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Occurrence of *Hymeniacidon perlevis* (Montagu, 1814) (Porifera, Demospongiae) in Kamil Abduş Lagoon, İstanbul, Turkey

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Abstract
This study was carried out to characterise the sponge fauna of the Turkish Kamil Abduş Lagoon. Only one sponge species (*Hymeniacidon perlevis* (Demospongiae, Halichondriidae) has been observed in alkaline, well oxygenated, polyhaline and high electrical conductivity waters of this shallow lagoon. The presence of this sponge species has been observed along 12 months on the hard substrate. Results showed that Kamil Abduş Lagoon is an important habitat for *Hymeniacidon perlevis*.

Keywords: Kamil Abduş Lagoon, *Hymeniacidon perlevis*, Sponge, İstanbul, Turkey

1. Introduction
Sponges (Porifera) are phylogenetically oldest ancient metazoan animals dating back to the Precambrian era (more than 580 million years ago) [1]. Porifera, or sponges, inhabit diverse aquatic habitats (e.g. marine, brackish and freshwater) [2]. Preferably marine, sponges occur worldwide from the Polar Regions to the tropics [3]. Currently, more than 8.500 valid sponge species are reported in the World Porifera Database (http://www.marinespecies.org/porifera/) and grouped in 25 orders, 128 families and 680 valid genera [4]. *Hymeniacidon perlevis* (Montagu, 1818) is an intertidal sponge. Sponges populate both coastal and deep waters, preferably on hard substrate but also on soft bottoms [5, 6, 7]. Most sponges prefer hard substrate such as rocks, metal or cement port, logs, macrophytes, wood sticks, shell of Mollusca and stones [5, 6].

Lagoons represent suitable environments for sponges, where they are able to colonise a wide range of habitats and substrates [7, 8]. Studies on sponge assemblages of Turkey seas reported a total of 138 sponge species, 82 of which from the Aegean Sea, 75 from the Sea of Marmara, 51 from the Levantine Sea, and 13 species from the Black Sea [9, 10]. Among them, records of *Hymeniacidon perlevis* (Montagu, 1814) date back to the second half of the last century from the Sea of Marmara and Aegean Sea at a depth ranging between 11 and 50 m on hard substrates [11, 12].

In the present paper, the sponge assemblage of the Kamil Abduş Lagoon (north coast of the Sea of Marmara, Turkey) was investigated with the aim to (a) identify and describe the occurring sponges and (b) determine the environmental factors which limit its distribution.

This study was conducted in Kamil Abduş lagoon on the İstanbul coast. *H. perlevis* was also present at one site representing the different habitat such as lagoon, and it was found in one sampling site to near of the sea. The spatial distribution and occurrence of sponge population was observed in only one area.

The sediment structure, water depth, water currents and hydrological regime are important factor to sponges such at least as much physicochemical variables. *H. perlevis* have a huge capacity to adapt and survive in marginal life situations.

2. Materials and Methods
2.1 Study area: Kamil Abduş Lagoon (40°49'47.20"N-29°17'12.80" E) is a small (75.5 ha) coastal lagoon within the Natural and Cultural Reserve (Fig. 1and 2). The depth of this shallow coastal lagoon varies from 30 to 80 cm and can reach a maximum value of 1.3 m. The lagoon is connected to the sea by two small shallow canals (less than 1 m deep). The shallow lagoon, Kamil Abduş, is located on the northern coast (Sea of Marmara) of the Kocaeli Peninsula, and within provincial boundaries of İstanbul (Turkey). The Kamil Abduş lagoon is a natural wetland surrounded by urban settlements.

Fig 1: The sampling location map of the *Hymeniacidon perlevis* collected in this study (Red arrows shows main directions of water stream in lagoon).

Many shipyards continue activities in west coast of the lagoon, resulting in strong anthropogenic pressure.

Fig 2: Kamil Abduş Lagoon (Turkey) sampling site photographs.

2.1 Field study

Four sampling sites were localised in the Kamil Abduş Lagoon during the sampling period, ranging from February 2016 and January 2017 (Fig. 1 and 2).

At each of the four sampling sites, monthly measurements of seven physicochemical variables (water temperature: Tw [ºC]; pH; oxidation-reduction potential: ORP [mV]; dissolved oxygen: DO [mg/L]; percentage of oxygen saturation: Sat [%]; salinity: Sal [‰]; electrical conductivity: EC [µS/cm]; atmospheric pressure: ATP [mbar]) were performed in situ by using electronic probes (WTW 340i multimeter). In addition, at each sampling site water samples for nutrients and Chlorophyll-a determination were collected at a depth of 0.5 m under the water surface by plastic bottles pretreated overnight with 1 M HCl solution and rinsed afterwards twice with redistilled water. Sponges was collected on hard substratum by using a spatula lowered to a depth of 50 cm from the shallow Kamil Abduş lagoon (40°49‘ 58.63- 65” N 29°17‘03.32-77” E- 40°49‘58.22-23”N, 29°17‘03.27- 73”E). The coordinates of the lake were obtained with a Garmin Etrex 12-channel GPS. Morphometric data of the sponge specimens were collected monthly and supported with *in vivo* photographs made by using a Canon digital camera (Fig. 3 and 4).

Fig 3: *In vivo* photographs of *Hymeniacidon perlevis* (Montagu, 1814) specimens in the Kamil Abduş Lagoon.

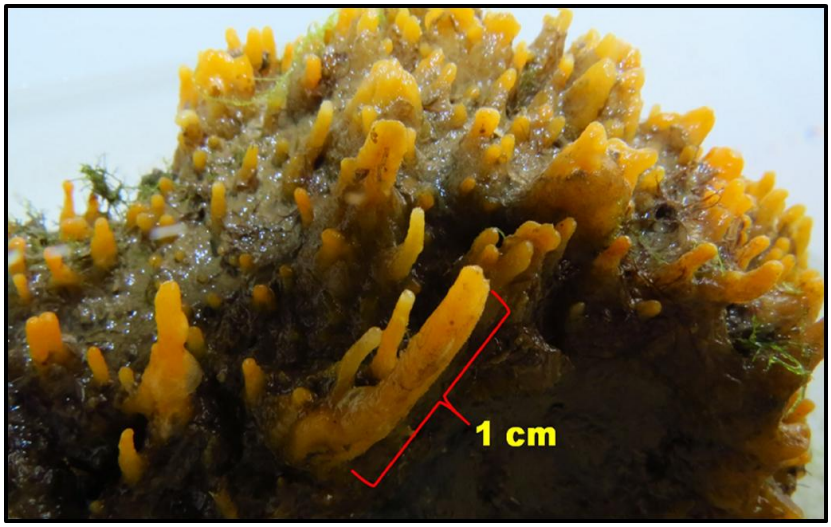

Fig 4: Detail of *Hymeniacidon perlevis* (Montagu, 1814) specimens from Kamil Abduş Lagoon.

2.2 Laboratory study

At the laboratory, water samples were filtered (0.5–1.0 L) using glass microfibre filters (0.45 µm 45/90mm Ø) for the determination of dissolved nutrients (nitrite, N–NO2−, nitrate, N–NO3− and orthophosphate (OP, PO43-) according to APHA [13] and Grasshoff *et al*. [14] methods. Water samples (according to phytoplantonic density 0.5 L or 1.0 L), for chlorophyll a (Chl-a) determinations were filtered through Whatman GF/C glass microfibre filters. Pigments were extracted in the laboratory with 90% acetone and measured according to Vollenweider [15]. Spectrophotometric measurements were performed using a Shimadzu UV-1800 spectrophotometer.

Dissected sponges were examined by light microscope to analyse the skeletal arrangement and the spicule morphotraits. The samples were processed by dissolution of the organic matter in boiling 65% nitric acid, suspended in alcohol and dropped onto slides for a light microscope following standard methods to characterise microtraits of spicules. Spicules measures were taken using an optical microscope with a micrometric eyepiece; at least 25 dimensional measurements were taken from each spicules type. Spicule photographs were taken using a Nikon digital camera DXM-1200 connected to a Nikon Eclipse E600 optical microscope and a personal computer (Fig. 5). Taxonomic decisions refer to the World Porifera Database [16] updated after Morrow & Cárdenas [17].

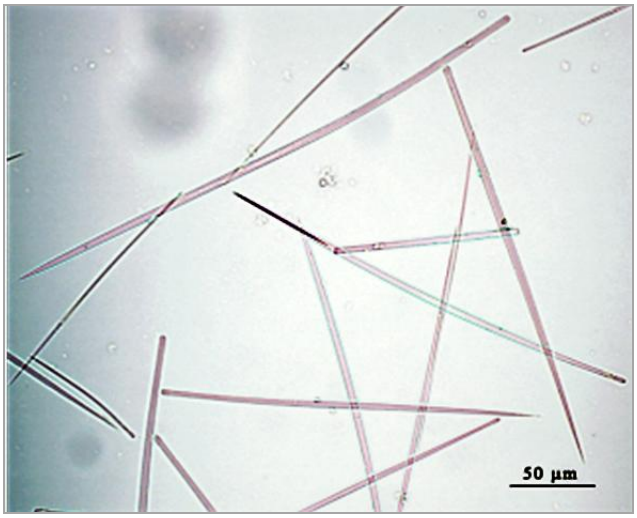

Fig 5: Spicules styles of *Hymeniacidon perlevis* (Montagu, 1814) from Kamil Abduş Lagoon.

3. Results

In the Kamil Abduş Lagoon only the sponge *Hymeniacidon perlevi*s was detected in one of the four sample sites.

Monthly changes of physicochemical variables, nutrients and Chl-a measured at the sampling site of the Kamil Abduş Lagoon where sponges were found, are shown in Table 1 and Fig. 6.

Table 1: Monthly measurements of physicochemical parameters, Chlorophyll-a and nutrients at Kamil Abduş Lagoon. Abbreviations: Tw (water temperature, °C), ORP (Oxidation-Reduction Potential, mV), DO (dissolved oxygen mg/L), Sat % (saturation), Sal. (Salinity, ‰), EC (electrical conductivity, mS/cm), ATP (Atmospheric pressure, mbar), Chl-a (chlorophyll a µg/L) Nitrite (N–NO2− mg/L), Nitrate (N–NO3− mg/L), and OP (orthophosphate, PO43- mg/L), Standard Deviation (SD).

	Tw	pH	ORP	DO	Sat.	Sal.	EC	ATP	Chl-a	Nitrite	Nitrate	OP
ST- 2 14.02.16	11.9	8.25	-65	11.5	103.5	24.5	39.6	1015	0.84	0.008	0.855	0.045
ST- 2 27.03.16	11.3	8.38	-72	7.42	66	24.6	39.6	1015	2.15	0.002	0.046	0.054
ST- 2 23.04.16	21.4	8.16	-62	5.86	49.4	25.1	39.5	1014	3.11	0.232	0.217	0.072
ST- 2 30.05.16	27.2	8.57	-70	5.54	70	23.2	36.5	1009	4.06	0.022	0.015	0.041
ST- 2 28.06.16	29.3	8.72	-76	4.93	23.4	23.4	36.8	1007	5.31	0.008	0.016	0.055
ST- 2 29.07.16	28.1	8.64	-73	3.64	46.7	24.6	38.5	1007	2.28	0.013	0.016	0.035
ST- 2 18.08.16	28.6	8.83	-85	4.99	64.7	25.2	39.2	1007	7.37	0.012	0.012	2.818
ST- 2 28.09.16	20.7	8.1	-65	4.11	43.2	24.9	39.6	1029	0.64	0.006	0.036	2.915
ST- 2 25.10.16	18.3	8.04	-67	7.47	83.8	24	38.1	1025	1.96	0.005	0.031	2.627
ST- 2 22.11.16	12.7	8.13	-72	7.87	73	23.4	37.5	1030	2.96	0.005	0.601	0.046
ST- 2 27.12.16	7.5	7.96	-62	8.67	70.6	23.1	37.9	1030	5.88	0.035	0.382	0.121
ST- 2 23.01.17	7.4	8	-66	9.41	77.6	22.4	36.7	1019	8.8	0.077	0.664	0.046
Mean ± SD	18.7±8.4	8.32±0.30	-70±7	6.78±2.35	64.3±21.1	24.0±0.9	38.3±1.2	1017±9	3.78±2.57	0.035±0.065	0.241±0.307	0.740±1.236

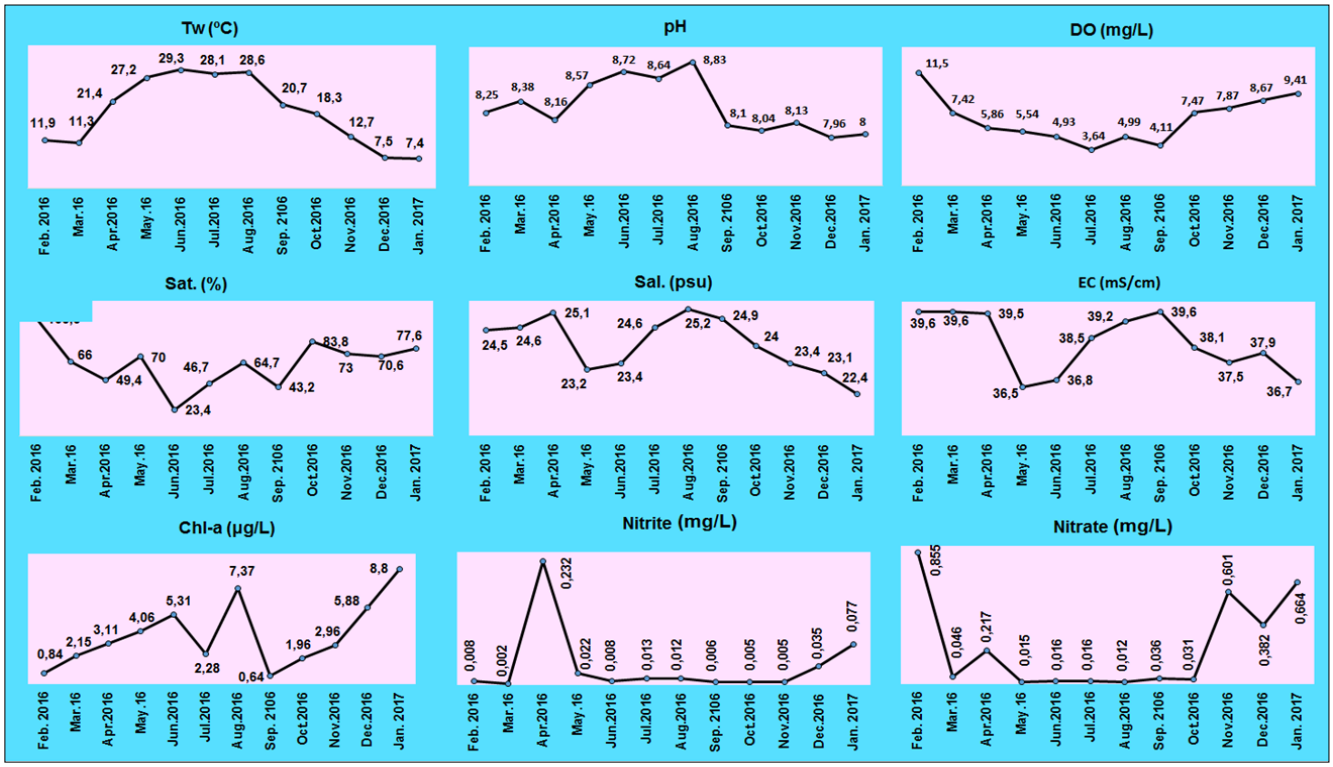

Fig 6: Monthly changes of physicochemical variables measured at sampling site of the Kamil Abduş Lago.

The pH value varied between 7.96 and 8.83 but did not fluctuate drastically during the sampling period, indicating slightly alkaline to medium alkaline water. Salinity was also consistent across the sampling period, ranging from 22.4 to 25.2‰. Surface water temperature ranged between 7.4 and 29.3°C and dissolved oxygen concentrations ranged from 3.64 to 11.25 mg/L, showing an inverse correlation. Electric conductivity was found be consistently varied between 36.5 and 39.6 mS/cm. Contents of Nitrite, Nitrate, OP and Chl-a in the water samples were in the range of 0.002-0.232 mg/L, 0.012-0.085 mg/L, 0.035-2.915 mg/L, and 0.64-8.80 µg/L, respectively.

3.1 Taxonomy

Class Demospongiae Sollas, 1885

Subclass Heteroscleromorpha Cárdenas, Pérez & Boury-Esnault, 2012

Order Suberitida Chombard & Boury-Esnault, 1999

Family Halichondriidae Gray, 1867

Genus: *Hymeniacidon* Bowerbank, 1858

Hymeniacidon perlevis (Montagu, 1814) (Fig. 3-5)

3.2 Description

The Kamil Abduş Lagoon specimens of *H. perlevis* are roundish, cushion-shaped with a massive behaviour and yellowish to greenish in colour. They reach a mean size of 11 ± 2 cm in length, 8 ± 2 cm in width and 4-5 ± 1 cm in height. The consistency is fragile and crumbly. Its surface is covered by emerging papillae and small digitations ranging in length between 0.4 and 10 mm (mean length 0.6 ± 0.2 mm) and a width ranging between 0.3 and 0.6 mm (mean width 0,25 ± 0,1 mm (Fig. 3 and 4).

3.3 Spicules
Spicules are styles, not differentiable in size categories, smooth, straight or faintly curved measuring 120-480 (± 270) x 3-12 (± 5) □m, rarely with sub-terminal swollen. (Fig. 5).

3.4 Skeleton
The skeleton is Halichondroid with tangential intercrossing bundles of styles and choanosomal confusedly arranged ones.

3.5 Distribution
This sponge is one of the most common species of Europe [18] with a wide distribution and can be considered cosmopolitan [16, 19, 20, 21]. *H. perlevis*, predominantly reported from temperate and colder waters, live in shallow subtidal and intertidal zones where it can colonise both hard substrates and soft bottoms, and where it is able to live buried into the sediment with its oscules projecting outwards [18, 22]. Extremely plastic in shape, it can form encrusting or massive specimens able to survive to prolonged periods of air exposure [21].

3.6 Remarks
H. perlevis in the Kamil Abduş Lagoon lives on rock partially buried into sediment (Fig. 3). It is able to tolerate strong variations of environmental parameters such as sea water temperature and salinity ranging from 7.4 and 29.3 °C and 22 and 25.2 ‰, respectively, and nutrients changes (Table 1).

4. Discussion
Hymeniacidon perlevis is not common in the Kamil Abduş Lagoon and was found at one sampling site only, during the entire sampling period without remarkable morphological changes. This species, rather diffuse in Europe seas, is one of the most common in the central Mediterranean lagoon systems [7]) where it inhabits an environment deeply affected by anthropogenic impact and is able to survive both to prolonged air exposure and strong environmental parameter changes [7, 21].

The subtidal habitats of Kamil Abduş lagoon are support to the sessile epibiota of filter feeding sponge such as *H. perlevis*. Greater proportion of the food consumed by *H. perlevis* was organic matter drifting with currents. Also, this species has not affected from change of any physicochemical variables as in this study. But, one of the most affecting environmental factor at the spatial distribution of this species was that of the nutrition. Because, the colonies of this species that the strong of marine currents (containing large amount nutrients) was observed in only one area.

The majority of benthic studies on Turkish lagoons were performed on specific benthic groups, and many of them for the identification of species belonging to some taxonomic groups, ignoring sponges. Generally, during characterisation of lagoon benthic composition, sample collection was done from few centimetres thick on soft sediment with the use of grab and hand nets, thus limiting the probability to find sponges.

Even though lagoon sponges were out of scope of many lagoon benthic studies, this marine sponge species, durable to environmental changes, was incidentally observed during another benthic study at Kamil Abduş Lagoon.

The quality of coastal waters in many regions of the Turkey has deteriorated in recent years as human population and activities have increased along coastal regions. Also, rapid urbanisation and industrialisation, and unnatural environmental regulations, threaten the future of this lagoon. Therefore, if lagoon fauna is not conserved, the faunistic and hydrological structure of this environment will be severely damaged due to anthropogenic activities, as is the case in many wetlands of Turkey. For that reason, fauna of the Kamil Abduş should be monitored with many ecological and faunistic studies.

H. perlevis seems to be a good and ideal species for pollution monitoring programmes. Because, *H. perlevis* is a very common sessile species from the mid-tidal to the subtidal zone [23], and it can easy collects from coastal habitats.

Kamil Abduş lagoon is located in one of the major urban and industrial development areas of the Istanbul. As a result, lagoonal habitats have experienced in land losses, reduction in water quality and shoaling in the past. Shoaling problems in Kamil Abduş Lagoon had been considered a threat because of the little volume of storage available of its. Kamil Abduş lagoon is almost as a natural harbour. Therefore, local administrators are planning a marina on the lagoon for yachts after deepening with dredging.

Conclusion that, change of the hydrological regime in this lagoon (which is positively affected by the microtidal currents) should be prevent by administorial preventions. In addition to this, preventions must be taken to pollution threat in the future. The lagoonal environments should be protect with coastal defence plans for sustainability of both private dwellings and also industrial infrastructures.

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