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The paranthurid isopod crustacean *Paranthura nigropunctata* (Lucas, 1846): first record from the Atlantic coast of Morocco

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Abstract

The littoral paranthurid isopod crustacean *Paranthura nigropunctata* (Lucas, 1846) is recorded for the first time from the littoral of El Jadida located on the Atlantic northwest coast of Morocco. Specimens were obtained from the invasive brown seaweed *Sargassum muticum* and the natives *Bifurcaria bifurcata* and *Cystoseira tamariscifolia* in January 2015. This new record further confirms a significant southward distribution of *P. nigropunctata* and contributes to the knowledge of the biogeography of this isopod. Heretofore, the species was only known from the western and eastern Mediterranean and some Atlantic coasts. The present finding is the first of the species from Moroccan Atlantic shores, and suggests that the species may also be present in other coastal localities from Morocco and Africa. Some data on morphology, ecology and spatial distribution of the species are provided.

Key words: *Paranthura nigropunctata*, Crustacea, new report, NE Atlantic, Morocco

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1 Introduction

Among paranthurid isopods, *Paranthura* is the largest, most speciose, with 71 valid species (WoRMS, 2017), and most cosmopolitan of anthuridean genera (Poore, 2001). Little is known about the ecology and biology of paranthurids (especially the genus *Paranthura*), probably because they never constitute abundant populations in marine benthic ecosystems (Frutos et al., 2011). Four *Paranthura* species are known to occur in coastal Atlantic European waters (Frutos et al., 2011; Lavesque et al., 2013): the three native species *Paranthura nigropunctata* (Lucas, 1849), *P. costana* (Bate and Westwood, 1868), *P. santiparrai* (Frutos, Sorbe and Junoy, 2011), and the introduced *P. japonica* (Richardson, 1909) recently reported from the Arcachon Bay, SW France (Frutos et al., 2011; Lavesque et al., 2013) and Mediterranean coasts (Marchini et al., 2014, 2015; Lorenti et al., 2015; Dailianis et al., 2016; Ferrario et al., 2016; Tempesti et al., 2016). One of these paranthurid isopods, *P. nigropunctata*, generally inhabits a wide variety of seaweeds and seagrasses. It has also been found in sediment (Castelló and Carballo, 2001), and at depths ranging from 0 to 50 m (Wägele, 1982; Castelló and Carballo, 2001; Poore, 2001; Castellanos et al., 2003). The species was first reported from Algeria, southwestern Mediterranean (Lucas, 1846). It is known as a Boreal-Atlantic and a Lusitanian species (Negoescu, 1980) but it is also regarded as a Mediterranean species (Wägele, 1981b, 1982; Costello et al., 2001). It has been described as a temperate and native NE Atlantic species like *P. costana* (Negoescu and Wägele, 1984; Junoy and Castelló, 2003; Frutos et al., 2011). *Paranthura nigropunctata* as all Paranthuridae species, presents an elongated cylindrical body without dorsal coxal plates (Poore, 2009) and has a characteristic uropodal structure in which the flat exopod is attached to the peduncle dorsolaterally and proximally to the terminal endopod such that the author Leach likened the "tail" (pleotelson and two uropods) of the type species to a five-petalled flower.

Specimens collected from the littoral of El Jadida constitute the first record of *P. nigropunctata* in the NW Atlantic coast of Morocco. This finding extends the geographical range of the species in the northeastern Atlantic and adds a new contribution to the macro-isopods diversity thriving on the invasive seaweed *Sargassum muticum* (Yendo) Fensholt beds and native fucales *Bifurcaria bifurcata* R. Ross, and *Cystoseira tamariscifolia* (Hudson) Papenfuss. Thus, this paper reports the discovery of *P. nigropunctata* in North African Atlantic marine waters. A brief description of its external morphology and its distribution is presented.

2 Materials and methods

Specimens of crustacean epifauna associated with the brown algae *B. bifurcata*, *C. tamariscifolia* and *S. muticum* were specifically collected during low spring tides from the littoral of El Jadida (33°10′50.2″N, 8°36′56.5″W) on the northwestern coast of Morocco (Fig. 1) in January 2015. One of the collected species of this macroalga-associated epifauna corresponds to *P. nigropunctata* and its specimens were conserved separately (in 70% ethanol) for examination. The species identification was based on diagnostic characters indicated by many authors (e.g., Barnard, 1925; Wägele, 1982; Poore, 2001; Frutos et al., 2011), see below for details. This is the first mention of the species in Moroccan Atlantic waters (northeastern Atlantic shore).

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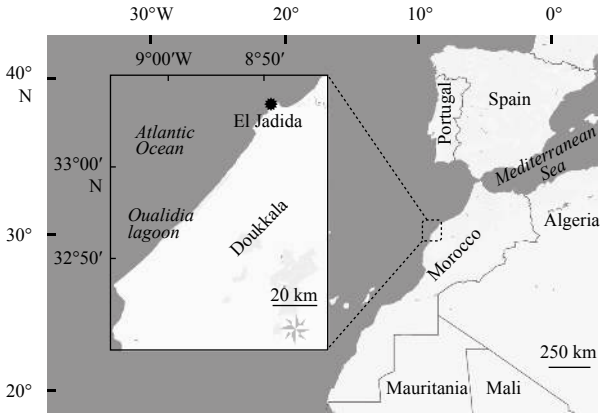

Fig. 1. Geographical position of the sampling site (black dot) on the coast of El Jadida, NW Morocco.

3 Results

3.1 *Systematics*

Subphylum Crustacea
Class Malacostraca
Subclass Eumalacostraca
Superorder Peracarida
Order Isopoda Latreille, 1817
Suborder Anthuridea Monod, 1922
Superfamily Anthuroidea Leach, 1814
Family Paranthuridae Menzies and Glynn, 1968
Genus *Paranthura* Bate and Westwood, 1866
Paranthura nigropunctata (Lucas, 1846)
Synonyms: *Anthura nigropunctata* Lucas, 1849, *Leptanthura melanomma* Vanhöffen, 1925
(Negoescu and Wägele, 1984; Castelló and Carballo, 2001)

3.2 *Material examined*

A total of five individuals of the isopod *P. nigropunctata* were found with sizes ranging between 6 and 11 mm. The collected individuals consisted of two juvenile and three adult specimens, no ovigerous females were found.

3.3 *Description*

The material examined was identified according to descriptions provided by literature and fits well with the descriptions of Barnard (1925), Wägele (1982) and Poore (2001). As all anthurideans, *P. nigropunctata* is an isopod with elongated cylindrical body shape (Figs 2a, b), with the maxilla 2 fused with the lower lip as a "hypopharynx", without extended dorsal coxal plates, and with the uropodal exopod held erect or parallel to the telson, attached to the peduncle dorsolaterally and more proximally than the terminal endopod (Poore, 2001). In this species, males are longer than females; body is pigmented, usually darkly colored, without dorsal coxal plates and with a full complement of seven pairs of pereopods in adults; pleonites 1–5 are free (Fig. 2d), pleonite 6 articulating with pleon and distinct from telson; telson lacks statocysts; eyes are well developed and pigmented; mandible has a three-articled palp; antenna 1 flagellum is shorter than peduncle; antenna 2 flagellum is flattened, plate-like, formed by short fused articles (Fig. 2c); pereopod 1 (P1) is subchelate, palm without tooth or strong proximal angle; P1 propodus is inflated, without proximal row of closely-set setae on mesial surface but with a row of complex robust setae along palm; P2–3 propodus is much less inflated; P4–7 carpus is roughly rectangular; pleopod 1 exopod is operculiform, wider than rami of other pleopods; pleopodal endopods have several marginal setae; appendix masculina of males has a straight apex; uropodal exopod is narrow and pointed (Fig. 2e), narrowly leaf-shaped, with the outer margin not sinuated; uropodal endopod is twice as long as broad with a straight inner margin; telson is dorsally slightly convex; it is narrow and elongate, ovate-lanceolate, with margins evenly convex and an acute setiferous apex.

The systematic list and the identification key, up to the species level of *Paranthura* recorded in European Atlantic and Mediterranean waters are presented in Table 1.

3.4 *Distribution*

The seaweed-associated isopod crustacean *P. nigropunctata* has a wide distribution (Fig. 3). It occurs in the European Atlantic littoral, northeastern Atlantic (Norman, 1907), and in the Mediterranean it is both in the western (e.g., Lucas, 1846; Negoescu, 1980; Wägele, 1981a, b; Sparla et al., 1993; Rodríguez-

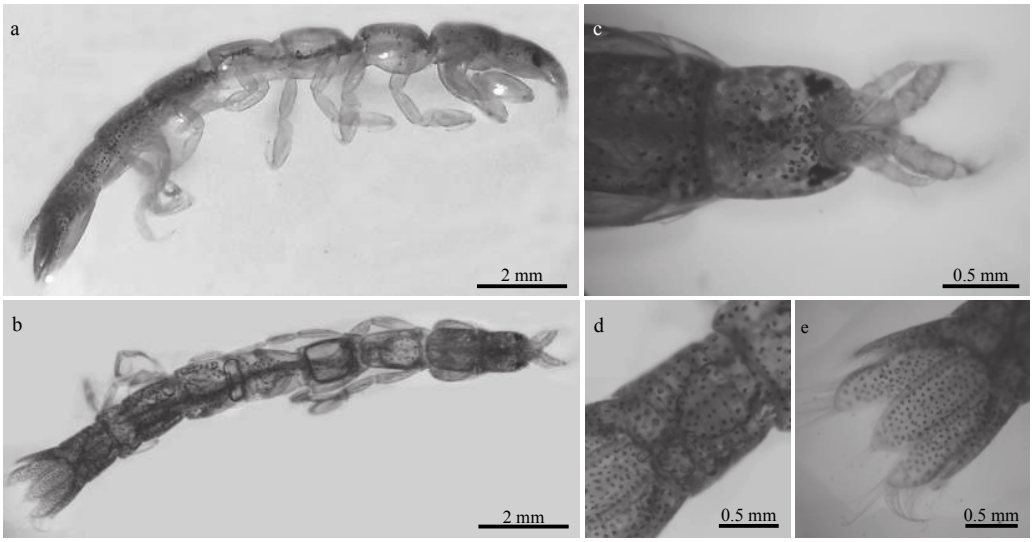

Fig. 2. *Paranthura nigropunctata*, male adult: lateral (a) and dorsal views of the body (b), anterior part with antenna 1 and 2 (c), dorsal view of pleon (posterior part) with pleonites free (d), and telson and uropods with narrow and pointed exopods (e).

Table 1. Identification key of *Paranthura* species in European Atlantic and Mediterranean coasts

Statocysts absent, pereonite 7 wider than long, much shorter than pereonite 6; pleonites 1–5 free or fused, all together not more than twice as long as wide; mouth parts acutely produced anteriorly, mandible with acute anteriorly-directed incisor; maxillipedal palp with all or most of the articles fused; pereopod 1 palm rarely with tooth or strong proximal angle, without even row of complex robust setae; pereopods 2 and 3 with carpus not or weakly produced posterodistally; pleopod 1 exopod wider than rami of the other pleopods	Paranthuridae
Pereopod 7 present in adults; pleonites free or fused, pleonite 6 articulating with pleon and delineated from telson; uropodal exopod narrowly leaf-shaped or broad and more or less notched; antenna 2 flagellum with less than 5 articles; mandible with a three-articulated palp; mandibular molar absent; maxillipedal palp almost as long as basis; pereopod 1 with row of setae evenly spaced along palm on mesial face; pleopod 1 exopod operculiform	*Paranthura*
1. Pleonites fused in the top of their dorsal region, but distinct at their sides	*Paranthura japonica* Richardson, 1909
Pleonites freeleft	2
2. Without eyes; body without pigmentationleft	*Paranthura santiparrai* Frutos, Sorbe & Junoy, 2011
Eyes well developed and pigmented; body pigmented	3
3. Uropodal exopod narrow and pointed; males with a straight appendix masculine	*Paranthura nigropunctata* (Lucas, 1846)
Uropodal exopod broad and oval; males with a hooked appendix masculina	*Paranthura costana* Bate & Westwood, 1868

Sánchez et al., 2001; Junoy and Castelló, 2003) and eastern basins (e.g., Kocatas, 1976; Negoescu, 1980; Antoniadou, 2004; Chintiroglou et al., 2004; Antoniadou et al., 2004). The species has been reported both in the Azores and the Cape Verde Islands (Vanhöffen, 1914; Negoescu and Wägele, 1984; Müller, 1994; Frutos et al., 2011), although the latter is questionable given the unusual habitat, and it is hypothesized to be a distinct species. It was recorded several times from the Iberian Atlantic shores (e.g., Monod, 1925; Anadón, 1975; Lombas and Anadón, 1985; Arrontes and Anadón, 1990a, b; Reboreda, 1995; Reboreda and Urgorri, 1995; Conradi, 1995; Viejo, 1999; Sánchez-Moyano et al., 2000; Castelló and Carballo, 2001; Conradi and López-González, 2001; Rodríguez-Sánchez et al., 2001; Pereira et al., 2006; Tato et al., 2009; Guerra-García et al., 2009, 2012; Pacios et al., 2011; Navarro-Barranco et al., 2012), and represents one of the most frequent species in the Chafarinas Islands, collected between 0 and 25 m depth (Castellanos et al., 2003), on a wide algal habitat range.

4 Discussion

During this study, five specimens of *P. nigropunctata* were found on the introduced *S. muticum* and native *C. tamariscifolia*

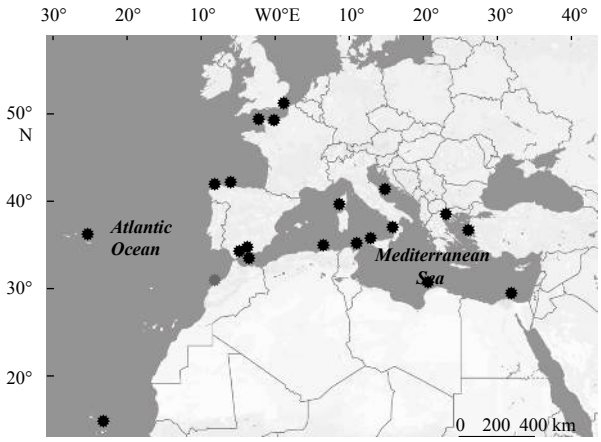

Fig. 3. Geographical distribution of *Paranthura nigropunctata*, indicating new records reported from the Atlantic coast of Morocco (red dot) and previous literature records around the world (black dots).

and *B. bifurcata* and exclusively in winter in mid-intertidal rockpools on the NW Atlantic coast of Morocco. No specimens were found in four other seaweed species, *Sargassum vulgare* C. Agardh, *Cystoseira humilis* Schousboe ex Kützing, *Cystoseira* sp., and *Gracilaria multipartita* (Clemente) Harvey and not beyond January times despite the monthly collections (January to December 2015). Thus *P. nigropunctata* remains a rare species with low abundances, which may be related with seasonality of its reproductive periods. Strong seasonality was reported further north by Arrontes and Anadón (1990b) with large densities from late summer to autumn and a prolonged period with low densities during winter and spring for this species. Otherwise it is also possible that the species might be locally abundant and widespread, but because it is patchily distributed and cryptic might be rarely detected.

The lack of previous records of this isopod species for the Moroccan coasts might be due to the small size of individuals, the low abundance of local populations, or its misidentification. Moreover, neither the species nor the genus was described in the taxonomic literature most commonly used for crustacean (isopod/amphipod) identification in Moroccan Atlantic coasts. In fact, it is well known that the genus *Paranthura* can be easily confused with other genera, especially *Cyathura* or other congeneric species like *Paranthura costana*, known to occur in coastal Atlantic European waters, from the Shetland Islands to Morocco (0–355 m depth) (Lavesque et al., 2013), and *P. japonica* native of the Asian waters of West Pacific and considered an introduced species for the American (e.g., Cohen and Carlton, 1995; Cohen et al., 2005; Ruiz et al., 2011), European waters of Atlantic (Frutos et al., 2011; Lavesque et al., 2013), and Mediterranean coasts (Marchini et al., 2014, 2015; Lorenti et al., 2015; Dailianis et al., 2016; Ferrario et al., 2016; Tempesti et al., 2016). It is possible that both congeneric species *P. japonica* and *P. costana* could affect *P. nigropunctata* populations through competitive interactions because they share similar habitats (Lorenti et al., 2015) and feeding resources (Marchini et al., 2014).

The species *P. nigropunctata* seems to adapt quite well to different types of biogenic habitats and/or microhabitats. It commonly inhabits a great variety of algal substrates, both in the intertidal and at shallow depths (genera as *Dictyopteris*, *Halopytis*, *Sargassum*, *Phyllophora*, *Peyssonnelia*, *Dilophus*, *Udotea*, *Taonia*, *Cladostephus*, *Jania*, *Cystoseira* and species as *Asparagopsis*

armata, *Ellisolandia* (ex-*Corallina*) *elongata*, *Halopteris filicina*, *Halopteris scoparia*, *Laurencia obtusa*, *Mesophyllum lichenoides*, *Rytiphlaea tinctoria, Stypocaulon scoparium*) (Müller, 1994; Wägele, 1982; Sparla et al., 1993; Castelló and Carballo, 2001; Castellanos et al., 2003; Pacios et al., 2011; Guerra-García et al., 2009, 2012). The species is also very common among algae and seagrasses of the upper littoral and in shallow subtidal macrophyte stands in the Mediterranean (Wägele, 1981b, 1982; Zupo and Stübing, 2010). These types of habitats offer suitable cryptic complex structures that favor the settlement of this kind of epiphytic specimens.

The fact that *P. nigropunctata* inhabits very different macroalgal species suggests that this isopod is not highly host specific. It can occur in both structurally complex algal habitats with erect and irregularly branched thallus (e.g., *Sargassum*, *Cystoseira* species) and algae with simple structural habitat complexity (e.g., *Dilophus*, *Taonia*). *Paranthura nigropunctata* is also found associated to the sediment fraction in macroalgal-dominated belts (Arrontes and Anadón, 1990a) and occurs also on sediments at shallow depths (Castelló and Carballo, 2001; Castellanos et al., 2003). Furthermore, the species is a common inhabitant of other habitat-building organisms or living biological substrata, recently considered as ecosystem engineers, such as bryozoans (Conradi, 1995; Conradi et al., 2000; Conradi and López-González, 2001; Castellanos et al., 2003), cnidarians (Castellanos et al., 2003) or the Scleractinian coral (Antoniadou and Chintiroglou, 2010), sponges and ascidians (Voultsiadou et al., 2007), which in their turn form a complex habitat for small-sized isopods like *P. nigropunctata*, thus contributing to the maintenance and the enhancement of their diversity in littoral rocky areas (Voultsiadou et al., 2007).

5 Conclusions

This study reports the first record of *P. nigropunctata* in Moroccan waters, and extends its geographical distribution area further to the south along continental Africa. This finding increases the knowledge on the Moroccan and North African marine macro-isopod diversity and provides evidence of a broader distributional pattern for this species in the eastern Atlantic region.

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