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Research Article

Records of Three Immature Gelatinous Specimens for the Turkish Mediterranean Coast with an Emphasis on Alternative Pathways

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ABSTRACT

From samples for the phytoplankton collected from the sea surface water of 67 stations along the entire Turkish Mediterranean coast during June-July 2019, three juvenile gelatinous organisms were recorded. Two cnidarian-hydrozoan species (*Podocorynoides minima* and *Gastroblasta raffaelei*) and one ctenophore (*Bolinopsis* cf. *vitrea*) occurred near Mersin Bay. The specimens were determined at the juvenile or eumedusoid stages. Referring to the literature, *Gastroblasta raffaelei* was presumably about 4-5-day old (1.05 x 1.56 mm in elliptical diameter), and *Podocorynoides minima* about a stage of liberated eumedusoid (0.327 x 0.316 mm in bell diameter x height). The specimen of *Bolinopsis* cf. *vitrea* was measured to be 11 mm in lobate (total) length and 8.6 mm in body width. Interestingly, all species were found at different locations close to each other on the set of the water rim current speeding easterly up to about 0.5 m s^{-1}. *Gastroblasta raffaelei* and *Podocorynoides minima* were first recorded on the Turkish Mediterranean coast. Early-staged specimens of these three species were described and discussed for their diagnostic structures with their occurrence in the Turkish Mediterranean Sea after the hydrozoans were reported in the Sea of Marmara, the ctenophore in the Black Sea, and other seas of the Mediterranean basin. The present study also discussed possible and presumable pathways of recent increased Turkish Mediterranean records of specimens that have been observed in the West Mediterranean Sea and the Adriatic Sea.

Keywords: New records, gelatinous species, Turkish Mediterranean waters

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INTRODUCTION

The Mediterranean Sea is specifically biologically well-diversified and significantly researched for its marine life (Vasilakopoulos et al., 2017). Although the Mediterranean Sea is recognized as a biodiversity hotspot (Coll et al., 2010), it has been threatened by pollution, over-exploitation, and global warming (Cuttelod et al., 2009). The eastern Mediterranean Sea, particularly the Levantine Sea is well open to the new records of the gelatinous organisms (Ctenophora and Cnidaria) besides other taxa. Most of them are invasive alien species (Galil, 2007). Many recent records (32 records since 2006, most of them since 2015) of zooplankton, especially gelatinous organisms, most inhabiting the West Mediterranean, and Adriatic Sea, to the Turkish marine system were noticed (Table 1). Furthermore, recent records have increased for other taxa (e.g., Patania & Mutlu, 2021; Garuti & Mutlu, 2021; Mutlu et al., 2023a). For all increased records there could be a vector for their transportation, such as water current among the other vectors, the straits, aquaculture, ship ballast water, etc.

Early staged-medusoid and juvenile ctenophore specimens are often encountered in the water samples for zooplankton and even phytoplankton. Their occurrences suggested that they could be established in the seas or trans-

Table 1. Recent records and sampling year of gelatinous zooplankton in the Turkish marine coasts. * is not a new record but is, at one location, extremely abundant specimens and ** is open water species but abundantly found at locations in Figure 1, which is found in the West Mediterranean Sea and recorded in the area symbolized in Figure 1.

Taxa	Regions	Year	Citations
Published specimen			
One ctenophore	Bosporus exit to Black Sea	2007	Öztürk, Mihneva, & Shiganova, 2011
Sixteen hydrozoans, One scyphozoan	Sea of Marmara, Aegean Sea	2006-2013	İşinibilir et al., 2015a; Isinibilir, Yilmaz, & Demirel, 2015b; İşinibilir, Ulucam, & Yüksel, 2019
One hydrozoan	Sea of Marmara	2015	Yılmaz et al., 2017
Two scyphozoans, One hydrozoan, One thaliacean	Sea of Marmara	2019-2020	İşinibilir et al., 2022
Two hydrozoans	Aegean Sea	2012, 2015-2016	Gülşahin, Tarkan, & Bilge, 2013; Gülşahin et al., 2016
One ctenophore	Aegean Sea	2015-2018	Killi, Abyzova, & Shiganova, 2019
One hydrozoan	Northernmost Aegean Sea	2021	Isinibilir, Yuksel, & Guresen, 2021
One lobat ctenophore	Turkish water	2015	Gülşahin and Türker, 2017
One new scyphozoan	Levant Sea	2018	Mutlu et al., 2020
One lobat ctenophore	Levant Sea	2020	Gokoglu and Galil, 2020
One cydippid ctenophore	Levant Sea	2019	Mutlu and Özvarol, 2022a
One hydrozoan	Levant Sea	2019	Mutlu and Ozvarol, 2022b
Unpublished specimens noticed			
One calanoid copepod (24 inds)	Levant Sea	2019	Duman, 2023
Four phytoplankton*	Levant Sea	2019	Karaca, 2023
One cheatognath**	Levant Sea	2019	Duman, 2023

ferred from one sea to another sea depending on their life longevity. In many cases, the literature is needed to identify immature gelatinous species as needed for the other taxa. To overcome such difficulties in the identification, laboratory studies were conducted to follow growth through different stages of the gelatinous species. This stage of growth could be differentiated by their diagnostic morphometries under different environmental conditions (Mayer, 1912; Oliveira et al., 2007; Gravili et al., 2007; Shiganova, 2020; Fabien Lombard pers. comm.).

Mediterranean plankton is easily drifted and moved from intra-seas of the Mediterranean Sea and inter-seas by water current induced by a variety of mechanisms of atmosphere-sea interactions over the Mediterranean Sea besides a variety of introduction vectors such as Suez Canal, ship ballast water, and aquaculture (Zenetos et al., 2012). Such events could change the temporal structure of ecosystems, fisheries, and surface water currents. Globally, the Mediterranean Sea is influenced by atmospheric actions, mainly North Atlantic Oscillation (NAO) (Raitsos et al., 2011) and slightly North Pacific Oscillation (NPO), Pacific Decadal Oscillation (PDO) and El Niño (Báez et al., 2022). Locally, the Mediterranean Sea is influenced by the Bimodal Oscillation System (BiOS) decadal-occurring around the Adriatic Sea and global warming (Poulain et al., 2013; Civitarese et al., 2023). The study area of the present study is one of the regions mostly affected by global warming and undergoes a process of tropicalization (Encarnação et al., 2019). All these events induced new aspects of the water current in the Mediterranean system and introduced new records of plankton among the Mediterranean

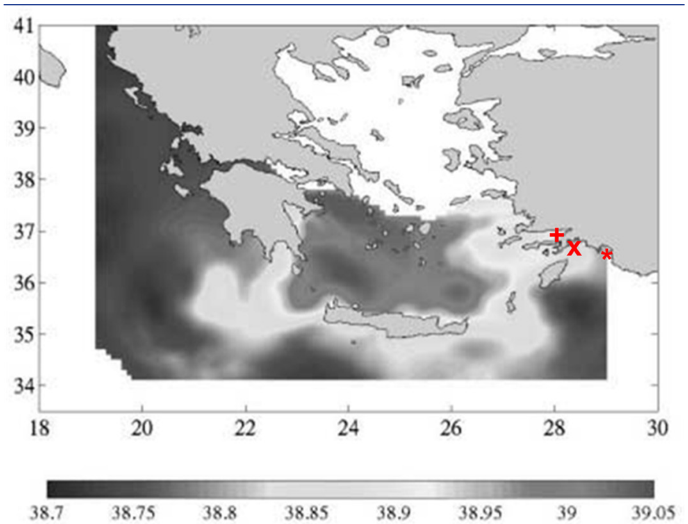


Figure 1. Water salinity at a deep layer having σt=29.18 (LIW) to show depth-wise changes of the layer along the different seas' interaction in 1991 (from Briand, Lascaratos, & Klein, 2000). + denotes records by Gülşahin, Tarkan, & Bilge, 2013; Gülşahin et al., 2016, x denotes records by Duman, 2023, Karaca 2023, and * denotes records by Mutlu and Özvarol, 2022a, b (see Table 1 for taxa observation and sampling dates).

seas, and ocean to the Mediterranean Sea. New records of the organisms particularly in the Turkish marine waters increased as the research was performed, or presumable new pathways could be developed in the Mediterranean Sea. Such introduction signaled the impulse of new records in the Turkish waters (Table 1).

Besides the endemic gelatinous species including medusoids of the hydrozoans of the Mediterranean Sea, the gelatinous alien species have altered the Mediterranean ecosystem (Coll et al., 2010; Dragičević et al., 2019); for instance, a new sea medusa, *Chrysaora pseudoocellata* Mutlu, Tulay, Olguner & Yılmaz 2020 was established in the eastern Mediterranean Sea (Dragičević et al., 2019; Mutlu et al., 2020; Douek et al., 2020). The records particularly the recent records coincided with decadal atmospheric and oceanic events, especially with a decadal period of BiOS which was first noticed in 1988. Furthermore, Duman (2023) and Karaca (2023) determined a new record of a calanoid copepod (specific to the Adriatic Sea) at one location and extreme-abundantly (more than at least 100-fold-higher at one location than other sampling stations of the present study) occurred phytoplankton species (three of four common in Adriatic Sea) at one location, respectively (Table 1, Figure 1). A delayed record could occur in the northern Turkish waters referring to southern Turkish waters. All species recorded in Table 1 originated from Atlanto-Mediterranean waters. Most of them were found in the western waters of the Levantine Sea. Depth-wise rise of a deep layer characterized by a water density of σ_t=29.18 (LIW) was observed along the Ionian Sea through the Aegean Sea to a part of the Levant Sea in 1991 (Briand et al, 2000). This event however coincided with the new records of some species for the Turkish waters (Table 1, Figure 1). Decadal events and this example (Figure 1) alert transportation of westerly originated species to the western coasts of Turkish waters beside the BiOS effect. Nevertheless, the BiOS induced acceleration of water velocity in the present study area (Figure 2).

A model that was recently conducted to simulate jellyfish dispersion in space showed a pathway of jellyfish distributional extension in time from the Egyptian (around the Suez Canal) and Israeli coast to the Turkish water on the set of the Atlantic water current (Edelist et al., 2022). Alternatively, BiOS is a water circulation process switching from cyclonic to anticyclonic or *vice versa* on decadal intervals via the North Ionian Gyre (NIG) (Civitarese et al., 2010) and leads to changes in the thermohaline current structure in the Southern Adriatic (Civitarese et al., 2010), followed effect on Surface Water (LSW) and Intermediate water (LIW) in the Levant Sear (Ozer et al., 2017) via Ionian Jet (Figure 2). The Ionian jet then pumped the waters to the Levantine Sea (Poulain et al., 2013) when the NIG became cyclonic circulation. Studies have started to understand the effect of the NIG on the plankton communities, for instance on the phytoplankton in the Mediterranean Sea (Jasprica et al., 2022), and spatiotemporal benthic-pelagic coupling changes (Ricci et al., 2022) as the severity of the winter condition has changed globally yielding BiOS (Poulain et al., 2013).

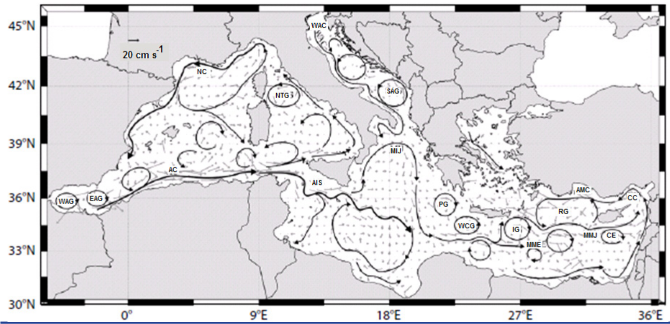


Figure 2. Mediterranean Sea surface water circulations affected by BiOS (Poulain et al., 2013).

Gelatinous biodiversity has increased in the Turkish marine environment. Öztürk, Mihneva, & Shiganova, (2011) contributed occurrence of one ctenophore, İşinibilir et al., 2015a, Isinibilir, Yilmaz, & Demirel, 2015b and İşinibilir, Ulucam, & Yüksel (2019) 16 hydrozoans and one scyphozoan, Yılmaz et al. (2017) one hydrozoan, Gülşahin, Tarkan, & Bilge (2013) and Gülşahin et al. (2016) two hydrozoans, and Gokoglu & Galil (2020) one ctenophore to the gelatinous biodiversity of the Turkish marine waters, followed by species records reported by Mutlu & Özvarol (2022a, b) and the present study (Table 1).

Therefore, the present study aims to mark the evidence of the occurrence of three gelatinous invertebrates in jelly form from a different region characterized with comprehensive environmental variables rather than other regions by the published studies and to discuss possible introductory pathways of western species-leveled intrusion undergoing the Mediterranean marine basin, particularly the Levantine Sea, and the Turkish coast.

MATERIAL AND METHODS

During a summer survey (June-July 2019) of acoustical studies on the vegetation along the entire Turkish Mediterranean coast (Taşucu Bay, the Mediterranean region, is the easternmost end – Datça Bay, the Aegean region is the westernmost end of the study area), water samples for a study of phytoplankton were collected from the surface waters of 67 stations (Figure 3). The locations of the sampling stations and the study area were described in detail in a study published by Mutlu et al. (2023b). The bottom depth of the stations varied between 5 m and 1000 m. One-third of the stations were in offshore waters and the rest were in coastal waters. Three major rivers (Goksu, Seyhan, and Ceyhan) flow into the eastern part, the coastal zone of which is eutrophic. On the contrary, Antalya and Muğla Bays are oligotrophic due to the absence of rivers compared to Mersin Bay. Sea surface temperature was at maxima (28 C in the Aegean part - 31 °C in the Mediterranean part), and salinity varied between 38 PSU and ~40 PSU in summer, respectively. Three of the stations were included in the present study because the species considered in the study were recorded only in the three stations (Table 1, Figure 1).

On board R/V "Akdeniz Su", 100 ml of the water sample was taken from the sea surface at each station using a 5-l Nansen bottle. The water was then fixed in a dark bottle using a 1% glutaraldehyde solution. During the survey, samples for physicochemical and optical parameters were collected from the surface (prefix S) and near-bottom (prefix N) waters some of them were measured on board, and the rest were frozen for lab analyses. One board and one litter of the water were filtered through CF/C for the nutrients and total suspended matter, and another one liter through CF/F filters for chl *a*. The samples were then frozen at -20 C on board. These parameters were physical (T; temperature in °C, pH; pH, S; salinity in PSU) using a multi-parameter probe (YSI, Hi-Tech), optical (Secchi disk depth), and chemical parameters (nutrients; NO_2+NO_3, NH_4, and PO_4, SiO_2, chl *a* and TSM; total suspended matter).

Three immature and early-staged gelatinous species were observed during the lab microscopic study. Each specimen was recorded at the different stations of the three stations (Figure 3). These three stations were sampled on July 02, 2019. All species were found at their early stages. Diagnostic terms of hydrozoan followed the description made by Bouillon et al. (2006) The staged species were identified using the descriptions ascribed by Mayer (1910, 1912), Madin (1991), Oliveira et al. (2007). Gravili et al. (2007) determined the stage development of *Gastroblasta raffaelei* Lang, 1886, regarding the different lab conditions with water temperature, and Schuchert (2007) of *Podocorynoides minima* (Trinci, 1903) and species of the ctenophores (Chun, 1880; Mayer, 1912; Oliveira et al., 2007; Shiganova, 2020). Photos of the specimens were taken, and their size was measured under the microscope; elliptical diameters of *G. raffaelei* and maximum bell width and height of *P. minima*.

The nutrients were measured following the standard UV-spectrophotometric procedures described by APHA (1999). The values of the nutrients were then converted to a unit µM. Total suspended solids (the material was dried in an oven at 60 ^{C} for 24 h, and then weighed before the weight of the dried membrane was subtracted from the total dry weight), and chlorophyll *a* (chl-*a*) were determined following Lorenzen's method (1967).

RESULTS AND DISCUSSION

Three gelatinous organisms were determined along the Turkish Mediterranean coast. These are *G. raffaelei* found at 22E, *P. minima* at 25E (hydrozoans), and *Bolinopsis* cf. *vitrea* at 23E (the ctenophore) (Figure 3).

Environment of the study area

The 22E, 23E, and 25E were the coastal stations within inshore waters (Figure 3). The coastal stations had a bottom depth of 49 m, 48 m, and 52 m, respectively (Table 2). The Sechhi disk depth at all stations varied between 13 m and 15 m. The sea surface temperature was measured in a similar range of 26-27 °C. The surface and near-bottom water salinity varied between 36.4 and 37.6 (PSU) (Table 2).

The concentration of the sea surface chl-*a* was 2-fold lower at two coastal stations (23E and 25E) than that of another station (22E). However, the total suspended matter was measured in a similar range at all the stations (Table 3). Sea surface SiO_2 was minima at 22E and maxima at 23E, like NH_4 and contrasted to NO_2+NO_3. Sea surface water PO_4 varied between 1.41 µM at 23E and 3.39 µM at 25E (Table 2).

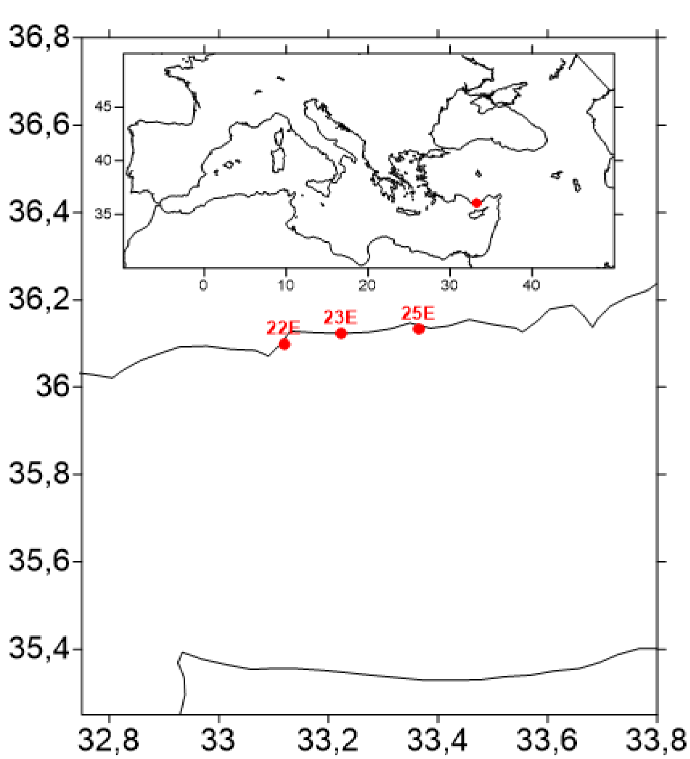


Figure 3. The study area (rectangle in color cyan) of the summer survey, and the area where the identified gelatinous specimens were found (red dot) at the sampling stations of the specimens (red dots labeled with station codes).

The stations were located between Turkey and the northern coast of Cyprus, which caused the derivation of the jet of the rim current. The current velocity was faster than 20 cm s^{-1} which is an average value for the Mediterranean Sea, and a maximum velocity of >50 cm s^{-1} was also measured along the Turkish Mediterranean coast (Poulain et al., 2013). These gelatinous planktons could be converged to the location by the rim current circumstance (Figures 2, 3).

Gelatinous species

Two species belonging to the phylum Cnidaria and one species to phylum Ctenophora were recorded for the first time along the Turkish Mediterranean coast. All three species were staged at a level of juvenile.

Species Gastroblasta raffaelei Lang, 1886

Phylum: Cnidaria
Class: Hydrozoa
Order: Leptothecata
Family: Campanulariidae
Genus: *Gastroblasta*

The material examined was an immature medusoid specimen collected from Tekeli (36° 05′ 91″ N, 33° 07′ 18″ E, station 22E, Mersin coast, Turkey, Eastern Mediterranean Sea) on 02 July 2019. Collection of the material was taken using a Nansen bottle from surface water at a seafloor depth of 49 m by Doğukan Kara-

Table 2. Distribution of the environmental parameters; bottom depth (depth), Secchi depth (SDD), surface (prefix S) and near-bottom (prefix N) water temperature (T), salinity (S), pH (pH), chl-a, total suspended matter (TSM), and the nutrients at stations of the present study. nm; not measured.

	22E	23E	25E
Depth (m)	49	48	52
SDD (m)	13	15	12.5
ST (°C)	26	27.1	26.5
NT (°C)	nm	nm	22.5
SS (PSU)	37.4	37.4	37.6
NS (PSU)	nm	nm	36.4
SpH	9.2	9.1	9.34
NpH	nm	nm	9.35
SChl-a (µg/l)	0.473	0.215	0.216
STSM (mg/l)	0.045	0.048	0.039
NTSM (mg/l)	nm	nm	0.054
$SSiO_2$ (µM)	8.83	10.51	9.39
$NSiO_2$ (µM)	12.18	nm	27.85
SNO_2+NO_3 (µM)	0.30	0.51	0.47
NNO_2+NO_3 (µM)	0.20	nm	0.28
SNH_4 (µM)	43.91	67.24	64.65
NNH_4 (µM)	422.36	nm	90.57
SPO_4 (µM)	2.07	1.41	3.39
NPO_4 (µM)	3.72	nm	3.72

ca. The specimen was measured to be 1.05 x 1.56 mm in the elliptical umbrella diameter.

Description: Umbrella (u) is much flatter, and elliptical and has a shorter axis of 1.05 mm and a longer axis of 1.56 mm (Figure 4A). There are eight tentacles (t) of which half of the completed tentacle is curly in length and the other half is straight with each originating from an incomplete pear-shaped tentacular bulb (TB) (Figure 4A, B). Manubria (m) were multiple urn-shaped and the central manubrium (m) was fully formed (Fig. 4) and the other two manubria were smaller (one just formed with two lips) than the central one. Developed two manubria had four lips (l) which were more pronounced in the central manubrium, developing manubrium has two lips (Figure 4). Two opposite weak radial canals (rc) were hardly observed crossing diagonally three manubria and a centripetal (circular) canal (cc) was developed. The velar opening (vo, velum) is rather wide (Figure 4).

Remarks: *Gastroblasta timida* resembles *G. raffaelei*, both having multiple manubria and centripetal radial canals, and differentiated in bell shape; *G. timida* in circular, and *G. raffaelei* in elliptical umbrella (Gravili et al., 2007). The specimen was about 4-5 days old medusa according to the description diagnosed by Gravili et al. (2007). *G. raffaelei* had different diagnostics under different temperature conditions (15 °C and 18 °C). Morphometrically, our specimen resembles a specimen of 4-5 days old *G. raffaelei* reared at 18 C by Gravili et al. (2007), but it is like stage reared at 15 ^{C} considering the size of the specimen.

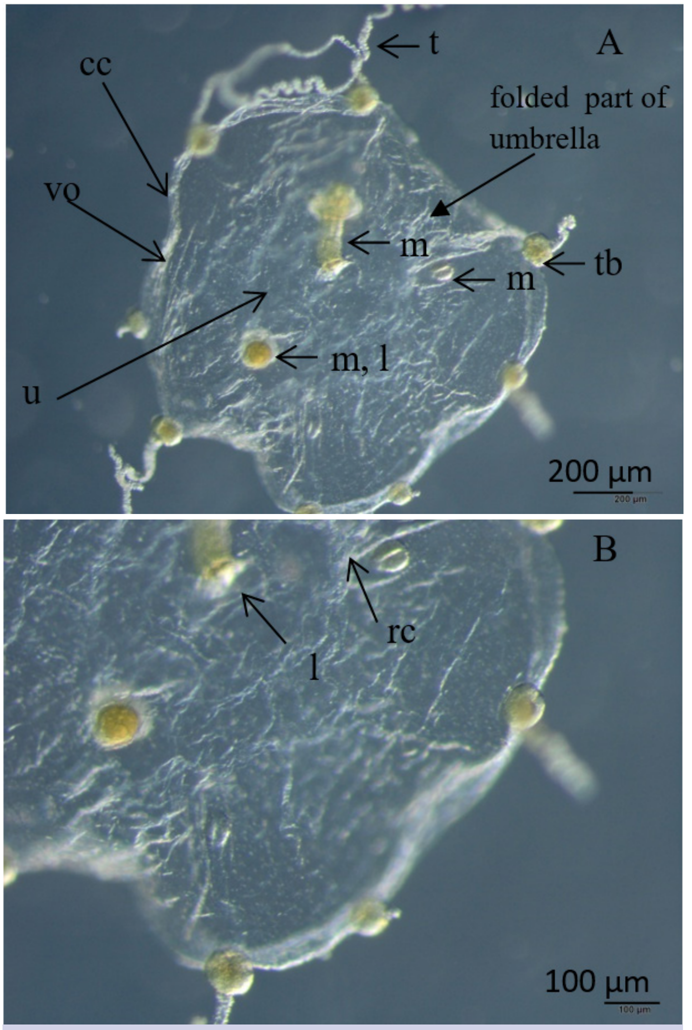


Figure 4. Oral view of *Gastroblasta raffaelei*: entire specimen (A), central manubrium, and newly occurred manubria at either side of the central manubrium (B). Umbrella (u), tentacles (t), tentacular bulb (tb) , manubria (m), central manubrium (m), lips (l), radial canals (rc), centripetal (circular) canal (cc), and velar opening (vo, velum).

Species Podocorynoides minima (Trinci, 1903)

Phylum: Cnidaria
Class: Hydrozoa
Order: Anthoathecata
Family: Rathkeidae
Genus: *Podocorynoides*

The material examined specimen was just released medusoid after the spawning and collected from surface water at a seafloor depth of 52 m off Akkuyu, Aydıncık (36° 07′ 98″ N, 33° 21′ 90″ E, station 25E, eastern Mediterranean Sea, Mersin coast, Turkey) on 02 July 2019, using a Nansen bottle by Doğukan Karaca. The size of the specimen was 0.327 x 0.316 mm in bell diameter x height.

Description: The body of the medusoid specimen is characterized by an incomplete sphere bell and untapered global pole of

Table 3. Previous occurrence, sampling year and location of three species in the Mediterranean Sea and adjacent seas.

Species	Region	Year	Location	Citation
Gastroblasta raffaelei				
	Tyrrhenian sea	1886	Gulf of Naples	Lang, 1886
	Ligurian Sea	1980	Portofino and Pontetto	Boero, 1980; Boero & Fresi 1986
	Balearic Sea	2003	Catalonian waters	Guerrero et al., 2018
	Ionian Sea, Adriatic Sea	2005	Otranto	Gravili et al., 2007
	Adriatic Sea		Northern coast	REGIONE DEL VENETO, SHAPE, 2013
	Marmara Sea	2008	İzmit Bay	Isinibilir, Yilmaz, & Demirel, 2015b
Podocorynoides minima				
	Ligurian Sea	1963-1964	Riviera-Corsica	Goy, 1972
	Red Sea	?		Schmidt, 1973
	Eastern Mediterranean		Lebanon water	Goy, Lakkis, & Zeidane, 1991
	Tyrrhenian Sea		Naples	Brinckmann-Voss, 1987
	Western Mediterranean	2004-2005	Tunisia	Touzri et al., 2012
	Marmara Sea	2006	Istanbul Bay	Isinibilir, Yilmaz, & Demirel, 2015b
	Adriatic Sea		Northern coast	REGIONE DEL VENETO, SHAPE, 2013
	Western Mediterranean	2014	Algeria	Kherchouche & Hafferssas, 2019
	Black Sea	2020	Romania	Mureşan, Teacă, & Begun, 2021
Bolinopsis vitrea				
	Aegean Sea	?	Turkey	Ergen, 1967
	Adriatic Sea	2003-2006	Italy	Shiganova & Malej, 2009.
	Black Sea	2007	Turkey	Öztürk, Mihneva, & Shiganova, 2011
	Adriatic Sea	2009	Montenegro	Lucic et al., 2012
	Adriatic Sea	2009-2010	Montenegro -Croatia	Branka et al., 2014
	Black Sea	2010	Bulgaria	Öztürk, Mihneva, & Shiganova, 2011; Öztürk, 2021
	Adriatic Sea		Northern coast	REGIONE DEL VENETO, SHAPE, 2013
	Levant Sea	?	Turkey	Çinar et al., 2014
	Adriatic Sea	2010-2019	Adriatic eastern coasts	Pestoric et al., 2021

the oral side and is shaped in a dome having thin global jelly and thicker apical jelly (Figure 5A). The subumbrella has a long gastric peduncle, cylindrical manubrium (m), elongated perradial lip (l) margins, and gonads (g) surrounding the manubrium (Figure 5A, B). The oral part has four radial canals (rc) extending to the apical pole, a narrow ring canal (rrc), four perradial tentacle bulbs (tb) pad-like, and tentacles (t) are very contractile (Figure 5A). Tentacles are first perpendicularly positioned (pp) to the umbrella or velum and then extended outward (Figure 5A).

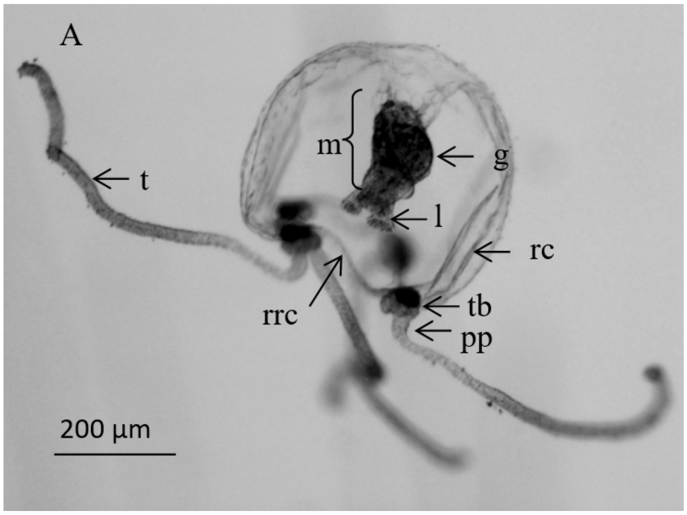
Remarks: *P. minima* is distinguished by having a distinct, round trunk, and oral tentacles. The species resembles members of the family Rathkeidae as compared to that of the Hydractiniidae (Schuchert 2007). The initial parts of oral tentacles are positioned perpendicular to the oral velum (Figure 5A) unlike the oblique tentacles of *Lizzia blondina* Forbes, 1848 (Schuchert 2007).

Species Bolinopsis cf. vitrea

Phylum: Ctenophora
Class: Tentaculata
Order: Lobata

The material examined was a specimen at the stage of immature and collected from surface water at a seafloor depth of 48 m off Aydınçık, (36° 07′ 37″ N, 33° 13′ 39″ E, station 23E, Mersin coast, Turkey, eastern Mediterranean Sea) on 02 July 2019 using a Nansen bottle by Doğukan Karaca. The size of the specimen was 11.1 x 8.5 mm in the total (lobate) length x maximal body width. The specimen had also an aboral length of 9.6 mm, and an auricle length of 8.6 mm (Figure 6).

Description: Body shape from the tentacular plane is semi-ellipsoid oval, and laterally compressed. It has a blunt-aboral apex and wide oral lobes terminated between the apical location and



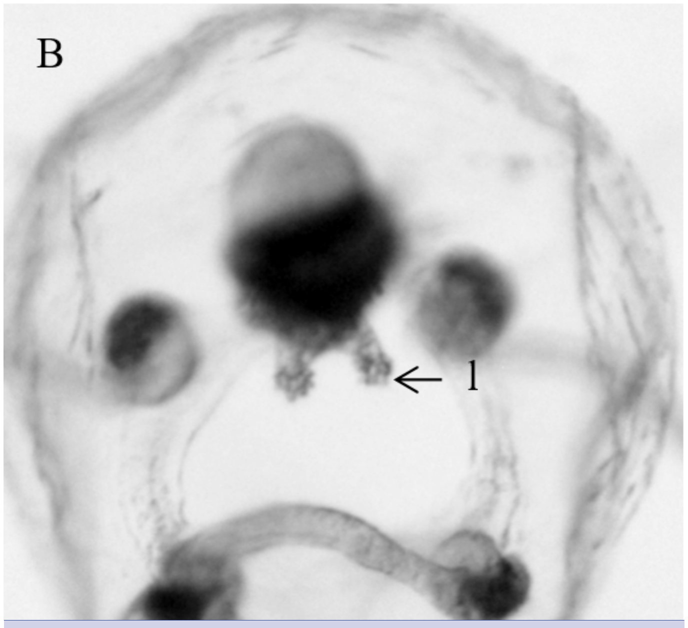


Figure 5. Liberated medusoid specimen of Podocorynoides minima; lateral view (A) and oral view focusing on the mouth lips (B). Manubrium (m), perradial lip (l), gonads (g), radial canals (RC), ring canal (rrc), tentacle bulbs (tb), tentacles (t), and tentacle in perpendicular position (pp) to velum.

mouth. Two poles of the specimen are about equal bluntness and lateral parts around the apical pole are characterized by multi-corners on the lateral of the body. The body surface has small granulation. Auricle (a) is developed and edged by ciliary combs (cc) and extends to just above the mouth. Tentacles (t) are very short and simple, initiated from tentacle bulbs (tb) located on each side of the mouth by extending to the bases of the auricles. Stomodaeum (s) is simple, long, and very narrow, has fine caliber chymiferous tubes, very simple meridional ventral tubes joined with the circumoral vessel, and two contrasted directional canals in "V" shape on each of two poles by joining to stomodaeum (Figure 6). Lobe (l) is initiated (li) in the middle part between mouth (m) and infundibulum (i)

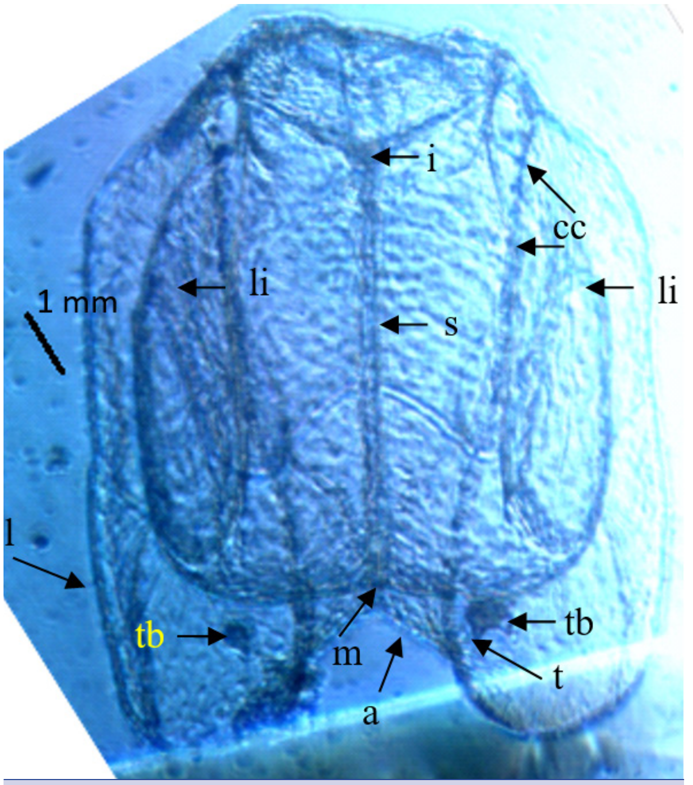


Figure 6. *Bolinopsis* cf. *vitrea*; view of the tentacular plane of its juvenile specimen. Auricle (a), ciliary combs (cc), tentacles (t), tentacle bulbs (tb), stomodaeum (s), lobe (l), initial region of the lobe (li), mouth (m), and infundibulum (i)

Remarks: According to descriptions performed by Mayer (1912), Oliveira et al. (2007), and Oliveira & Migotto (2006) for the adult specimen of *Bolinopsis vitrea* (L. Agassiz, 1860), all characters of a very simple and narrow stomodaeum, position of large tentacle bulbs, tip position of just developed auricle and oral lobe and mouth shape with reverse 'V' (Fig. 4) support that the specimen seems to be *B. vitrea*. Immature and mature *Mnemiopsis* specimens are distinguished as having auricle furrows (Oliveira et al., 2007), small tentacle bulbs positioned at the middle of the body and not acute and blunt aboral apex (Shiganova, 2020), and the specimen of the present study lacks the auricle furrows but having blunt aboral apex. Specimens of genus *Leucothea* pass to the stage of genus *Bolinopsis* which is closely related to *Leucothea* covered with small papillae on the whole outer surface (Mayer, 1912) as occurred in the present specimen with the very small pits-like granulates on the outer surface of the body. However, the present specimen lacks 2 remarkable blindly-ending sacs and the tentacle bulbs nearly to the level of the funnel. The tentacle bulbs are positioned at a level of mouth in the present specimen as differentiated by Oliveira et al. (2007). It is hereby remarked that the species could be *Bolinopsis vitrea* but was recognized as *Bolinopsis* cf. *vitrea* due to the following remarks: "I once got a juvenile like this and grown it in the lab (thinking it was either *Bolinopsis* or *Mnemiopsis*).... to turn out it was *Leucothea multicornis* once grown" (Fabien Lombard, pers. comm.) and "It is difficult with the small ones as the lobe morphology about statocyct change. What I can say for sure is that it does look like neither *Mnemiopsis* nor *Bolinopsis infundibulum*" (Cornelia Jaspers, pers. comm.).

Early stages of gelatinous specimens are very passive swimmers at movement and could be much more drifted by water currents than the adult specimens. Eumedusoid hydrozoan had a short stage passage to become adult (Gravili et al., 2007). This occurrence of such newcomers to a sea suggested that the specimen could be established in the region where they are found and could be passively moved from one sea to another sea via the water current depending on its velocity or via ship ballast water. This could induce a broad-scale distribution of the organisms in the Mediterranean Sea (Table 3).

Body morphometry and structure of gelatinous organisms were differentiated by the environmental parameters under lab conditions or from sea to sea worldwide (Gravili et al., 2007; Shiganova, 2020). Such differences led to the importance of local morphometry of the organisms reported to widen their descriptive knowledge. There are some studies published on such structural differences; Gravili et al. (2007) reared *G. raffaelei* under lab conditions in two different seasons and temperature conditions; 15 and 18 °C. The size of specimens at the same age is larger at 18 °C than at 15 °C. Our specimen fits with both sizes (4-5 days old) of specimen reared at 15 °C and the diagnostic structure of specimen reared at 18 °C rather lower than our sampling temperature of the water with higher chl-*a* concentration coincided with higher ammonium concentration than the other two stations (Table 2). Isinibilir, Yilmaz, & Demirel, 2015b showed a similar diagnostic structure of *G. raffaelei* in the Sea of Marmara, which is colder than the present study area, to the structure of specimen reared at 15 C (Gravili et al., 2007). Nutritional conditions as well as temperature could induce such differences between different Turkish and Italian waters. Near-bottom temperature was measured at around 22 C (Table 2). Similar structural differences were observed for a ctenophore species, *M. leidyi* in the European seas (Shiganova, 2020).

Gastroblasta raffaelei which endemic species to the Mediterranean Sea overspread the Mediterranean Sea, particularly the Adriatic, Tyrrhenian and Ligurian Seas (Bouillon et al., 2004; Gravili et al., 2007) and was first reported occurring in the Sea of Marmara for the Turkish waters (Isinibilir, Yilmaz, & Demirel, 2015b). Up to now, the species was however not reported for the Turkish Mediterranean coast (Çinar et al., 2014). *G. raffaelei* was recently recorded in the Catalan Sea (Guerrero et al., 2018) (Table 3). *Podocorynoides minima* has been distributed globally in the temperate waters of the world; Mediterranean, Atlantic Ocean, Indo-Pacific Ocean (Schuchert, 2007), Sea of Marmara (Isinibilir, Yilmaz, & Demirel, 2015b) and Black Sea (Table 3).

Regarding ctenophoran lobate distribution only in the Turkish waters, *M. leidyi* A. Agassiz, 1865 which was introduced first to the Russian waters of the Black Sea in 1987 (Vinogradov et al., 1989) was reported in the Turkish Black Sea in 1991 (Mutlu et al., 1994; Mutlu, 1999) and in the Mediterranean Sea, Mersin Bay in 1992 (Uysal & Mutlu, 1993; Kideys & Niermann 1993). *Bolinopsis vitrea* which is a cosmopolitan species in the world was reported in the Black Sea (Öztürk, Mihneva, & Shiganova, 2011), and *Leucothea multicornis* (Quoy & Gaimard, 1824), which is a cosmopolitan species in the world, in the Turkish Mediterranean Sea, Antalya Bay from a sample taken in 2020 (Gokoğlu & Galil, 2020). However, *B. vitrea* was generally observed in the eastern Mediterranean Sea and adjacent seas (Table 3). Recently, the occurrence of *Beroe mitrata* (Moser, 1907) was reported in the Turkish waters. (Killi, Abyzova, & Shiganova, 2019). However, Çinar et al. (2014) previously reported the species, *B. vitrea* from the Turkish Levant water. Nevertheless, *L. multicornis* was reported for the first observation in the eastern Mediterranean (Galil et al., 2014), followed by occurrences in the Syrian waters (Mamish, Durgham, & Ikhtiyar, 2019), and Greek waters (Digenis & Gerovasileiou, 2020).

Most of all three species records were performed from the western Mediterranean Sea and Adriatic Sea (Table 3). Regarding their Mediterranean-wide occurrence, a common location is Adriatic Sea with occurrence in our one sampling conducted in the summer of 2019. Furthermore, increased records have occurred in the Turkish marine waters (Table 1). This brings about speculation about the coincidence of the decadal formation of BiOS (Gacic et al., 2010) with three species found in the present study and other records (Table 1). The BiOS has the power to create the high-level variability of the Mediterranean Sea and the strong interconnection of its sub-basins by affecting the vectors of the saltier LIW, the LSW, and the fresher Atlantic Water (Civitarese et al., 2023). The BiOS which changed the cycle pattern of the Northern Ionian Gyre affected the Levant hydrographs in decadal periods. The Mid-Ionian Jet pumped the water toward the Turkish Mediterranean waters via two vectors: one directly to Rhodes gyre (RG) and the other to easternmost Levant water by the Atlantic current (CC) (Figure 2). The water of the study area had fewer saline waters and relatively high primary production (Table 2) as compared to the expected value (39 PSU) of the summer salinity in the Levant Sea (Lascaratos, Williams, & Tragou, 1993; Poulos, Drakopoulos, & Collins, 1997).

In comparison to the western vector introducing specimens to the Turkish Levant waters, Civitarese et al. (2023) monitored the decadal formation of the NIG circulation from 1996 to 2018. Regarding the records given in Table 1 and the present study, all physical data suggested an alternative way of water transportation by the BiOS or LIW derived by BiOS toward the Turkish waters (Figures 1, 2). Compared to regular summer measures existence of less saline and warmer water indicated that there was physical water transportation from somewhere to the present study area during the summer of 2019 as inferred from decadal surface water currents (Table 2, Figure 3).

In comparison to the eastern (Red Sea) vector introducing specimens to the Turkish Levant waters, Edelist et al. (2022) conducted a particle dispersal model to simulate jellyfish dispersion in space and showed a pathway of jellyfish distributional extension in time starting from the Egyptian (around Suez Canal) and Israeli coasts to the Turkish water on the set of the Atlantic water current path during 2017-2018 based on the sea surface current. Consequently, the particle arrived at İskenderun Bay which was far away from the record locations of the present study if the particles were released from the Egyptian coast. Subsequently, the particles arrived at Antalya Gulf which was on the set of record locations of the present study but far away from the record locations given in Figure 1 and locations of unpublished records given in Table 1 if the particles were released from the Israeli coast (Edelist et al., 2022).

Recently, Mutlu & Özvarol (2022a, b) and Uttieri et al. (2023) discussed possible introductory pathways of the zooplankton to the eastern Mediterranean Sea regarding the effect of the BiOS; three species (*Hormiphora plumosa* M. Sars, 1859, *Oceania armata* Kölliker, 1853 and *Pseudodiaptomus marinus*, Sato, 1913, respectively) are also observed in the Adriatic Sea and adjacent seas. Jasprica et al. (2022) related the BiOS caused by severe winter conditions to phytoplankton composition and distribution in the southern Adriatic Sea.

CONCLUSION

Early-staged specimens of hydrozoans and ctenophores could be morphometrically different under different environmental conditions and sea-to-sea. Description of these three immature gelatinous organisms was characterized for the Turkish Levant coast. However, records of the gelatinous organisms have increased in the Turkish waters. Discussing the possible vectors of their introduction to the Turkish coasts, water pumped by BiOS is bifurcated at Rhodes gyre. One branch was entrapped in Rhodes gyre, and another branch was joined to the Atlantic current, both affecting the Turkish Mediterranean coast (Figure 2) (Poulain et al., 2013). Therefore, it is possible that the species could have entered the eastern Mediterranean by the Atlantic and met BiOS through the western Mediterranean.

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