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Source: Revue suisse de Zoologie, 130(2) : 297-305

Published By: Muséum d'histoire naturelle, Genève

URL: https://doi.org/10.35929/RSZ.0104

Revue suisse de Zoologie (September 2023) 130(2): 297-305 ISSN 0035-418

Porcellio danieli sp. nov., a new terrestrial isopod from Southern Spain closely related to maghrebian species of the genus (Isopoda: Oniscidea: Porcellionidae)

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Abstract: A new species of terrestrial isopod, *Porcellio danieli* sp. nov., (Oniscidea: Porcellionidae) is described from the southernmost Iberian Peninsula (province of Cádiz, Spain). The new species belongs to the '*laevis*-*hoffmannsseggii*' systematic complex, with close affinities with other maghrebian-saharian representatives of the same genus. Their similarities and differences with other species of the group are discussed, and some species found in both southern Spain and northern Africa are listed.

Keywords: Cádiz Province - Iberian Peninsula - Maghreb - taxonomy - woodlice.

INTRODUCTION

The terrestrial isopod genus *Porcellio* Latreille, 1804 (Oniscidea) includes more than 200 species and has a very high diversity in the western Mediterranean area, especially in North Africa (Schmalfuss, 2003; Taiti & Rossano, 2015). Except for a few widely distributed species, most of the approximately 55 species of *Porcellio* known from the Maghreb region are endemic and only a few are found in both North Africa and the Iberian Peninsula (see Discussion and Table 1).

In this paper, *Porcellio danieli* sp. nov. from the extreme south of Spain is described and fully illustrated. This new species is morphologically closely related to Maghreb-Saharian species belonging to the "*laevis*" (or North African) and "*hoffmannseggii*" (or Betic-Rifian) groups (Vandel, 1951).

MATERIAL AND METHODS

The specimens were collected by hand, preserved in 75% ethanol and dissected under a stereomicroscope (Euromex Nexius). Body parts were prepared on slides with Aman's lactophenol or Faure's liquid. The drawings were made with the aid of a camera lucida mounted on Olympus CH30 and Motic K-400 microscopes. The final drawings were digitally inked with a graphic tablet (INTUOS) using the GIMP software (Montesanto, 2015). Photographs of preserved specimens were taken using a Dino-Lite digital microscope AM4113T, with natural illumination. The type material has been deposited at the Museu Balear de Ciències Naturals (Balearic Museum of Natural Sciences, MBCN) in Sóller (Majorca Island) and two dissected specimens in the author's personal collection (CLLG).

TAXONOMY

Order Isopoda Latreille, 1817
Suborder Oniscidea Latreille, 1802
Family Porcellionidae Brandt, 1831
Genus *Porcellio* Latreille, 1804

***Porcellio danieli* sp. nov.**

Figs 1-5

Type material

Holotype: MBCN 26604, female; Spain, Cádiz, Puerto Real, 36.659672 -5.672454; 28.02.2021; leg. Daniel Rojas. – *Paratypes*: MBCN 26605, female; same collection data as the holotype. – MBCN 26606, female; Spain, same locality as the holotype, 15.11.2020; leg. Daniel Rojas. – MBCN 26607, male; Spain, same locality as the holotype, 3.03.2021; leg. Daniel Rojas. – MBCN 26608, male; same locality and collection date; leg. Daniel Rojas. – MBCN 26609, female; same locality

Manuscript accepted 13.06.2023
DOI: 10.35929/RSZ.0104

and collection date; leg. Daniel Rojas. – MBCN 26610, female; same locality and collection date; leg. Daniel Rojas. – CLLG 1057, male; same collection data as the holotype, dissected and mounted on slides. – CLLG 1152, female; Spain, Cádiz, Rota, 36.643283, -6.373049, 13.11.2021; leg. Antonio Pizarro, dissected and mounted on slides. All geographic coordinates correspond to World Geodetic System 1984 (WGS84).

Diagnosis: A species of *Porcellio* characterized by the following combination of morphological features, not found in any other species within the '*laevis-hoffmannseggii'* complex: color pattern with longitudinal stripes on the pleon; glandular fields of tergites 2-7 located in the center of the epimera; antennal flagellum with articles of same length; first male pleopod exopod with elongated posterior lobe and rounded tip; endopod apically bilobed with fine long setae; carpal bulge of seventh male pereopod with its widest part on the distal third; uropodal exopods slightly longer in males than in females.

Etymology: Named after the andalusian naturalist Daniel Rojas Pichardo, the first collector of the new species.

Description: *Body* convex, with outline as in Fig. 2A. *Colour* (see Fig. 1): purplish brown with white spots; pereon and pleon with a darker central stripe that may be (or not) crossed by another narrower and lighter central stripe; cephalon pigmented except for the anterior parts of lateral lobes; pereonites 1-7 with unpigmented stripe delimiting epimera; epimera with anterior and lateral parts unpigmented and a posterior white spot containing the noduli laterales; pleon purplish brown with two para-median white stripes; pleon epimera pigmented, except for lateral white spots; antennae, pleotelson and uropods pigmented.
Dorsal surface of cephalon and pereon with granulations; a row of granules on the posterior half and the posterior edge of pereon tergites 1-7; pleon smooth, except for a row of small granulations on the posterior margin. *Glandular fields* circular or ovoid, with 25-30 pores each, separated from lateral margin, on a pigmented area. *Integument* with shingle-like scales (length 0.015 mm) and triangular scale-setae (length 0.02 mm), each composed by a triffid seta and a hyaline scale with blunt apex (Fig. 2B). *Noduli laterales* (length 0.07 mm) located in a circular unpigmented area; noduli 1 to 4 approximately equidistant from lateral margins (Fig. 2C). *Cephalon* (Figs. 2D-E) without suprantennal line; lateral lobes obliquely protruding frontwards and directed downwards, with rounded anterior edge; median lobe less protruding than lateral ones, widely rounded or subtriangular; eyes composed by about 35 ommatidia; front swollen, forming a differentiated blunt tubercle. Hind margin of *pereonites 1-2* with marked concavity on each side; *pereonites 3-4*, with straight hind margin; posterior margin of *pereonites 5-6*, regularly concave; hind margin of *pereonite 7*, slightly sinuous; posterior tips of epimera 1-4 blunt, 5-7 more acute, directed backwards. *Pleon* (Fig. 2F) slightly staggered relative to outline of pereon; pleon epimera with posterior tips directed backwards.
Pleotelson (Fig. 2F) with differentiated basal and distal parts; basal part with slightly convex sides; tip extends slightly beyond posterior margin of uropodal protopods. *Pleopods 1-2* with monospiracular internal lungs. *Uropod* protopods (Fig. 2F) with slightly oblique posterior edge, not reaching further than telson tip; exopods acuminate, approximately 1.7 to twice as long as protopods; endopods, visible dorsally, about 1.4 times longer than the protopods. *First antenna* (Fig. 2G) with 3 articles of similar length; distal article with 10-12 aesthetascs and triangular lobe.

Fig. 1. *Porcellio danieli* sp. nov. Habitus of preserved female specimen, dorsal view. Scale bar: 2 mm.

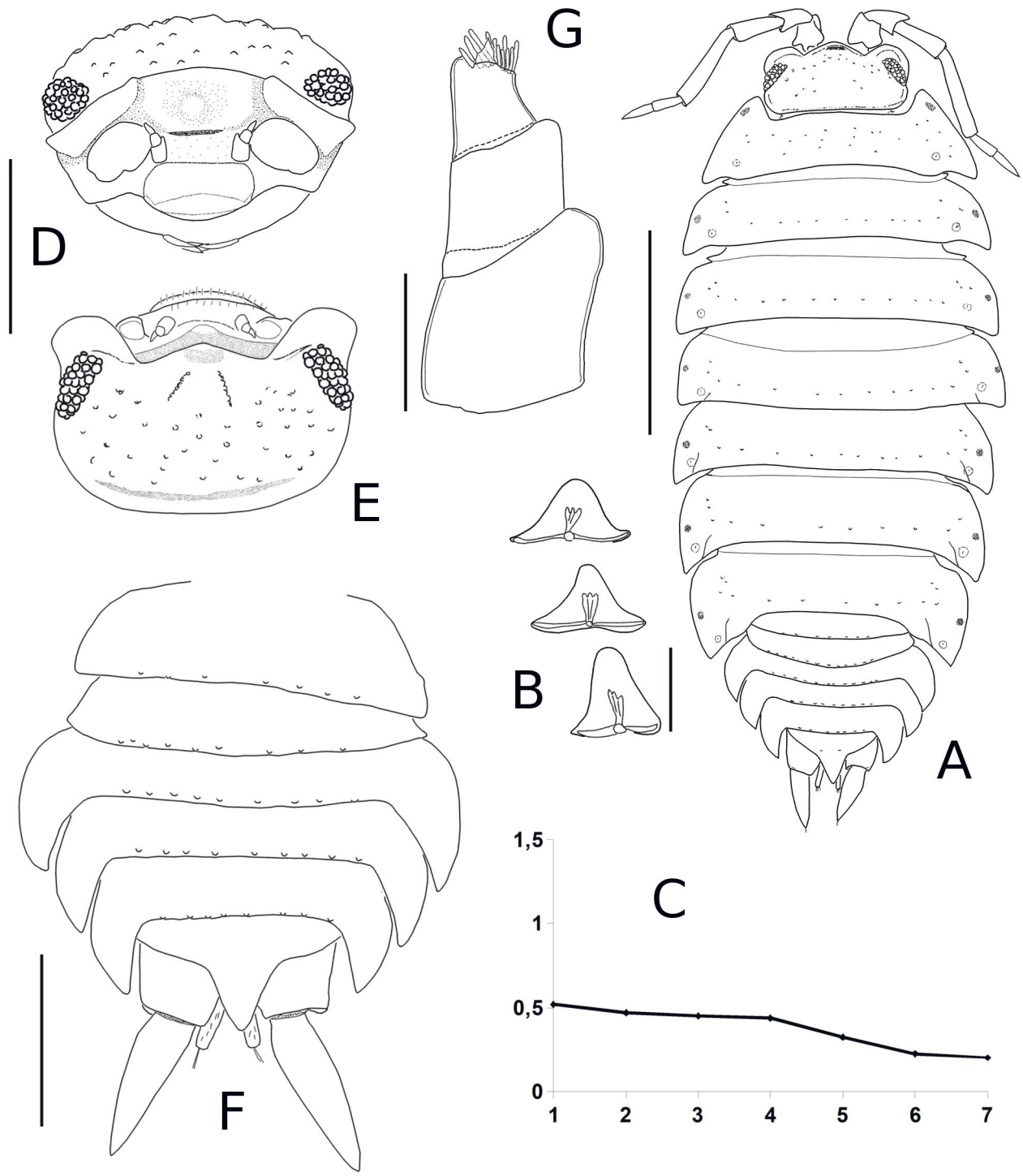

Fig. 2. *Porcellio danieli* sp. nov. (A) Female, dorsal view. (B) Dorsal scale-setae. (C) Noduli laterales d/c coordinates. (D) Cephalon, frontal view. (E) Cephalon, dorsal view. (F) Pleon, pleotelson and uropods of a male specimen, dorsal view. (G) First antenna. Scale bars: A, 2.5 mm; B, 0.015 mm; D-E, 1 mm; F, 1 mm; G, 0.1 mm.

Second antenna (Fig. 3A), when extended backwards reaches the second pereon-tergite hind margin; peduncular articles with short teeth; flagellar articles of equal length; distal article bearing three rows of aesthetascs (Fig. 3B) and dense setae field on the opposite side (Fig. 3C). *Right mandible* (Fig. 3D) with dichotomized molar penicil and 2 free penicils. *Left mandible* (Fig. 3E) with dichotomized molar penicil, 2 penicils on pilose lobe and 5 free penicils. *Maxillule*, external branch (Fig. 3F) with 4 + 6 teeth (2 slightly toothed); internal branch (Fig. 3G)

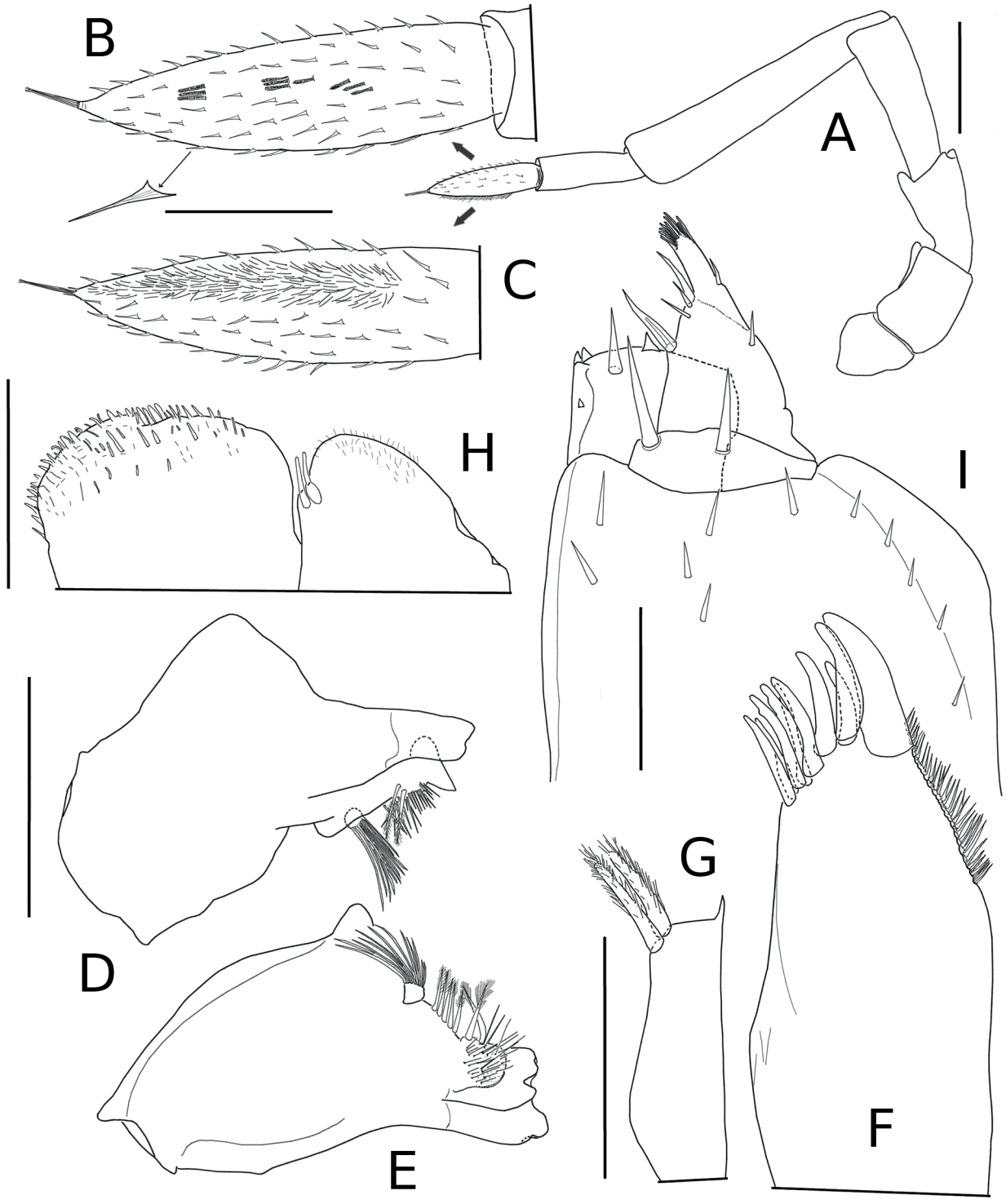

Fig. 3. *Porcellio danieli* sp. nov. Male. (A) Second antenna. (B-C) Distal article of antennal flagellum. (D) Right mandible. (E) Left mandible. (F) Maxillule, external branch. (G) Maxillule, internal branch. (H) Distal part of maxilla. (I) Maxilliped. Scale bars: A, 0.5 mm; B-C, 0.20 mm; D-E, 0.25 mm; F-G, 0.25 mm; H, 0.10 mm. I, 0.20 mm.

with 2 long penicils and sharp posterior corner. *Maxilla* (Fig. 3H) inner lobe twice as wide as the outer; 2 setae between the two lobes. *Maxilliped* (Fig. 3I), first palp article with 2 setae; second palp article with 1 medial strong seta; distal article with tuft of short setae; endite sub-quadrangular, with 2+1 triangular teeth on anterior edge and 1 strong seta on caudal face.

Male: *Pereopod 1* (Fig. 4A), merus and carpus with brush of setae on sternal margin (Fig. 4B); dactylar ornamentation as in Fig. 4C; *pereopods 2-4* with brushes similar to pereopod 1, progressively less dense. *Pereopod 7* (Fig. 4D), carpus with elongate lobe on tergal margin, with widest part on distal third. *Pleopod 1* (Fig. 5A-C) *exopod* with elongated posterior lobe, about twice long as wide, distally rounded; *endopod* with distal part sinuous, apically bilobed with a tuft of fine setae on inner apex. *Pleopod 2* (Fig. 5D-E) *exopod* triangular with straight inner margin; *endopod* slightly longer than exopod. *Uropodal exopods* slightly longer than in female.

Measurements: Maximum length of male, 11.1 mm; female, 14.2 mm.

Distribution: West of the province of Cádiz, Andalusia, in the south of the Iberian Peninsula. Probably more widespread.

Type locality: Puerto Real, Cádiz, Spain. Sandy area with sparse shrub vegetation.

Remarks: Although *Porcellio danieli* sp. nov. is closely related to some North African species of the genus, according to the available descriptions and illustrations it differs from all of them by a unique combination of morphological characteristics. Due to its somatic, integumentary and male sexual features, it can be classified in an intermediate position between the North

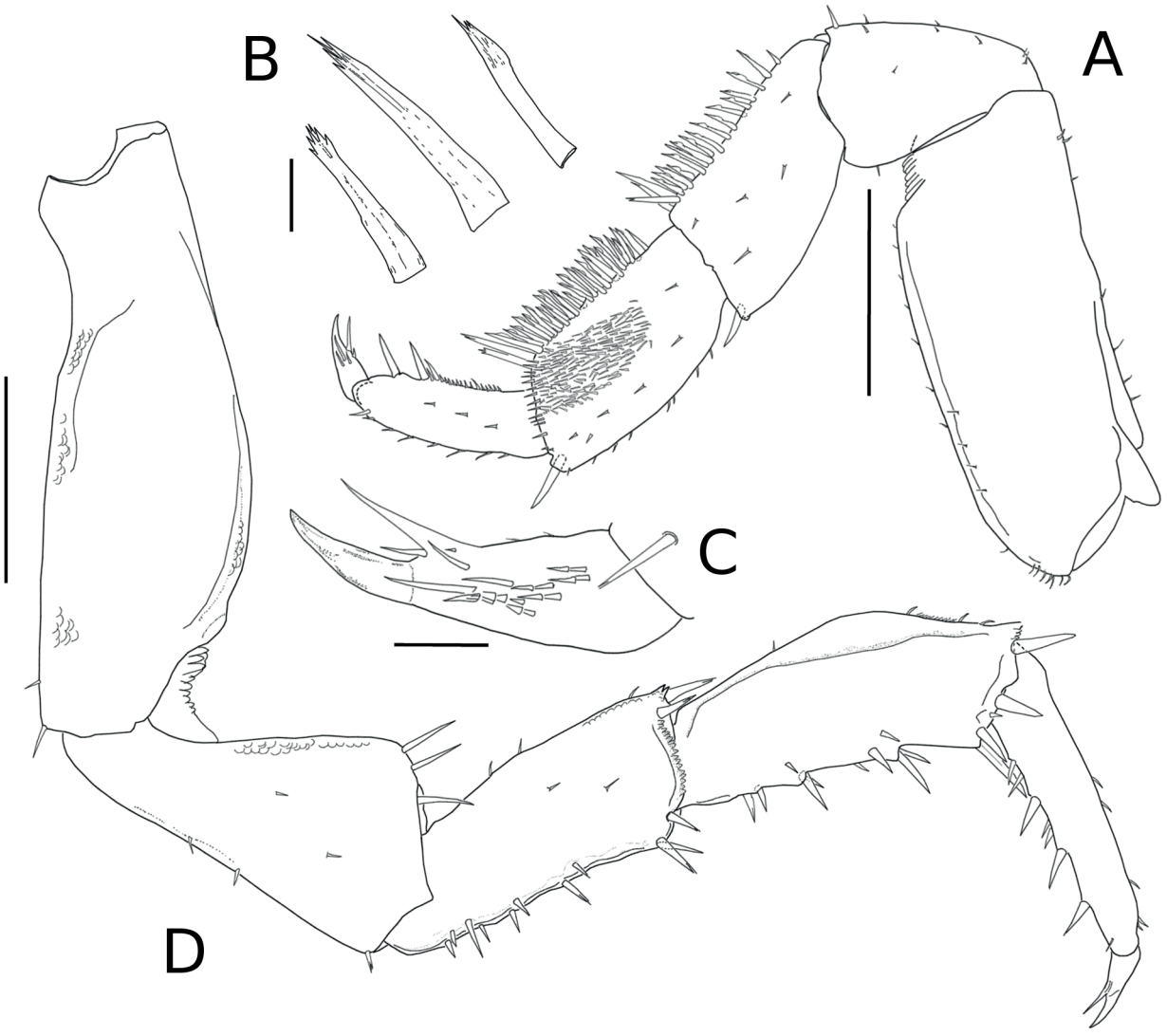

Fig. 4. *Porcellio danieli* sp. nov. Male. (A) First pereopod. (B) Setae of sternal margin of merus and carpus of the first pereopod. (C) Dactylus of pereopod 1. (D) Seventh pereopod. Scale bars: A, 0.5 mm; B-C, 0.05 mm; D, 0.5 mm.

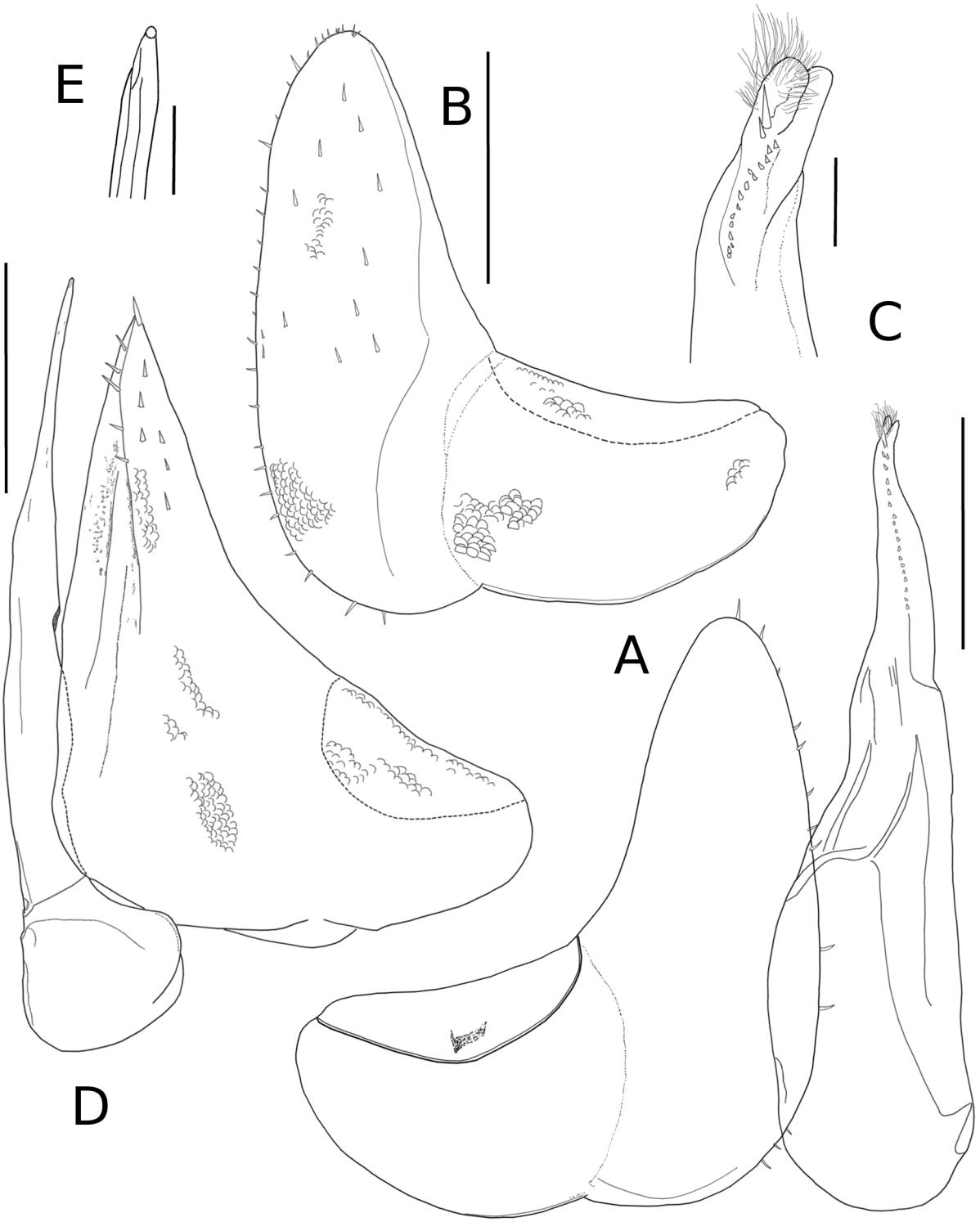

Fig. 5. *Porcellio danieli* sp. nov. Male. (A) First pleopod, ventral view. (B) First pleopod exopod, frontal view. (C) Distal portion of the first pleopod endopod, ventral view. (D) Second pleopod, frontal view. (E) Distal portion of the second pleopod endopod, frontal view. Scale bars: A-B, 0.5 mm; C, 0.04 mm; D, 0.5 mm; E, 0.04 mm.

African group (‘*laevis*’) and the Betic-Rifian group (‘*hoffmannseggii* ‘) as defined by Vandel (1951). With the species of the ‘*laevis*’ group, it shares the following morphological characters: median frontal lobe not very developed; rounded/oval glandular fields, containing numerous pores and located medially of pereon-tergites 2-7 (anterior position only on pereonite 1); weak dorsal granulations; exopodite of the first male pleopod triangular with elongated posterior lobe with rounded distal end. With the species of the ‘*hoffmannseggii*’ group, it shares the following characters: well-marked sinuosity of pereonites 1-2 and protuberance on the sternal edge of the carpus of the male seventh pereopod. However, according to Vandel (1951), these last two characteristics are also present in some species of the ‘*laevis*’ group (see discussion). Following Schmalfuss (1987b), both groups were considered herein a single systematic unit (see discussion).

The males of *Porcellio danieli* sp. nov. have the first pleopods with the posterior lobe of the exopodite ending in a rounded tip, and a bulge on the sternal border of the carpus of the seventh pereopod. Within the *laevis*/*hoffmannseggii* group, only a few species present this combination of characters and, among them, only *Porcellio magnificus* Dollfus, 1892, has been recorded in the Iberian Peninsula. However, *P. danieli* sp. nov. differs greatly from this latter taxon by its somatic characteristics and dimensions (see Schmalfuss, 1987a).

The other species of the *laevis*/*hoffmannseggii* group recorded in the Iberian Peninsula, which characteristics are well-defined (see discussion), are the cosmopolitan *Porcellio laevis* Latreille, 1804, *Porcellio hoffmannseggii hoffmannseggii* Brandt, 1833, *Porcellio flavocinctus* Budde-Lund, 1885, *Porcellio franzi* Schmölzer, 1955, *Porcellio ornatus* Milne Edwards, 1840, *Porcellio variabilis* Lucas, 1849 and *Porcellio wagneri* Brandt, 1841.

Porcellio danieli sp. nov. differs from *P. laevis* in its habitus and dimensions, and in the shape of the first pleopod and the seventh pereopod of the male. It differs from all the other aforementioned species by having the posterior lobe of the exopodite of the first male pleopod triangular, with a rounded apex, instead of apically widened and notched (see Vandel, 1962; Schmalfuss, 1987a; Schmölzer, 1955; Medini & Charfi-Cheikhrouha, 1998; Medini-Bouaziz *et al.,* 2006; Taiti & Rossano, 2015; Cifuentes, 2018).

The comparison with the male sexual characters of *Porcellio ribauti* Verhoeff, 1907, a North African species reported in Spain by Schmölzer (1955), is not possible because this species is only known from a single female specimen. According to its redescription (Caruso & Di Maio, 1990b), *P. ribauti* has a much broader body with expanded epimera and very large lateral cephalic lobes, whereas *P. danieli* sp. nov. has a more convex body, smaller dimensions and small lateral cephalic lobes.

In the Maghreb, several species belonging to the *laevis*/*hoffmannseggii* group also have the exopodite of the first male pleopod with a triangular posterior lobe which is neither distally broadened and notched, but can be more or less sharp and possesses a rounded tip: *Porcellio riffensis* Caruso & Di Maio, 1990, *Porcellio lepineyi* Verhoeff, 1937, *Porcellio atlanteus* Verhoeff, 1937, *Porcellio omodeoi* Caruso & Di Maio, 1990, *Porcellio villiersi* Paulian de Félice, 1939, *Porcellio gauthieri* Paulian de Félice, 1939, *Porcellio aghousi* Paulian de Félice, 1939, *Porcellio albinus* Budde-Lund, 1885, *Porcellio spinipes* Dollfus, 1893 and *Porcellio saharaiensis* Di Maio & Dalens, 1991.

Porcellio danieli sp. nov. differs from *P. riffensis* in having a bulge on the carpus of the seventh male pereopod and by the morphology of the endopodite of the first pleopod. It differs from *P. lepineyi* mainly in the color pattern, the carpal lobe in pereopod 7 of the male (much more

Table 1. List of *Porcellio* species recorded to date from both the Iberian Peninsula and the Maghreb. With an asterisk for the records that need to be confirmed. The cosmopolitan species *P. laevis* and the widely distributed littoral species *P. lamellatus* are excluded. Based mainly on Schmölzer (1971), Schmalfuss (2003) and Taiti & Rossano (2015).

SPECIES	IBERIA	MOROCCO	ALGERIA	TUNISIA
P. auritus Budde-Lund, 1885	X	-	X*	-
P. echinatus Lucas, 1849	X	X	X	-
P. flavocinctus Budde-Lund, 1885	X	X	-	-
P. hoffmannseggii hoffmannseggii Brandt, 1833	X	X	-	-
P. humberti Paulian de Félice, 1939	X	X	-	-
P. ocellatus Budde-Lund, 1885	X	-	X*	-
P. ornatus Milne-Edwards, 1840	X	X	X*	-
P. ribauti Verhoeff, 1907	X*	-	X	-
P. variabilis Lucas, 1849	X*	X	X	X
P. wagneri Brandt, 1841	X	X*	X	-

pronounced in adult specimens), the shape and structure of the endopodite of the first male pleopod, and the sexual dimorphism of the uropods. From *P. atlanteus*, it differs mainly in coloration, in the shape of the tergal edge lobe of the carpopodite of the seventh male pereopod, and in the shape of the endopodite of the first male pleopod. It differs from *P. omodeoi* mainly by the barely marked carpal lobe in this species, in the shape of the head lobes, and in the endopodite of the second male pleopod.

The remaining species have been ruled out for comparison because they are endemic to very remote mountainous areas or because they are clearly Saharan or steppe species with very different general somatic characteristics (dimensions, habitus, colour, appendages, etc.) (see Paulian de Félice, 1939; Caruso & Di Maio, 1990a, b; Di Maio & Caruso, 1991; Di Maio & Dalens, 1991).

DISCUSSION

The so-called *'laevis'* group (Vandel, 1951) of the genus *Porcellio*, is only represented in the Iberian fauna by the cosmopolitan *P. laevis*, but it is highly diverse in the Maghreb, a geographical area very close to southern Spain. In the southern Iberian Peninsula, several species of the '*hoffmannseggii*' group are common. This last group, named Betic-Rifian by Vandel (1951), should not be confused with the so-called "Betic-Rifian subgroup" which is a subdivision of the *Porcellio* "Atlantic group" (Vandel, 1958). Only one species of this last complex, *Porcellio humberti* Paulian de Félice, 1930, is present both in the south of the Iberian Peninsula and in the Rif region.

According to Schmalfuss (1987b) the '*laevis*' and '*hoffmannseggii*' groups should not be considered separate systematic units, because they share a common derived characteristic (synapomorphy) consisting of an exopodite of the first male pleopod with a very elongated posterior lobe. This posterior lobe is distally rounded or pointed in the '*laevis*' group, whereas it is distally expanded outwards, notched or truncated, in the '*hoffmannseggii*' group.

Due to the proximity of the Cadiz region to northern Morocco, a North African origin of *P. danieli* sp. nov. populations cannot be totally excluded, but the new species differs from all North African and Iberian species that are well described and illustrated.

Due to their high degree of endemicity, only a few *Porcellio* species belonging to these groups have been reported from both sides of the Strait of Gibraltar (see Table 1). Moreover, some of these records need confirmation (see Table 1) and may correspond to different species (Schmalfuss, 2003). Unfortunately, it is not possible to identify some *Porcellio* species from the Maghreb and southern Iberian Peninsula based only on their original descriptions, which makes faunistic comparisons difficult. Among these insufficiently described and poorly or never characterized species are *Porcellio auritus* Budde-Lund, 1885*; Porcellio conifer* C. Koch, 1856; *Porcellio coronatus* C. Koch, 1856; *Porcellio ocellatus* Budde-Lund, 1885 and *Porcellio pulverulentus* Budde-Lund, 1885 (see Schmalfuss, 2003).

ACKNOWLEDGMENTS

I thank Daniel Rojas Pichardo from Tarifa and Antonio Pizarro from Rota for the collection and donation of the specimens that have served for the description of *Porcellio danieli* sp. nov. Thanks also to Rafel Matamales-Andreu and to an anonymous reviewer for helping to improve the original manuscript.

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