

Occurrence of *Paraleucilla magna* (Porifera: Calcarea) in the eastern Adriatic Sea

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*The paper presents the first record of non-indigenous calcareous sponge *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004 in the area of the eastern Adriatic coast. The species was observed in the central Adriatic Sea in the area of Ploče harbour (international maritime transport) in 2011. It was present at depth from 0.5 m to 7 m in fouling community of photophilic algae and filter feeders. Maximal recorded abundance of this sponge was 4-5 N m⁻² in the autumn. Collected data are the base for future monitoring of sponge's spreading in the area of the eastern Adriatic coast.*

Key words: *Paraleucilla magna*, non-indigenous species, Adriatic Sea

INTRODUCTION

One of the main threats to biodiversity in marine ecosystems is introduction, establishing and spreading of non-indigenous (allochthonous) species. In the last decades in the Adriatic Sea, semi-enclosed part of the Mediterranean Sea, numerous non-indigenous species such as algae, invertebrates and fishes, were recorded (DESPALATOVIĆ *et al.*, 2008; DRAGIČEVIĆ & DULČIĆ 2010; OCCHIPINTI-AMBROGI, 2011), and according to recent review, 190 non-indigenous species were noted in the Adriatic Sea (ZENETOS *et al.*, 2012). Non-native species entered in the Mediterranean Sea by different pathways: through Suez Canal, by shipping and mariculture (GALIL, 2008). Whereas shipping is recognised as a powerful mean of introduction in the Adriatic Sea (GALIL, 2008), baseline survey with the aim to identify non-indigenous species in Croatian harbours was performed in 2011, in the harbours of Split and Ploče.

Calcareous sponge *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004 was for the first time recorded in the Mediterranean Sea in 2001 in the area of the north-western Ionian Sea (Mar Piccolo and Mar Grande of Taranto) (LONGO *et al.*, 2004). Additional records, regard to Italian coast, are from Porto Cesareo also in the north-western Ionian Sea, from the port of Naples in the central Tyrrhenian Sea and from the port of Brindisi in the southern Adriatic Sea (LONGO *et al.*, 2007). The species was also recorded in the central Mediterranean Sea in Malta (Marsaxlokk Bay) (ZAMMIT *et al.*, 2009), and along north-western coast of the West Basin and north-east of the Iberian Peninsula (ZAMMIT *et al.*, 2009; GUARDIOLA *et al.*, 2012).

Beside the records in the Mediterranean Sea, *P. magna* was described from the Brazilian coast in the Atlantic Ocean, where it is the most abundant calcareous sponge (KLATAU *et al.*, 2004).

The life-cycle of this sponge has been investigated in the area of Brazilian coast in the Atlan-

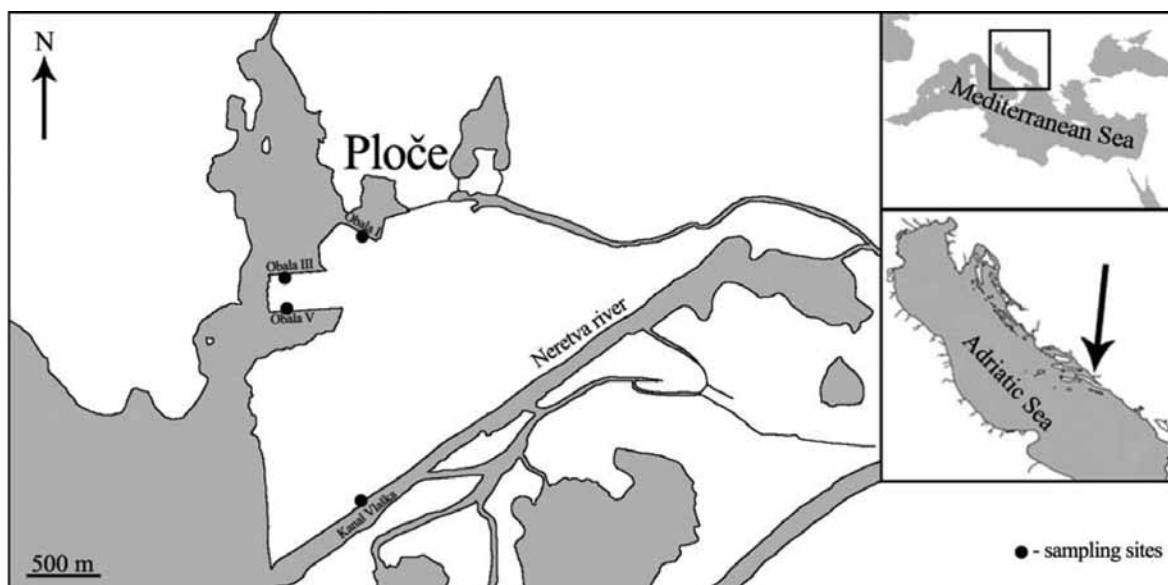


Fig. 1. Sampling sites: investigated terminals, Obala I, Obala III, Obala V and Kanal Vlaška, in the harbour of Ploče in the eastern Adriatic Sea, Croatia (43°02'53" N; 17°25'33" E)

tic Ocean (LANNA *et al.*, 2007; LANNA & KLAUTAU, 2010) and in the area of the southern Italy, in the Ionian Sea in the Mediterranean Basin (LONGO *et al.*, 2012). Additionally, genetic structure and differentiation of this calcarean sponge was investigated in the area of the western Mediterranean Sea (GUARDIOLA *et al.*, 2012); and its recruitment (PADUA *et al.*, 2012a) and macrofauna associated with this sponge in the area of Rio de Janeiro in the Atlantic Ocean (PADUA *et al.*, 2012b).

Paraleucilla magna is considered as an invasive species in a semi-enclosed basin of the Mediterranean Sea (LONGO *et al.*, 2007), and the aim of this study was to investigate population of this sponge in the area of Ploče harbour as a base for future monitoring of its spreading.

MATERIAL AND METHODS

Samples of the sponge were collected during biological baseline survey in harbour of Ploče (43°02'53" N; 17°25'33" E), important Croatian harbour for international maritime transport, in June and October 2011, and December 2012. Samplings were performed in the area of four terminals in the harbour: Kanal Vlaška, Obala I, Obala III and Obala V (Fig. 1).

The collection of samples was based on

CRIMP protocol (HEWITT & MARTIN, 1996, 2001). Samples were collected from three transects on each terminal, from concrete vertical walls, 15 m apart from each other, at depths of 0.5 m, 3 m and 7 m (Fig. 1). All sampling areas were photographed before scraping.

Collected specimens were fixed in 5% formaldehyde solution in seawater and then preserved in 70% ethanol.

Identification of the collected *Paraleucilla magna* was based on spicule morphology and skeletal architecture according to LONGO *et al.* (2007).

RESULTS

Identification of collected *Paraleucilla magna* in the harbour of Ploče was confirmed by examination based on skeletal architecture and on spicule morphology (Fig. 2). Two types of spicules were found: triactines and tetractines.

The measures of triactines (N=25) were: length of the paired actines ranged from 136–409 μm (mean \pm SD: 296 \pm 69 μm), length of the unpaired ranged from 99–434 (mean \pm SD: 217 \pm 94 μm), and thickness of the actine at its base ranged from 15–50 μm (mean \pm SD: 27 \pm 7 μm).

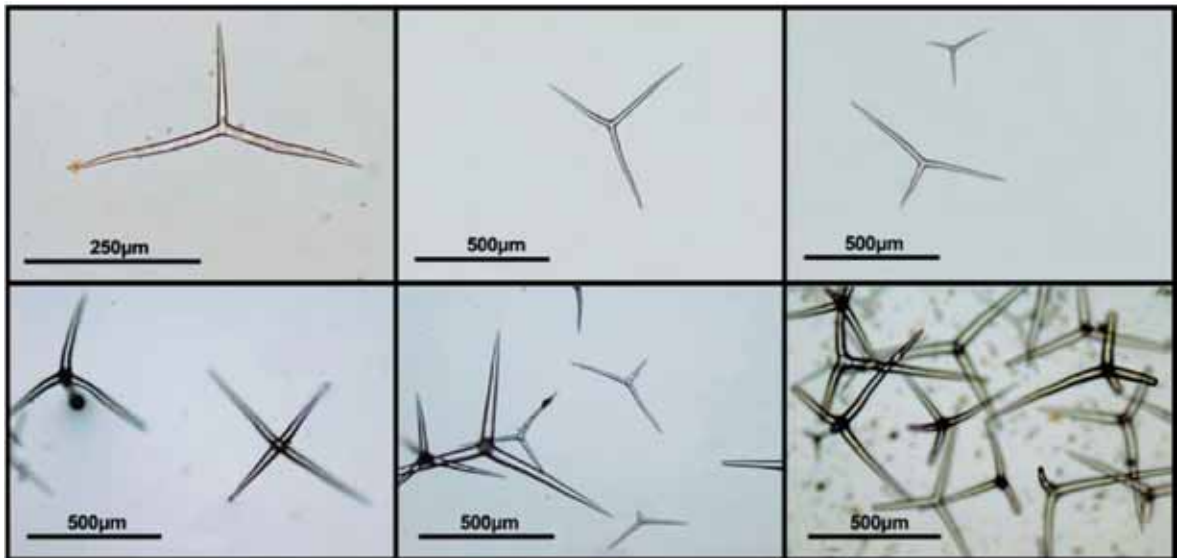


Fig. 2. Triactine and tetractine found in skeleton of *Paraleucilla magna* collected in the harbour of Ploče in the eastern Adriatic Sea

The measures of tetractines (N=25) were: length of the apical actines ranged from 62–645 μm (mean \pm SD: 384 \pm 149 μm), length of basal ones ranged from 192–645 μm (mean \pm SD: 412 \pm 100 μm), and thickness of the actine at its base ranged from 22–95 μm (mean \pm SD: 49 \pm 15 μm).

The collected specimens were of different morphologies that varied from tubular to irregular massive shapes, and the colour was white-cream (Fig. 3). The size of collected specimens varied from 1 to 7 cm in height.

In June 2011 only one specimen of *P. magna*



Fig. 3. *Paraleucilla magna* in the fouling benthic community in the harbour of Ploče in the eastern Adriatic Sea

was recorded on terminal Obala III at depth of 7 m in community of photophilic algae and filter feeders.

In October 2011 species was observed in the area of three terminals, Obala I, Obala III and Obala V, at depths from 0.5 m to 7 m (Fig. 1). It was the most abundant in the area of terminal Obala III at depths from 0.5 m to 3 m, where maximal recorded abundance of the species was 4-5 N m⁻². In the area of terminal Kanal Vlaška the species was not observed.

In December 2012 the sponge *P. magna* was not found in the harbour area.

Beside *P. magna*, 62 species of macrobenthic invertebrates were recorded inside the harbour. The highest number of invertebrate species was recorded at 3 m of depth. In the fouling community at terminals where *P. magna* was recorded the dominance of bivalves *Mytilus galloprovincialis* Lamarck, 1819, *Mytilaster minimus* (Poli, 1795), *Ostrea edulis* Linnaeus, 1758 and *Arca noae* Linnaeus, 1758 was observed, but very abundant were also tunicates *Microcosmus* sp., *Halocynthia papillosa* (Linnaeus, 1767) and *Phallusia fumigata* (Grube, 1864). Additionally, scleractinian coral *Cladocora caespitosa* (Linnaeus, 1767) was sporadically abundant on harbour's walls. Beside *P. magna*, four other sponges were recorded inside the harbour: *Cliona celata* Grant, 1826, *Ircinia variabilis* (Schmidt, 1862), *Sycon raphanus* Schmidt, 1862 and *Tethya aurantium* (Pallas, 1766).

DISCUSSION

The finding of *Paraleucilla magna* in the harbour of Ploče on the eastern Adriatic coast is the second record of this species in the Adriatic Sea. Previously, species was recorded only in the port of Brindisi in the southernmost part of the western Adriatic coast (LONGO *et al.*, 2007). During the last decades many areas of the eastern Adriatic coast were investigated for the purposes of scientific investigations of benthic communities or monitoring projects, but this conspicuous species has never been observed or collected.

The composition of benthic communities in harbours in the central and southern Adri-

atic Sea were not investigated before baseline investigation in harbours of Ploče and Split carried out in 2011, when *P. magna* was observed. This non-indigenous sponge was found only in the harbour of Ploče but due to the lack of any historical data about species composition in that area, the time of introduction can not be estimated with certainty.

The harbour of Ploče, situated in the area of Neretva River Delta, is eutrophic environment with low water movement and it conforms to environments that are described as favourable for colonisation of this sponge (LONGO *et al.*, 2007). *Paraleucilla magna* was found in fouling community on concrete walls of the harbour, where ships continuously disembark and embark cargo, from very shallow water (0.5 m) to around 7 m of depth. In the area of previous records in the Mediterranean Sea the species also occurred in shallow depths, e.g. on fouling community on surface buoys, down to 10 m depth (LONGO *et al.*, 2007; ZAMMIT *et al.*, 2009). In the area of Ploče harbour *P. magna* was observed on all terminals except terminal Kanal Vlaška, which is separated from the others and under the greatest influence of river which suggests that this sponge can not survive in waters of very low salinity.

Recorded abundance of the species in the harbour of Ploče was greatest in autumn (October 2011), but the time of species disappearance in that year was not recorded. In the successive year, 2012, complete disappearance of sponge specimens was observed at the end of autumn (December), although it was expected that the species would show its maximal biomass in that period of the year as was the case in the north-western Ionian Sea, where the species shows temporal variations in biomass with peaks during the autumn and early winter (the highest value was recorded in December), and it declines or disappears in winter and summer (LONGO *et al.*, 2007). Since the continuous monitoring of the species was not carried out, it is impossible to estimate the exact time of species disappearance, but the hydrological conditions (especially temperature) vary from year to year so the differences in time of disappearance on

month scale are reasonable. On the other hand, time of the species disappearance in the harbour of Ploče agrees with KLAUTAU *et al.* (2004) who indicated that *P. magna* in the area of Brazil (Rio de Janeiro State) shows strong seasonality, disappearing in autumn.

The area of harbour of Ploče is affected by international shipping traffic and in that way vulnerable for colonisation of non-indigenous species, as was the case of introduction of invasive tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923), probably introduced as ship fouling, and that invaded surrounding areas in Neretva River Delta (CUKROV *et al.*, 2010). Also, shipping traffic may be considered as the most probable way of introduction of *P. magna* in this harbour. Beside shipping traffic, aquaculture (bivalve farming) may be considered as a vector of spreading of this species (LONGO *et al.*, 2007). Consequently, bivalve farms that are present on many locations along the eastern Adriatic coast could be endangered. Until now, presence of this non-indigenous sponge was not observed or reported by farmers as was the case with mussel farms in the area of the north-western Ionian Sea (LONGO *et al.*, 2007). In the fouling community in the harbour of Ploče mussel *Mytilus galloprovincialis* was very abundant species, even dominated on

shallow depth (up to 0.5 m), but the presence of sponge attached on mussel shells was observed only sporadically, contrary to findings in the Mar Piccolo of Taranto where it was recorded that *P. magna* selects mussel shells among the available hard substrata (LONGO *et al.*, 2007).

Paraleucilla magna is the first non-indigenous sponge recorded in the area of the eastern Adriatic coast. Since the species shows its invasive character along the Italian coast by rapidly extending its range with the ability to colonize different environments with high abundance (LONGO *et al.*, 2007), we can expect the same scenario along the coast of the eastern Adriatic. Particular focus, apart from harbours, should be on mussel farms, which were confirmed as endangered points for species colonisation.

ACKNOWLEDGEMENTS

The data were collected within the framework of Biological baseline survey in Croatian ports founded by Ministry of maritime affairs, transport and infrastructure, carried out in 2011, and Biodiversity of benthos in the middle Adriatic Sea (Croatian Ministry of Science, Education and Sports, grant no. 001-0000000-3203) project.

REFERENCES

- CUKROV, M., M. DESPALATOVIĆ, A. ŽULJEVIĆ & N. CUKROV. 2010. First record of the introduced fouling tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923) in the eastern Adriatic Sea, Croatia. *Rapp. Comm. int. Mer Médit.*, 39: 483-483.
- DESPALATOVIĆ, M., I. GRUBELIĆ, V. NIKOLIĆ, B. DRAGIČEVIĆ, J. DULČIĆ, A. ŽULJEVIĆ, I. CVITKOVIĆ & B. ANTOLIĆ. 2008. Allochthonous warm water species in the benthic communities in the eastern part of the Adriatic Sea. In: F. Briand (Editor). *Climate warming and related changes in Mediterranean marine biota*. CIESM Workshop Monographs, 35: 51-57.
- DRAGIČEVIĆ, B. & J. DULČIĆ. 2010. Fish Invasions in the Adriatic Sea. In: D. Golani and B. Appelbaum-Golani (Editors). *Fish invasions of the Mediterranean Sea: change and renewal*. Pensoft Publishers, Sofia-Moscow, pp. 255-266.
- GALIL, B.S. 2008. Alien species in the Mediterranean Sea – which, when, where, why? *Hydrobiologia*, 606: 105-116.
- GUARDIOLA, M., J. FROTSCHER & M.J. URIZ. 2012. Genetic structure and differentiation at a short-time scale of the introduced calcarean sponge *Paraleucilla magna* to the western Mediterranean. *Hydrobiologia*, 687: 71-84.
- HEWITT, C.L. & R.B. MARTIN. 1996. Port surveys for introduced marine species – background considerations and sampling protocols.

- CRIMP Tec. Rep. No 4. CSIRO Division of Fisheries, Hobart, 40 pp.
- HEWITT, C.L. & R.B. MARTIN. 2001. Revised protocols for baseline port surveys for introduced marine species: survey design, sampling protocols and specimen handling. CRIMP Tec. Rep. No 22. CSIRO Division of Fisheries, Hobart, 46 pp.
- KLAUTAU, M., L. MONTEIRO & R. BOROJEVIC. 2004. First occurrence of the genus *Paraleucilla* (Calcarea, Porifera) in the Atlantic Ocean: *P. magna* sp. nov. *Zootaxa*, 710: 1-8.
- LANNA, E., L.C. MONTEIRO & M. KLAUTAU. 2007. Life cycle of *Paraleucilla magna* Klautau, Monteiro and Borojevic, 2004 (Porifera, Calcarea). In: M.R. Custódio, G. Lôbo-Hajdu, E. Hajdu and G. Muricy (Editors). *Porifera Research: Biodiversity, Innovation and Sustainability*. Série Livros 28, Museu Nacional, Rio de Janeiro, pp. 413-418.
- LANNA, E. & M. KLAUTAU. 2010. Oogenesis and spermatogenesis in *Paraleucilla magna* (Porifera, Calcarea). *Zoomorphology*, 129: 249-261.
- LONGO, C., L. SCALERA-LIACI, M. MANUEL & G. CORRIERO. 2004. Note sui poriferi del Mar Grande e del Mar Piccolo di Taranto (Mar Ionio). *Biol. Mar. Medit.*, 11: 440-443.
- LONGO, C., F. MASTROTOTARO & G. CORRIERO. 2007. Occurrence of *Paraleucilla magna* (Porifera: Calcarea) in the Mediterranean Sea. *J. Mar. Biol. Ass. U. K.*, 87: 1749-1755.
- LONGO, C., C. PONTASSUGLIA, G. CORRIERO & E. GAINO. 2012. Life-Cycle Traits of *Paraleucilla magna*, a Calcareous Sponge Invasive in a Coastal Mediterranean Basin. *PLoS One*, 7(8): e42392.
- OCCHIPINTI-AMBROGI, A., A. MARCHINI, G. CANTONE, A. CASTELLI, C. CHIMENZ, M. CORMACI, C. FROGLIA, G. FURNARI, M.C. GAMBI, G. GIACCONE, A. GIANGRANDE, C. GRAVILI, F. MASTROTOTARO, C. MAZZIOTTI, L. ORSIRELINI & S. PIRAINO. 2011. Alien species along the Italian coasts: an overview. *Biol. Invasions*, 13: 215-237.
- PADUA, A., E. LANNA, C. ZILBERBERG, P.C. DE PAIVA & M. KLAUTAU. 2012a. Recruitment, habitat selection and larval photoresponse of *Paraleucilla magna* (Porifera, Calcarea) in Rio de Janeiro, Brazil. *Mar. Ecol.*, 34: 56-61.
- PADUA, A., E. LANNA & M. KLAUTAU. 2012b. Macrofauna inhabiting the sponge *Paraleucilla magna* (Porifera: Calcarea) in Rio de Janeiro, Brazil. *J. Mar. Biol. Ass. U. K.*, doi.org/10.1017/S0025315412001804.
- ZAMMIT, P.P., C. LONGO & P.J. SCHEMBRI. 2009. Occurrence of *Paraleucilla magna* Klautau et al., 2004 (Porifera: Calcarea) in Malta. *Medit. Mar. Sci.*, 10(2): 135-138.
- ZENETOS, A., S. GOFAS, C. MORRI, A. ROSSO, D. VIOLANTI, J.E. GARCÍA RASO, M.E. ÇINAR, A. ALMOGI-LABIN, A.S. ATES, E. AZZURRO, E. BALLESTEROS, C.N. BIANCHI, M. BILECENOGU, M.C. GAMBI, A. GIANGRANDE, C. GRAVILI, O. HYAMS-KAPHZAN, P.K. KARACHLE, S. KATSANEVAKIS, L. LIPEJ, F. MASTROTOTARO, F. MINEUR, M.A. PANCUCCI-PAPADOPOULOU, A. RAMOS ESPLÁ, C. SALAS, G. SAN MARTÍN, A. SFRISO, N. STREFTARIS & M. VERLAQUE. 2012. Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. *Medit. Mar. Sci.*, 13(2): 328-352.

Received: 18 January 2013

Accepted: 2 May 2013

Pojava vrste *Paraleucilla magna* (Porifera: Calcarea) na području istočnog dijela Jadranskoga mora

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SAŽETAK

Ovaj rad predstavlja prvi nalaz strane vrste spužve vapnenjače *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004 na području istočne obale Jadrana. Vrsta je opažena 2011. godine na području luke Ploče (međunarodni pomorski promet) u srednjem Jadranu. Bila je prisutna na dubini od 0,5 m do 7 m u obraštajnoj zajednici fotofilnih algi i filtratorskih vrsta beskralješnjaka. Najveća zabilježena abundancija ove spužve je bila 4-5 N m⁻² tijekom jeseni. Sakupljeni podaci su osnova za buduće praćenje širenja ove spužve na području istočne obale Jadrana.

Ključne riječi: *Paraleucilla magna*, strane vrste, Jadransko more, prvi nalaz

