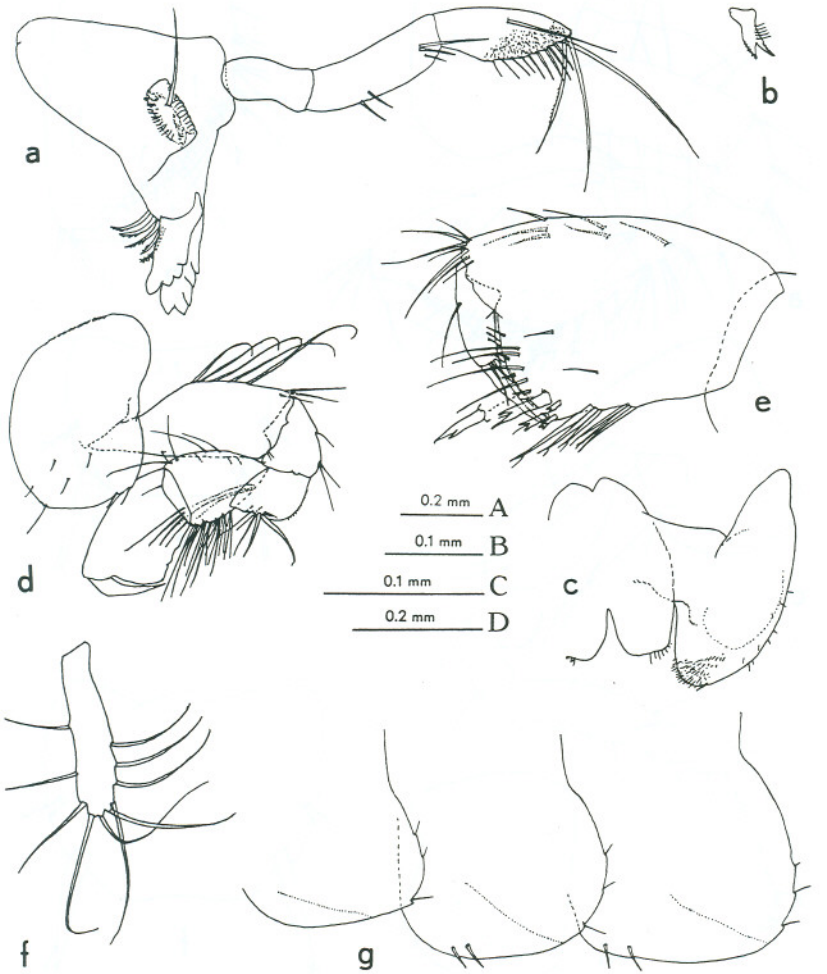

Fig. 2. *Pseudoniphargus portosancti* n. sp. (female paratype). a) left mandible (scale B); b) lacinia mobilis of right mandible (B); c) labium (B); d, gnathopod 1 (A); e) propodus of gnathopod 1 (B); f) oostegite of pereiopod 4 (A); g) epimeral plates 1 to 3, from the left (A).

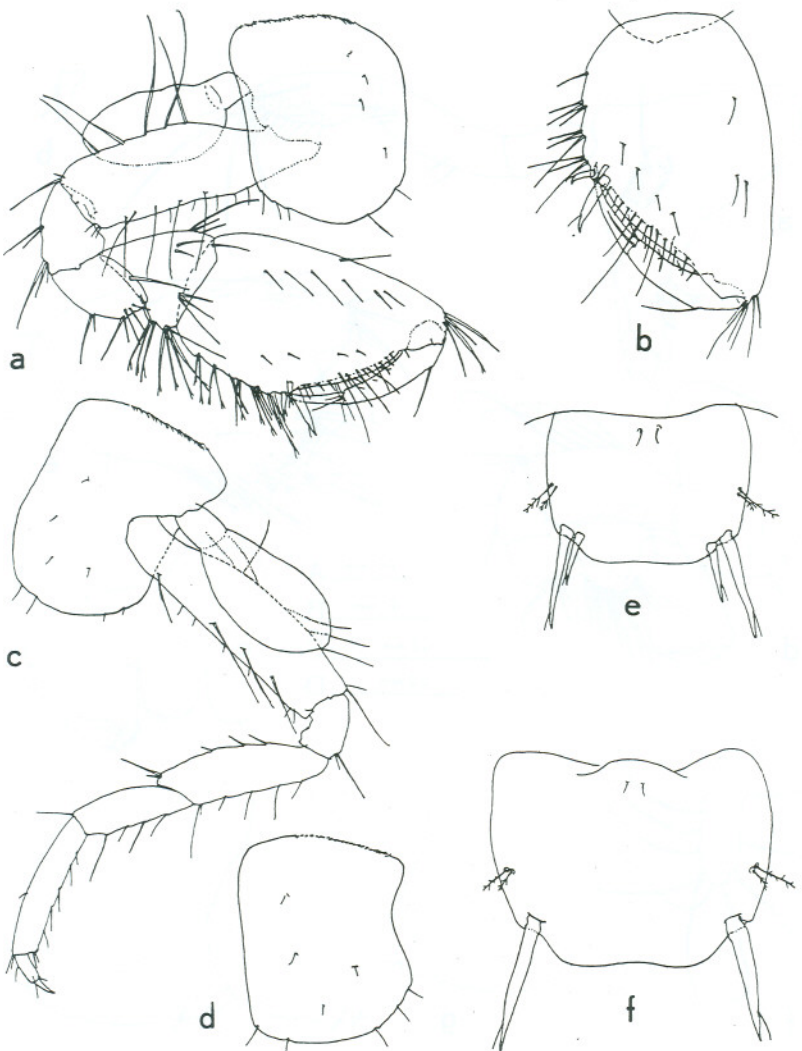

Fig. 3. *Pseudoniphargus portosancti* n. sp. (b and f, male paratype; remaining figures female paratype). a) gnathopod 2 (scale A); b) propodus of gnathopod 2 (D); c) pereiopod 3 (A); d) coxal plate of pereiopod 4 (A); e) telson (B); f) telson (C). Scales on fig. 2.

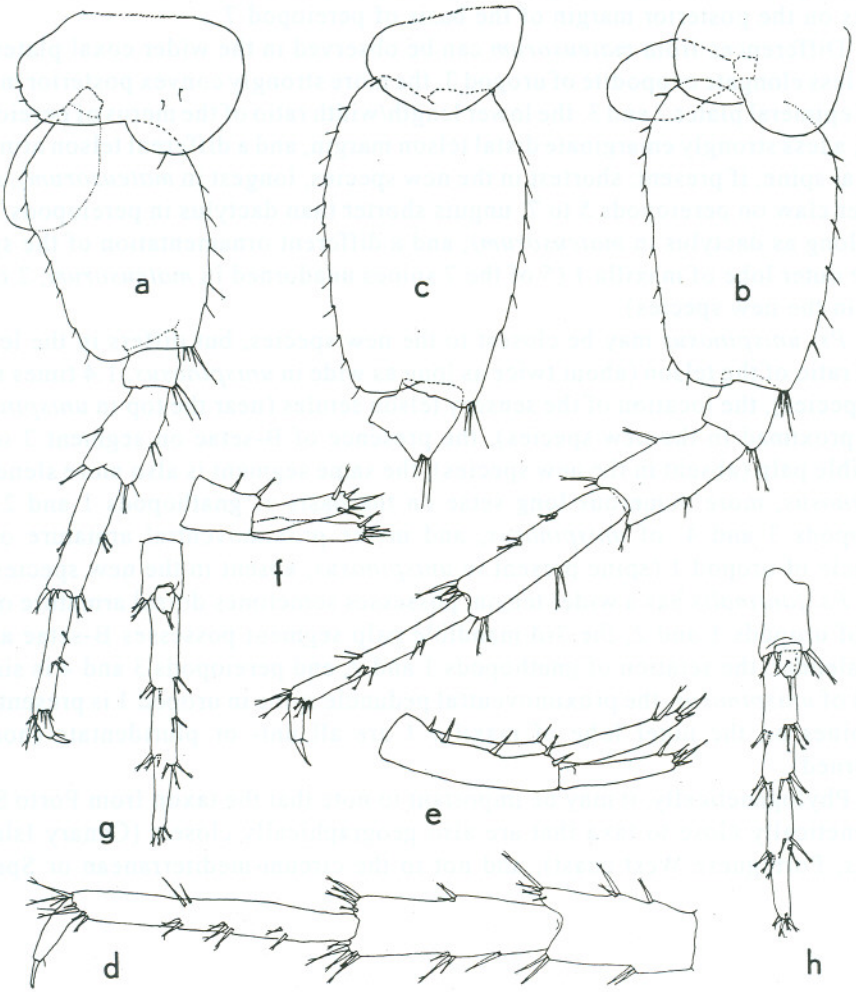

Fig. 4. *Pseudoniphargus portosancti* n. sp. (c and g, male paratype; remaining figures female paratype). a) pereiopod 5; b) pereiopod 6; c) basal segments of pereiopod 7; d) distal segments of pereiopod 7; e) uropod 1; f) uropod 2; g) h, uropod 3. All to scale A. Scale on fig. 2.

from Bermuda, one from Gibraltar, and one from La Coruña (NW Spain).

Differences from *brevipedunculatus* reside in the third uropod (not sexually dimorphic in the new species), the more rounded posteroventral corner of the epimeral plates, the absence of a V-shaped distal notch in the telson, and fewer setules on the posterior margin of the basis of pereiopod 7.

Differences from *mateusorum* can be observed in the wider coxal plates 1 to 4, the less elongate exopodite of uropod 3, the more strongly convex posterior margin of the epimeral plates 2 and 3, the lower length/width ratio of the merus of pereiopods 5 to 7, a less strongly emarginate distal telson margin, and a different telson armature (medial spine, if present, shortest in the new species, longest in *mateusorum*), a less slender claw on pereiopods 5 to 7, unguis shorter than dactylus in pereiopods 3 and 4 (as long as dactylus in *mateusorum)*, and a different ornamentation of the spines on the outer lobe of maxilla 1 (5 of the 7 spines unadorned in *mateusorum*, 2 out of the 7 in the new species).

Ps. unispinosus may be closest to the new species, but differs in the length/ width ratio of the telson (about twice as long as wide in *unispinosus*, 1.4 times in the new species), the location of the sensory telson setules (near the top in *unispinosus*, more proximad in the new species), the presence of B-setae on segment 3 of the mandible palp (absent in the new species), the same segment is also more slender in *unispinosus*, more numerous long setae on the basis of gnathopods 1 and 2, and pereiopods 3 and 4, of *unispinosus*, and in the proximoventral armature of the peduncle of uropod 1 (spine present in *unispinosus*, absent in the new species).

Ps. fontinalis has a wider telson, possesses sometimes dorsal armature on the rami of uropods 1 and 2, the 3rd mandible palp segment possesses B-setae and is more slender, the setation of gnathopods 1 and 2, and pereiopods 3 and 4 is similar to that of *unispinosus*, the proximoventral peduncle spine in uropod 1 is present, and the spines on the outer lobe of maxilla 1 are all uni- or pluridentate (none is unadorned).

Phylogenetically, it may be important to note that the taxon from Porto Santo is phenetically close to taxa that are also geographically closest (Canary Islands, Azores, Portuguese West coast), and not to the circum-mediterranean or Spanish taxa.

B) Taxa from Madeira

Pseudoniphargus macrurus n. sp.

Material.- 1 male (holotype), 38 paratypes of both sexes (all in ZMA, Cat. nr. Amph. 109.125, but for 6 paratypes in MMF, nr. 25195). Madeira, Stn 92-43. , Levada da Central da Ribeira da Janela (= S. of Porto Moniz); UTM coordinates BB [2] 9725 x [36] 3605; small trickle spring with cemented basin; altitude *ca.* 450 m; 28 Apr. 1992.

22 specimens (ZMA Amph. 109.126). Madeira, Stn. 92-11. Ribeira Brava in village Ribeira Brava, just N. of bridge in road to Porto Moniz; *ca.* 300 m from the sea; UTM coordinates CB [3] 0675 x [36] 1650; altitude < 10 m; Bou-Rouch biophreatical pump in gravel, sand and boulders on the river bank; probe at 50 cm under the sediment surface; electric conductivity 0.1-0.2 mS/cm, temperature 17.0°-18.5° C; 22 Apr. 1992.

4 specimens (ZMA Amph. 109.127). Madeira, Stn. 92-47. Madeira, as Stn. 92-11, but *ca.* 400 m from the mouth of the river, 1 May 1992.

11 specimens (ZMA Amph. 109.128). Madeira, Stn. 92-49, same place as Stn. 92-11, 1 May 1992.

Description.- Adult (terminal) male 4.3 mm (from frontal margin cephalic segment to posterior margin 3rd urosomite); adult female (with setose oostegites 4.1 mm. White, no eyes. Body smooth.

Antenna 1 (fig. 5c) with relatively slender peduncle segments. Flagellum 17-segmented; one aesthetasc on each of the flagellum segments 5 through 16; aesthetascs longer than half the length of corresponding flagellum segment. Accessory flagellum 2-segmented, almost as long as first flagellum segment.

Antenna 2 (fig. 5d) with some long setae on peduncle segments 4 and 5. Flagellum 8-segmented; no calceoli.

Upper lip, lower lip and maxilla 2 as in *Ps. portosancti*. Mandible palp (fig. 5a): segment 2 with 1+2+2 ventral setae; segment 3 with 1 A-seta, 2 B-setae, no C-setae, 11 D-setae, and 3 E-setae; D-setae of almost uniform size. Maxilla 1: distal margin of palp with 8 setae; outer lobe with 7 distal spines of which lateralmost spines are unidenticulate, central spines bidenticulate, and medialmost spine tridenticulate; inner lobe with 2 distal setae. Maxilliped as in *Ps. portosancti*, but claw of palp slender (fig. 5b).

Gnathopod 1 (fig. 6a): coxal plate longer than wide, with 2 or 3 longish setae on ventral margin; basis with 1 or 2 long setae in proximal part of medial surface, and *ca.* 7 setae on posterior margin. Palmar angle with 4 bifid spines.

Gnathopod 2 sexually dimorphic: propodus larger in male than in female,

palmar margin of male longer in relation to posterior propodal margin (cf. figs. 6b, c); ventral margin of coxal plate with 2 or 3 setules. Coxal gill pedunculate, elongate-oval, some 75% of length of basis; basis with 6 long setae on anterior, and 5 on posterior margin; no medial setae. Palmar angle with 3 spines, one of which long.

Pereiopod 3 (fig. 7a): coxal plate 1.5 times longer than wide, with 4 setules on ventral margin; basis with 5 long anterior setae and 6 long posterior setae. Dactylus shorter than unguis. Pereiopod 4 (fig. 7b) similar to P3, but coxal plate wider; posterior emargination of coxal plate shallow.

Pereiopod 5 (fig. 8a) rather short; coxal gill smaller than on anterior legs; basis slightly tapering, posterior margin convex, with some 9 setules; posteroventral corner produced into rounded, somewhat overhanging lobe, in male (fig. 8a) slightly more pronounced than in female (fig. 7c). Claw slender.

Pereiopod 6 (fig. 8b) slightly shorter than P7 (fig. 8c), but similar in morphology of all segments, except for coxal plate; basis elongate, slightly tapering, with 8 to 12 setules on posterior margin; posterodistal lobe in male well-pronounced (figs. 8b, 7e), in female (figs. 7d, 8c) almost absent. Claw very slender.

Oostegites (fig. 7a) linear, with 6 setae in distal part, present on gnathopod 2 and pereiopods 3 through 5. Coxal gill present on gnathopod 2 and pereiopods 3 through 6.

Epimeral plates 1 to 3 (fig. 5e-g) rounded; posteroventral angle indicated by small tooth; armature of ventral margin variable: with 0 to 2, 2 to 3, and 1 to 4 spines, respectively; posterior margin with several setules.

Pleopods: pedunculus naked, but for 2 mediodistal retinacula, each bearing 3 or 4 pairs of teeth. Exopodite of first to third pleopods of 8, 7, and 6 to 7 segments, respectively; endopodite of 7, 5, and 5 segments. No clothespeg spines on endopodite.

Uropod 1 (fig. 7f) with short proximoventral spine on pedunculus; laterodorsal peduncular margin with 2 spines, mediodorsal margin unarmed; distal margin with 2+1 spines. Dorsal margin of rami unarmed.

Uropod 2 (fig. 7g): dorsal margin of rami unarmed.

Uropod 3 strongly sexually dimorphic. In terminal (''senile'') males (figs. 6e, 8d), the monomerous exopodite is upcurved, almost 20 times as long as its diameter, and its spines are, in particular in the distal part, short or even setiform. Entire uropod 3 of male (= pedunculus + exopodite) attaining *ca.* 38% of body length. In young males and in females (fig. 8e) exopodite straight, and armed with strong spines; entire uropod 3 is less elongate, attaining *ca.* 25% of body length. Endopodite always small, scale-like, with 1 dorsal seta and 1 distal spinule.

Telson (fig. 5h) distinctly wider than long; medial notch distinct, rounded; lateroapical lobes with 2 or 3 spines, of which 2 long.

Etymology.- The specific name, *macrurus,* is derived from the Greek words *makros* (= long) and *oura* (= tail), alluding to the long ''tail'' (the 3rd uropod) of the terminal male.

Remarks.- Among the almost 60 described species in the genus *Pseudoniphargus*, there are only five that share the following combination of characters with *Ps. macrurus* n. sp.: (1) uropod 3 of terminal males with strongly elongate exopodite; (2) peduncle of uropod 3 of male *not* elongated; (3) basis of pereiopod 5 to 7 of male with overhanging posterodistal lobe; (4) dorsal of rami of uropod 1 naked.

These five species are: *Ps. brevipedunculatus* Stock, 1980 (from Faial, Azores), *Ps. mateusorum* STOCK, 1980 (from the Setubal area, Portugal), and three taxa from Tenerife, Canary Islands, viz. *Ps. porticola* STOCK, 1988, *Ps. longicauda* STOCK, 1988, and *Ps. candelariae* SÁNCHEZ, 1990.

From all these species, *Ps. macrurus* can be distinguished at once by the long unguis on pereiopods 3 to 7. *Ps. brevipedunculatus* differs moreover in the absence of sexual dimorphism in the propodus of gnathopod 2, and in having more numerous setules along the posterior margin of the basis of pereiopods 5 to 7. *Ps. candelariae* has distinctly more elongate coxal plates 1 to 4 than the new species, and has a setose (not naked) anterior margin of the basis of gnathopod 1. *Ps. mateusorum* possesses a pointed (not rounded) lobe on the basis of the posterior pereiopods and has only 1 spine (versus several spines) on the ventral margin of the epimeral plates. *Ps. porticola* is characterized by more strongly setulose coxal plates 1 to 4 and by a deeper emargination of the posterior margin of coxal plate 4. *Ps. longicauda* appears to be phenetically closest to the new species, but bears more setules on the ventral margin of coxal plates 1 to 4, and possesses a mediodistal spine on the telson (laterodistal spines only in *Ps. macrurus*).

The new species has been discovered in two ecologically rather different situations: in the mountains of the North coast of Madeira (altitude *ca.* 450 m) in a small spring-fed basin, and in the lowlands of the South coast, in interstitia of sand and gravel of a river bed.

Pseudoniphargus littoralis n. sp.

Material.- 1 female (holotype), 1 fragmentary male, lacking all thoracic appendages (allotype), 2 females paratypes (ZMA Amph. 109.124).

Madeira, Stn 92-22. Machico, southern end of beach near the discharge of the Fonte de São Roque; UTM coordinates CB^{3}3495 x ^{36}2070; Bou-Rouch biophreatical pump in coarse sand and boulders; probe at 70 cm under the substrate surface; near

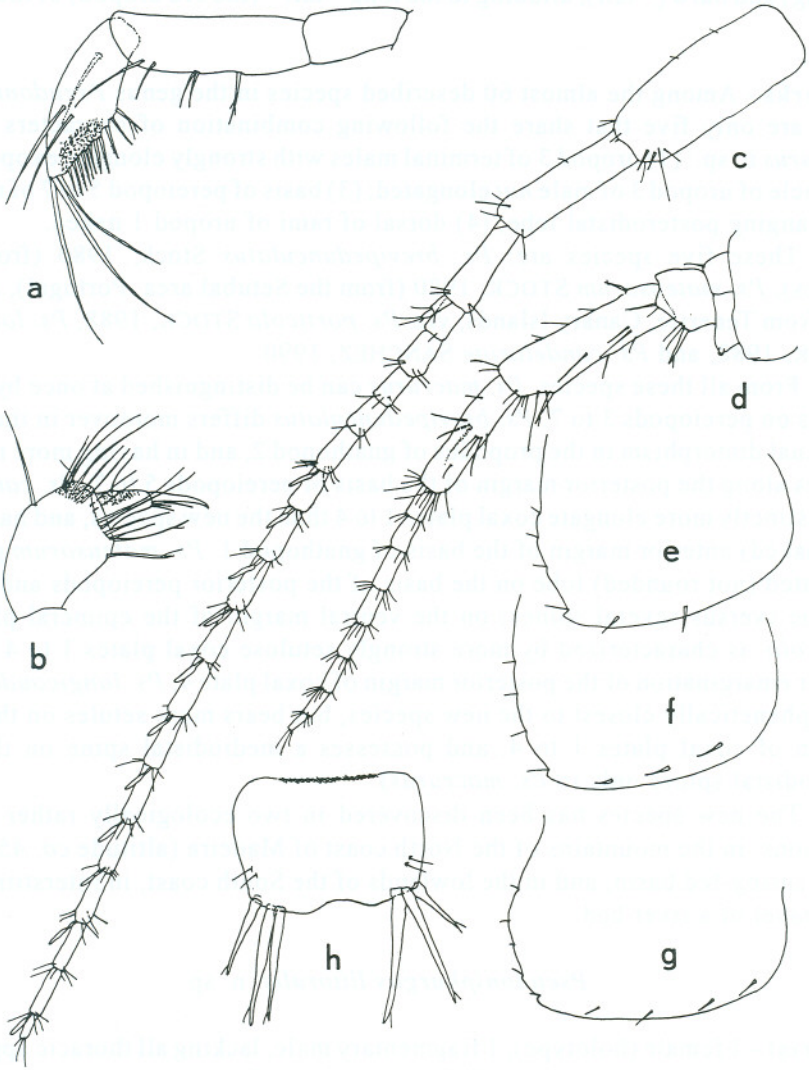

Fig. 5. *Pseudoniphargus macrurus* n. sp. (paratypes from Stn. 92-43). a) mandible palp, female (scale B); b) tip of maxillipedal palp, male (B); c) antenna 1, male (A); d) antenna 2, male (A); e) epimeral plate 1, male (A); f) epimeral plate 2, male (A); g) epimeral plate 3, male (A); h) telson, female (B). Scales on fig. 2.

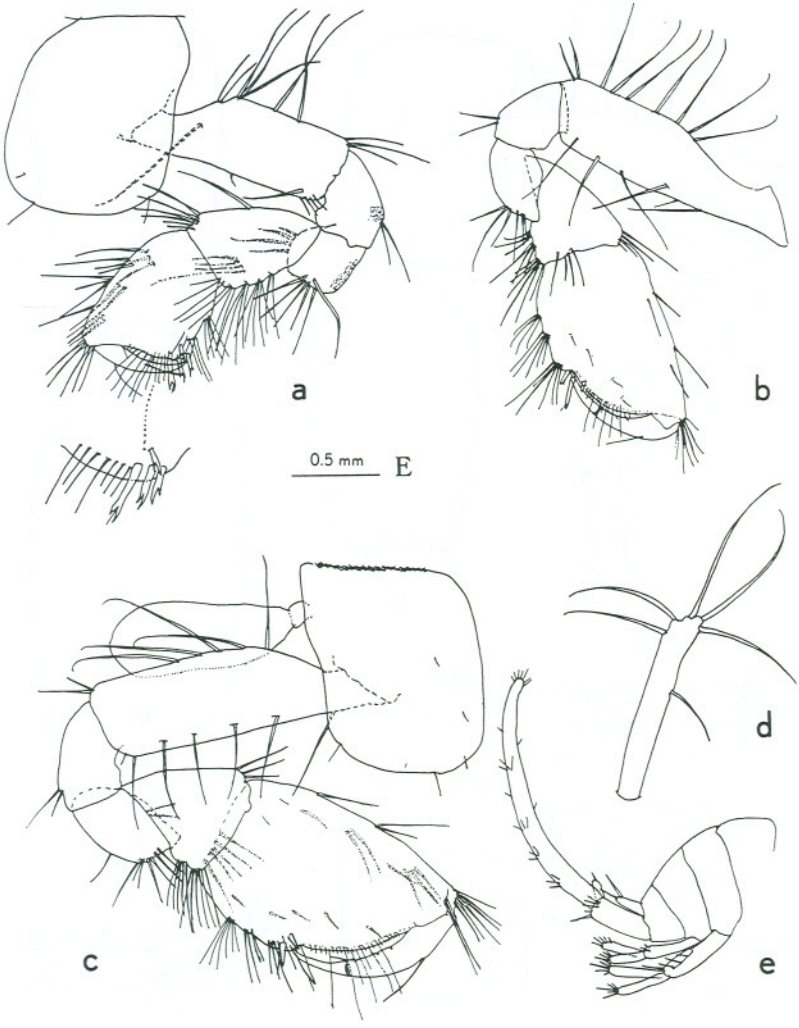

Fig. 6. *Pseudoniphargus macrurus* n. sp. (paratypes from Stn. 92-43). a) gnathopod 1, male (scale A); b) gnathopod 2, female (A); c) gnathopod 2, female (A); d) oostegite of pereiopod 4, female (A); e) urosomites, male, from the left (E). Scale A on fig. 2.

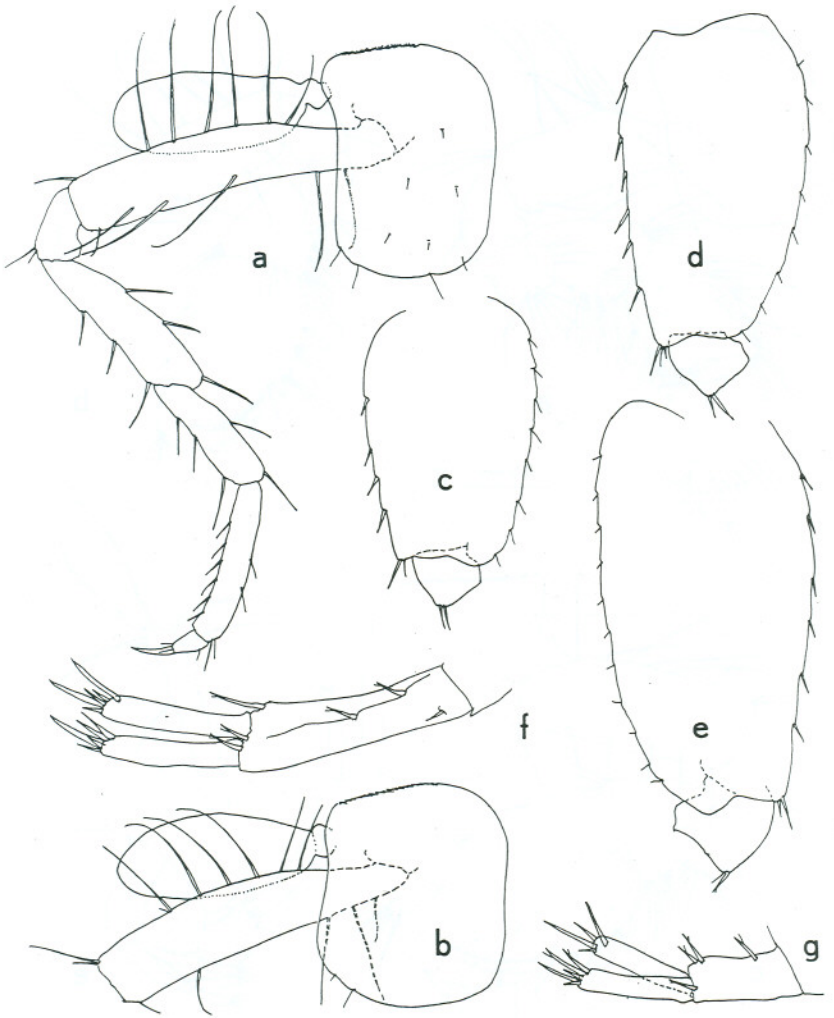

Fig. 7. *Pseudoniphargus macrurus* n. sp. (paratypes from Stn. 92-43). a) pereiopod 3, male (scale A); b) proximal part of pereiopod 4, male (A); c) basis of pereiopod 5, female (A); d) basis of pereiopod 6, female (A); e) basis of pereiopod 7, male (A); f) uropod 1, male (A); g) uropod 2, male (A). Scale on fig. 2.

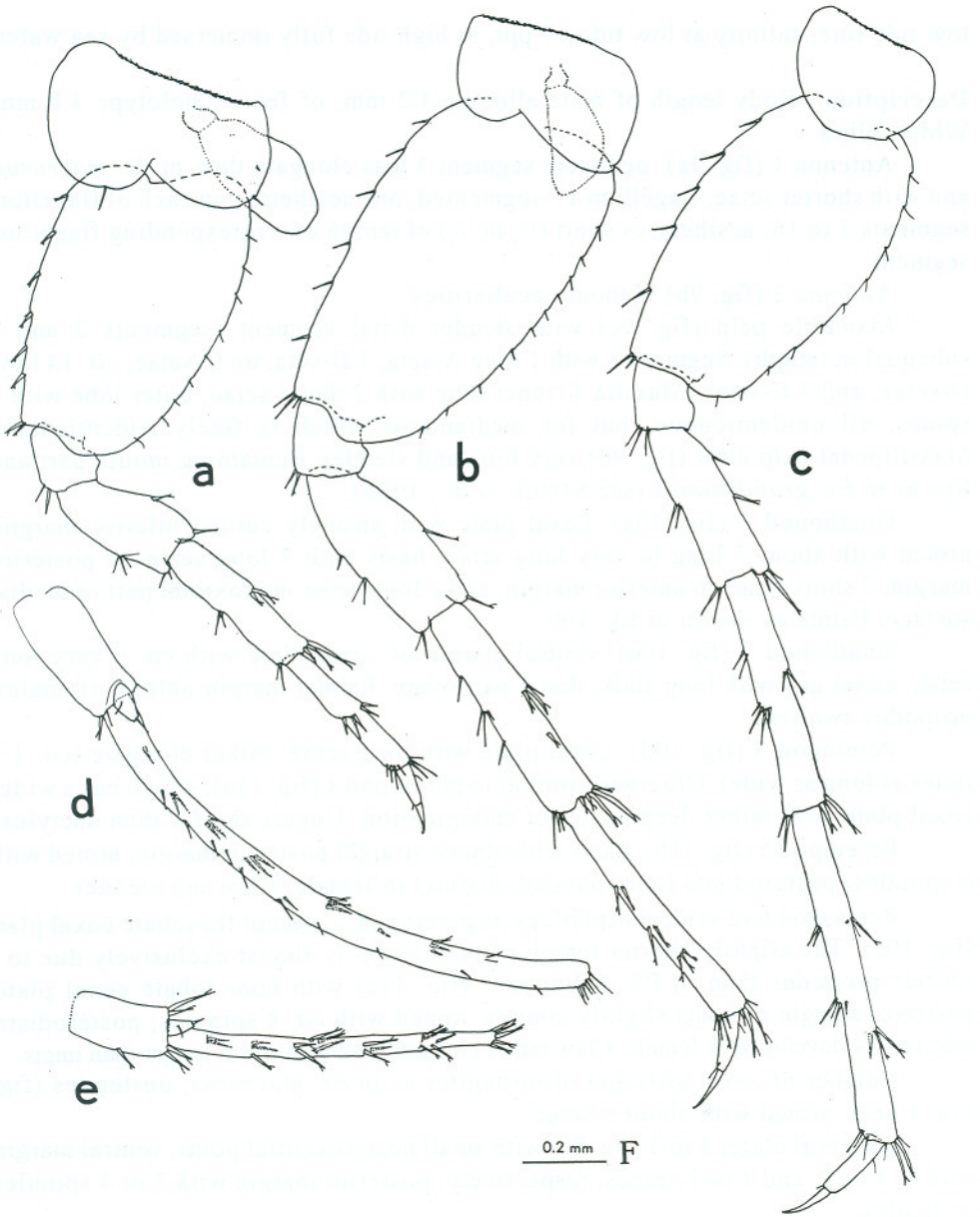

Fig. 8. *Pseudoniphargus macrurus* n. sp. (paratypes from Stn. 92-43). a) pereiopod 5, male (scale F); b) pereiopod 6, male (F); c) pereiopod 7, female (F); d) uropod 3, male (F); e) uropod 3, female (F).

low tide line; salinity at low tide 19 ppt, at high tide fully immersed by sea water.

Description.- Body length of male allotype 4.2 mm, of female holotype 3.8 mm. White, blind.

Antenna 1 (fig. 9a): peduncle segment 3 less elongate than in *Ps. macrurus*, and with shorter setae; flagellum 17-segmented; one aesthetasc on each of flagellum segments 3 to 16; aesthetascs short ($^1/_4$ to $^1/_3$) of length of corresponding flagellum segment.

Antenna 2 (fig. 9b) without peculiarities.

Mandible palp (fig. 9c) with slender distal segment (segments 2 and 3 subequal in length). Segment 3 with 1 long A-seta, 1 B-seta, no C-setae, *ca.* 14 long D-setae, and 3 E-setae. Maxilla 1: inner lobe with 2 distal setae; outer lobe with 7 spines, all unidenticulate, but for medianmost which is finely tridenticulate. Maxillipedal palp claw (fig. 9d) very long and slender. Remaining mouth part and lips as in *Ps. grandimanus* (see STOCK *et al.*, 1986).

Gnathopod 1 (fig. 10a): coxal plate with strongly curved inferior margin, armed with about 7 long to very long setae; basis with 7 long setae on posterior margin, 3 short setae on anterior margin, and 2 long setae in proximal part of medial surface. Palma as shown in fig. 10b.

Gnathopod 2 (fig. 10c): ventral margin of coxal plate with *ca.* 6 very long setae; coxal gill with long stalk, distal part ovate. Palmar margin oblique (female), propodus swollen.

Pereiopod 3 (fig. 10d): coxal plate with long setae, rather elongate (*ca.* 1.7 times as long as wide). Otherwise similar to pereiopod 4 (fig. 11a), which has a wider coxal plate with rather deep posterior emargination. Unguis shorter than dactylus.

Pereiopod 5 (fig. 11b): basis with almost straight posterior margin, armed with 6 spinules; posterodistal lobe rounded, distinct in female. Claw not slender.

Pereiopod 6 of same morphology as pereiopod 7, except for lobate coxal plate (fig. 10e). The slightly shorter length of pereipod 6 is almost exclusively due to a shorter propodus than in P7. Pereipod 7 (fig. 11c) with non- lobate coxal plate; posterior margin of basis slightly convex, armed with *ca.* 8 spinules; posterodistal lobe poorly developed in female. Claw rather elongate, dactylus much longer than ungis.

Number of coxal gills and of oostegites as in *Ps. macrurus*; oostegites (fig. 11a) linear, armed with about 9 setae.

Epimeral plates 1 to 3 (fig. 9e) with small posteroventral point; ventral margin with 1, 1 or 2, and 1 or 2 spines, respectively; posterior margin with 3 or 4 spinules or setules.

Retinacula of pleopods with 3 or 4 pairs of teeth; exopodite of first to third pleopods of 7, 7, and 6 segments, respectively; endopodite of 6, 5, and 5 segments.

Pleopod 1 devoid of clothespeg spines; first endopodite segment of pleopods 2 and 3 bears 1 clothespeg spine.

Uropod 1 (fig. 9f): pedunculus with ventroproximal spine; laterodorsal margin with 2 spines, mediodorsal margin unarmed; distal margin with 3 spines. Dorsal margin of rami unarmed, both in uropod 1 and in uropod 2 (fig. 9g).

Uropod 3 of male (fig. 10g) 25% of body length; in female shorter, 19% of body length (fig. 10f). In both sexes fundamentally of same morphology. Exopodite not elongate, distinctly less than 10 times as long as wide; armature consisting of strong spines. Pedunculus not elongate either.

Telson (figs. 9h-i) at least twice as wide as long; distal notch wide but very shallow; variable number of laterodistal spines (1, 2 or 3), at least 1 spine very long.

Etymology.- The name *littoralis* is proposed because of the intertidal habitat of the new species.

Remarks.- The following combination of characters separates *Ps. littoralis* from its congeners: (1) telson at least twice as wide as long; (2) coxal plate 4 with rather deep posterior emargination; (3) ventral margin of coxal plates 1 to 4 with several long setae; (4) unarmed dorsal margin of rami of uropod 1; and (5) epimeral plates with 1 or 2 spines on ventral margin.

Ps. littoralis is particularly noteworthy because of its habitat. Only one out of fifty-odd described species in the genus is known from the marine intertidal zone, viz. *Ps. adriatica* S. KARAMAN, 1955; all others are inland water taxa. The shape of the telson and the great elongation of peduncle and exopodite of uropod 3 in male readily separate *adriatica* (Mediterranean) from *littoralis* (Madeira).

The discovery of a second species of *Pseudoniphargus* in the marine environment is phylogenetically of particular importance: the regression model of evolution in stygobionts (STOCK, 1977, 1980) predicts that members of the same genus occur both in marine (usually interstitial) habitats and in inland, freshwater stygohabitats, in the latter (due to a higher degree of isolation preventing geneflow) in a greater diversity of taxa than in the former. *Pseudoniphargus* fulfills these criteria perfectly (see also BOUTIN & COINEAU, 1990 and NOTENBOOM, 1991).

Pseudoniphargus spec.

Material.- 1 fragmentary specimen and 1 juvenile. Madeira, Stn. 92-36. Mouth of Ribeira da Janela (SE of Porto Moniz); UTM coordinates BB ^{2}9885 x ^{36}3701; in gravel of intertidal rockpool on the beach, fed by spring; Bou-Rouch biophreatical pump, probe 50 cm under the sediment surface; temperature 18.2° C; electric

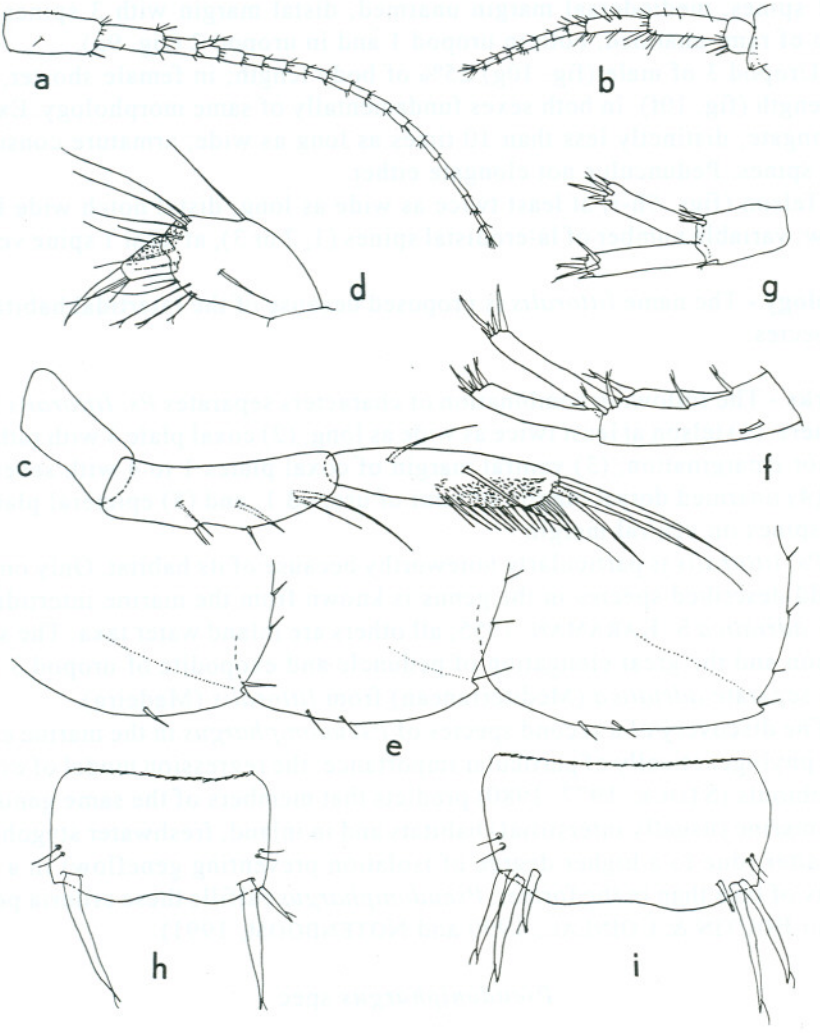

Fig. 9. *Pseudoniphargus littoralis* n. sp. (female holotype, male allotype). a) antenna 1, male (scale E); b) antenna 2, male (E); c) mandible palp, male (A); d) distal part of maxillipedal palp, male (B); e) epimeral plates 1 to 3, from the left, male (A); f) uropod 1, female (A); g) uropod 2, female(A); h) telson, female (B); i) telson, male (B). Scales on fig. 2.

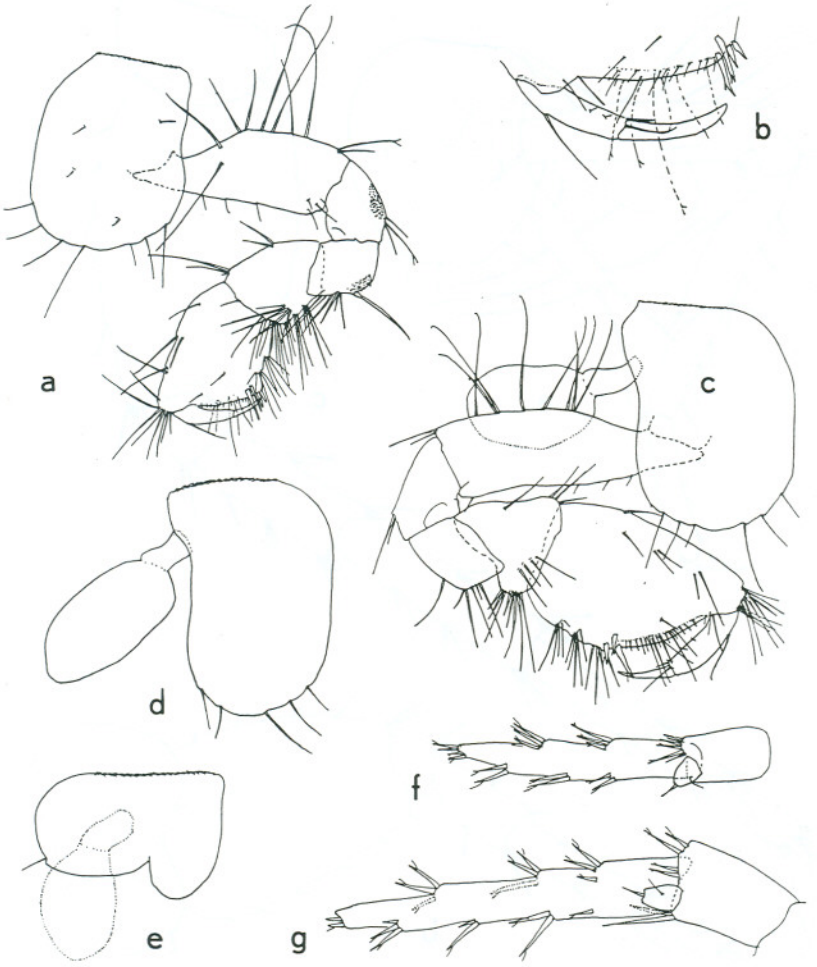

Fig. 10. *Pseudoniphargus littoralis* n. sp. (female holotype, male allotype). a) gnathopod 1, female (scale A); b) palma of gnathopod 1, female (B); c) gnathopod 2, female (A); d) coxal plate 3, female (A); e) coxal plate 6, female (A); f) uropod 3, female (A); g) uropod 3, male (A). Scale on fig. 2.

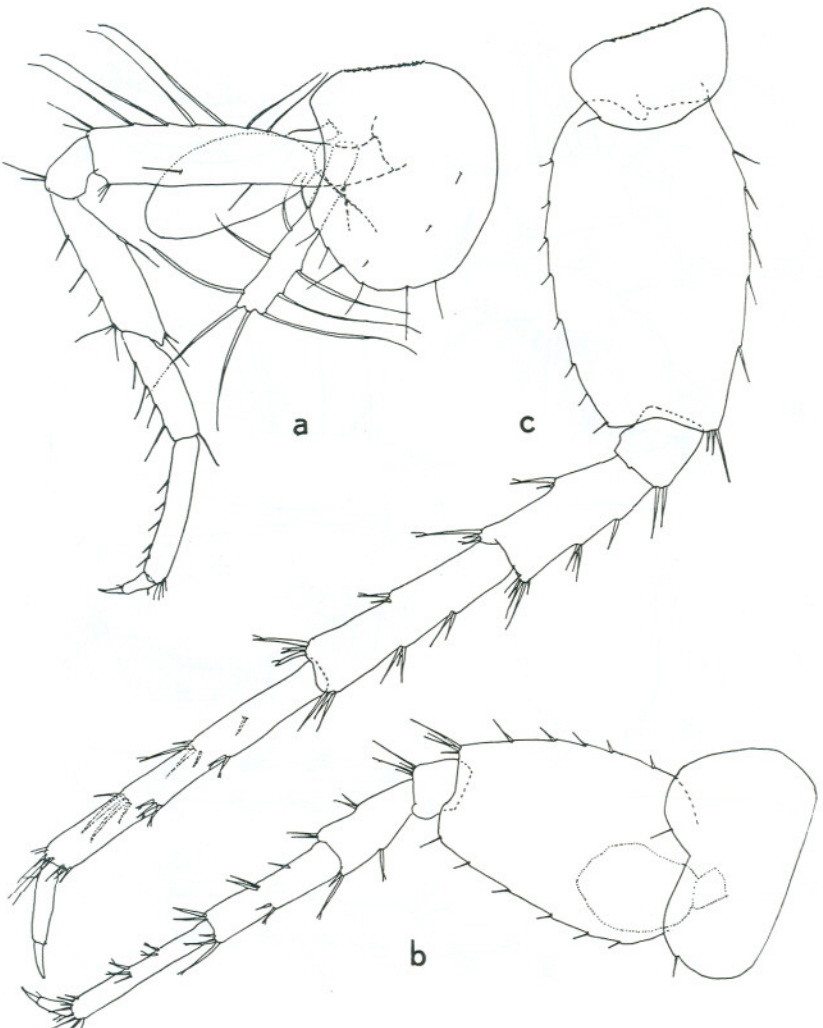

Fig. 11 - *Pseudoniphargus littoralis* n. sp. (Female holotype). a) pereiopod 4 (scale A); b) pereiopod 5 (A); c) pereiopod 7 (A). Scale on fig. 2.

conductivity at low tide 0.1 mS/cm, but at high tide immersed by sea water; 27 Apr. 1992. (ZMA Amph. 109.129.)

Remarks.- These fragmentary or juvenile specimens cannot be properly identified. Attempts to collect additional specimens failed.

ACKNOWLEDGEMENTS

The fieldwork for this study was carried out with the aid of a NATO (Brussels) Collaborative Research Grant, contract 880011, to the senior author. Dr. M. J. BISCOITO, Director, and Mr. G. E. MAUL, former Director, of the Museu Municipal do Funchal (Madeira, Portugal) are thanked for their hospitality and efficient assistance during the preparations of the fieldwork. Mr. J. J. VERMEULEN (Amsterdam) rendered valuable assistance during the fieldwork on Madeira.

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Received 20.07.1992