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Data on the distribution of the uncommon Mediterranean sponge *Pachymatisma johnstonia* (Porifera: Demospongiae)

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Abstract
The sponge *Pachymatisma johnstonia* (Bowerbank in Johnston, 1842), surveyed mainly along the north-east Atlantic coast, is recorded for the first time in the Southern Adriatic Sea. The specimen is collected at a depth of 228 m, off the Gargano coast (Apulia, Italy). The present study analyzes morphological characters, skeletal elements (spicules), and habitat of *P. johnstonia* and discusses a comparison between the Atlantic specimens. Moreover, this record extends the distribution of this uncommon species in the Mediterranean Sea.

Keywords: Pachymatisma johnstonia, *Tetractinellida*, *Mediterranean Sea*, *aphotic zone*, *new record*

Introduction

Although the Mediterranean sponge fauna is one of the most studied in the world (Van Soest et al. 2012), the majority of these data are referred to habitats shallower than 100 m. Instead, there are limited data for sponges in the Mediterranean deep-sea areas (Bo et al. 2012) with most of the data deriving from indirect sampling methods (Vacelet 1969; Voultsiadou 2005) or from by-catch specimens collected by bottom trawlers (Santín et al. 2018). Species belonging to the order Tetractinellida have been often surveyed in deep water but can be found in shallow depths (Cárdenas & Rapp 2013). The genus *Pachymatisma* Bowerbank in Johnston, 1842 (Tetractinellida, Geodiidae) contains only five species, distributed as follows: *P. areolata* Bowerbank 1872 from western Indian Ocean (Bowerbank 1872; Burton 1926; Lévi & Day 1967); *P. monaena* Lendenfeld, 1907 from South Africa (von Lendenfeld 1907; Samaai 2006); *P. bifida* Burton 1959 from the Maldives (Burton 1959); *P. normani* Sollas 1888 from the northeast Atlantic (Sollas 1888; Cárdenas et al. 2007; Sim-Smith & Kelly 2015); *P. johnstonia* (Bowerbank in Johnston, 1842) from the southern part of the north-east Atlantic and the Mediterranean Sea (Cárdenas et al. 2007).

P. johnstonia is one of the most common and known sponges throughout the north-east Atlantic coasts (Cárdenas et al. 2007) and it is mainly found in the littoral and sublittoral zones. In the Mediterranean Sea, it is not common and was reported only two times: in a shallow marine cave in the Tyrrhenian Sea (Gulf of Naples, Russ & Rützler 1959; Sarà 1964) and the Northern Adriatic Sea (Pansini personal communication in Cárdenas et al. 2007) (Figure 1). This work aims to report the presence of *P. johnstonia* in the aphotic zone of the Southern Adriatic Sea and provide its morphological description.

Materials and methods

Study area

The study area, the Southern Adriatic Sea (GFCM Geographical sub-area, GSA, 18,

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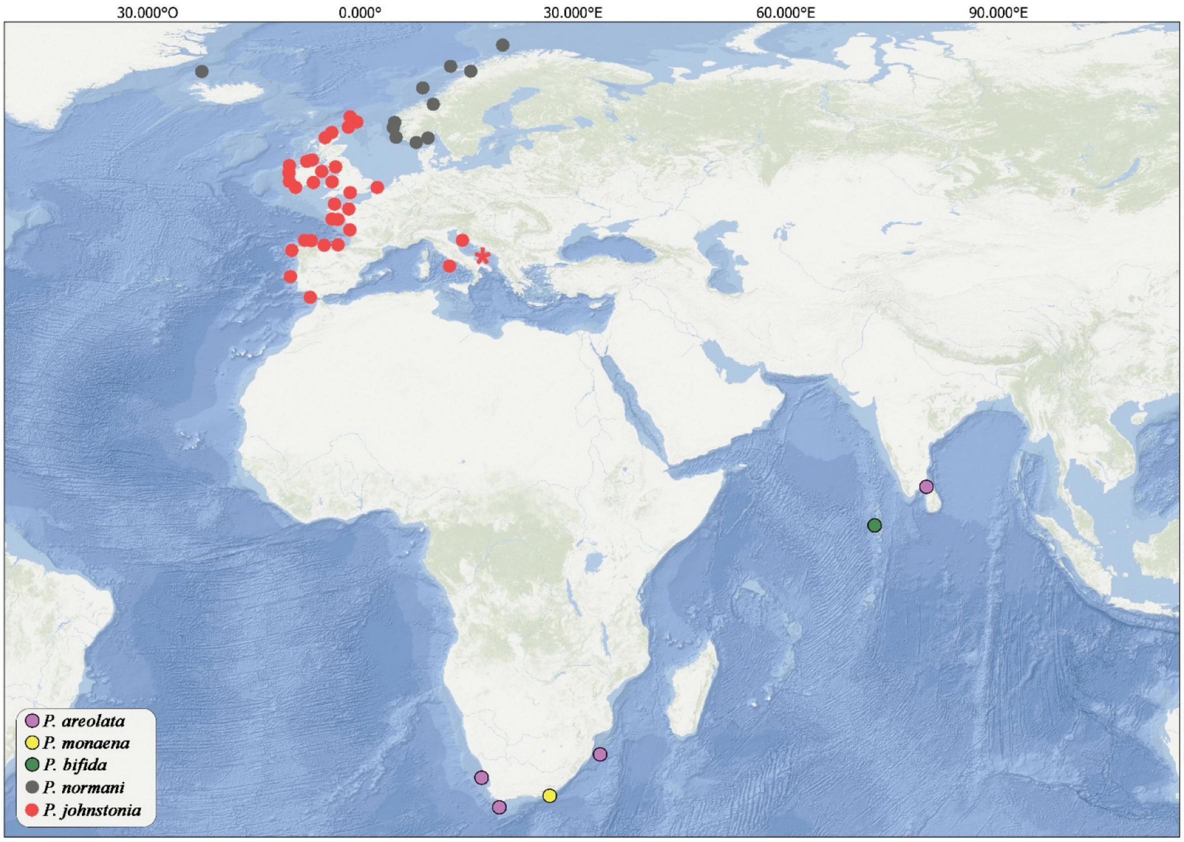

Figure 1. Map of the distribution of the genus *Pachymatisma*. Main source: world porifera database (de Voogd et al. 2024) and Cárdenas et al. (2007). The red star indicates the new report by the present study.

Central Mediterranean), extends along the western side from the Saccione river mouth (Italy, lat. 41°55′N–long. 15°08′E) to the Cape of Otranto (Italy, lat. 40°04′N–lon. 18°29′E) and along the eastern side from the Croatia–Montenegro border (lat. 42°24′N–lon. 18°32′E) to the Albania–Greece border (lat. 39°52′N–lon. 19°58′E) (Ceriola et al. 2008).

The Southern Adriatic shows substantial differences between its Southern and Northern portions. In the first, the isobaths are close together, and the depth of 200 m is reached only 8 miles from Capo d'Otranto; in the second, the Gulf of Manfredonia is located with a wide continental shelf and a shallow slope. Here, inputs of nutrient-rich material from rivers flowing from the north towards the south of the Gargano (Fortore River, Saccione torrent) greatly influence the nature of marine sediments and existing benthic communities. On the continental shelf, the bottom is shallow and almost exclusively sedimentary. As the distance from the coast increases and the slow waning of the bottom, together with the reduced hydrodynamics, the mud increases, favoring the establishment of muddy sand communities (Lembo & Spedicato 2011).

Sampling

The trawl surveys Mediterranean International Bottom Trawls Survey (MEDITS) was carried out every year in the context of the Data Collection Framework (European Commission Regulations 1004/2017) in all EU countries including in the Southern Adriatic Sea (GSA18 sensu FAO-General Fisheries Commission for the Mediterranean) (AAVV 2017; Spedicato et al. 2019). Although the MEDITS purpose is to collect data on the abundance and distribution of certain commercial species, in recent years the survey was used as a useful occasion to collect data also on the benthos community. Even though the trawl net is not the best sampler for a quantitative analysis of benthic biocoenosis and it is only limited to trawlable grounds, it can still be useful for qualitative assessments and spatial analyses on wider study areas than those traditionally sampled for epibenthic communities (Fernandez-Arcaya et al. 2019; Carbonara et al. 2020, 2022).

In August 2023, using bottom trawls (with a vertical and wing opening of 21 m and 194 m, respectively), the sample was collected in a station at 228 m depth, at a sea temperature of 13.8°C, located about 55 km off the Gargano promontory (Southern Italy, Apulia – 41°55′18.0″ N 16°49′48.6″ E) (Figure 2). The total weight and the number of individuals were recorded, and then the samples were frozen.

Analysis

To obtain skeletal elements of the sponge (spicules), slides were prepared using the protocol suggested by Hooper (2000). Spicules were observed and measured with an optical microscope. For each type, 25 random spicules were measured (except for the triaenes since cladomes were often broken) and dimensions were reported as minimum – *mean* – maximum. The spicules were also observed in a scanning electronic microscope (SEM - HITACHI TM3000 Tabletop). The terminology applied for the morphological description of the spicules follows Łukowiak et al. (2022). The taxonomic identification of sponge specimens was conducted using "Systema Porifera" (Hooper & Van Soest 2002) and all available literature. Other taxa were identified at the lowest possible taxonomic level to obtain information about biocenosis (Pérès & Picard 1964).

Results

Taxonomic account

Class DEMOSPONGIAE Sollas, 1885

Order TETRACTINELLIDA Marshall, 1876

Family GEODIIDAE Gray, 1867

Genus *Pachymatisma* Bowerbank in Johnston, 1842

Pachymatisma johnstonia (Bowerbank in Johnston, 1842)
(Figures 3, 4)

Morphology

The specimen is hard, irregular massive, with a maximum diameter of 12 cm and a weight of

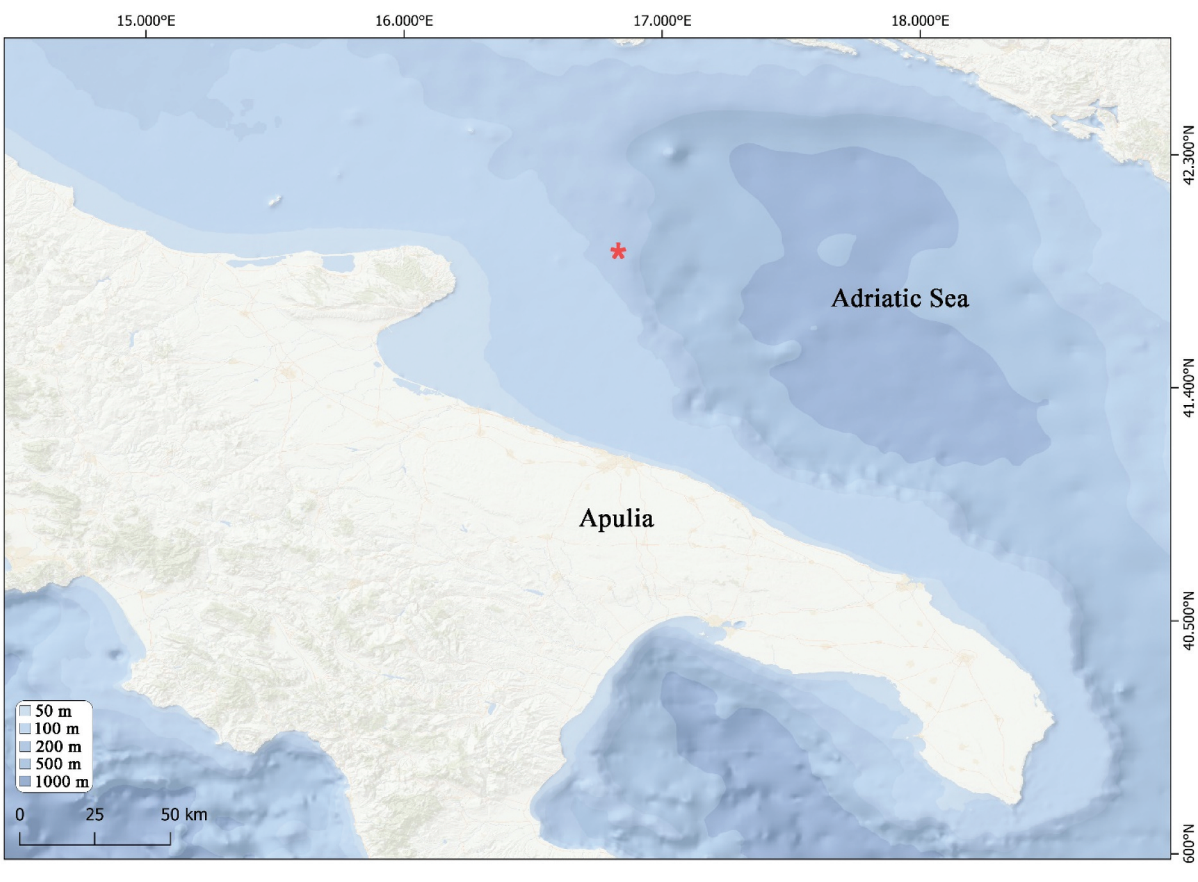

Figure 2. Details of the location of the sampling site.

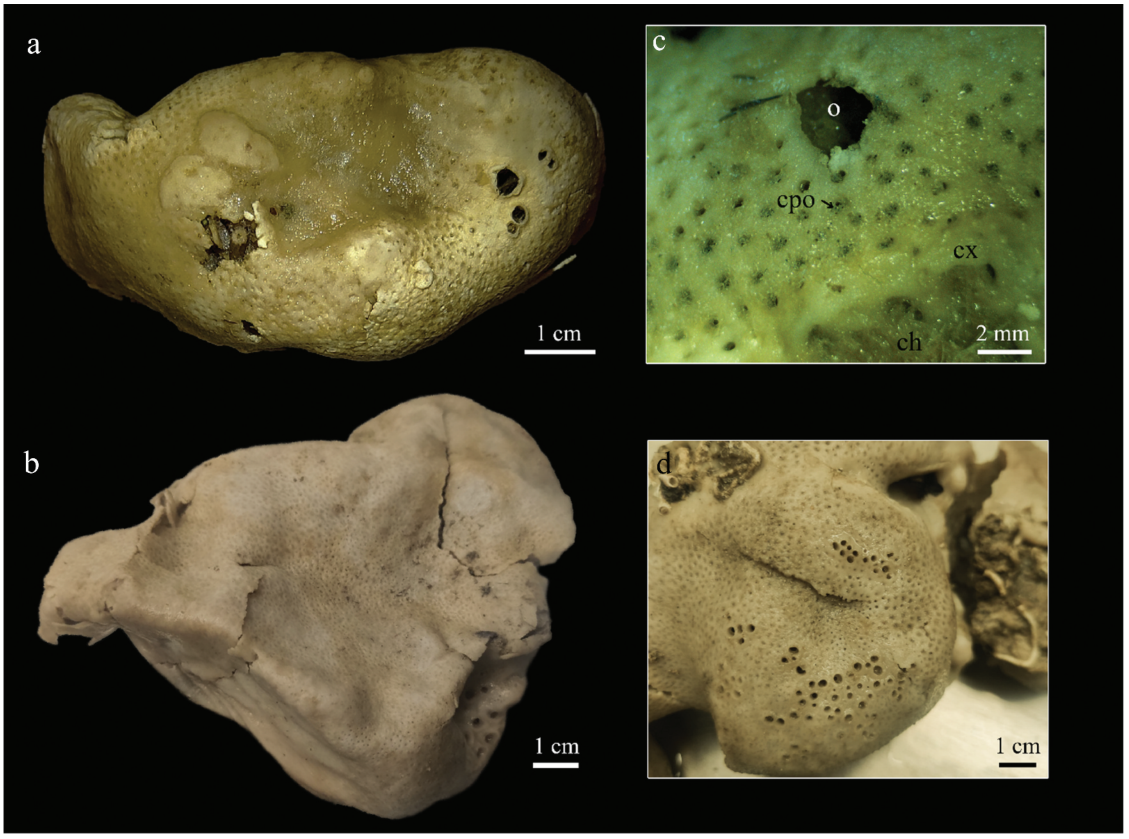

Figure 3. a, b – different views of the specimen of *Pachymatisma johnstonia* collected off the coast of Gargano; c - details of *P. johnstonia*. o = osculum; cpo = cribriporal ostia; cx = cortex; ch = choanosome; d – oscules along the edges of the specimen.

300 g. The surface is covered with small, flattened nodular bumps and outgrowths. The conspicuous tough cortex, thick from 0.47 to 0.95 mm, is whitish and poorly attached to the choanosoma. This latter was yellowish with a compressible texture and was very spiculose. Colors of the cortex and choanosoma refer to the sample seen after freezing. The oscules range from 1 to 3 mm and cribriporal ostia were frequent (Figure 3).

Spicules

Megasclere. Strongyles are straight or bent and oxeas are rather rare, ranging 420 − *796* − 984 × 12− *14.9* − 21.6 µm; orthotriaenes are not frequently present with clads ranging 252 − *297.6* − 348 µm. Microsclere. Spiny microrhabds, sometimes centrotylote or with a larger width at one end, ranging 12 − *19.8* − 25 × 1.5 − *3* − 5.4 µm; flattened globular or ellipsoidal sterraster, ranging 75 − *104.3* − 135 µm; oxyaster are regular to irregular spiny with 4−11 actines, ranging 27 − *43.7* − 70 µm (Figure 4).

Habitat

The dominant biocenosis is the bathyal muds (VB). The characteristic species of this biocenosis found in the haul include the echinoderms *Gracilechinus acutus* (Lamarck, 1816), *Odontaster mediterraneus* (von Marenzeller, 1893), the mollusc *Scaphander lignarius* (Linnaeus, 1758), and the crustacean *Parapenaeus longirostris* (Lucas, 1846). In addition, due to its conspicuous presence, there is a facies of compact muds with the cnidarian *Actinauge richardi* (Marion, 1906). Despite the dominance of VB organisms, the sea urchin *Cidaris cidaris* (Linnaeus, 1758) indicates the presence of biocenosis of the offshore rocky bottoms (RL). The echinoid *Spatangus purpureus*

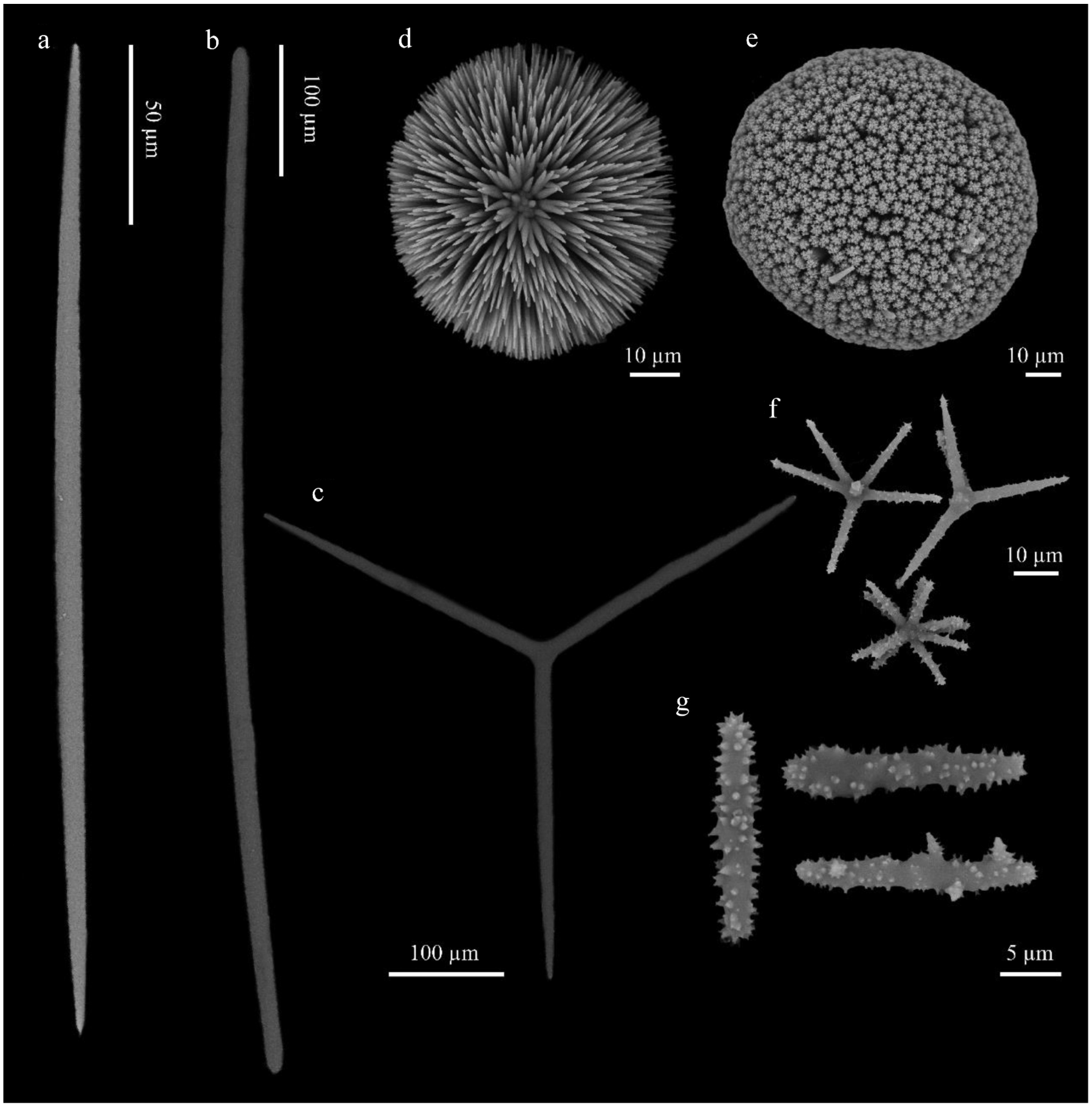

Figure 4. Spicules of *P. johnstonia*: a - oxea, b - strongyle, c - cladome of orthotriaene, d - immature sterraster, e - sterraster, f - oxyasters, and g - microrhabds.

O.F. Müller, 1776 suggests currents near the bottom. Lastly, the existence of muddy facies (VTC) interspersed with or surrounded by RL can be assumed in this station.

Remarks

P. johnstonia is often confused with *P. normani*. However, in *P. johnstonia*, sterrasters measure less than 140 µm in diameter, compared to an overall average of 174.3 µm in *P. normani*. Additionally, the distinctive traits of *P. johnstonia* are strongyles much more abundant than oxeas, and oscula arranged in a line along the edges of oblong ridges (Figure 3) (Cárdenas et al. 2007).

Discussion and conclusion

The MEDITS trawl survey aims to gather data on the distribution, relative abundance, and biological characteristics of commercial fish species. These surveys are particularly valuable for obtaining information on non-commercial invertebrates and bycatch species, where data is often limited (Carbonara et al. 2020, 2022; Stamouli et al. 2023). This study demonstrates how

Table I. Comparison of spicule dimensions of *P. johnstonia* specimens from the Mediterranean Sea (Southern Adriatic Sea) and shallow and deep zones of the Atlantic Ocean. Values are expressed as minimum-*mean*-maximum length × width.

Materials	Depth (m)	Cortex thickness (mm)	Strongyles (length × width µm)	Orthotriaene clads (length µm)	Microrhabds (length x width µm)	Sterraster (diameter µm)	Oxyaster (diameter µm)	References
Gargano, Adriatic Sea	228	0.47–*0.7*–0.95	420–*796*–984 × 12–*14.9*–21.6	252–*297.6*–348	12–*19.8*–25 × 1.5–*3*–5.4	75–*104.3*–135	27–*43.7*–70	Present paper
Roscoff, Atlantic Ocean	inter-sub tidal	<1	520–*836.6*–1176 × 10–*17.3*–26	174–*254.7*–328	10–*20.3*–26 × 2–*3.9*–7	82–*104.7*–119	22–63	Cárdenas et al. 2007
Mingulay Reef, Atlantic Ocean	168	1	530–*1059.8*–1330 × 4–*18.3*–25	197–*363.8*–465	16–*23.7*–43 × 3–*4.9*–10	102–*115.5*–130	41–*50.5*–80	Cárdenas et al. 2007

research cruises, initially aimed at studying fish stocks, can be used to expand knowledge of the distribution of sponge fauna in deepwater areas of the Mediterranean Sea.

To date, there was neither morphological nor skeletal element information about the specimens collected in the Mediterranean Sea. The spicule size of the *P. johnstonia* specimen found in the Southern Adriatic Sea overlaps with that of the shallow Atlantic species rather than with deeper specimens collected in the Atlantic Sea (Table I). The seawater silica concentration can plausibly explain these data. Previous research showed a positive correlation between the size of demosponge spicules and the silica concentration of the surrounding water (Mercurio et al. 2000; Bertolino et al. 2017). In the central-southern Adriatic Sea, the silicate decreases from the coastal area towards the open sea (Baric et al. 2002).

The present record updates the distributional range of this species in the Mediterranean Sea. It represents the first record for the Southern Adriatic Sea (Figure 1).

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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