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8 authors, including:

Soukaina Kaidi
Université Chouaib Doukkali

Chaouti Abdellatif
Université Chouaib Doukkali

Miguel Angelo Mateus
Universidade do Algarve

Zahira Belattmania
Université Chouaib Doukkali

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Record of the first *Pleonexes* species (Crustacea: Amphipoda: Ampithoidae) in Moroccan waters: *Pleonexes gammaroides* Spence Bate, 1857

Soukaina KAIDI[1], Abdellatif CHAOUTI[1*], Miguel MATEUS[2], Zahira BELATTMANIA[1], Ester A. SERRÃO[2], Aschwin H. ENGELEN[2], Abdeltif REANI[1] and Brahim SABOUR[1]

(1) Phycology, Blue Biodiversity and Biotechnology RU, Laboratory of Plant Biotechnology, Ecology and Ecosystem Valorization – CNRST Labeled Research Unit N°10, Faculty of Sciences, Chouaib Doukkali University, 24000 El Jadida, Morocco

(2) CCMAR – Centre of Marine Sciences, University of Algarve, Gambelas, Faro, Portugal

**Corresponding author: chaouti@ucd.ac.ma*

Abstract: The ampithoid amphipod crustacean *Pleonexes gammaroides* Spence Bate, 1857 is reported from Morocco (northeastern Atlantic Ocean) for the first time, where it is the only representative of the genus *Pleonexes* Spence Bate, 1857 so far. Specimens were collected from the upper fringe of the infralittoral zone (including low intertidal) of El Jadida coastline associated with the holdfasts of the kelp *Saccorhiza polyschides* (Lightfoot) Batters (Phaeophyceae), colonising the sublittoral fringe in the southernmost distribution limit (Morocco). This finding updates the known geographical distribution of *P. gammaroides* in northern Africa and northeastern Atlantic. Some ecological and distributional details of this amphipod species are briefly discussed here.

Résumé : *Signalement de la première espèce de* Pleonexes *(Crustacea : Amphipoda : Ampithoidae) dans les eaux marocaines :* Pleonexes gammaroides *Spence Bate, 1857.* Le crustacé amphipode *Pleonexes gammaroides* Spence Bate, 1857 est signalé pour la première fois sur les côtes marocaines (Atlantique nord-est) où il est, à ce jour, le seul représentant du genre *Pleonexes* Spence Bate, 1857. Des spécimens ont été collectés au niveau de la zone infralittorale supérieure (y compris le médiolittoral inférieur) du littoral d'El Jadida, associés aux bulbes de l'algue brune (kelp) *Saccorhiza polyschides* (Lightfoot) Batters (Phaeophyceae) colonisant la frange infralittorale dans sa limite de distribution la plus méridionale (Maroc). Cette découverte met à jour la répartition géographique de *P. gammaroides* en Afrique du Nord et en Atlantique nord-est. Certains détails concernant l'écologie et la répartition de cette espèce amphipode sont brièvement discutés.

Keywords: Atlantic coast of Morocco ● Kelp-associated fauna ● Marine gammaridean Amphipoda ● New report ● Northeastern Atlantic

Introduction

The marine gammaridean Amphipoda (Crustacea) of Moroccan marine waters are poorly known due to the scarcity of faunistic and ecological studies on these coastal areas. Amphipods are one of the dominant taxa among vagile mesoinvertebrates, and are regarded as key ecosystem components due to their important role in energy flow through food webs since they serve as a food source for a large variety of marine fauna/predators (McKenzie & Moore, 1981). Most of the crustacean amphipods are primary consumers, hence constituting important trophic linkages between benthic primary producers and higher rank

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consumers (Izquierdo & Guerra-García, 2011). Due to a multiplicity of trophic and morpho-functional adaptations, amphipods are able to colonise a variety of marine environments (Barnard & Karaman, 1991; Scipione, 2013), as they are common inhabitants of many marine substrata or microhabitats such as sponges, ascidians, bryozoans, pieces of wood, corals, seagrasses, and macroalgae (Bellan-Santini, 1971; Scipione, 2013). Thus, they enhance and sustain the biodiversity thriving in marine and coastal waters and are important for understanding many functional aspects of marine biodiversity. Moreover, amphipods are considered highly sensitive to changes produced by environmental variables (e.g. Cruz et al., 2003; Izquierdo & Guerra-García, 2011).

Marine amphipods of the family Ampithoidae Boeck, 1871 are among the most conspicuous amphipods and dominate invertebrate assemblages inhabiting shallow-water macroalgal and seagrass habitats (Peart & Lörz, 2017; Sotka et al., 2017), as they are common throughout tropical and temperate shallow marine waters worldwide (Peart & Ahyong, 2016; Peart & Lörz, 2017). This family is commonly found in warm waters, but some species have been recorded from cold regions in both Atlantic and Pacific oceans (Peart & Ahyong, 2016). The ecological importance of Ampithoidae has stimulated numerous studies (e.g., Peart & Ahyong, 2016; Sotka et al., 2017), being a speciose family of mostly herbivorous and tubicolous amphipods with approximately 230 species described all over the world belonging to 16 genera (Peart & Lörz, 2017). The family was originally described by Boeck (1871) but its name has been wrongly attributed to Stebbing 1899 (see in Stebbing, 1906), which has since been followed by many subsequent authors including Barnard & Karaman (1991).

Among ampithoidian genera, the genus *Pleonexes*, established by Spence Bate in 1857 is one of the widely distributed amphipod genera (Lee et al., 2019), which comprises 12 species according to the World Register of Marine Species (Horton et al., 2022). Members of this genus occur in the eastern Atlantic Ocean *Pleonexes gammaroides* Spence Bate, 1857, *P. helleri* (Karaman, 1975), and *P. kaneohe* (J.L. Barnard, 1970), Pacific Islands *P. kulafi* (J.L. Barnard, 1970), *P. poipu* (J.L. Barnard, 1970), *P. kava* (Myers, 1985) and *P. maxillissius* (Ledoyer, 1984)), Indian waters *P. auriculata* (Rabindranath, 1972), Australian waters *P. meganae* (Peart, 2007), *P. parakava* (Peart, 2007) and *P. rotunda* (Peart, 2007), and Korean waters *P. koreana* (Kim & Kim, 1988). However, *Pleonexes* is also known for its conflicting taxonomy, as it was first proposed by Spence Bate in 1856, although it remained a *nomen nudum* until 1857 when a relevant description of the group was provided (Sotka et al., 2017). This classification changed with Barnard (1970) who reduced *Pleonexes* into subgeneric level, which was again modified by Conlan's (1982) cluster analysis that recognised the group at the genus level. According to Barnard (1970), *Pleonexes* seemed to have been an artificial genus composed of members of *Ampithoe* with dorsal telsonic hooks as extensions of the normal nobs plus subprehensile pereopods 5-7. Based on similarity in the prehensile pereopods and the presence of large recurved hooks on the telson, Barnard & Karaman (1991) reconsidered *Pleonexes* as a subgenus within *Ampithoe* for *A. poipu*, *A. aptos* (J.L. Barnard, 1969), and *A. helleri* species as well as *A. auriculata*, where the telsonic hooks are considered intermediately developed (Sotka et al., 2017). A short review of *Pleonexes* as subgenus was previously given by Mateus and Afonso (1974) together with a table of comparative characters for the six recognised species. *Pleonexes* was only relegated from the familiar generic status to that of a subgenus by Barnard (1970) on the evidence of a gradation of characters between *Ampithoe* and *Pleonexes*. The subgenus was identified in the Atlantic by the marked expansion of the propodus of peraeopods 5-7 and the pair of prominent hooked spines on the distal margin of the telson, although an examination of all *Ampithoe* species revealed a gradation of these characters, which suggested that *Pleonexes* might not be a valid subgenus (Lincoln, 1976). *Pleonexes* was then considered to be only a junior synonym of the largest ampithoid genus *Ampithoe* until the recent research of Peart and Ahyong (2016) in which *Pleonexes* was removed from synonymy with *Ampithoe* and resurrected as a valid genus of family Ampithoidae most closely related to the genus *Paranexes* Peart, 2014 (Peart & Ahyong, 2016). *Pleonexes* is particularly separated from *Ampithoe* by the presence of a rounded, reduced uropod 1 peduncular spur, enlarged apical telsonic cusps forming large hooks, expanded bases, and meri of peraeopods 3 and 4, and strongly prehensile peraeopods 5-7 (Peart & Ahyong, 2016).

Thus, *Pleonexes gammaroides* Spence Bate, 1857, recorded within this genus was originally described by Spence Bate (1856) as *Ampithoe gammaroides*, then reassigned as *P. gammaroides* which was recently confirmed by a phylogenetic analysis, pinpointing *P. gammaroides* as a correct nomenclature unlike other congeneric species that were reconducted to different valid genera (Peart & Ahyong, 2016). Further, the species was also considered to be a senior synonym of *Ampithoe (Pleonexes) neglecta* Lincoln, 1976 (Costello & Myers, 1987) now accepted as *Pleonexes* *helleri*, and is known as shallow-water gammarid amphipod dwelling macrophytes in temperate marine waters, being typical to eastern Atlantic Ocean (Lincoln, 1976). However, *P. gammaroides* has never been reported from Moroccan waters before and only five species of the genus *Ampithoe* (considering the genera conflicting taxonomy between *Pleonexes* and *Ampithoe*) were known through some studies dealing with macrophyte-inhabiting macro-epifauna on Atlantic and Mediterranean coasts of Morocco (Bitar, 1987; Menioui & Ruffo, 1988; Menioui, 1992; Belattmania et al., 2018), i.e. *Ampithoe ferox* (Chevreux, 1901), *A. ramondi* Audouin, 1826, *A. riedli* Krapp-Schickel, 1968, *A. rubricata* (Montagu, 1808), and *Ampithoe* sp. (reported by Bitar (1987) and Belattmania et al. (2018) without identifying the species). All of these species were confirmed as *Ampithoe* since they were not concerned by the resurrection of the genus *Pleonexes* (Peart & Ahyong, 2016). Nonetheless, little is known about the distribution of *Pleonexes* in the whole northeast Atlantic region, especially along the Moroccan coasts, where no species of this genus have been recorded so far. According to Barnard (1970), the genus *Pleonexes* is poorly represented everywhere in the northeast Atlantic Ocean as well.

An investigation of macro-epifauna associated with the kelp *Saccorhiza polyschides* (Lightfoot) Batters along the littoral of El Jadida on the northwestern Atlantic coast of Morocco yielded a number of epiphytal gammaridean amphipod specimens. Some of them were identified as *Pleonexes gammaroides* Spence Bate, 1857. The present study reports the first finding of *P. gammaroides* inhabiting holdfasts of *S. polyschides* in the southernmost geographical limit of this kelp and represents the first mention of the genus *Pleonexes* Spence Bate, 1857 in Morocco. Some morphological traits, and ecological and distribution aspects of this ampithoid amphipod are highlighted.

Material and Methods

Samples were collected as a part of a recent investigation of *S. polyschides*-associated epifauna on the El Jadida coastline (33°24'60.7"N-8°55'68.5"W) along the northwestern Atlantic coast of Morocco. The sampling was conducted in May 2018 (spring) on a moderately wave-exposed shore and was performed during the daytime at 0.5 m low tide at the upper level of the infralittoral fringe (including the lower intertidal and immediate subtidal zones).

The kelp species was carefully removed from the substratum with a metal scraper, and immediately placed in plastic bags with 10% formalin buffered with seawater, to prevent the loss of mobile fauna. In the laboratory, kelp individuals were washed in freshwater to collect the majority of the associated organisms. Specimens were sieved (0.5 mm mesh size), sorted and stored in 70% ethanol for later identification and counting. One of sampled species corresponded to *P. gammaroides* and its specimens were conserved separately for examination. *Pleonexes gammaroides* specimens were identified based on descriptions provided by Lincoln (1976 & 1979) as main references in addition to descriptions of many authors (e.g., Conlan, 1982; Peart & Ahyong, 2016).

Results

Systematics

Subphylum Crustacea Brünnich, 1772
Class Malacostracea Latreille, 1802
Subclass Eumalacostracea
Superorder Peracarida Calman, 1904
Order Amphipoda Latreille, 1816
Suborder Senticaudata Lowry & Myers, 2013
Superfamily Corophioidea Leach, 1814
Family Ampithoidae Boeck, 1871
Genus *Pleonexes* Spence Bate, 1857

Synonyms

Pleonexes gammaroides Bate, 1857 (Sars, 1894) Stebbing, 1906 (Chevreux & Fage, 1925).

Amphithoe gammaroides Bate, 1856 & 1862 (Bate & Westwood, 1863; Della valle, 1893).

Ampithoe hamulus Boeck, 1876. *Ampithoe longicornis* Boeck, 1871.

Sunamphithoe hamulus Bate, 1857 (Bate & Westwood, 1863; Boeck, 1872).

Sunamphithoe longicornis Boeck, 1870 & 1872.

Material examined

The collected individuals consisted of two adult males of *P. gammaroides*. Neither identifiable juveniles nor females were found. These two specimens were deposited in the Scientific Institute in Rabat, Mohammed V University, Agdal-Rabat, Morocco (Collection voucher n°: ZACmapa01.01 & ZACmapa01.02).

El Jadida coastline (33°24'60.7"N-8°55'68.5"W), Collection data (Kaidi, 16/05/2018, from 8h30 to 10h30, ~3 m-depth, Bulb of *Saccorhiza polyschides*), 2 specimens (male - 8.53 mm (ZACmapa01.01); male - 9.72 mm (ZACmapa01.02)).

Diagnosis

The main taxonomical characters allowing to distinguish *Pleonexes* from *Ampithoe* are:

Pereopods 5-7 propodus only weakly expanded distally; telson without pair of large curved distal spines .... ***Ampithoe***

Pereopods 5-7 propodus strongly expanded distally; subchelate; telson distal margin with pair of prominent curved spines or cusps .... ***Pleonexes***

The main distinguishing taxonomical characters used to avoid the confusion between the two congeneric species *Pleonexes gammaroides* and *P. helleri* are:

1. Gnathopod 2 male and female, only basis with anterodistal lobe; in male propodus with broad, sinuous, excavate palm. Antennae relatively short, about one-third body length, moderately setose .... ***Pleonexes helleri* (Karaman, 1975)**

2. Gnathopod 2 male and female, basis and ischium with pronounced anterodistal lobe; in male propodus very broad with straight palm. Antennae elongate, up to half body length or more, sparsely setose especially in male ....***Pleonexes gammaroides* Spence Bate, 1857**

Description

The collected individuals consisted of two adult male specimens of *P. gammaroides* with strongly built bodies of 9.718 and 8.534 mm.

Antenna 2 (Fig. 1) robust and sparsely setose. Gnathopod 1 (Fig. 2A) distinguished by its robustness and short carpus compared to the elongate propodus, the latter being rectangular with an oblique palm. Gnathopod 2 is larger and more robust than Gnathopod 1 (Fig. 2B); the basis presenting a very large anterodistal lobe, and large asymmetrical lobe on anterior margin of the ischium (Fig. 2B). Propodus is very broad with a straight and finely toothed palm, delimited by distinct angle from posterior margin, while distal part of the anterior margin is expanded towards base of dactylus (Fig. 2B). Pereopod 5 basis broadly expanded but still longer than wide (Fig. 2C); merus longer than carpus; propodus broad distally, palm with 3-4 short spines and one long curved spine, inner and outer palmar surface with small group of long setae (Fig. 2D). Pereopod 7 (Fig. 2E) is generally similar and little longer than Pereopod 5 and Pereopod 6; basis being narrowly oval with weakly convex posterior margin (Fig. 2F).

Uropods are moderately elongate and spinose (Fig. 2G). Uropod 3 peduncle elongate with single distal spine (Fig. 2H); the outer ramus being distinguished by pair of large curved spines, while small apical spine

Figure 1. *Pleonexes gammaroides*. Full body of an adult male collected from El Jadida coastline, NW Morocco (Collection voucher number ZACmapa01.01)

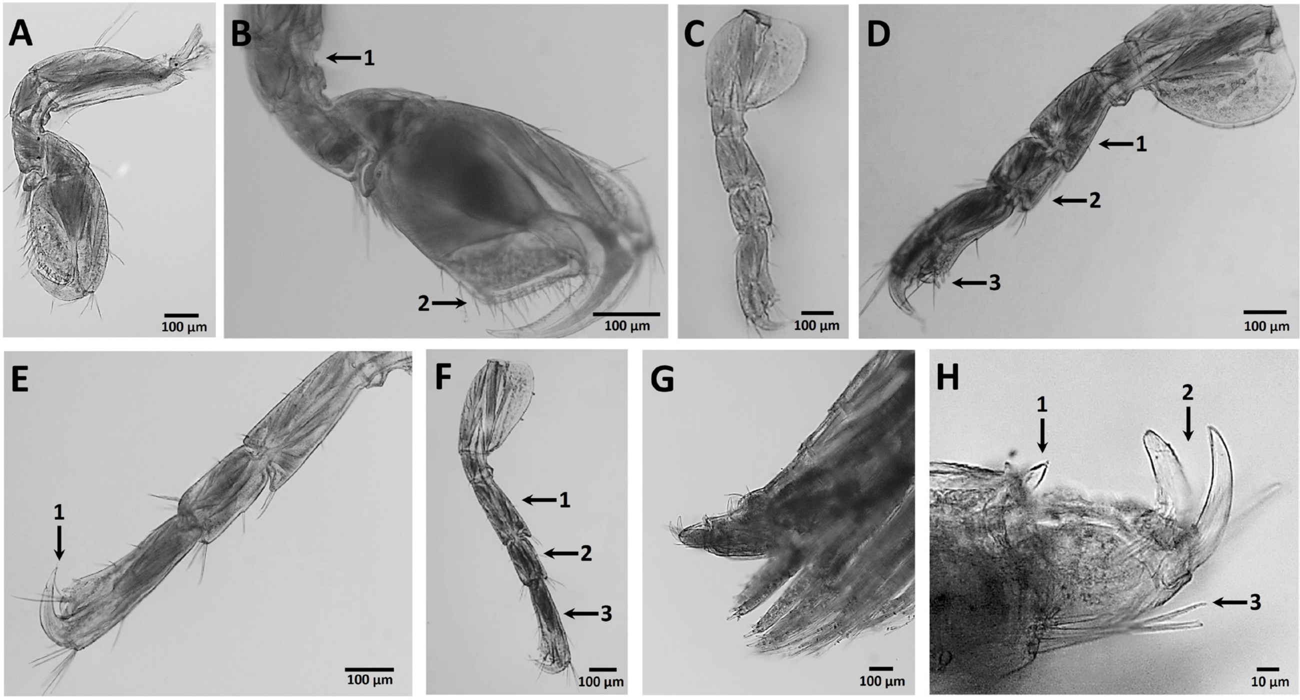

Figure 2. *Pleonexes gammaroides* (adult male). **A.** Gnathopod 1. **B.** Gnathopod 2 (male): 1-ischium large asymmetrical lobe on anterior margin, 2- Propodus with a straight palm delimited by distinct angle; **C.** Pereopod 5. **D.** Segments of Pereopod 5: 1- merus, 2-carpus, 3-palm with 3-4 short spines and one long curved spine with small group of long setae. **E.** Pereopod 7: 1-palm with 3-4 short spines and one long curved spine, and small group of long setae. **F.** Pereopod 7: 1- merus, 2-carpus, 3- propodus. **G.** Urosome. **H.** Uropod 3: 1- single distal spine; 2-pair of large curved spines on the outer ramus; 3- long setae.

and long setae can be seen on inner ramus. Telson fleshy entire, with short dorsal setae.

Discussion

Ecology

Pleonexes gammaroides is a macrobenthic species (Paiu et al., 2015) occurring at the lowest level of the eulittoral intertidal zone between 0 and 11 m depth ranges (Cruz et al., 2003; Anokhina, 2006; Sampaio et al., 2016). The species is also known for its important plasticity as it was reported in various marine and paralic ecosystems (Bellan-Santini, 1971; Cruz et al., 2003; Izquierdo & Guerra-García, 2011), including a variety of habitats and environmental characteristics regarding pollution, hydrodynamism, and consequently also physico-chemical parameters such as salinity, light intensity, and organic matter content. However, the species predominance and density were found to be mostly affected by moonlight illumination degree (Anokhina, 2006) and nitrate concentrations in the hosting biotope (Cruz, 2003). *Pleonexes gammaroides* is considered as a typical phytophagous, tube building species, which was shown to be epibenthic amphipod associated with various seagrass and algal habitats with different structural complexities (Bellan-Santini, 1971). In fact, many studies have shown it to be strongly related to mostly arborescent algae (Rhodophyta *Chondrus* and *Rhodymenia*, *Schottera nicaeensis* Guiry & Hollenberg, 1975, *Plocamium cartilagineum P.S. Dixon, 1967* and *Asparagopsis armata* Harvey, 1855 as well as calcareous species (*Corallina* sp., *Corallina elongata* J.Ellis & Solander, 1786 and *Tenarea tortuosa* Me.Lemoine, 1910) (Feldmann & Magne, 1964; Bellan-Santini, 1971; Izquierdo & Guerra-García, 2011; Guerra-García et al., 2012). *Pleonexes gammaroides* has also been mentioned within the epifaunal community inhabiting the green alga *Ulva lactuca* Linnaeus, 1753 (Bellan-Santini, 1971), and various Phaeophyceae with soft and floating thalli such as *Bifurcaria bifurcata* R. Ross, 1958*, Cystoseira* sp.*,* C. Agardh, 1820, *Ericaria crinita*, *E. amentacea* Molinari & Guiry, 2020 *Fucus serratus*, Linnaeus, 1753, *Halopteris scoparia* Sauvageau,1904, *Padina pavonia* J.V. Lamouroux, 1816 and *Sargassum muticum* Fensholt, 1955 (Truchot, 1963; Feldmann & Magne, 1964; Bellan-Santini, 1971; Withers et al., 1975), and kelp species, being found within

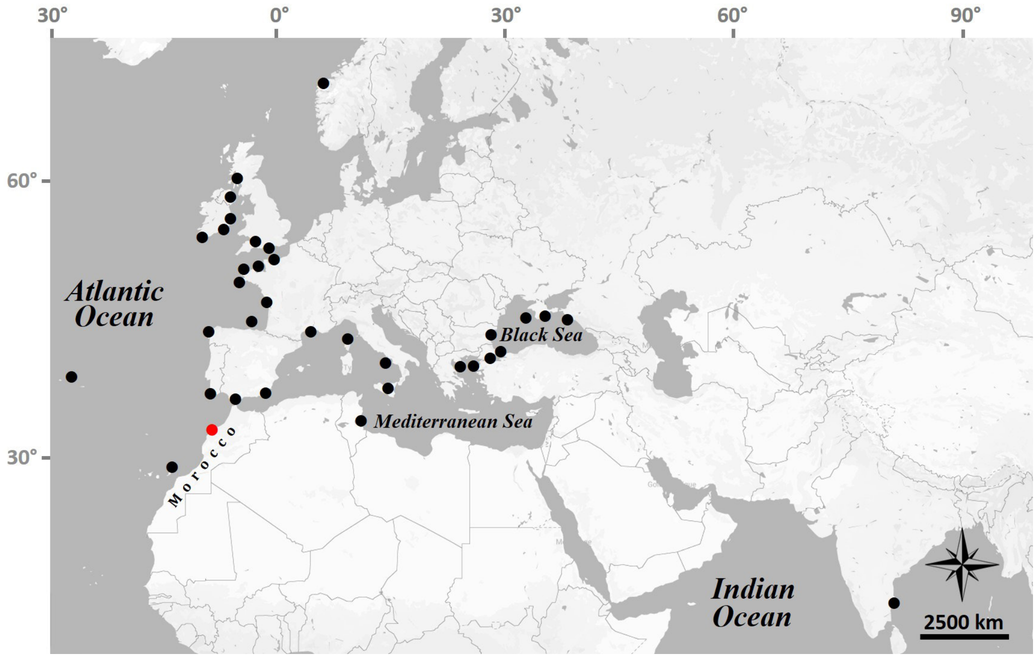

Figure 3. *Pleonexes gammaroides*. Map with the first record in Morocco (red dot) including previous literature records (black dots).

Saccorhiza polyschides (Lightfoot) Batters, 1902 bulb (McKenzie & Moore, 1981), and the holdfasts of both *Saccharina latissima (Linnaeus) C.E.Lane, C.Mayes, Druehl & G.W.Saunders, 2006* (L'hardy, 1962), and *Laminaria hyperborea* (Gunnerus) Foslie, 1884 (McKenzie & Moore, 1981). In addition to phytal habitats, *P. gammaroides* is also frequent in rockpools (Feldmann & Magne, 1964; Bellan-Santini, 1971), and has been found associated with mussel beds (Bellan-Santini, 1971), with the sponges *Halichondria panicea* (Pallas, 1766) and *Hymeniacidon perlevis* (Montagu, 1814) (Costello & Myers, 1987). Reportedly, the species would have even maintained a rare commensal symbiosis with anemone species (Patzner, 2004). It has also been recorded within communities inhabiting artificial reefs (Paiu et al., 2015) and sandy sediments (Sampaio et al., 2016).

In the present study, the amphipod species was associated with the bulb of *S. polyschides* in the low intertidal and shallow sublittoral (0.8-1.2 m depth). The sampling site is moderately exposed to hydrodynamic forces. It is also naturally colonised by two sympatric kelp species *S. polyschides* and *Laminaria ochroleuca* Bachelot de la Pylaie patchily distributed on rocky bottoms with seawater temperature of 16.25 ± 1.25°C, salinity of 35.76 ± 1.43, pH of 8.07 ± 0.39, dissolved oxygen of 25.05 ± 13.32 mM, nitrogen (as $NO_2^- + NO_3^-$) of 6.37 ± 5.10 µM, phosphates (as PO_4^{3-}) of 1.03 ± 0.42 µM, and suspended matter of 12.50 ± 1.14 mg.L^{-1} (Belattmania et al., 2018).

Geographical distribution range and ecological considerations

Pleonexes gammaroides is regarded as an Atlantic warm-temperate species of northern Hemisphere (Conlan, 1982) with a widespread distribution range, reported from various shores mainly within the Atlantic Ocean, in addition to its occurrence in the Black Sea, Aegean Sea, Marmara Sea, and very few uncertain records from the Mediterranean Sea, Adriatic Sea, and Indian Ocean (Fig. 3).

However, *P. gammaroides* is known as a common species of the Atlantic Ocean (Guerra-García et al., 2012; Lee et al., 2019), and was even considered to be exclusively Atlantic according to the zoogeographical classification of epifaunal assemblages sampled along the Mediterranean and Atlantic shores of the Iberian Peninsula (Izquierdo & Guerra-García, 2011). This conclusion might be supported by several studies performed in the Mediterranean Sea (e.g., Bakalem et al., 2020) where *P. gammaroides* was not mentioned with the Mediterranean typical fauna including congener species. Also, it is important to notice that most of the Mediterranean records of *P. gammaroides* were mentioned by Chevreux and Fage (1925) referred to in Lincoln (1976 & 1979) as misleading identifications of the species, confused with *Ampithoe (Pleonexes) neglecta* now accepted as *Pleonexes helleri.* Lincoln (1976 & 1979) also stated that the distribution of *P. gammaroides* probably does not extend into the Mediterranean, which explains the few records of the species following those publications that became the main references for the species identification.

This study reports the first occurrence of *P. gammaroides* as the only species of the genus *Pleonexes* recorded hitherto from Moroccan coasts, and the second in the broader spatial scale corresponding to the Azores-Canaries-Madeira ecoregion. The latter is a different location from the areas where the species was mostly found. In fact, considering the present study and those of Chevreux and Fage (1925), and Moro Abad et al. (2003) in the Canary Islands, there are only three records of *P. gammaroides* on the North African Atlantic coast, all reported in upwelling areas from the northeast Atlantic.

Due to its ability to occur in various types of biogenic habitats, *P. gammaroides* is widely distributed, and commonly colonises a large variety of phytal substrates. Macroalgal species are the hosting habitats from which *P. gammaroides* is chiefly recorded, often described as an epibenthic amphipod species dwelling mainly brown, green and red seaweeds (e.g., Truchot, 1963; Bellan-Santini, 1971; Izquierdo & Guerra-García, 2011). However, *P. gammaroides* was also considered not habitat-specific (Bellan-Santini, 1971; Izquierdo & Guerra-García, 2011) and was found in places around the world with different environmental conditions (Sampaio et al., 2016). Nonetheless, most of these extensive distributional records are yet to be taxonomically verified as they may in fact be a species complex.

In the present study, *P. gammaroides* has been found associated with the annual kelp *Saccorhiza polyschides*. This occurrence of the amphipod species within the kelp might be related to its ecology, as well as the hosting alga identity and the geographical scale of the sampling area. Patterns of the composition, distribution, and abundance of kelp-associated macrofauna were shown to be influenced by various factors, starting with the thalli structure, in this case, a unique and distinguished bulbous structure of *S. polyschides* holdfast. The latter differs from all other kelp holdfasts by offering a complex internal channeling system of more root-like ramifications, creating crevices, and so considerable interstitial hiding space for epifauna such as *P. gammaroides* (McKenzie & Moore, 1981; Tuya et al., 2011) also known to be a tube-building species (Conlan, 1982).

Amphipods associated with kelps are recognised as sedentary dwellers with very limited mobility. Hence, in the present study, *P. gammaroides* benefits from the additional protection of *S. polyschides* holdfast, an important structural shelter for mesoherbivores against predators, physical stress, and disturbance, i.e., wave action or desiccation. Further, it also provides a sediment-rich environment representing an extra-biotope in which *P. gammaroides* was recorded as dwelling fauna (Sampaio et al., 2016).

Besides the interesting *S. polyschides* holdfast structure, macroalgal epiphyte amounts are often found attached on these thalli lower parts. This is the case for this study's samples, all gathered with various branched red and brown seaweeds that correspond to epiphytes of floating thalli such as *Chondracanthus acicularis* Fredericq, 1993*, Corallina elongata* J. Ellis & Solander, 1786*, Ericaria selaginoides* (Linnaeus) Molinari & Guiry, 2020, *Gelidium corneum* J.V. Lamoureux, 1813, *G. spinosum* P.C. Silva,1966, *Gracilaria multipartita* Harvey, 1846, *Gymnogongrus* sp.*,* Martius, 1833 and *Halopteris incurvis* in addition to the *Chlorophyta Ulva* sp*.* Their presence plays a major role in the enhancement of the kelp structural complexity while providing diverse food resources and habitats for *P. gammaroides.* In fact, the latter is regarded as a typical phytophagous species feeding directly on hosting algae (Withers et al., 1975). However, *P. gammaroides* has been reported in several types of biogenic habitats with different level of palatability and architectural complexity ranging from simple to more complex structure (Bellan-Santini, 1971; Izquierdo & Guerra-García, 2011; Guerra-García et al., 2012; Sampaio et al., 2016). Great abundances of *P. gammaroides* were previously found within the northeastern Atlantic waters where it is known as a common species inhabiting particularly various seaweeds along its wide distribution range from Norway to the Canary Islands (Feldmann & Magne, 1964; Bellan-Santini, 1971; Lincoln, 1976). It should be noted that the investigated rocky shore of El Jadida located on the Atlantic coast of Morocco, is closer to the southernmost distribution range edge of the species offering contrasting environmental conditions for both *P. gammaroides* and its hosting kelp.

Abiotic factors exert considerable influence upon kelps and their associated epifauna. The first record of *P. gammaroides* in Morocco can then be accounted for by the climatic conditions and the tidal zone of the studied site, since *P. gammaroides* has never been mentioned among the reported faunal communities of Morocco (i.e., Bitar, 1987; Menioui & Ruffo, 1988; Menioui, 1992), not even by studies of the fauna inhabiting intertidal zones of the same study area (Belattmania et al., 2018). This is, to some extent, supported by this finding, as *P. gammaroides* specimens were collected from the upper fringe of the infralittoral zone corresponding to a different sampling zone in the littoral.

On a larger scale, and despite the latitudinal gradient, *P. gammaroides* is found in different ecoregions of the temperate northern Atlantic realm, mostly reported within the Northern European Seas, the Black Sea province, and the Lusitanian province along with few doubtful records in the western Mediterranean Sea province.

This Moroccan record of *P. gammaroides* might be induced by a possible biogeographical reconfiguration, as a result of the reciprocal impact of Mediterranean waters, over the biota inhabiting the adjacent Atlantic across the Strait of Gibraltar (Tuya et al., 2012), which involves water exchange between the Mediterranean Sea and the Atlantic Ocean. Thus, ocean climate patterns of this study ecoregion might be the main reason behind this first occurrence of *P. gammaroides* in the rocky shore of El Jadida (NW Morocco), as the location belongs to a wide transitional area of the Atlantic and Mediterranean waters (Tuya et al., 2012), therefore involving three adjacent ecoregions of the Lusitanian province (south European Atlantic shelf, saharan upwelling, and the Azores, Canaries and Madeira isles). The latter provides interesting climatic conditions for *P. gammaroides* and its hosting kelp such as upwelling regimen from which benefits both the Canary Isles and the Moroccan Atlantic coast.

The lack of previous *P. gammaroides* records along the Moroccan Atlantic coast could also be explained by its seasonality. The species remains rare with low abundances, except for the high densities reported during the winter (Cruz et al., 2003). Otherwise, it is also possible that the species might be locally abundant and widespread, but because of its cryptic and patchy distribution, it might remain hardly and rarely detected. In addition, the lack of previous records could also be imputed to the small size of individuals, and to a potential misidentification of the species by not reaching the lowest identification taxon (species). It is likely that *P. gammaroides* may have been present in Morocco but not identified due to possible confusion between *Pleonexes* and other genera, especially *Ampithoe*. This might be the case of Bitar (1987) and Belattmania et al. (2018) who reported *Ampithoe* sp. The genus being a former taxonomic name of many congener species of *P. gammaroides* that might be concerned by the new resurrection of *Pleonexes*, therefore changing the species nomenclature (Peart & Ahyong, 2016).

Conclusion

This study represents the first record of the amphipod *Pleonexes gammaroides* in the northwest Moroccan Atlantic coast. This corresponds to one of the southernmost distribution records of the species along the temperate northern Atlantic realm, thus, increasing the knowledge about the distributional aspects of this species. This also represents the second signalisation of the species on the North African Atlantic coast and the only and the first representative of the genus *Pleonexes* from Moroccan waters. Hence, its biogeographic distribution is now extended farther south in the northeast Atlantic, and we certainly expect to find it in other biogeographic ecoregions. Since many of the North African shores present similar environmental conditions along their NE Atlantic coast, we suggest that the distributional range of *P.gammaroides* might be extended to other southern localities, and additional samplings are required to confirm its presence there. This study contributes to adding new data on Moroccan and North African Atlantic biodiversity. Further studies are warranted to explore the local and regional amphipod diversity.

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