

MARINE RECORD

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New records of Sea Spiders (Arthropoda: Pycnogonida) for continental Portugal and notes on species distribution

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Abstract

A sampling effort carried out in the Northern coast of Portugal revealed the presence of two species of sea spiders that are recorded for the first time in Portugal: *Anoplodactylus angulatus* and *Ammothella longiocolata*. While *A. angulatus* is widespread along the North East Atlantic coast, *A. longiocolata* is recorded for the first time outside of the Mediterranean Sea. Eight species were recorded in this survey, increasing the pycnogonid species list of Portugal to twenty-four. A species list of the Pycnogonids of continental Portugal including references and distribution is provided.

Keywords: *Anoplodactylus angulatus*, *Ammothella longiocolata*, Iberian Peninsula, Portugal, Atlantic

Introduction

Pycnogonids or sea spiders are an exclusively marine group of arthropods that includes 1340 species (Bamber et al., 2015). Their phylogenetic position has been the subject of debate for many years, and they are currently considered to be a sister group of the rest of the Chelicerata (Regier et al., 2010; Andrew, 2011), although their phylogeny is not clearly resolved.

By comparison with other areas, the Pycnogonida of the Iberian Peninsula have been intensively studied (see Soler-Membrives & Munilla, 2015). Nevertheless, faunal studies focused on pycnogonids in Portuguese waters are scarce in the literature; most of the available data come from wider studies on benthic community studies where pycnogonids are rarely found in high numbers.

The first attempt to document pycnogonid records and studies of the Portuguese fauna was by Nogueira (1956) who listed 16 species (13 coastal, 3 abyssal). In her synopsis Nogueira (1967) corrected the list, recognizing 19 species, and Stock (1978) described a new species of *Nymphon* from abyssal depth off Portugal increasing the pycnogonid species to 20. Recently, Munilla León and Soler-Membrives (2014) in their

monograph of the Pycnogonida of the Iberian Peninsula and Balearic Islands added two more species from a revision of material performed by Munilla in Lisbon Museu Bocage, totalling 22 species.

In this paper, all records available for Portuguese waters are collated adding new information gathered from sampling on the northern coast, including ecological remarks.

Materials and methods

Three granitic rocky shores were sampled along the Portuguese north coast between June and July 2010 (Fig. 1). The localities were Viana (41° 41' 49.79"N 8° 51' 10.52"W), Foz (41° 09' 15.55"N 8° 40' 50.46"W) and Aguda (41°02'43.22"N 08°39'10.31"W). The survey area presents a semidiurnal tidal regime, with the largest spring tides about 4.0 m. The exposed coastline is dominated by swells from the north-west (73 %) with about 19 % of swells coming from the west. Swell direction plays a key role in controlling nearshore circulation responsible for a continuous interchange between surf zone and offshore waters. The mean wave height varies widely between seasons, with typical wave heights during the spring-summer months being between 1 and 3 m. Most storms occur during autumn-winter months when waves often exceed 7 m in height (Dias et al., 2002). A more detailed description of the study area including

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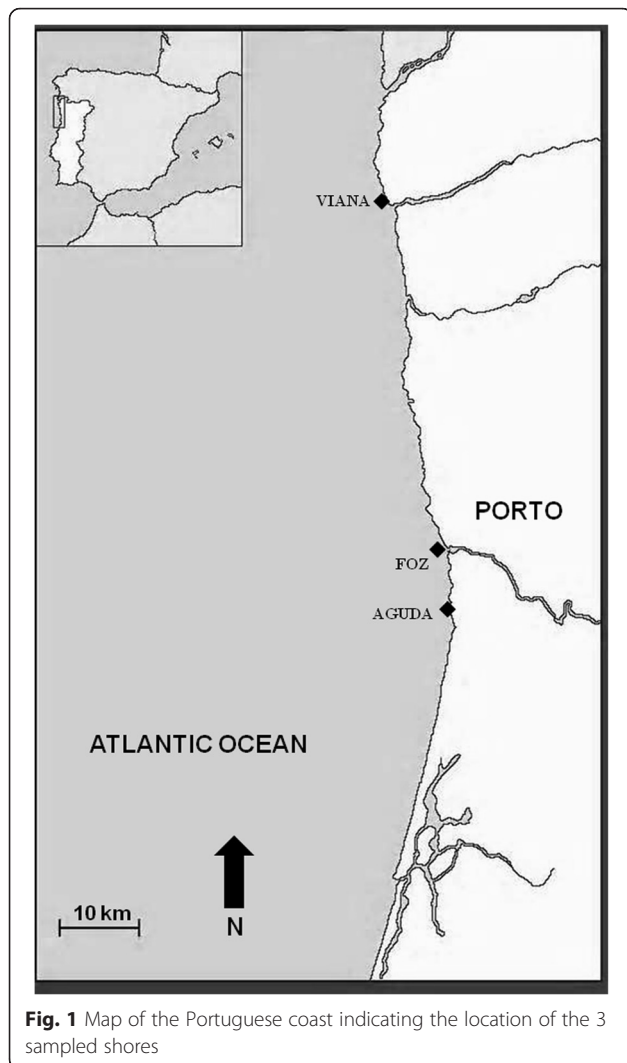


Fig. 1 Map of the Portuguese coast indicating the location of the 3 sampled shores

patterns of surface water temperature, upwelling etc. can be found in Rubal et al. (2013).

Sampling was done at low tide level. The dominant algae associated with pycnogonid collections were: Viana: assemblages dominated by *Corallina officinalis*, *Lithophyllum* spp. and *Mastocarpus stellatus*; Foz: assemblages dominated by *Chondracanthus acicularis*, *Codium tomentosum* and *Osmundea pinnatifida* and Aguda: assemblages dominated by *Ulva* spp., *Chondracanthus acicularis* and *Corallina officinalis*. For a detailed list of macroalga species in each shore see Veiga et al. (2013a).

In each site, 15 samples of 20x20 cm (an approximate area of 0.6 m²) were scraped and all fauna and algae collected in a labelled plastic bag. Samples were pooled in the field and fixed in 4 % neutralized formaldehyde solution. Each sample was washed over a 0.5 mm sieve in the laboratory and pycnogonids were sorted from the macroalgae under a dissecting microscope at 30x magnification.

Specimens from each site were stored in ethanol (70 %) pending taxonomic study.

In this study we provide a complete list of Pycnogonida present along continental Portugal compiled from existing literature (Table 1). Due to significant environmental gradients along the Portuguese coast, we have divided it in three regions similar to previous studies (e.g. Veiga et al., 2013b) based on oceanographic, geological and biological criteria described by Rubal et al. (2013): North Portugal from the Minho estuary to Aveiro, central Portugal from Aveiro to Sines and south Portugal from Sines to the estuary of the Guadiana river. The southern coastline of the Algarve was not considered due to the lack of pycnogonid records.

Part of the specimens were donated to the Museo Natural de Ciencias Naturales de Madrid (MNCN). The rest remains in the collection of the Laboratory of Marine Animals Adaptations (ADAM) of the University of Vigo (Spain). Classification and nomenclature follows that of Bamber (2010). This report covers the coastal and off-shore waters of continental Portugal only. An account of pycnogonid collections from the Açores can be found in Bamber & Costa (2009).

Results and discussion

A total of eight pycnogonid species were found in this study (Table 1), six of which were previously known from Portuguese coasts. *Ammothella longiocularata* (Faraggiana, 1940) and *Anoplodactylus angulatus* (Dohrn, 1881) represent new records increasing the number of species from continental Portuguese waters to twenty-four (Table 1).

New records

SYSTEMATICS

Family AMMOTHEIDAE Dohrn, 1881

Genus *Ammothella* Verrill, 1900

Ammothella longiocularata (Faraggiana, 1940)

Ammothea (*Ammothella*) *longiocularata*: Faraggiana, 1940

Material examined

3 specimens, MNCN 20.03/858-860 and 10 specimens, ADAM, all Foz, 41° 09' 15.55"N 8° 40' 50.46"W, 29/07/2010, macroalgae, intertidal, collected by M. Rubal and P. Veiga. 1 specimen, ADAM, Aguda, 41°02'43.22"N 08° 39'10.31"W, 30/07/2010, macroalgae, intertidal, collected by M. Rubal and P. Veiga.

Diagnosis

After Bamber (2010) and Munilla León and Soler-Membrives (2014): Trunk with sutures present between segments 1 and 2 and between 2 and 3. Cephalon with conspicuous anterolateral tubercles, ocular tubercle three times as tall as wide, with four eyes. Lateral processes separated, each bearing a dorsodistal, elongate,

Table 1 List of Pycnogoid species collected in continental shores of Portugal

Species	Depth	Habitat	Sites	Region	Reference
Family Nymphonidae					
<i>Nymphon gracile</i> Leach, 1814	I	M, P	V (1)	N, C, S	Nobre , 1903
<i>Nymphon macrum</i> Wilson, 1880	S (78 m)	-	nf	N	Stephensen , 1935
<i>Nymphon tubiferum</i> Stock, 1978	D (740 m)	MS	nf	C	Stock , 1978
Family Callipallenidae					
<i>Callipallene brevisrostris</i> (Johnston, 1837)	S	-	nf	-	Stock , 1952
<i>Callipallene emaciata</i> (Dohrn, 1881)	I	M	nf	C	Nogueira , 1956; Patrício et al. 2006
<i>Callipallene tiberi</i> (Dohrn, 1881)	D	M, S	nf	C, S	Nogueira , 1956
Family Phoxichilidiidae					
<i>Anoplodactylus angulatus</i> (Dohrn, 1881)	I	M	V(1)	N	This study
<i>Anoplodactylus oculatus</i> Carpenter, 1905	S, D	-	nf	C	Munilla León et al. 2014
<i>Anoplodactylus petiolatus</i> (Kroyer, 1844)	I	M	V(1)	N, C, S	Nogueira , 1956; Cunha et al. 1997
<i>Anoplodactylus pygmaeus</i> (Hodge, 1864)	I	M	V(1),A(2)	N, C, S	Nogueira , 1956; Neto et al., 2010
<i>Anoplodactylus virescens</i> (Hodge, 1864)	I, S	M	F(1),A(3)	N, C, S	Nogueira , 1956; Patrício et al. 2006
Family Endeidae					
<i>Endeis spinosa</i> (Montagu, 1808)	I	M	nf	C,S	Nogueira , 1956
Family Ammotheidae					
<i>Achelia echinata</i> Hodge, 1864	I,S	M	V(1)	N, C, S	Nogueira , 1956
<i>Achelia langi</i> (Dohrn, 1881)	I	-	nf	C, S	Nogueira , 1967
<i>Achelia vulgaris</i> (Costa, 1861)	I,S	M, S	nf	C, S	Nogueira , 1956
<i>Ammothella longiocolata</i> (Faraggiana, 1940)	I	M	F(13),A(1)	N	This study
<i>Cilunculus europaeus</i> Stock, 1978	D	M, S	nf	C	Munilla León et al. 2014
<i>Ammothella longipes</i> (Hodge, 1864)	I	M, S	V(1),F(1)	N, C	Nogueira , 1956
<i>Paranymphon spinosum</i> Caullery, 1896	D (750 m)	MS	nf	S	Loman , 1912
<i>Tanystylum conirostre</i> (Dohrn, 1881)	I	-	nf	C, S	Nogueira , 1967
<i>Tanystylum orbiculare</i> Wilson, 1878	I	M	nf	C	Nogueira , 1956
Family Ascorhynchidae					
<i>Ascorhynchus abyssi</i> Sars, 1877	D (1500 m)	-	nf	S	Bouvier , 1917
Family Colossendeidae					
<i>Colossendeis colossea</i> Wilson, 1881	D (2028 m)	MS	nf	C	Topsent, 1897
Family Pycnogonidae					
<i>Pycnogonum litorale</i> (Strom, 1762)	I	M	nf	N, C	Nobre , 1903, Azeda et al., 2013

Depth: intertidal (I), subtidal (S) and deep sea (D) when available the depth was provided in meters. Habitat: macroalgae (M), sand (S), muddy sand (MS) and plankton (P). Sites where species were found in this study, Viana (V), Foz (F), Aguda (A), not found (nf) and the number of individuals. Region: North Portugal (N), central Portugal (C) and South Portugal (S). Bold references refer to works versed specifically on pycnogonids; the rest are generalist ecological works

fleshy tubercle with no seta. Abdomen with pair of dorso-distal setae, exceeding distal margin of first coxa of fourth leg. Proboscis large, fusiform. Chelifores present, reaching half of proboscis length; scape one articulated, with distal plumose spines. Palps of nine articles, second longer than fourth, five distal articles subequal, ventrally setose. Ovigera with compound spines in pairs on articles 7 to 10. Walking legs with simple spines and some plumose spines, femur shorter than tibiae, bearing cement gland opening in males via short distal tube, tarsus

short, sole of propodus with three or four larger spines, auxiliary claws about half as long as the main claw.

Distribution

Mediterranean Sea and North of Portugal.

Remarks

Ammothella longiocolata, described from the Ligurian Sea (Faraggiana, 1940) has been cited on ten occasions, all in the Mediterranean Sea (Koçak & Katagan 2008

and references therein), where it is considered endemic and is widespread from East to West in northern and western coasts (Koçak & Katagan 2008; Munilla León and Soler-Membrives 2014). The westernmost record to date is from Chafarinas Islands in Alboran Sea (Munilla & Nieto 1999), and the current record represents the first for *A. longiocolata* in the Atlantic. The sea water in the North-West Atlantic coast of the Iberian Peninsula is often colder than in the Mediterranean and the hydrodynamic pressure significantly higher, so the occurrence in Northern Portugal indicates that *A. longiocolata* tolerates a broader range of these two factors than previously thought.

In the Iberian Mediterranean, *A. longiocolata* is found at 12 m depth, while in the Atlantic was found in the intertidal. This depth difference suggests habitat shift in order to maintain the temperature preferred and might indicate temperature constraints for this species. As pycnogonid species are rarely identified to species level in benthic surveys and Portugal shore is poorly sampled, it is most likely that this species it has gone unnoticed until now.

Family PHOXICHILIDIIDAE Sars, 1891

Genus *Anoplodactylus* Wilson, 1878

Anoplodactylus angulatus (Dohrn, 1881)

Phoxichilidium angulatum: Dohrn, 1881

Material examined

1 specimen, MNCN 20.03/861, Viana, 41° 41' 49.79"N 8° 51' 10.52"W, 30/07/2010, macroalgae, intertidal, collected by M. Rubal and P. Veiga.

Diagnosis

After Bamber (2010) and Munilla León and Soler-Membrives (2014): Trunk compact, sutures present. Cephalon not overhanging proboscis base. Lateral processes with no tubercles, slightly separated. Ocular tubercle dome shaped, with four pigmented eyes. Proboscis with characteristic distinct angulate distal corners, with ventral basal protuberance in males. Abdomen inclined about 45°, reaching mid-length of the last legs first coxa. Chelifores scape straight, as long as proboscis, chela palm longer than fingers, fingers with 3–6 internal teeth. Ovigera six articulated. Walking legs sparsely spinose, first coxa with two distolateral spines, coxa 2 as long as 1 and 2 together, femur with 2–6 cement pores, femur and tibia subequal in length, tarsus compact, propodus with distinct heel, bearing two large proximal and three slender distal spines, sole with no lamina, main claw about as long as sole, auxiliary claws small, lateral.

Distribution

Northeast Atlantic and Mediterranean Sea.

Remarks

Anoplodactylus angulatus has been recorded not only in the Mediterranean Sea (e. g. Arnaud, 1987; Munilla, 1988; Krapp et al., 2008; Koçak et al., 2010) but also in the British Isles (King & Crapp 1971; Roberts, 1981) and Macaronesia (Sanchez and Munilla 1989; Bamber and Costa 2009), which indicates that the species is widespread in the area in spite of the scarcity of its records. This species is now new record for Portuguese waters.

Other Pycnogonida species found in this study

Only three of the remaining species had been previously recorded in the north of Portugal: *Nymphon gracile* Leach, 1814, *Nymphon macrum* Wilson, 1880 and *Pycnogonum litorale* (Strom, 1762). These were recorded by Nobre (1903), Stephensen (1935) and Nogueira (1956, 1967). On the other hand, the new records (i.e. *A. longiocolata* and *A. angulatus*) and *N. macrum* are the only species recorded exclusively in the northern region although their broad general distribution in the North East Atlantic suggests that they might be present throughout the Portuguese coast.

Two additional species previously known from southern areas of Portugal were found in the north for the first time: *Anoplodactylus pygmaeus* (Hodge, 1864) and *Anoplodactylus virescens* (Hodge, 1864), although the latter was cited in the Northwest of Spain (Munilla, 1987; Soler-Membrives & Munilla, 2015). *P. litorale*, previously found at Foz by Nobre (1903) was not recorded. Azeda et al. (2013) listed this species amongst the taxa found in a monitoring survey near Lisbon, which would confirm the presence of this species in the central region.

Callipallene brevis (Johnton, 1837) was listed by Stock (1952) as being recorded from the littoral zone on the Portuguese coast but the precise location has not been identified. Nogueira (1967) questioned this record and the species has not been recorded again. Nevertheless, the presence of *C. brevis* in northern Portugal is feasible, given the recent report in the nearby Galicia, NW Spain (Esquete et al., 2013)

Nogueira overlooked *Tanystylum conirostre* (Dohrn, 1881) in her first report of the pycnogonids of Portugal (1956), but amended the mistake in her synopsis (1967), although in the latter the description and drawings of *Tanystylum orbiculare* Wilson, 1878 and *T. conirostre* are confounded.

The 24 pycnogonid species recorded in Portugal (Table 1) represent about 36 % of the 65 species found in the Iberian Peninsula (Munilla León and Soler-Membrives 2014) and about 25 % of the 84 species recorded by Bamber (2010) for the North East Atlantic. These results suggest that the pycnogonid diversity in the continental Portuguese shores is still poorly known, and an increase in the research effort will improve the information about the diversity and geographical

distribution of the Pycnogonida in the Iberian Peninsula and worldwide.

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Authors' contributions

MR and PV did the sampling and sorting of the samples and drafted parts of the manuscript. PE identified the specimens and redacted the manuscript. All authors read and approved the final manuscript.

Competing interests

None of the authors have any competing interests in the manuscript.

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