

First record of Superornatiremidae (Copepoda: Harpacticoida) from Mediterranean waters, with description of three new species from Balearic anchihaline caves*

DAMIÀ JAUME

Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB),
Ctra. Valldemossa, km 7'5, 07071 Palma de Mallorca, Spain.

SUMMARY: Three new representatives of the harpacticoid family Superornatiremidae are described from the flooded coastal karst of the Balearic Islands. The monotypic genera *Superornatiremis* and *Intercrusia*, restricted thus far to Bermudian anchihaline caves, are represented each by an isolated vicariant in similar environments on Mallorca, viz.: *S. mendai* and *I. garciai*. The amphi-Atlantic pattern displayed by *Neoechinophora*, with 3 species known from Bermudian caves and another one in a sea-flooded lava tube in Lanzarote (Canary Islands), is expanded to include also the Mediterranean region upon the discovery of *N. xoni* in Mallorca. The distribution range of the family now fits the amphi-Atlantic/Mediterranean track displayed by many stygobiont malacostracans, generally interpreted as Tethyan in origin. The trilobate condition of the proximal syncoxal endite of the maxilla of *Intercrusia* is confirmed.

Key words: Copepoda, Harpacticoida, Superornatiremidae, *Neoechinophora*, *Superornatiremis*, *Intercrusia*, anchihaline caves, Mediterranean.

RESUMEN: PRIMEROS REGISTROS DE LA FAMILIA SUPERORNATIREMIDAE (COPEPODA: HARPACTICOIDA) EN EL MEDITERRANEO, Y DESCRIPCIÓN DE TRES ESPECIES DE CUEVAS ANQUIHALINAS DE LAS ISLAS BALEARES. – Se describen tres nuevos copépodos harpacticoides Superornatiremidae en base a material colectado en cuevas litorales de las islas Baleares. Un nuevo representante de los géneros *Superornatiremis* y *Intercrusia*, hasta ahora monotípicos y localizados en cuevas anquihalinas de la isla de Bermuda, vive en ambientes similares de la isla de Mallorca, viz.: *S. mendai* y *I. garciai*. Por otra parte el género *Neoechinophora*, constituido hasta ahora por 3 especies restringidas a cuevas de Bermuda y por una cuarta localizada en un tubo volcánico anegado por el mar en la isla de Lanzarote, ve expandida su área de distribución hasta el Mediterráneo tras el hallazgo de *N. xoni* en Mallorca. La familia Superornatiremidae goza ahora de un patrón de distribución anfi-Atlántico/ Mediterráneo similar al conocido para muchos malacostráceos estigobiontes, patrón al que se le viene suponiendo un origen tetiano. Se confirma la condición trilobulada del endito proximal de la síncoxa maxilar de *Intercrusia*.

Palabras clave: Copépodos, Harpacticoides, Superornatiremidae, *Neoechinophora*, *Superornatiremis*, *Intercrusia*, cuevas anquihalinas, Mediterráneo.

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INTRODUCTION

The Superornatiremidae constitute a recently described family of tsebidiomorph harpacticoid copepods characterised by their most unusual first leg, which exhibits numerous additional setation elements on both rami in comparison to the armature displayed in other copepods (Huys and Boxshall, 1991; Huys, 1996). Superornatiremids have 3 and 2 spines on the outer margins of the first and second exopodal segments, respectively, and 1 or 2 setae on the outer margin of the second endopodal segment. The terminal endopodal segment bears 7 setae, with 2 located on the outer margin. No other copepods possess more than 2 spines on the outer margin of exopodal segment 1, nor more than 1 spine on the outer margin of segment 2. Moreover, none possesses any armature elements on the outer margin of the second endopodal segment, nor more than 1 seta on the outer margin of the third endopodal segment of the first swimming leg.

On the assumption that evolution within the Copepoda has proceeded primarily by oligomerization and reduction of armature elements on segments (Boxshall *et al.*, 1984; Huys and Boxshall, 1991), superornatiremids can be regarded as a very primitive group since they display the most plesiomorphic condition of leg 1 known in all copepods. However, all of these additional armature elements are regarded as secondary additions and not as ancestral structures, since the three genera comprising the family share many derived features with the advanced family Tsebidae Stebbing, 1910 (see Huys and Boxshall (1991) and Huys (1996)).

Superornatiremids are noteworthy also by the type of habitat they apparently are restricted to: anchihaline caves located in the circum-Caribbean region and Bermuda, and also the Canary Islands. Thus, the single species of *Superornatiremis* Huys, 1996 and *Intercrusia* Huys, 1996 inhabit several caves on Bermuda, whereas *Neoechinophora* Huys, 1996 displays 4 species in caves on Bermuda and the Canaries, and several as yet undescribed taxa in similar environments in Belize and Eleuthera (Bahamas) (Huys, 1996).

The present paper provides the description of three new species of *Superornatiremis*, *Neoechinophora* and *Intercrusia*, collected in anchihaline caves in Mallorca (Balearic Islands, Mediterranean). This discovery now expands the known distribution range of the family to fit the Amphi-Atlantic/Mediterranean track displayed by many stygobiont malacostracans, generally regarded as Tethyan in origin (Stock, 1993).

MATERIAL AND METHODS

The three species under consideration were gathered in anchihaline caves (*sensu* Stock *et al.*, 1986) located on the NE coast of Mallorca (Balearic Islands). Detailed information on the various localities sampled is presented below for each species (see "Material examined". Samples were taken using meat-baited traps placed at different depths in the cave lakes and left for several days, and also using a hand-held plankton net with an extensible (to 3 m) handle.

The terminology used in the descriptions follows Huys and Boxshall (1991). Material is deposited both in The Natural History Museum, London (BMNH), and in the Museu de la Naturalesa de les Illes Balears, Palma de Mallorca (MNCM).

TAXONOMIC PART

Subclass COPEPODA Milne Edwards, 1840
Order HARPACTICOIDA Sars, 1903
Family SUPERORNATIREMIDAE Huys, 1996

Genus *Neoechinophora* Huys, 1996

Neoechinophora xoni sp. nov.
(Figs. 1-7)

Material examined. Cova de na Mitjana (Capdepera, Mallorca). UTM coordinates: 539.10; 4390.95. Topographic profile of the cave published by Ginés *et al.* (1975): fossil coastal cave excavated in Triassic fissured limestone, 5 m from shoreline. It has a subaerial entrance at 7 m above sea level and harbours a shallow lake (depth < 0.5 m) subjected to direct marine influence, with a sandy bottom, a slight swell, and a clearly marine fauna (Chaetognatha, *Palaemon serratus*, crabs, Cumacea). Holotype: adult male 0.41 mm (BMNH reg. no. 1997.17). Allotype: adult female 0.44 mm (BMNH reg. no. 1997.18). Paratypes: 15 males, 22 females and 4 copepodids (BMNH reg. nos. 1997.19-59). Collected by author, 17 July 1994. 61 individuals, both sexes (MNCM.334); collected by author, 28 June 1996.

Adult male. Body (Figs. 1A, B) 0.41 to 0.46 mm long, slender, cyclopiform, colourless. Nauplius eye absent. Prosome 4-segmented, with first pedigerous somite completely incorporated into cephalosome to form cephalothorax. Rostrum developed, fused to cephalic shield, rounded in lateral aspect. Cephalothorax subrectangular in lateral aspect, posterolateral corner evenly rounded and produced to cover part of pleura of second pedigerous somite; anterior margin of cephalothorax straight, forming right angle with lateral margin. Second to fourth pedigerous somites with evenly rounded posterolateral corners.

Urosome (Fig. 1C) 6-segmented. Fifth pedigerous somite with smooth hyaline frill along dorsal hind margin. Genital somite quadratic, slightly larger than following somites, with smooth hyaline frill along dorsal and lateral hind margins; sixth legs (Fig. 1D) reduced to paired, symmetrical opercular flaps fused to somite, armed with distal seta plus short spine on inner margin and seta on outer margin; row of spinules around insertion point of distal seta. First abdominal somite with 2 parallel ventrolateral rows of spinules on each side. Second and third abdominal somites with single row of spinules across ventral surface. Smooth hyaline frill along hind margin of each abdominal somite. Anal somite

(Figs. 1C, E) with weakly developed operculum provided with row of 32-34 tiny spinules; row of ventrolateral and ventral spinules present on each side of somite, as figured. Paired wide pores located ventrolaterally near hind margin of somite; ventral, lateral and laterodorsal hind margin adorned with row of spinules. Caudal rami subquadrate, symmetrical, 1.38 times as long as wide, armature consisting of 7 setae. Seta I implanted ventrally, reduced; seta II implanted laterally, about midway along outer margin of ramus. Rows of tiny spinules around insertion points of setae I, II and VII, as figured. Ventral hind margin of caudal rami with row of coarse spinules.

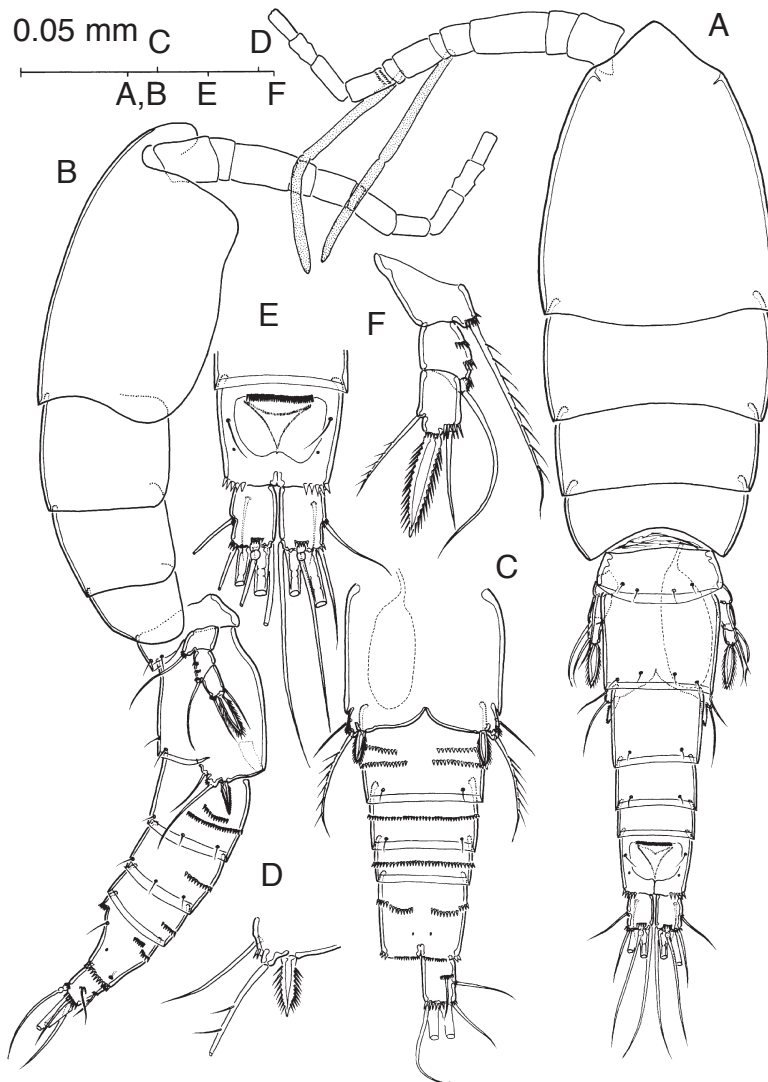


FIG. 1. – *Neoechinophora xoni* sp. nov., adult male. A, body, dorsal; B, same, lateral; C, urosome (excluding P5-bearing somite), ventral; D, detail of armature of sixth leg; E, anal somite and caudal rami, dorsal; F, fifth leg, anterior.

Antennules (Figs. 2A, B) symmetrical, elongate, slender, 11-segmented, haplocer; geniculation between segments 8 and 9. Segment 5 represented by U-shaped sclerite. Segment 8 with 2 spinule combs on dorsal surface. Segmental fusion pattern and armature as follows: segment 1 (corresponding to ancestral segment I), 1 seta; segment 2 (corresponding to ancestral segment II), 1 seta; segment 3 (fused ancestral segments III to VIII), 10 setae; segment 4 (fused IX-XII), 6 + aesthetasc; segment 5 (XIII), 2 setae; segment 6 (XIV-XVII), 7 + ae; segment 7 (XVIII), 2 setae; segment 8 (XIX-XX), 2 setae plus 2 modified plate-like elements; segment 9 (XXI-XXIII), 1 seta plus 3 modified plate-like elements; segment 10 (XXIV-XXV), 4 setae; seg-

ment 11 (XXVI-XXVIII), 6 setae plus acrothek, consisting of aesthetasc and basally fused seta. Antenna (Fig. 3A) with reduced, bare coxa.

Basis and proximal endopod segment fused forming allobasis; original segmentation marked by transverse chitinous rib along abexopodal margin; 2 spinule rows adorning segment as figured; single abexopodal seta on segment. Endopod with 2 transverse frills subdistally; lateral armature consisting of 3 unequal setae; apical armature consisting of 1 subdistal seta, 4 geniculate setae, plus 2 long setae adorned with spinules as figured. Exopod 3-segmented, armature formula (2,2,2); setae on second segment with basal tuft of setules and bearing spinules as figured.

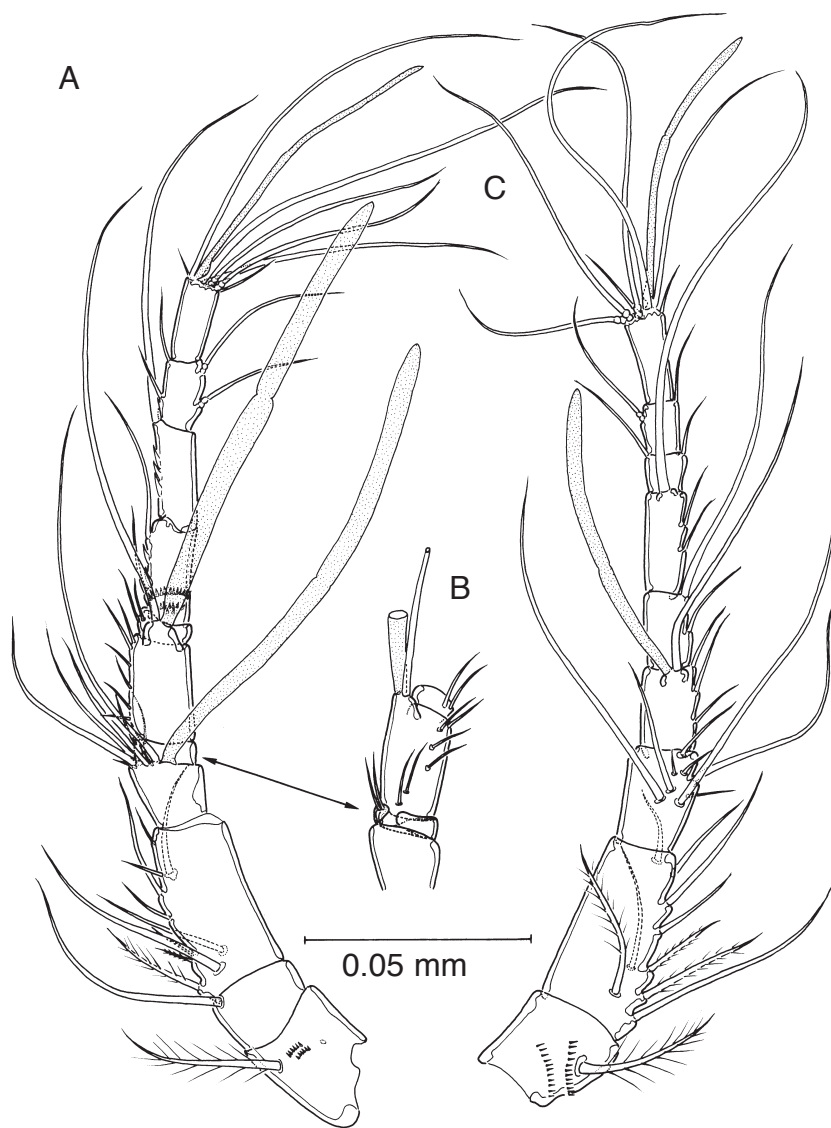


FIG. 2. – *Neoechinophora xoni* sp. nov., antennule, ventral. A, adult male; B, detail of segments 5 to 7, anterior; C, adult female.

Labrum and labium (not figured) fused forming a well developed oral cone.

Mandible (Figs. 3B, C) with stylet-like gnathobase bearing series of small, rounded teeth ventrally and single long seta dorsally. Palp biramous, with subquadrate basis armed with 2 unequal

setae and row of spinules at inner distal corner; inner seta modified, swollen, with densely set long setules on distal third. Endopod 1-segmented, elongate, with 3 terminal subequal setae, 2 of them fused at base; 2 rows of tiny setules on segment, as figured. Exopod 4-segmented, setal formula (1,1,1,1).



FIG. 3. – *Neoechinophora xoni* sp. nov., adult male. A, antenna; B, mandible, coxal gnathobase; C, mandibular palp; D, maxilliped.

Maxillule (Figs. 4A, B) with partially fused praecoxa and coxa forming syncoxa. Outer margin with 2 spinulose bulges. Praecoxal arthrite slender, produced into spinous process at distal corner and bearing 3 spines and 4 setae distributed as figured. Coxal endite armed with 4 termi-

nal setae and 2 shorter setae subdistally. Basis with 2 endites; proximal bearing 2 setae, distal bearing 3 unequal setae. Exopod elongate, slender, covered with patch of fine setules; 4 setae distally. Endopod 1-segmented, reduced, with 3 unequal setae.

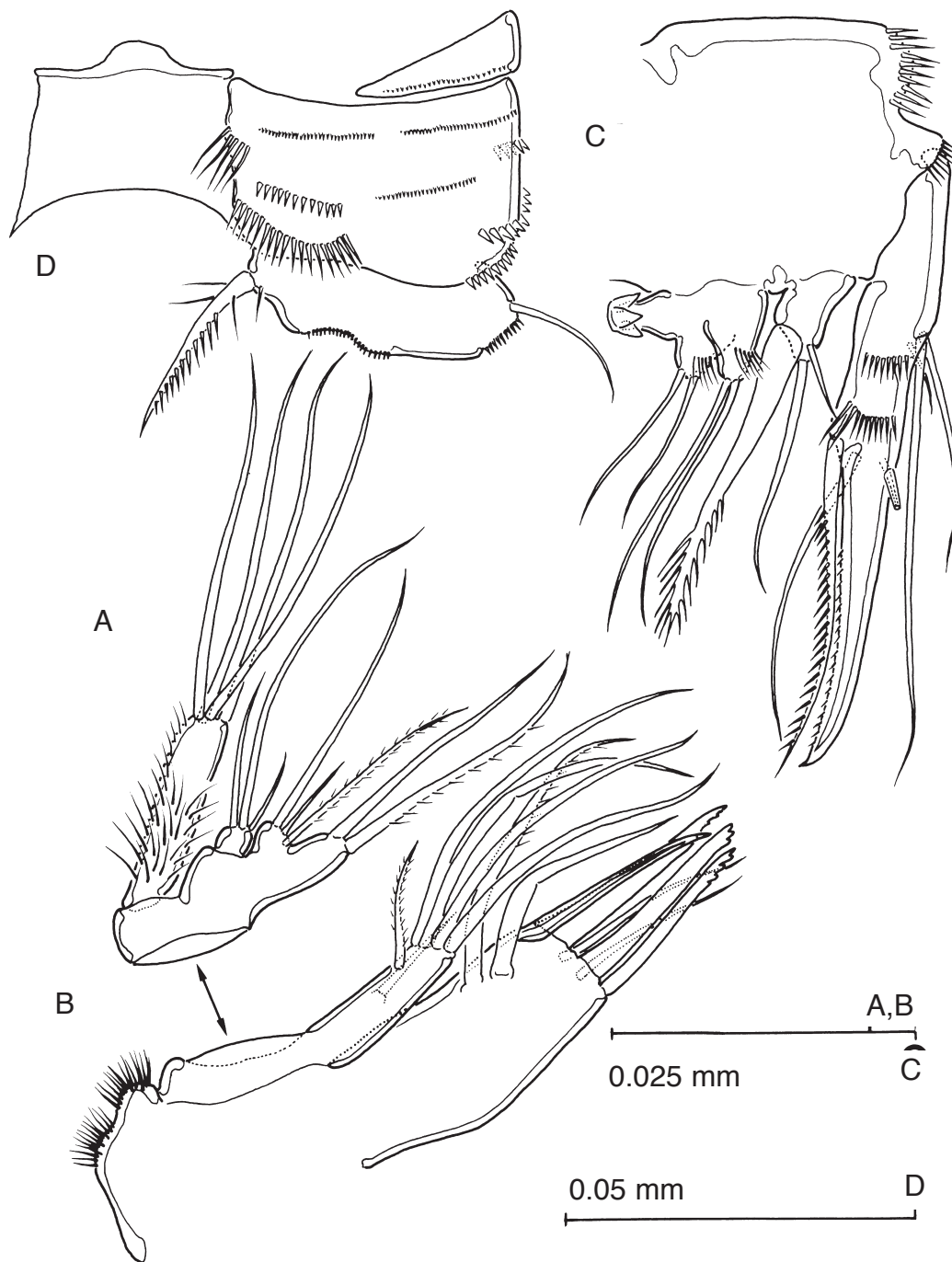


FIG. 4. – *Neoechinophora xoni* sp. nov., adult male. A, B, maxillule with disarticulated palp (A); C, maxilla; D, leg 1 praecoxa, coxa, basis and intercoxal sclerite, anterior.

Maxilla (Fig. 5C). Syncoxa with 2 well developed endites. Proximal endite trilobate, proximal lobe with 3 overlapping barb-like spinules on tip; other lobes armed with 2 setae each. Distal endite with 1 thick seta serrate apically and 2 unequal, slender setae. Allobasis drawn out into long claw, with 2 setae at base; 2 combs of spinules adorning segment as figured. Endopod completely incorporated into allobasis, bearing 3 unequal setae.

Maxilliped (Fig. 3D) subchelate, with unarmed syncoxa adorned with 2 rows of spinules, as figured. Basis with reduced seta subdistally along medial margin and several rows of spinules as figured. Endopod elongate, drawn out into long subdistal claw accompanied by 2 short outer setae at base, and 1 seta along medial margin; apical pedestal on segment, with 2 thick, geniculate setae.

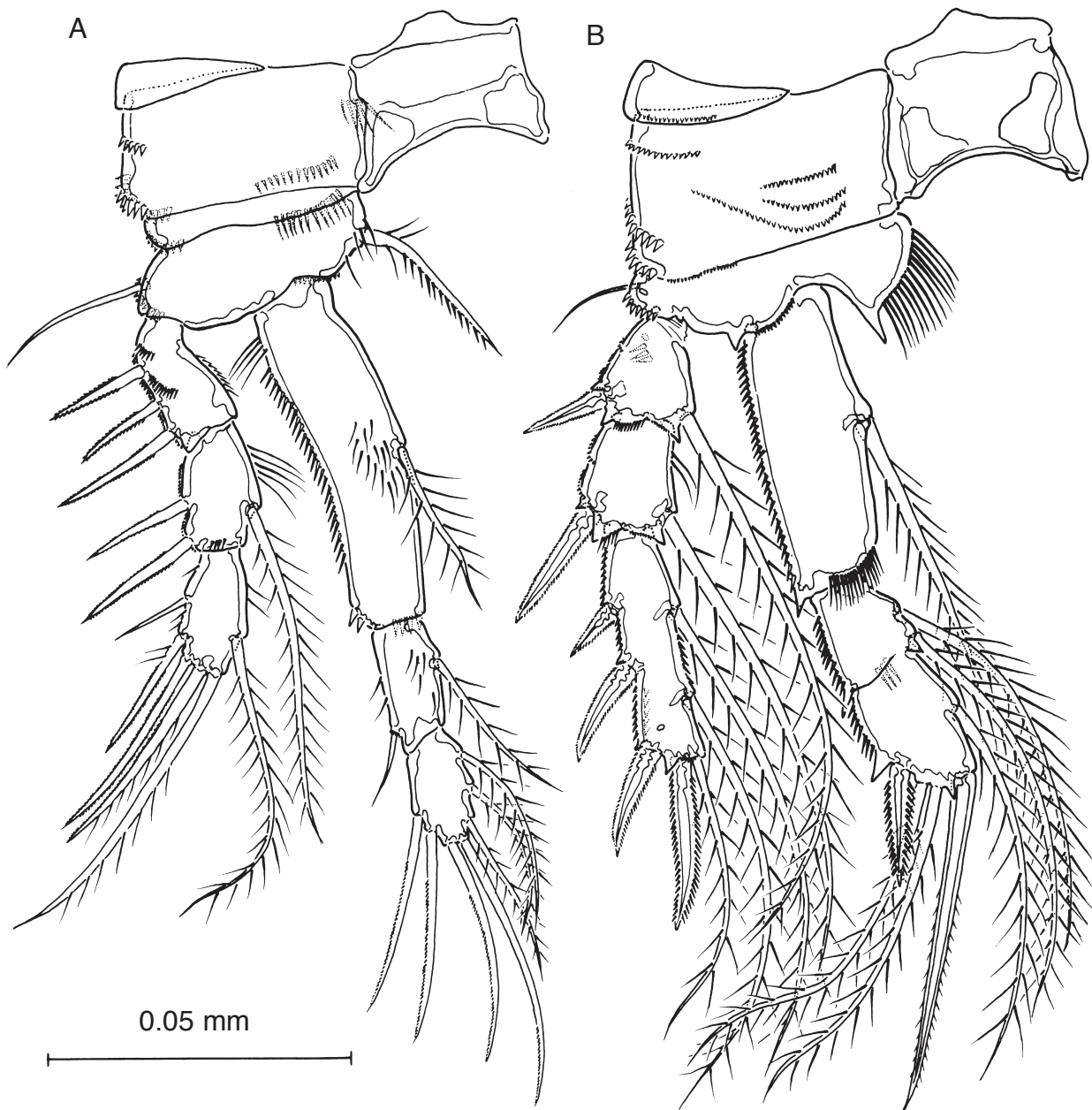


FIG. 5. – *Neoechinophora xoni* sp. nov., adult male. A, leg 1, posterior; B, leg 2, anterior.

Swimming legs (Figs. 4D; 5; 6) biramous, both rami 3-segmented, although distal segments of endopod of leg 2 not completely separate. Small praecoxa developed in each leg. Coxae of leg pairs joined by intercoxal sclerite. Coxae displaying complex, species-specific pattern of spinules and setules, as figured. Armature formula as follows:

Leg	Coxa	Basis	Exopod	Endopod
1	0-0	1-1	III-0;II-1;6	0-1;I-1;2,2,3
2	0-0	1-0	I-1;I-1;III,I+1,2	0-1;(0-2;I,2,I+1)
3	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,2,I+2
4	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,I+1,1

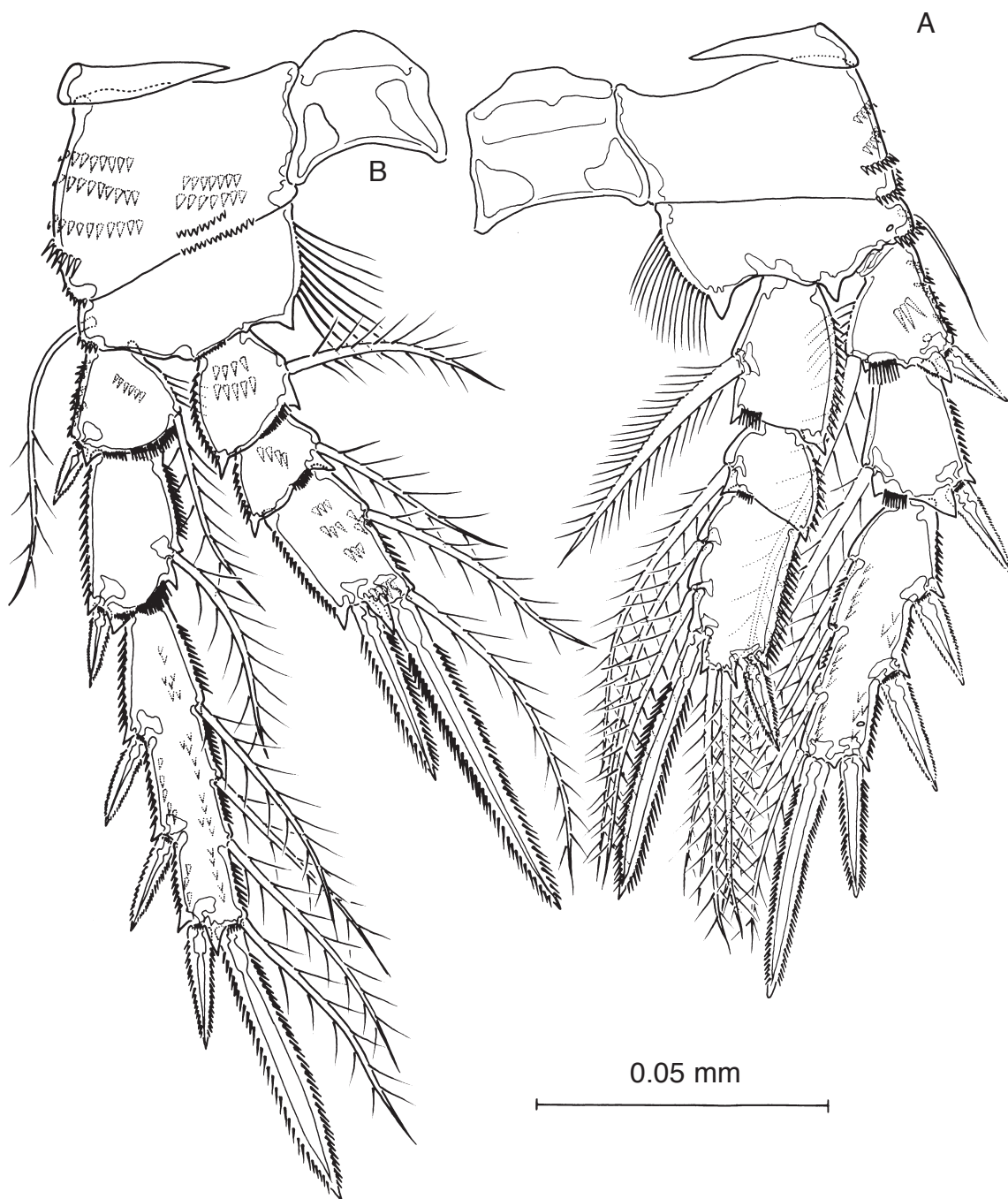


FIG. 6. – *Neoechinophora xoni* sp. nov., adult male. A, leg 3, anterior; B, leg 4, anterior.

Fifth legs (Figs. 1A, B, F) uniramous, displaced ventrolaterally, 3-segmented, not incorporated into somite. Baseopod and proximal endopodal segment both bearing 1 distal seta on outer margin. Distal endopodal segment armed with apical pinnate spine flanked by 2 setae. Several rows of spinules on segments, distributed as figured.

Adult female. Body (Figs. 7A, B, D, E) 0.43 to 0.49 mm long, resembling male, with sexual dimorphism in antennule, leg 5, leg 6 and genital segmentation.

Genital double-somite (Figs. 7A-C) with dorsal and ventrolateral surface frill marking original segmentation; ventrolateral bulges present in anterior half. Gonopores separate, displaced laterally, each covered by vestigial leg 6 bearing 2 unequal setae. Single copulatory pore small,

located midventrally inside wide depression; latter completely covered by rounded, hyaline epicopulatory flap.

Antennule (Fig. 2C) elongate, slender, 9-segmented. Armature formula as follows: segment 1, 1 seta; segment 2, 9 setae; segment 3, 8 setae; segment 4, 4 setae + aesthetasc; segment 5, 2 setae; segment 6, 3 setae; segments 7 and 8, 2 setae each; segment 8, 6 setae plus acrothek, acrothek consisting of aesthetasc and basally fused seta.

Fifth legs (Figs. 7A, B, F) uniramous, 2-segmented, displaced ventrolaterally. Baseopod partially incorporated into somite; outer lobe bearing single seta, inner lobe carrying 2 setae. Exopod slender, 5 times as long as maximum width; armature consisting of 1 inner, 2 outer, and 1 apical setae; rows of spinules on segment as figured.

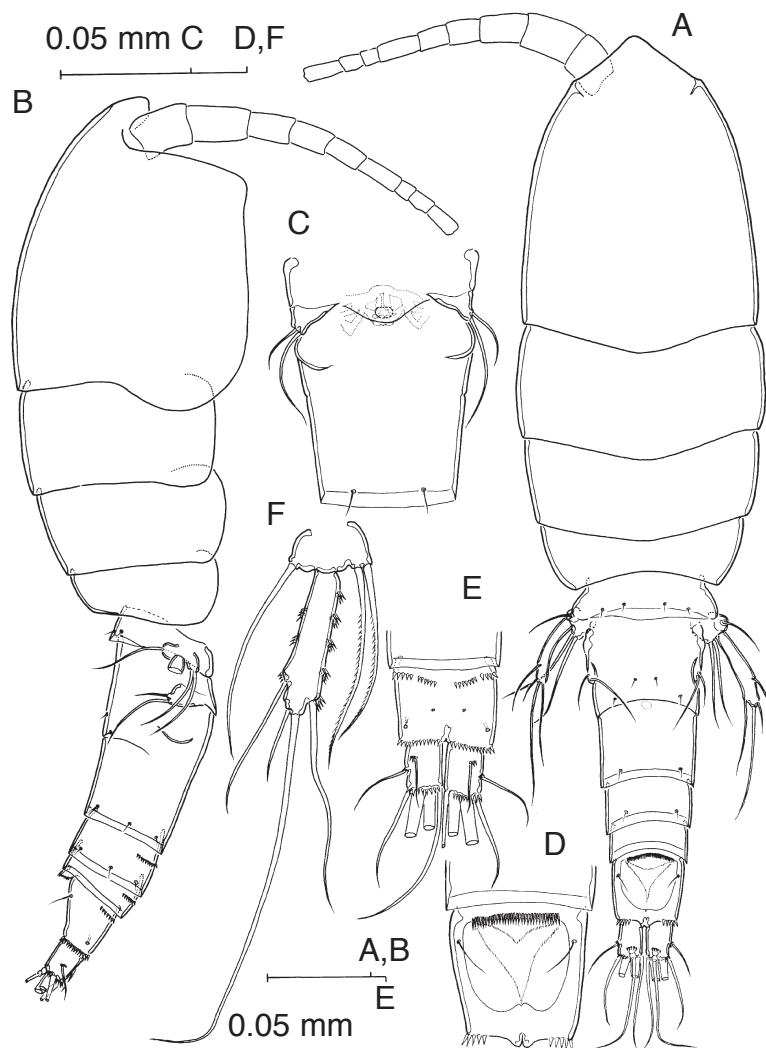


FIG. 7. – *Neoechinophora xoni* sp. nov., adult female. A, body, dorsal; B, same, lateral; C, genital double-somite, ventral; D, anal somite, dorsal; E, anal somite and caudal rami, ventral; F, fifth leg, anterior.

Etymology. The new species is dedicated to Joan Pons-Moyà “Xoni”, one of the speleologists who discovered Cova de na Mitjana and pointed out to the author the faunistic potential of the cave.

Remarks. *N. xoni* can be readily distinguished from the other representatives of the genus by the elongate, non-ovoid shape of the female’s fifth leg exopod, resembling that of *Intercrusia problematica* Huys, 1996 and also by the male sixth legs, which are both non-articulating and completely fused to somite. Additional diagnostic character states can be deduced from Table 1.

Genus *Superornatiremis* Huys, 1996

Superornatiremis mendai sp. nov. (Figs. 8-13)

Material examined. Cova de na Mitjana (Capdepera, Mallorca). Holotype: adult male 0.48 mm (BMNH reg. no. 1997.9). Allotype: adult female 0.47 mm. (BMNH reg. no. 1997.10), mouthparts dissected on one slide; mounted in lactophenol sealed with nail varnish. Paratypes: four adult males (BMNH reg. nos.

1997.11-14), one with mouthparts dissected on one slide and mounted in lactophenol sealed with nail varnish. Collected by author, 17 July 1994. - Cova de na Barxa (Capdepera, Mallorca). UTM coordinates: 539,30; 4393,10. Topographic profile published by Andrews et al. (1989): fossil coastal cave excavated in Triassic fissured limestone, 10 m from shoreline, with a subaerial entrance at 3 m above sea level. Anchihaline lake reaching a maximum depth of 1.5 m. No chemical analysis of the water was made, but it was fresher and warmer than the neighbouring sea. Single male and female, not preserved. Collected by author, 17 July 1994.

Adult male. Body (Figs. 8A, B) 0.47 to 0.52 mm long, slender, cyclopiform, colourless. Nauplius eye absent. Prosome 4-segmented, with first pedigerous somite completely incorporated into cephalosome to form cephalothorax. Rostrum developed, fused to cephalic shield, rounded in lateral aspect. Cephalothorax subrectangular in lateral aspect, posterolateral corner evenly rounded and produced to cover part of pleura of second pedigerous somite; anterior margin of cephalosome straight, forming right angle with lateral margin. Second to fourth pedigerous somites with evenly rounded posterolateral corners.

TABLE 1. – Major differences between *Neoechinophora* species. Abbreviations: md., mandible; prox., proximal; max., maxilla; mxp., maxilliped; abd-(1-3), abdominal somites 1 to 3; basoend., basoendopod.

	<i>N. xoni</i>	<i>N. fosshageni</i>	<i>N. daltonae</i>	<i>N. jaumei</i>	<i>N. karaytugi</i>
no. setae male antennule segment 3	10	8	10	9	?
no. setae female antennule segment 3	8	7	8	?	7
no. segments on antennary exopod	3	4	3	4 (indistinctly)	2
md. exopod formula	(1,1,1,1)	(1,1,1,2)	(1,1,1,1)	(1,1,1,1)	(1,1,1,1)
no. setae md. endopod	3	3	3	4	?
no. barb-like spinules on prox. lobe of prox. syncoxal endite of max.	3	6	1	6	3
no. setae max. endopod	3	3	3	1	3
no. setae mxp. basis	1	0	1	0	0
ventrolateral bulges on female genital double-somite	Yes	No	Yes	?	No
no. ventral spinule rows on male abd-1	2	1	2	1	?
no. ventral spinule rows on male abd-2	1	1	1	0	?
no. ventral spinule rows on male abd-3	1	0	1	0	?
length: width caudal ramus	1.38	3.85	1.5	2.2	1.4
no. setae inner lobe of baseoend. female leg 5	2	2	1	?	2
no. setae exopod female leg 5	4	5	4	?	4
length: width exopod female leg 5	5	2.3	3	?	3.3
both male leg 6 fused to somite	Yes	No	No	No	?
no. setae inner margin distal exopod segment of legs 3-4	3	3	3	2	3

Urosome (Fig. 8C) 6-segmented. Fifth pedigerous somite with smooth hyaline frill along dorsal hind margin. Genital somite quadratic, slightly larger than following somites, with smooth hyaline frill along dorsal and lateral hind margins; sixth legs reduced to paired opercular flaps armed with distal seta plus short spine on inner margin and seta on outer margin; row of spinules around insertion point of distal seta; sixth legs asymmetrical: right articulated to somite, left completely fused to it. First abdominal somite with 2 parallel ventrolateral rows of coarse spinules on each side. Second and third abdominal somites with single row of more slender spinules across ventral surface. Smooth hyaline frill along posterior mar-

gin of each abdominal somite. Anal somite (Figs. 8C, D) with weakly developed operculum provided with row of tiny spinules; row of ventrolateral and ventral spinules disposed at each side of somite, as figured. Paired wide pores located ventrolaterally near hind margin of somite; ventral, lateral and laterodorsal hind margin adorned with row of coarse spinules. Caudal rami subquadrate, symmetrical, 1.12 times as long as wide, armature consisting of 7 setae. Seta I implanted ventrally, reduced; seta II implanted laterally, about midway along outer margin of ramus. Rows of tiny spinules around insertion points of setae I, II and VII, as figured. Ventral hind margin of caudal rami with row of coarse spinules.

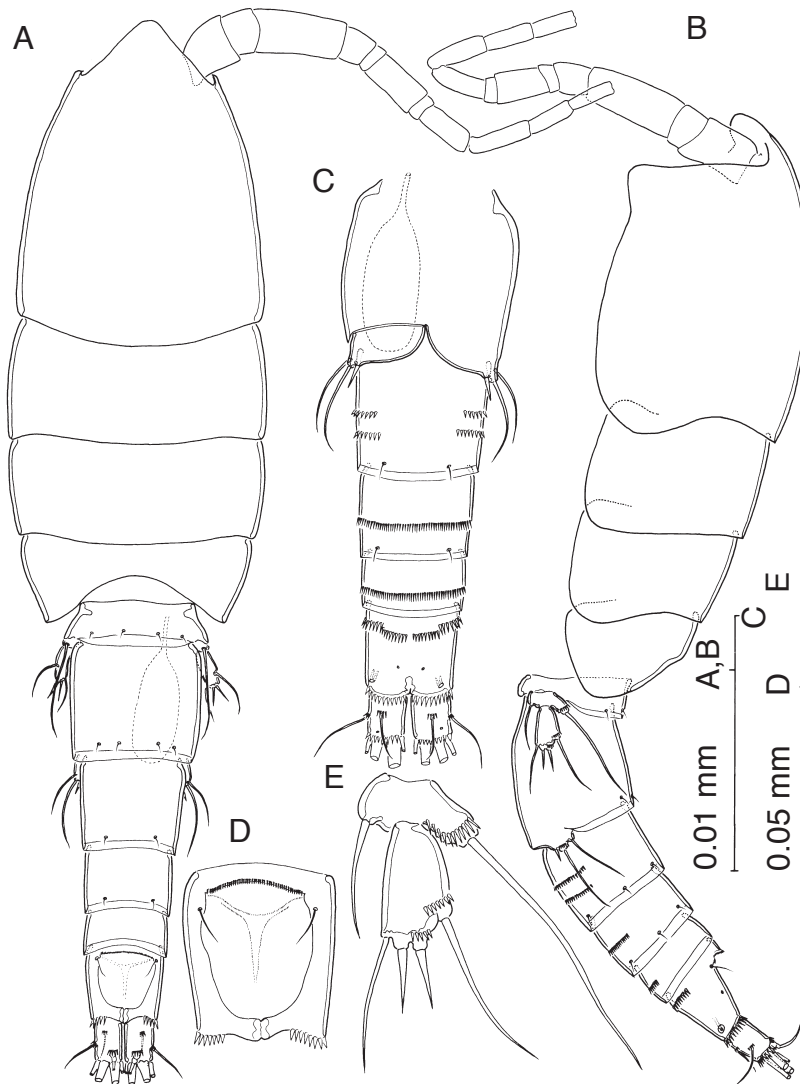


FIG. 8. – *Superornatiremis mendai* sp. nov., adult male. A, body, dorsal; B, same, lateral; C, urosome (excluding P5-bearing somite), ventral; D, anal somite, dorsal; E, fifth leg, anterior.

Antennules (Fig. 9A) symmetrical, elongate, slender, 11-segmented, haplocer; geniculation between segments 8 and 9. Segment 5 represented by U-shaped sclerite (although form is not detailed in figure). Segment 8 with single spinule comb on dorsal surface. Segmental fusion pattern and armature as for *N. xoni*, described above.

Antenna (Fig. 13A) with reduced coxa, adorned with row of long spinules. Basis and proximal endopod segment completely fused forming allobasis, bearing abexopodal seta; three groups of spinules on surface of segment, as illustrated. Endopod 1-seg-

mented, with 4 sets of spinules as figured; lateral armature consisting of 3 unequal setae; apical armature consisting of 1 subdistal seta, 4 geniculate setae, plus 2 long setae adorned with spinules as figured. Exopod 3-segmented, armature formula (2,2,2); proximal seta reduced, remaining setae with stout denticles at both sides except setae on second segment, which bear also basal setules as figured. Three rows of short spinules on proximal segment and 1 row on distal segment.

Labrum and labium (not figured) fused forming a well developed oral cone.

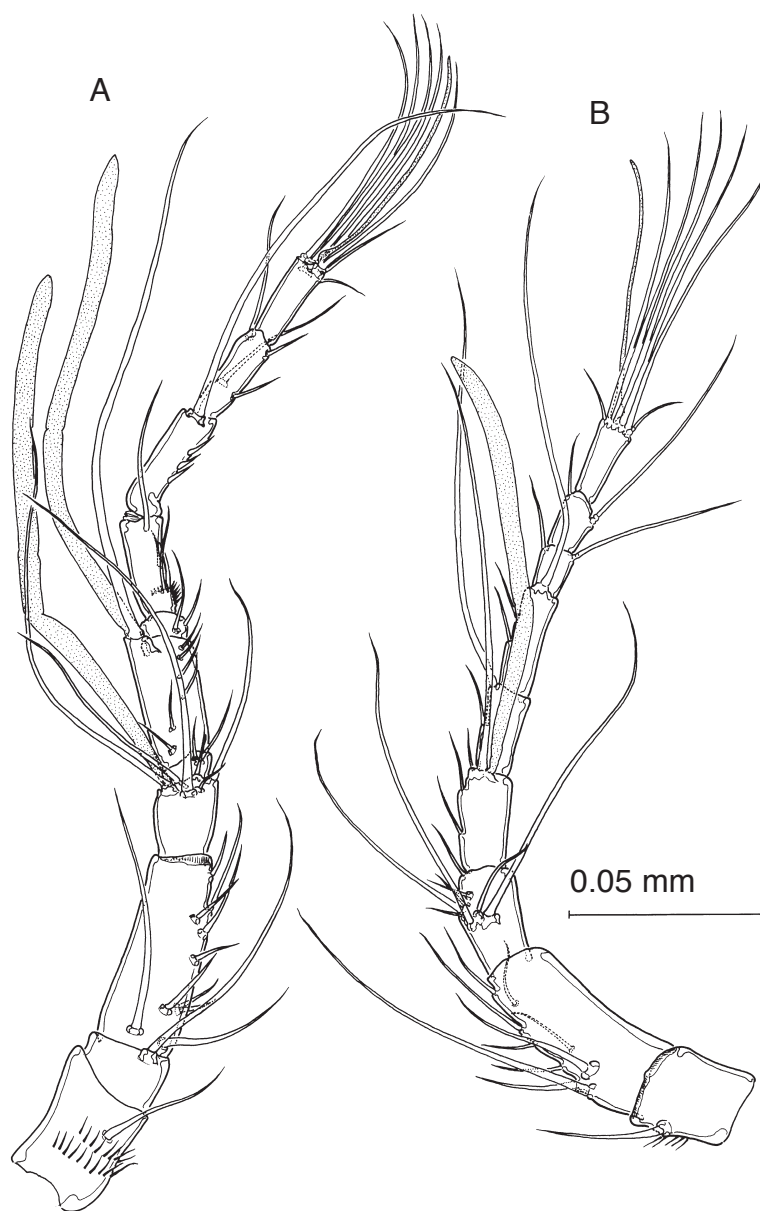


FIG. 9. – *Superornatiremis mendai* sp. nov., antennule, ventral. A, adult male; B, adult female.

Mandible with gnathobase (Fig. 10A) stylet-like, as in *N. xoni*. Palp (Fig. 10B) biramous. Basis with row of spinules and 2 setae at inner distal corner (outer one short and bipinnate, inner one modified, swollen, with densely set long setules in distal half). Exopod 4-segmented, armature formula (1,1,1,1); seta on proximal segment reduced; tuft of setules on proximal segment as figured; distal segment with row of short setules. Endopod 1-segmented, with 1 short and 2 long setae.

Maxillule (Fig. 10C) as described above for *N. xoni*, except for slight differences in distribution of spinule/setule rows on segments.

Maxilla (Fig. 10D) with general structure similar to *N. xoni*. Proximal lobe of proximal syncoxal endite with 5 barb-like spinules, increasing in size distally;

middle and distal lobes each with 2 setae and tuft of setules. Distal endite with 1 coarse seta apically serrate along one side and 1 slender seta. Allobasis drawn out into long claw bearing fine spinules towards the tip; one pinnate and 1 smooth seta at base. Endopod incorporated into allobasis, with 1 plumose, 1 long and 1 reduced bare setae. Several groups of spinules present on syncoxa and allobasis, as figured.

Maxilliped (Fig. 10E) subchelate. Syncoxa with 2 spinule rows as figured. Basis with reduced seta subdistally along medial margin and 4 rows of spinules present as figured. Endopod elongate, drawn out into long subdistal claw accompanied by 2 relatively long outer setae at base, and 1 pinnate seta along medial margin; apical pedestal on segment, with 2 thick setae.

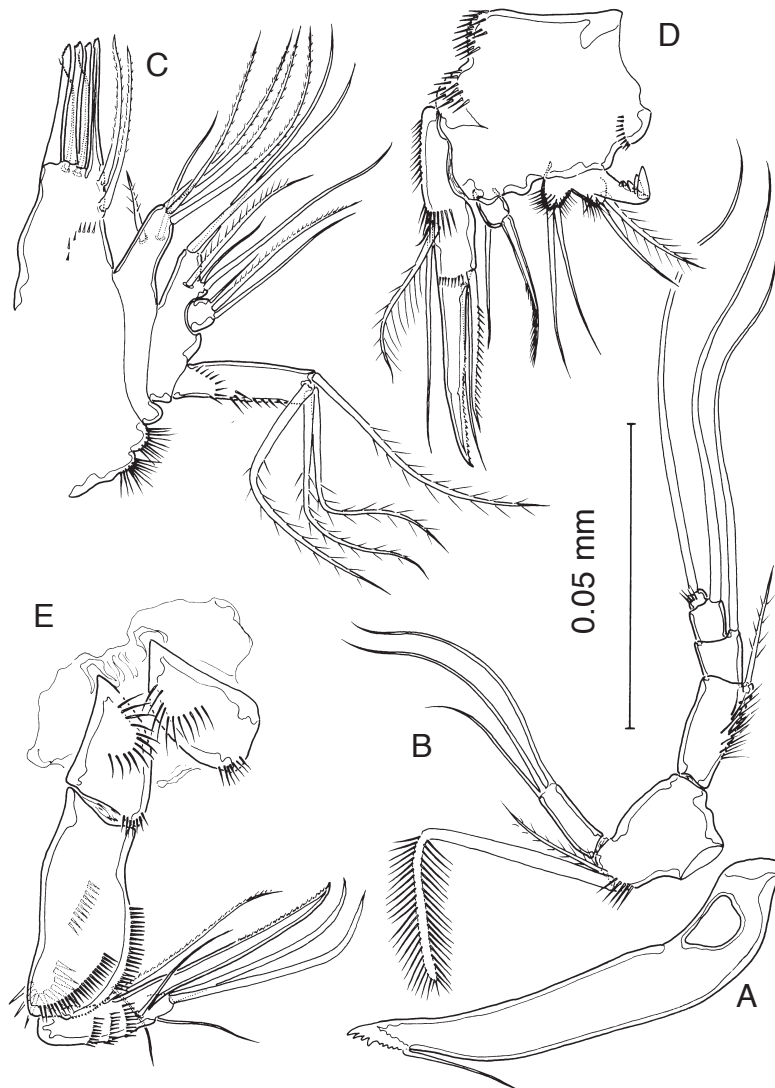


FIG. 10. – *Superornatiremis mendai* sp. nov., adult male. A, mandible, coxal gnathobase; B, mandibular palp; C, maxillule; D, maxilla; E, maxilliped.

Swimming legs (Figs. 11; 12) biramous, both rami 3-segmented, although distal segments of endopod of leg 2 not completely separate. Small praecoxa developed in each leg. Coxae of leg pairs joined by intercoxal sclerite. Coxae displaying complex, species-specific pattern of spinules and setules, as figured. Outer spines on leg 1 exopod displaying characteristic subterminal tubular extensions.

Armature formula as follows:

Leg	Coxa	Basis	Exopod	Endopod
1	0-0	1-1	III-0;II-1;7	0-1;2-1;2,2,3
2	0-0	1-0	I-1;I-1;III,I+1,2	0-1;(0-2;I,2,I+1)
3	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,2,I+2
4	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,I+1,1

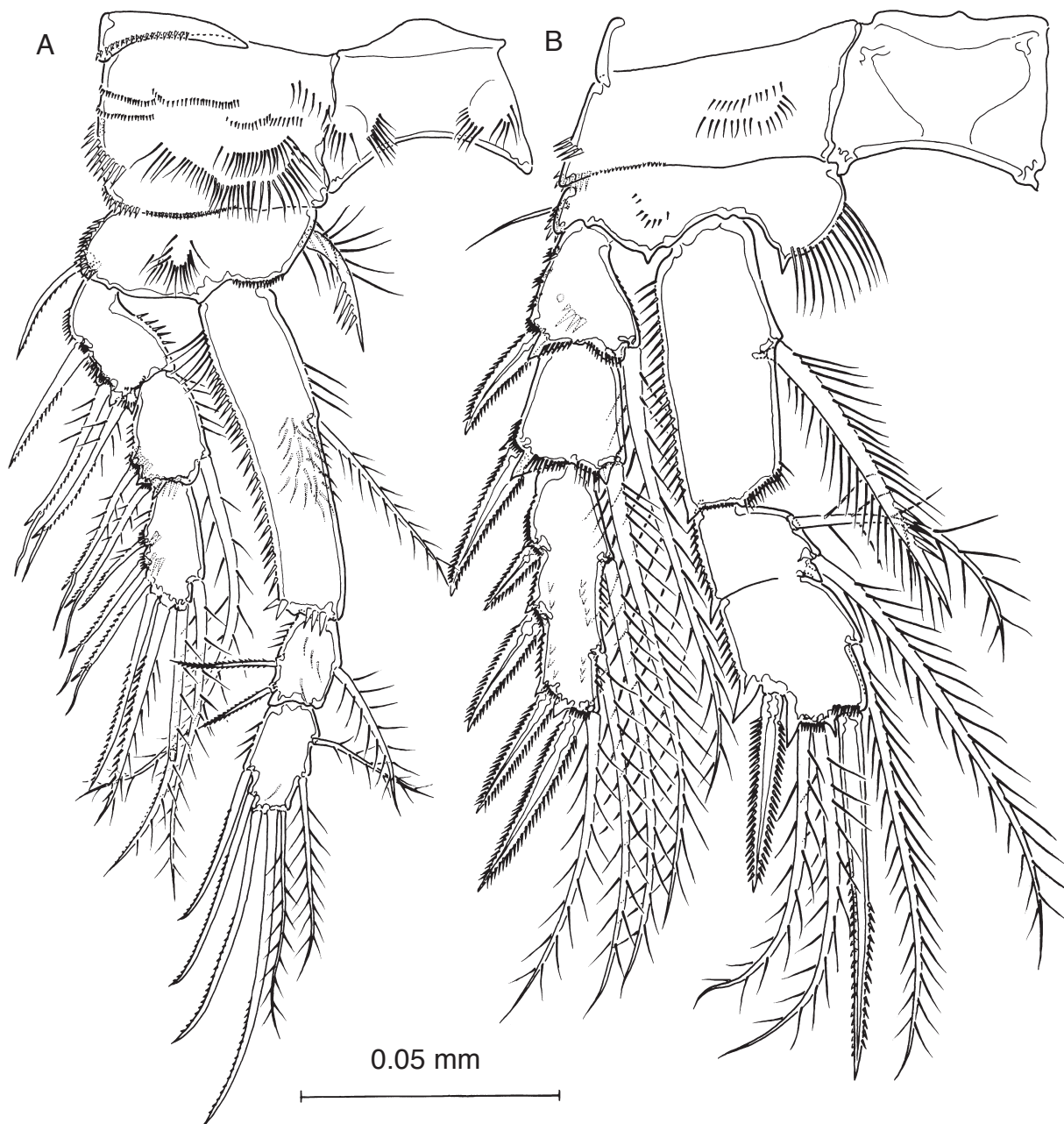


FIG. 11. – *Superornatiremis mendai* sp. nov., adult male. A, leg 1, anterior; B, leg 2, anterior.

Fifth legs (Figs. 8A, B, E) implanted ventrolaterally, uniramous, 2-segmented. Intercoxal sclerite absent. Baseoendopod about twice wider than long, furnished with single seta on each side; row of coarse spinules along outer lobe. Exopod about 1.5

times longer than wide, with 2 short setae distally, slender seta implanted subdistally along inner margin, plus seta implanted at three quarters of distance along outer margin; 2 outer setae with spinules around base.

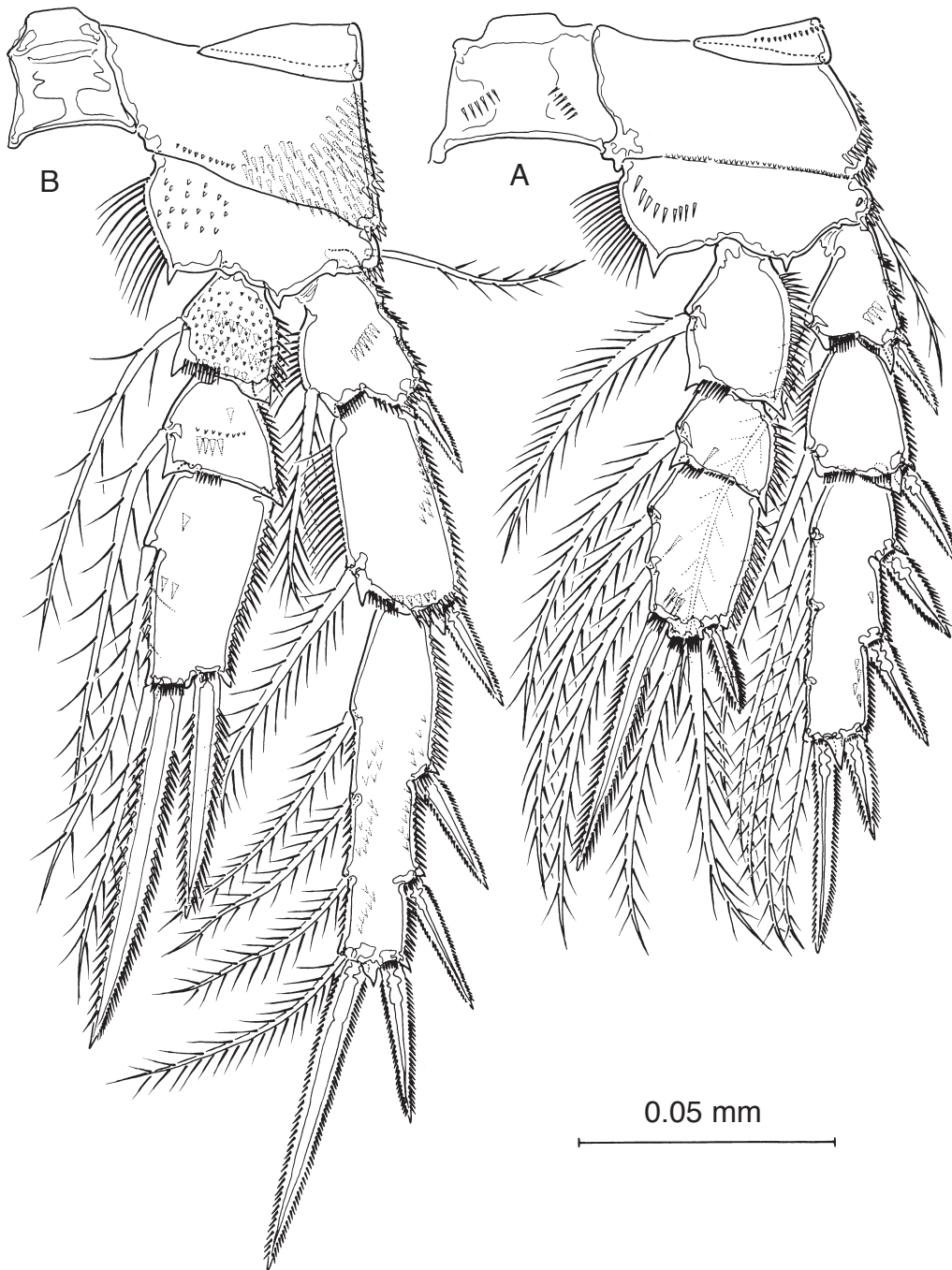


FIG. 12. – *Superornatiremis mendai* sp. nov., adult male. A, leg 3, anterior; B, leg 4, anterior.

Adult female. Body (Fig. 13B) 0.47 mm long, resembling male except for antennule, leg 5, leg 6 and genital segmentation.

Genital double-somite (Figs. 13 B-D) with dorsal and ventrolateral surface frill marking original segmentation. Gonopores separate, displaced laterally, each covered by vestigial leg 6 bearing 2 unequal setae. Single copulatory pore small, located midventrally in wide depression, latter completely covered by broad, incised hyaline lamella; bifid epicopulatory flap as figured.

Antennule (Fig. 9B), slender, 9-segmented. Segmentation and armature as for *N. xoni*, described above.

Fifth leg (Fig. 13E) 2-segmented. Baseopod partially incorporated into somite, with single seta on outer lobe and 2 strong bipinnate setae on inner lobe. Exopod ovoid, 2.35 times as long as wide, with anterior surface bearing several spinule rows as figured. Armature consisting of 1 inner seta, longest, 1 long apical seta, and 2 short, outer setae.

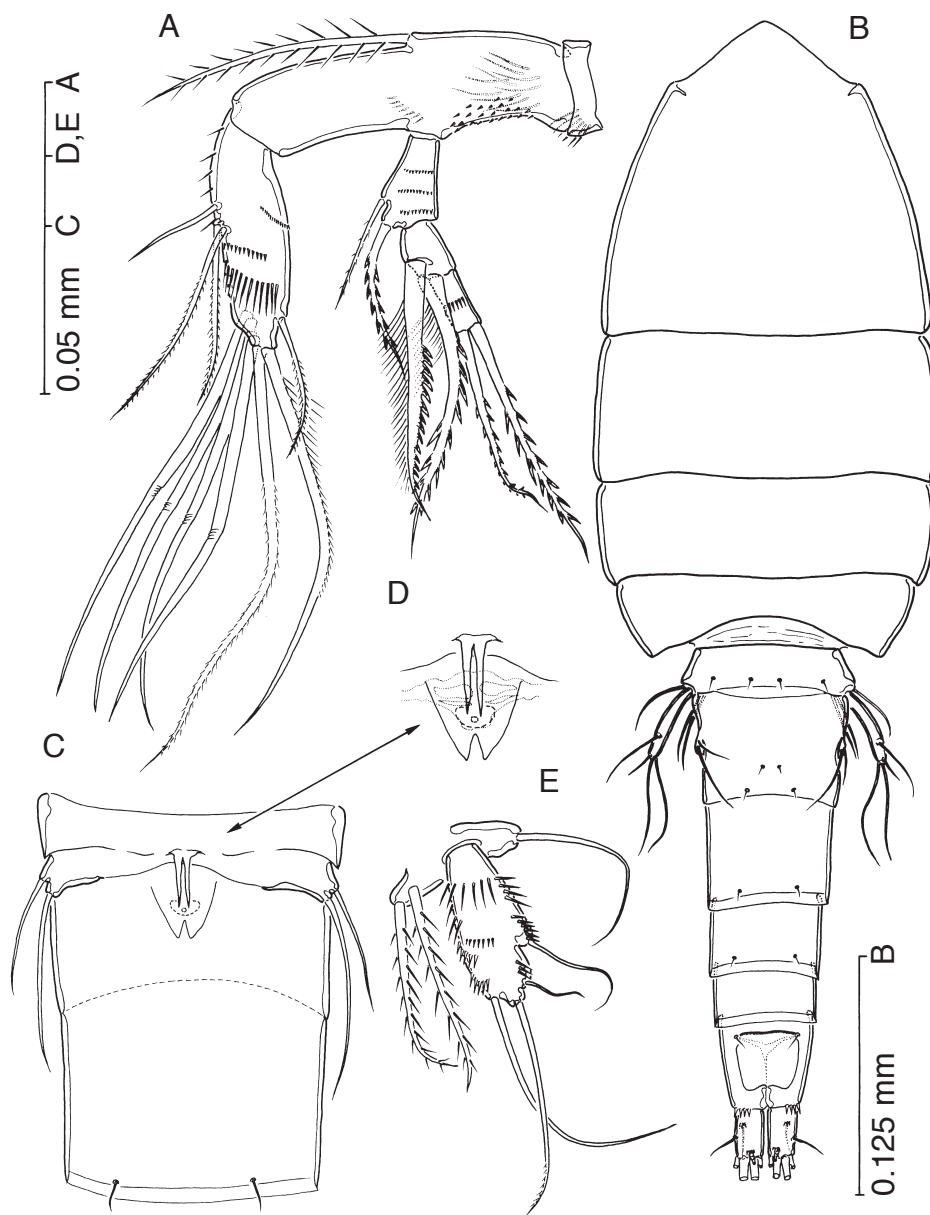


FIG. 13. – *Superornatiremis mendai* sp. nov. A, adult male antenna; B, adult female body, dorsal; C, genital double-somite, ventral; D, detail of genital field; E, female fifth leg, anterior.

Etymology. The specific name honours Jaume Damians “Menda”, old friend and companion of the author in many speleological surveys.

Remarks. The major diagnostic difference between *S. mendai* and the other representative of the genus, *S. mysticus* Huys, 1996, inhabitant of Bermudian caves, is found in the armature along the inner margin of the distal exopod segment of leg 4, provided with 3 setae in *S. mendai* whereas with only 2 in *S. mysticus*. The male antennule segment 3 also differs in the number of armature elements in both taxa: 10 in *S. mendai* as opposed to 8 in *S. mysticus*. The proximal exopod segment of the mandible in *S. mendai* is adorned with a tuft of setules which is absent in *S. mysticus*. The maxilla differs in the number of barb-like spinules on the proximal lobe of the proximal syncoxal endite (5 in *S. mendai* versus only 2 in *S. mysticus*), and also in the number of setae on the distal syncoxal endite (2 in *S. mendai*, 3 in *S. mysticus*). The male leg 5 of *S. mendai* has the basoendopodal outer lobe provided with a row of coarse spinules, whereas it is bare in *S. mysticus*. The female leg 5 differs in the no. of setae on the exopod, 4 in *S. mendai* whereas 5 in *S. mysticus*, with additional differences in the relative length of the segment and setae, and the pattern of spinule rows on the anterior surface of segment.

Other differences pertain to the swimming legs. Thus, in *S. mendai* the surface of intercoxal sclerites of legs 1 and 4 is adorned with setules, whereas those of legs 3 and 4 are bare. In *S. mysticus* a different condition is displayed, with intercoxal sclerites 1 and 4 bare, and sclerites 2 and 3 provided with setules. In *S. mendai* the anterior surface of the basis of leg 1 is adorned with a patch of long setules which is absent in *N. mysticus*. The inner coxal seta of this leg bears a row of stout denticles along distal outer margin in *S. mendai*, whereas it is uniformly bipinnate in *S. mysticus*.

Genus *Intercrusia* Huys, 1996

Intercrusia garciai sp. nov. (Figs. 14-17)

Material examined. Cova de na Mitjana (Capdepera, Mallorca). Holotype: adult female 0.43 mm (BMNH reg. no. 1997.15); mouthparts and swimming legs 1 and 2 dissected on 3 slides and mounted in lactophenol sealed with nail varnish. Paratype: single, partially damaged adult female with leg pairs 3 and 4 dissected on 1 slide and mounted as holotype (BMNH reg. no. 1997.16). One adult female not preserved. Collected by author, 17 July 1994.

Adult female. Body general aspect (Fig. 14A) as in species described above. Urosome (Fig. 14B)

5-segmented. Genital double-somite (Figs. 14A-C) with dorsal and ventrolateral surface frill marking original segmentation. Gonopores separate, displaced laterally, each covered by vestigial leg 6 bearing 2 unequal setae. Single copulatory pore small, located midventrally in wide depression, latter covered by broad, non-incised hyaline lamella; bifid epicopulatory flap as figured. Second abdominal somite with single row of spinules across ventral surface; row absent on third abdominal somite.

Anal somite with weakly developed operculum provided with row of coarse spinules; row of ventrolateral and ventral spinules present on each side of somite. Paired wide pores located ventrolaterally near hind margin. Coarse spinules present around ventral and lateral hind margin, more slender spinules around laterodorsal hind margin. Caudal rami symmetrical, about 2.0 times as long as wide, armature as in previous species.

Antennule (Fig. 14D) slender, 9-segmented, with segmentation and armature identical to *N. xoni*.

Antenna (Fig. 15A) with reduced coxa, adorned with patch of spinules. Basis and proximal endopod segment completely fused forming allobasis, bearing abexopodal seta; three rows of spinules on surface of segment, as illustrated. Endopod 1-segmented, with 3 rows of spinules present as figured in distal half, and group of sparse spinules in proximal half. Lateral armature of endopod consisting of 3 unequal setae; apical armature consisting of 1 subdistal seta, 4 geniculate setae, plus 2 long setae adorned with spinules as figured. Exopod 3-segmented, second segment formed by partial fusion of segments 2 and 3 expressed in *N. fosshageni* Huys, 1996. Armature formula (2,2,2); proximal seta reduced, remaining setae with stout denticles at both sides except setae on second segment, which bear also setules disposed as figured.

Labrum and labium (not figured) fused forming a well developed oral cone.

Mandible with gnathobase (Fig. 15B) stylet-like, as in *N. xoni*; row of tiny setules along proximal part, as figured. Palp (Fig. 14C) with condition of exopod unconfirmed; basis with row of spinules at outer margin and 2 setae at inner distal corner (outer one short and bipinnate, inner one modified, swollen, with densely set long setules in distal half). Endopod 1-segmented, with 1 short and 2 long setae. Maxillule (Fig. 15D) as described for *N. xoni*, except for slight differences in distribution of spinule/setule rows on segments.

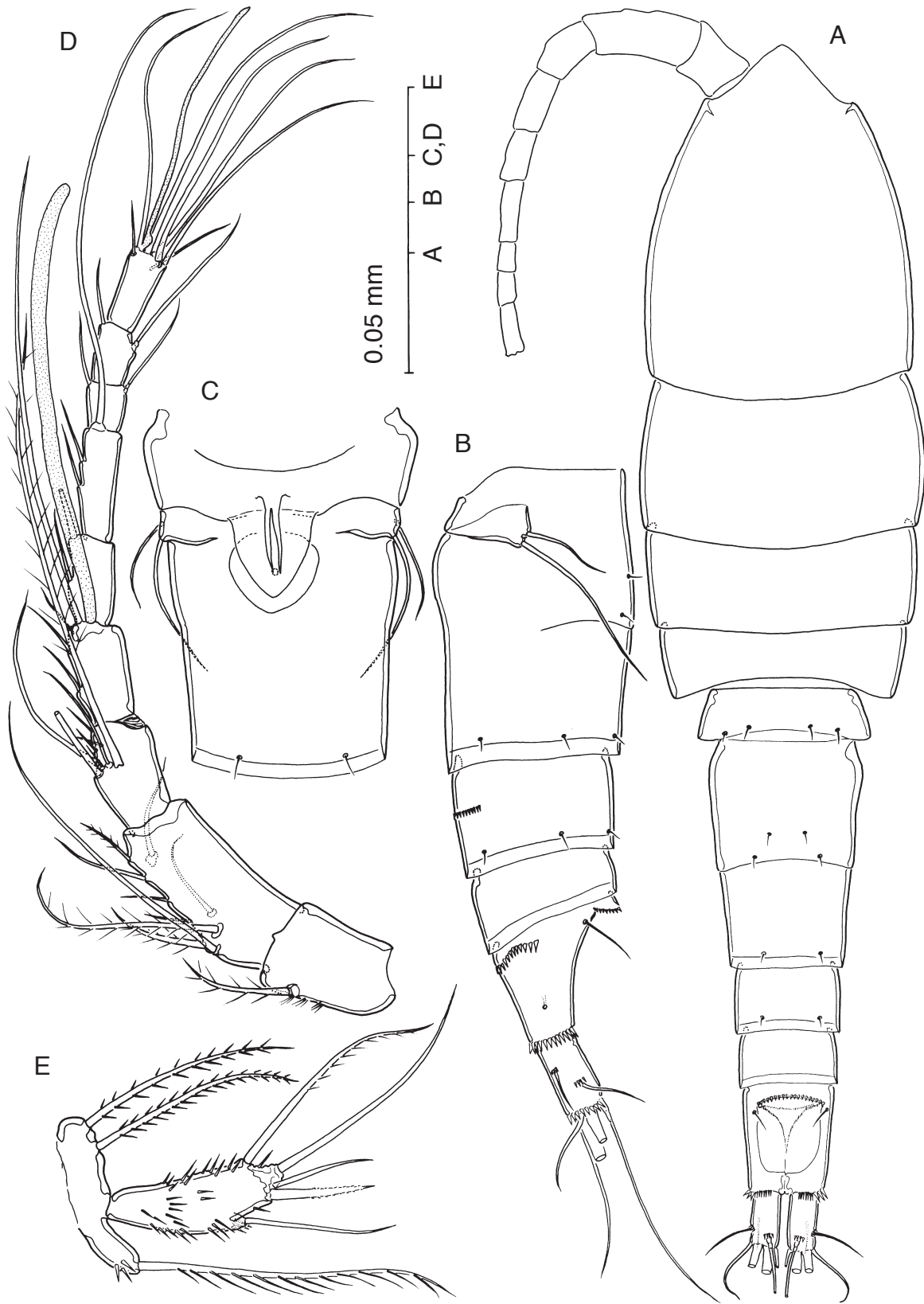


FIG. 14. – *Intercrusia garciai* sp. nov., adult female. A, body, dorsal; B, urosome (excluding P5-bearing somite), lateral; C, genital double-somite, ventral; D, antennule, ventral; E, fifth leg, anterior.

Maxilla (Fig. 15E) with general structure similar to *N. xoni*. Proximal lobe of proximal syncoxal endite with 6 barb-like spinules; middle and distal lobes each with 2 setae. Distal endite with 1 coarse seta apically serrate along one side and 2 slender setae, one of them reduced. Allobasis drawn out into long claw bearing fine spinules towards the tip; one pinnate and 1 smooth seta at base. Endopod incorporated into allobasis, with 3 unequal, bare setae, one of them reduced. Four rows of spinules disposed on allobasis as figured.

Maxilliped (Fig. 15F) subchelate. Syncoxa with 1 row of coarse spinules as figured. Basis with reduced seta subdistally along medial margin and 6 rows of spinules disposed as figured. Endopod elongated,

drawn out into long subdistal claw accompanied by 2 short outer setae at base, and 1 pinnate seta along medial margin; apical pedestal on segment, with 2 thick, geniculate setae. Swimming legs (Figs. 16; 17) biramous, both rami 3-segmented, although distal segments of exopod of leg 2 not preserved in individuals analysed, and distal segments of endopod of this leg partially fused. Small praecoxa developed in each leg. Coxae of leg pairs joined by intercoxal sclerite. Coxae displaying complex, species-specific pattern of spinules and setules, as figured. Outer spines on leg 1 exopod displaying characteristic subterminal tubular extensions except proximal spine of first, and proximal and third spine of third segment. Armature formula as follows:

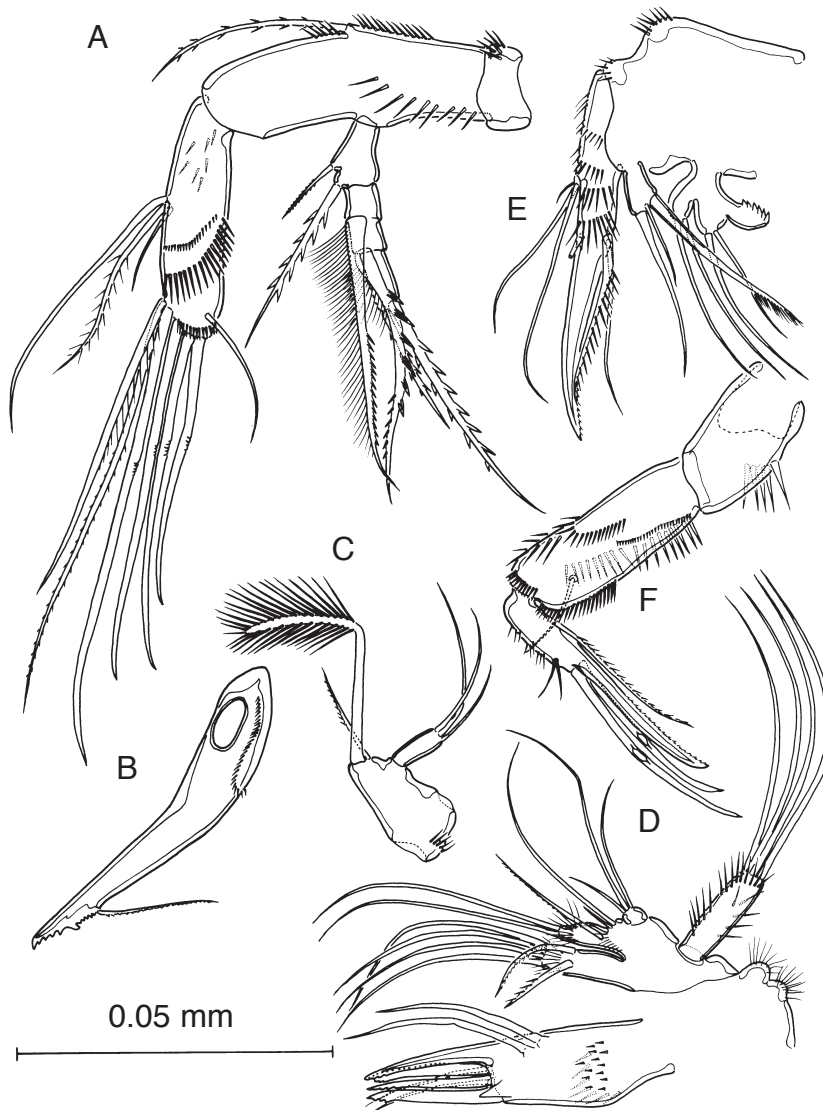


FIG. 15. – *Intercrusia garciai* sp. nov., adult female. A, antenna; B, mandibular gnathobase; C, mandibular palp; D, maxillule with praecoxal arthrite disarticulated; E, maxilla; F, maxilliped.

Leg	Coxa	Basis	Exopod	Endopod
1	0-0	1-1	III-0;II-1;6	0-1;1-1;2,2,3
2	0-0	1-0	I-1;?;?	0-1;(0-2; I,2,I+1)
3	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,2,I+2
4	0-0	1-0	I-1;I-1;III,I+1,3	0-1;0-1;I,I+1,1

Fifth leg (Fig. 14E) 2-segmented. Baseoendopod partially incorporated into somite, with single seta

on outer lobe and 2 strong bipinnate setae on inner lobe; several coarse spinules at base of outer lobe seta. Exopod ovoid, 2.74 times as long as wide, with anterior surface bearing several spinule rows as figured. Armature consisting of 5 setae, distributed as figured; one of setae short and coarse.

Male. Unknown.

Etymology. Species dedicated to Lluç García, carcinologist from Sóller (Mallorca).



FIG. 16. – *Intercrusia garciai* sp. nov., adult female. A, leg 1, posterior; B, praecoxa, coxa and basis of leg 1, anterior; C, leg 2, anterior.

Remarks. The new species from the Balearic islands is placed in *Intercrusia* based on the presence of a single outer seta on the second segment of the endopod of leg 1, and also the presence of subterminal tubular extensions on the outer spines of the exopod of the same leg. However, *I. garciai* sp. nov. differs from *I. problematica* Huys, 1996, so far the only representative of the genus, in several respects that might justify a separate generic status for the former. Thus, the third segment of exopod of leg 1 bears 7 elements in *I. problematica* whereas only 6 in *I. garciai*. Besides, several spines on the

outer margin of exopod of leg 1 do not bear subterminal tubular extensions in *I. garciai*, namely the proximal spine on the first segment and the first and third spines on the third segment. These spines are provided with tubular extensions in *I. problematica*. The genital field of both taxa differs also in the apparent absence of hyaline lamella covering the copulatory pore of *I. problematica*. Pending the discovery of new species of the genus that could reveal the taxonomic significance of these features, we adopt the transitorial solution of including the new Balearic taxon in *Intercrusia*.

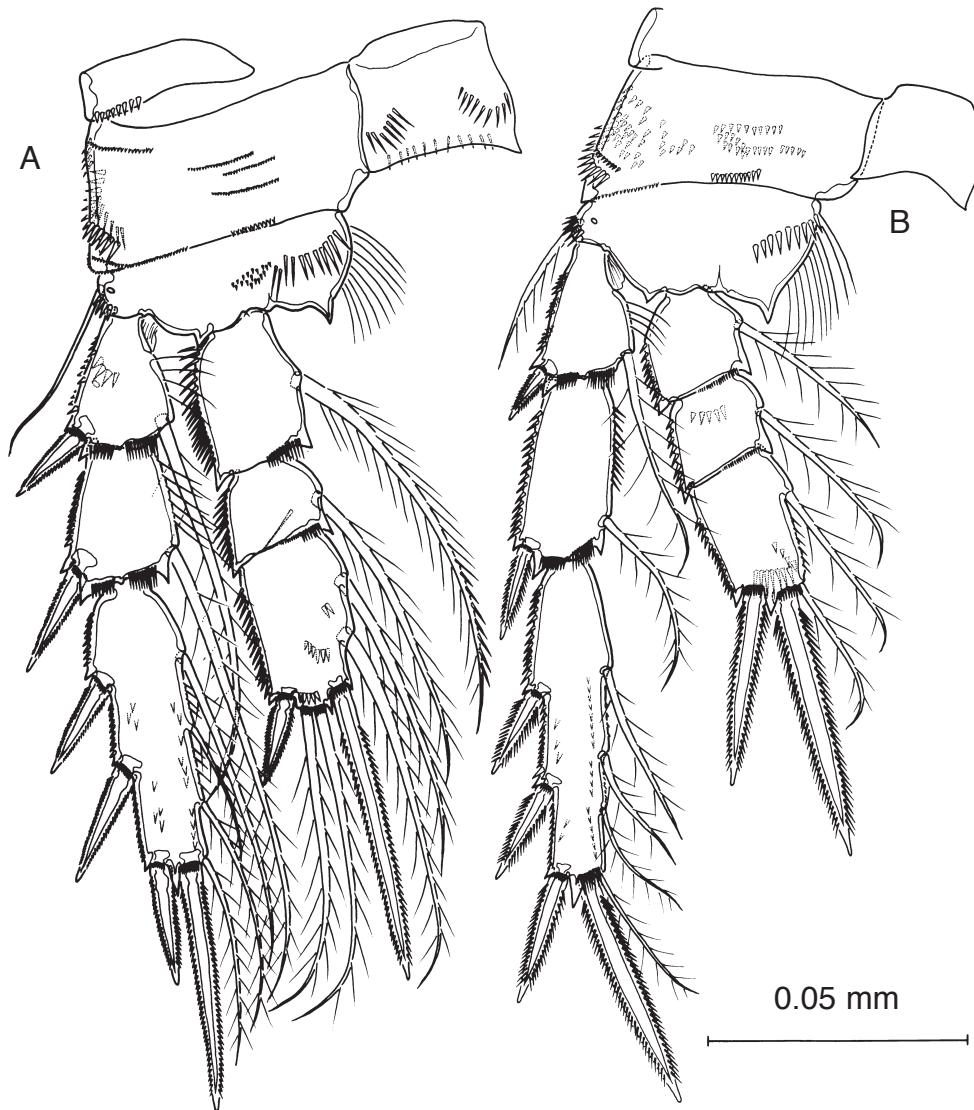


FIG. 17. – *Intercrusia garciai* sp. nov., adult female. A, leg 3, anterior; B, leg 4, anterior.

Additional differences between both taxa include the absence of paired dorsolateral tufts of setules on the genital double-somite of *I. garciai*, the shape of the exopod of leg 5, (ovoid and 2.74 times as long as wide in *I. garciai* as opposed to elongate, 4 times as long as wide in *I. problematica*), and also the relative length of caudal rami, 2 times as long as wide in *I. garciai* whereas wider than long in *I. problematica*. Other differences to be mentioned are (1) the absence of the ventral row of spinules on the third abdominal somite of *I. garciai*, and (2) the armature around the hind margin of anal somite is homogeneously integrated by coarse spinules in *I. problematica*, whereas it includes also a dorsolateral set of more slender spinules in *I. garciai*.

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REFERENCES

- Andrews, J.N., A. Ginés, J. Pons-Moyà, P.L. Smart and M. Trias. – 1989. Noves dades sobre el jaciment paleontològic de la Cova de na Barxa (Capdepera, Mallorca). *Endins*, 14-15: 17-26.
- Boxshall, G.A., F. Ferrari and H. Tiemann. – 1984. The ancestral copepod: towards a consensus of opinion at the First International Conference on Copepoda 1981. *Crustaceana* (Supplement 7): 68-84.
- Ginés, A., J. Ginés and J. Pons-Moyà. – 1975. Nuevas aportaciones al conocimiento morfológico y cronológico de las cavernas costeras mallorquinas. *Speleon* (Monografía 1): 49-56.
- Huys, R. – 1996. Superornatiremidae fam. nov. (Copepoda: Harpacticoida): an enigmatic family from North Atlantic anchihaline caves. *Sci. Mar.* (in press)
- Huys, R. and G.A. Boxshall. – 1991. *Copepod Evolution*. The Ray Society, London.
- Stock, J.H. – 1993. Some remarkable distribution patterns in stygobiont Amphipoda. *J. nat. Hist.*, 27: 807-819.
- Stock, J.H., T.M. Iliffe and D. Williams. – 1986. The concept "Anchihaline" reconsidered. *Stygologia*, 2: 90-92.

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