

The non-indigenous and invasive species *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004 (Porifera: Calcarea) in the Algerian coast (Southwestern of Mediterranean Sea)

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The non-indigenous and invasive calcareous sponge Paraleucilla magna Klautau, Monteiro & Borojevic, 2004 has been detected for the first time on the Algerian coast. The species has been recorded at high abundance in Algiers Port (Algiers) and in Pisan Island (Béjaïa) during spring 2018. It was present from 2 m to 20 m of depth at the community of seaweeds with filter feeders established on artificial hard substrates and on rocky boulders. Total of 172 individuals were recorded not exceeding 5 cm in height. Anthropogenic activities such as aquaculture farms or shipping traffic might be important vectors or act as stepping-stones in further expansion of Paraleucilla magna. Additional recording of the species adds to the knowledge of its biogeography distribution, biology and ecology in the Mediterranean and may improve selection of key geographical sites for future monitoring on the species proliferation and expansion.

Key words: *Paraleucilla magna*, non-indigenous species, invasive species, Algerian coast

INTRODUCTION

The Mediterranean Sea is a hotspot for marine biodiversity (COLL, 2010), but it also is one of the most important marine NIS hotspots in the world (OCCHIPINTI-AMBROGI, 2000).

Paraleucilla magna has recently been recorded along the Brazilian coast (Rio de Janeiro),

where it was considered cryptogenic and it is one of the most abundant calcareous sponges in the area (KLAUTAU *et al.*, 2004; LANNA *et al.*, 2014). The species was firstly discovered in the Mediterranean Sea in the Mar Piccolo of Taranto (north-western Ionian Sea, southern Italy) and then in other close localities of South Italy: Porto Cesareo (north-western Ionian Sea), port

of Brindisi (southern Adriatic Sea) and Naples harbour (central Tyrrhenian Sea) attached to mussel rows and several artificial substrates (LONGO *et al.*, 2007). It was also recorded in the central Mediterranean Sea: Malta (Marsaxlokk Bay) (ZAMMIT *et al.*, 2009), Spain (FROTSCHER *et al.*, 2008; GUARDIOLA *et al.*, 2011), Adriatic Sea Ploče harbor (CVITKOVIĆ *et al.*, 2013) and Brač Island in Croatia (KLAUTAU *et al.*, 2016), Gulf of Olbia in Italy (BALDACCONI *et al.*, 2013), Portugal, Madeira and Acores (GUARDIOLA *et al.*, 2016), sea of Marmara in Turkey (TOPALOGLU *et al.*, 2016) and Tivat in Montenegro (MAČIĆ *et al.*, 2016).

P.magna populations mainly live within habitats enriched in suspended organic material (eutrophic environment), close to sea farms, harbours, and river mouths. Its presence next to those areas and its continuous spreading drew attention to its potential invasive character. In Mediterranean Sea, *P.magna* is considered as an invasive species (LONGO *et al.*, 2007; ZAMMIT *et al.*, 2009; LANNA *et al.*, 2014; GUARDIOLA *et al.*, 2016). Therefore, the aim of this study was to enrich knowledge about the biogeography distribution of this species in Mediterranean Sea and set a baseline for future monitoring of its spreading.

MATERIAL AND METHODS

Study area

Specimens *Paraleucilla magna* was counted in two different localities along of the Algerian coast southwestern Mediterranean Sea (Fig.1) in spring 2018 during a sampling campaign to carry out an inventory of marine biodiversity. The first sampling site was the Algiers Port (AP) (36°45'52"N; 3°4'9"E) located in the Algerian capital, centre of the Algerian coast, which represents one of the most important industrial and commercial Mediterranean harbour. The samples were obtained along the port out pier composed of artificial boulders and influenced by a moderated turbidity due to the muddy nature of sediment. The second site, located in Béjaïa at 200 km eastern from the first sampling site, was Pisan Island (PI) (36°49'31"N; 4°59'51"E). It is a natural area far away from anthropogenic discharges and exposed to offshore currents.

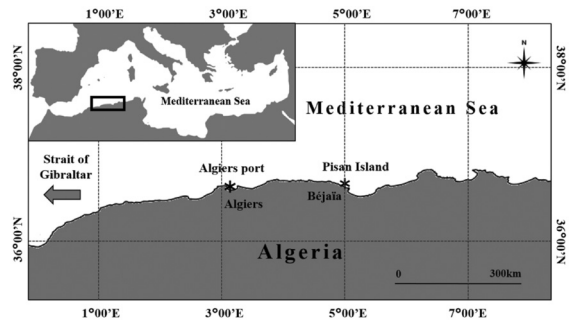


Fig. 1. Record location of *Paraleucilla magna* at Algiers port, Algiers centre and Pisan Island, Béjaïa, Algeria

Sampling methodology

A total of 40 underwater transects have been sampled (20 each site) at depths ranging between 2 - 20 m according to a stratified strategy, from which transects have been placed randomly. Data were collected in underwater visual census (UVC) by SCUBA divers according to the Belt transect method (HILL *et al.*, 2004) in transects 50 m long and 4 m wide using a multidecameter placed on the bottom (i.e. a prospecting area of 200m² per transect). Two divers counted simultaneously the number of individuals at each side of the metric belt. The size (highest point \pm 1 cm) of each individual was measured (using a rule reported on the PVC counting board). Collected specimens were fixed in 5% formaldehyde solution in seawater. The identification was performed on basis of spicule morphology (KLAUTAU *et al.*, 2004; LONGO *et al.*, 2007).

Data analysis

For each site, abundance (number of individuals per 200 m²), height (cm), mean and standard error (\pm SE) were computed. A multivariate analysis of the variance based on permutation test (permutations=999) (PERMANOVA) with two factors (Locality = (Lo): fixed, Depth range = (De): fixed) was carried out using PRIMER-E software (CLARKE *et al.*, 2006) with PERMANOVA+ package (ANDERSON *et al.*, 2008) in order to determine the differences in abundance and height of individuals between localities (Lo = Algiers port, AP; Pisan Island, PI) and depth ranges (De = First depth range FDR: 0-10 m;

Table 1. Results of PERMANOVA (two factors) for abundance (ind./200m²) and the height of individuals (cm). Locality = Lo, fixed (Algiers port, AP; Pisan Island, PI), Depth range = De, fixed (First depth range, FDR; Second depth range, SDR). Values in bold indicate a significant effect

Source	Abundance				Height			
	df	MS	Pseudo-F	P(perm)	df	MS	Pseudo-F	P(perm)
Locality, Lo	1	0.35679	10.748	0.003	1	33.415	55.123	0.001
Depth range, De	1	0.29363	8.8457	0.007	1	12.763	21.054	0.001
Lo x De	1	9.66E-2	2.912	0.085	1	3.1451	5.1882	0.023
Residual	36	3.32E-2			168	0.6062		
Total	39				171			
Transformation	Fourth root				No Lo = AP < PI			
Pair-wise test	Lo : AP > PI De : FDR > SDR				FDR = AP < PI; SDR = AP < PI Lo x De: AP = FDR < SDR; PI = FDR < SDR			

Second depth range SDR: 10- 20 m). Pair wise tests were applied to analyze differences between groups.

RESULTS

Populations of *P. magna* were found at the community of seaweeds with filter feeders (particularly Hydrozoa), established on artificial hard substrates (AP) and on rocky boulders (PI). Individuals were recorded at depths ranging between 2 and 20 m, but the highest individual abundance was found between 2 and 12 m under moderate turbidity conditions. A total of 172 individuals has been recorded, from which 140 has been observed in AP (MEAN±SE = 7±1.68 ind./200m²) and 32 in PI (MEAN±SE = 1.6 ± 0.98 ind./200m²). The individuals did not exceed 5 cm in height and the mean height varied from 2.25 ± 0.06 cm in AP to 3.44 ± 0.18 cm in PI.

Population abundance analyzed with PERMANOVA showed significant differences between localities (Lo: AP > PI) and depth ranges (De: FDR > SDR) ($P < 0.05$). Individuals height showed a very significant differences between localities (Lo: AP < PI) and depth range (FDR = AP < PI; SDR = AP < PI) ($P < 0.001$) and a significant difference for interaction Lo x De (AP = FDR < SDR; PI = FDR < SDR ($P < 0.05$) by Main Wise Test (Table 1).

The sponge showed different morphologies ranging from tubular for small individuals to

irregular shape for the largest one. It was friable, and fragile in appearance. The Color varied from white-cream to yellowish. The surface was smooth and seems to glitter underwater. The specimens were easy detachable from the substrate.

DISCUSSION

The finding of *Paraleucilla magna* at the center of Algiers coast represents the first record of this species in southwestern Mediterranean Sea. According to LONGO *et al.* (2007, 2012), the most probable vectors responsible for the recent expansion of this sponge along west Mediterranean coasts is bivalve farming and shipping traffic. The presence of the sponge in Algerian aquaculture farms had not yet been reported, pointing to farms as entrance vectors. Nevertheless, given the fast species spread and growth, aquaculture farms could act as “stepping stone” to colonize other areas.

P. magna observed underwater, shows different abundances depending on the study area, transect sampled and depth range. In AP, the species was more abundant in transects located at the exposed side of the dike than the sheltered side, whereas in PI, the individuals were more scattered, confirming that the species tend to be more abundant in eutrophic environments as reported previously (LONGO *et al.*, 2007; ZAMMIT *et al.*, 2009; GUARDIOLA *et al.*, 2016). Depth range

seems has an impact on the vertical distribution of the species, which is more abundant in the first ten meters. The species abundance found in the present study is lower than the mean value reported for other areas. However, sampling season and habitat conditions (temperature and primary production, eutrophication) are important factors that seems to determine the species abundance (LONGO *et al.*, 2007). According to LONGO *et al.* (2007) and KLAUTAU *et al.* (2004), *P. magna* shows a wide temporal variation in biomass with peaks during the autumn and early winter, whereas the species populations decline or disappear in winter and summer. Conversely, in western Mediterranean, the species reproduces in winter-spring and autumn concomitantly with peaks of primary production and temperature ranging between 14°C (March) and 21°C (June) (GUARDIOLA *et al.*, 2016). According to the latter authors, *P. magna* populations that form part of fouling assemblages and are subjected to eutrophic conditions, reproduced continuously along the year, while those established in native assemblages under non-eutrophic conditions were clearly seasonal and disappeared after reproduction.

The invasive character of the sponge has been highlighted by its abundance in AP and by its competition with native biodiversity in PI. Indeed, the sponge has been observed colonizing ascidian (*Didemnum* sp.) and competing for the space with the Hexacorallia *Astroides calycularis* (an endemic, protected Mediterranean species). GUARDIOLA *et al.* (2016) reported that, under favourable trophic circumstances, the species might overgrow native seaweeds (e.g. *Halopteris scoparia*) and filter-feeder invertebrates.

The results of the present study add to those obtained by other authors around the Mediterranean about the distribution, the biology, the ecology of *P. magna* and its threaten for the marine biodiversity, habitat sustainability, and ecosystems functioning. The presence of this species in natural and artificial environments along the Algerian coast suggests its probable invasion of most marinas along the Mediterranean Sea in the near future. The present study set a baseline for future research for spatial and temporal distribution of this species and its interaction with the native biota. Management measures must be undertaken to control the ecological and socio-economic impact of this newly introduced species.

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Nezavičajna i invazivna vrsta *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004 (Porifera: Calcarea) uz Alžirsku obalu (jugozapadno Sredozemlje)

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SAŽETAK

Nezavičajna i invazivna karbonatna spužva *Paraleucilla magna* Klautau, Monteiro i Borojević, 2004, prvi put je otkrivena na alžirskoj obali. Vrsta je zabilježena u velikom broju u luci Alžir (Alžir) i na otoku Pisan (Béjaïa) tijekom proljeća 2018. godine. Prisutna je na dubini od 2 m do 20 m u zajednici morskih algi s filtarskim hranilicama postavljenim na umjetnim tvrdim podlogama i na velikim stijenama. Ukupno su zabilježene 172 jedinke koje ne prelaze 5 cm visine. Antropogene aktivnosti kao što su farme akvakulture ili pomorski promet mogu biti važni vektori ili djelovati kao potporni korak u daljnjem širenju *Paraleucilla magna*. Dodatno bilježenje vrste doprinosi poznavanju njegove bio-geografske distribucije, biologije i ekologije u Sredozemlju, te može poboljšati odabir ključnih geografskih mjesta za buduće praćenje proliferacije i širenja vrste.

Ključne riječi: *Paraleucilla magna*, nezavičajne vrste, invazivne vrste, alžirska obala