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First record of *Bursatella leachii* de Blainville 1817 (Mollusca; Gastropoda; Aplysiidae) in Black Sea

Bursatella leachii de Blainville 1817'nin (Mollusca; Gastropoda; Aplysiidae) Karadeniz'deki ilk kaydı

Türk Denizcilik ve Deniz Bilimleri Dergisi
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Vincenzo Di MARTINO[1,*], Bessy STANCANELLI[2]

[1] *CNR/ISAFoM (National Research Council of Italy/Institute for Agricoltural and Forestry System in the Mediterranean) via Empedocle, 58, 95125 Catania, Italy.*

[2] *Aqua Stories; via Vampolieri, 25/31 int. 27, 95022 Aci Catena (Catania), Italy*

ABSTRACT

This study reports the presence of the ragged sea hare *Bursatella leachii* de Blainville 1817 in the Black Sea. A total of 484 specimens of this species were observed during scuba diving and snorkeling at depths ranging from 1.0 to 4.0 meters in September 2023. The samples were observed on the sandy-muddy bottom of Kumbaba Beach and the sandy bottom of Uzunkum Beach in Şile district (Istanbul province). The density of individuals per square meter of the seabed was calculated and the highest number of individuals was detected on the Kumbaba Beach near the mouth of the Türknil River. Considering the location of discovery, it is logical to assume that the introduction of this species into the Black Sea may have occurred naturally. This hypothesis can be supported for two main reasons; a) Şile beaches are a few kilometers away from the Bosphorus Channel, b) the report of *B. leachii* closest to Şile district dates back to January 2020, when the species was observed on the seabed on the southern coast of the Dardanelles. Long-term monitoring and more in-depth studies should be conducted in the region to give certainty to these hypotheses.

Keywords: *Bursatella leachii*, Black Sea, Türkiye, Alien invasive species, Non-Indigenous species.

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[*] (corresponding author)
E-mail: vincenzo.dimartino@cnr.it

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ÖZET

Bu çalışma, Karadeniz'de dağınık deniz tavşanı *Bursatella leachii* de Blainville 1817'nin varlığını rapor etmektedir. Eylül 2023 ayı içerisinde 1,0 ila 4,0 m arasında değişen derinliklerde tüplü dalış (SCUBA) ve şnorkel dalışı ile toplam 484 örnek gözlemlenmiştir. Örnekler, Şile ilçesi (İstanbul ili) Kumbaba plajının kumlu-çamurlu tabanında ve Uzunkum plajının kumlu tabanında gözlemlenmiştir. Deniz tabanındaki bireylerin metrekaredeki yoğunluğu hesaplanmış ve en yüksek birey sayısı Türknil nehrinin ağzına yakın Kumbaba sahilinde tespit edilmiştir. Türün tespit edildiği bölge göz önüne alındığında, bu türün Karadeniz'e girişinin doğal yollarla meydana gelmiş olabileceği düşünülmektedir. Bu hipotez iki ana nedenden dolayı desteklenebilir; a) Şile sahilleri Boğaziçi Kanalı'ndan birkaç kilometre uzaktadır, b) Şile ilçesine en yakın *B. leachii*'nin raporu, türün Çanakkale Boğazı'nın güney kıyısındaki deniz yatağında gözlemlendiği Ocak 2020'ye dayanmaktadır (Çanakkale Boğazı). Bu hipotezlere kesinlik kazandırmak için bölgede uzun süreli izleme ve daha derinlemesine çalışmalar yapılmalıdır.

Anahtar sözcükler: *Bursatella leachii*, Karadeniz, Türkiye, İstilacı tür, Yabancı tür

1. INTRODUCTION

For over a century the biota of the Mediterranean Sea and, more recently, that of the Black Sea have been subject to continuous and profound changes caused by the introduction of alien exotic species.

The presence of Non-Indigenous Species in the Black Sea has become increasingly high in recent years to the point that this basin has become home to a large number of alien species that are naturalizing in it. In the same way as what happened for the Mediterranean, also for the Black Sea there are essentially three main transport routes: a) maritime transport; b) introduction, intentional or unintentional, by humans activities; c) Mediterraneanisation, the process through which many species overcome the ecological barriers, represented by the Turkish Straits, and penetrate the Black Sea (Öztürk, 2021; Aydın and Sözer, 2016).

Molluscs are one of the phyla with the highest number of species in the world; it is estimated that they may constitute approximately 25% of the entire marine fauna of the seas and among them there are some of the most invasive species with the greatest ecological impact (Molnar *et al.*, 2008).

In the entire Mediterranean basin, it is estimated that there are over 200 species of alien mollusca (Sabelli and Taviani, 2014).

The sea hare *Bursatella leachii* de Blainville, 1817 (Gastropoda; Heterobranchia; Aplysiidae) is a circumtropical species widely distributed in the Atlantic and Indo-Pacific oceans, including the Red Sea (Bebbington, 1969; Marcus, 1972; Burn, 2006; Bazzicalupo *et al.*, 2020).

The first report of this mollusk in the Mediterranean dates back to the first half of the 1900s and was made along the coasts of Israel (O'Donoghue and White, 1940). Since then, *B. leachii* has spread throughout the Mediterranean and is currently considered the most widespread exotic taxon in this basin (Zenetos *et al.*, 2016; Crocetta *et al.*, 2017; Selfati *et al.*, 2017; Travaglini and Crocetta, 2019). The numerous reports of *B. leachii* confirm the presence of this sea hare in at least 21 of the 23 coastal countries of the Mediterranean (Selfati *et al.*, 2017; Monnier *et al.*, 2024).

B. leachii is a typical species of marine areas from warm temperate to tropical, especially in calm and shallow environments, although there are sporadic reports of specimens observed at over 20 meters of depth (O'Donoghue, 1929; Eales, 1970; Barash and Danin, 1971).

This species is commonly observed in estuaries, coastal lagoons and coastal waters of sheltered areas; sometimes it can also establish itself in lagoon environments (e.g. ponds used for shrimp cultivation) and in port waters (Lowe and Turner, 1976; Arkronrat *et al.*, 2016; Behera *et al.*, 2020; Parera *et al.*, 2020).

B. leachii is a detritivorous and herbivorous benthic mollusc that usually grazes on the surface layers of sandy and muddy seabeds as well as the

muddy layers that cover the surfaces of seabed rocks (Rudman, 1998; Clarke, 2006; Kazak and Cavas, 2007; Antit *et al.*, 2011; Otero *et al.*, 2013; Sethi *et al.*, 2015; Gimènez-Casalduero *et al.*, 2016; Ballesteros *et al.*, 2022). These eating habits have meant that this sea hare has developed a varied diet with a prevalence of cyanobacteria, Rhodophycea, Chlorophycea and Pheophyceae (Paige, 1988; Clarke, 2006).

It is therefore a particularly useful species for the biological control of toxic blooms of marine cyanobacteria (Capper *et al.*, 2005, 2006; Capper and Paul, 2008).

B. leachii has diurnal habits and is usually active at dawn, when large gatherings of individuals form, while isolated individuals are found during sunset hours (Ramos *et al.*, 1995).

Being a simultaneous hermaphroditic species with cross-fertilization, it has a rapid life cycle and reproduces several times a year (Kaplan, 1988; Otero *et al.*, 2013). It follows that *B. leachii* populations present large demographic fluctuations with periods of large aggregations of individuals which disperse after a few days. These large assemblages form when the optimal ecological and meteorological conditions for fertilization occur (Lowe and Turner, 1976; Zenetos *et al.*, 2004; Clarke, 2006; Crocetta *et al.*, 2013; Gonzàlez-Wangüemert *et al.*, 2014). In these cases, the population density can reach values of over 50 ind/m^{-2}.

The present study reports the first record of the non-indigenous ragged sea hare *B. leachii* (Figure 1) along the coastline of Black Sea, namely in the Turkish coasts, and provides an update of the known distribution of *B. leachii* in the Mediterranean Basin compared to what has been reported from previous work of Rizgalla and Crocetta (2020) and Monnier *et al.* (2024).

2. MATERIALS AND METHODS

The presence of *B. leachii* (372 individuals) was recorded for first time on September 10th, 2023 in the soft bottoms of the Black Sea, in Kumbaba Beach (41.173341° N; 29.569386° E), a beach in the Şile District (Istanbul province), about 40 kilometers east of the Bosphorus. A few days later, on September 15th 2023, 112 sea hare specimens were recorded at Uzunkum Beach (41.171767° N; 29.634561° E), also in the Şile district (Figure 2).

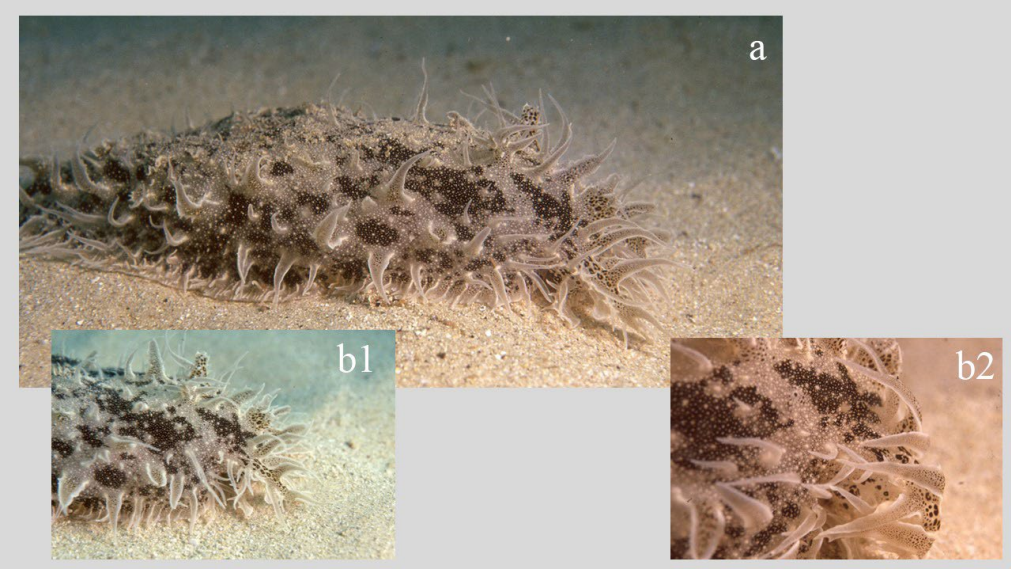

Figure 1. *Bursatella leachii* de Blainville 1827 in the Turkish Black Sea bottoms; "a": specimen on sandy mud bottom; "b1": anterior portion of a specimen; "b2" magnification of the cephalic region of a specimen.

Figure 2. Location of study area in the Black Sea where *B. leachii* specimens were observed during the present study; "a": Kumbaba Beach; "b": Uzunkum beach near Şile district.

2.1. Site descriptions

Kumbaba Beach is the west part of a long sand coast east of Şile approximately 3 kilometers long and limited to the east by the port of Şile and to the west by a very small rocky promontory; not far from it the Türknil River flows into it (41.173341° N; 29.569386° E) (Figure 2a). The seabed of this site is characterized by fine sand mixed with mud that accumulates due to the seasonal contributions that the nearby river pours into the sea during flood periods. In the seabed of this area a meadow of *Zostera noltei* Hornemann develops and on the few rocks that emerge from the mud from the bottom various algal species develop with a good abundance of the *Rhodophyta Gracilaria verrucosa* (Huds.) Papenf. and the Heterokontophyta *Dictyota dichotoma* (Huds.) Lamour.

Uzunkum beach, located east of the town of Şile, is a one kilometer long beach enclosed between two small rocky promontories (41.171767° N; 29.634561° E) (Figure 2b). The seabed of the bay is almost completely sandy and in the deepest part is characterized by sand mixed with mud with numerous rocky outcrops. In these seabeds the most evident vegetation is characterized by the seagrass *Zostera noltei*. The bottom rocks are covered by an algal population characterized by the Heterokontophytes *Gongolaria barbata* (Stackhouse), *Padina pavonica* (Linnaeus) Thivy, 1960 and *Dictyota dichotoma* (Linnaeus) Thivy and by the Rhodophyta *Gracilaria verrucosa*. Along this beach there are no river mouths and the only contributions of terrigenous material occur during the most intense meteorological events.

2.2. Sampling methods

The observations were made in September 2023 (on the 10th and 15th) at depths ranging from 1 to 4 meters by two research divers using scuba and snorkeling. The observations on the individuals of *B. leachii* were carried out with the *visual census* technique, counting all the specimens present along a transect parallel to the coastline, 300 meters long and 5 meters wide on average. Thus, obtaining a sampling surface of 1500 square meters. To obtain more precise counts of the specimens in the investigated area, the entire transect was divided into sectors 100 meters long and 5 meters wide; in each of these sectors the specimens were counted. This way of operating allowed us to obtain a more realistic estimate of the number of *B. leachii* specimens present in the study area.

The dives were always carried out in the central hours of the day, between 12:00 and 15:00, in each of the sampling sites. This allowed us to compute the average number of specimens found on each of the beaches we surveyed (Table 1).

Furthermore, 15 specimens of *B. leachii* were randomly collected for morphometric measurements from each of the two sampling sites. For each specimen collected, length, width and weight were recorded (Table 2). All captured specimens were measured in situ and promptly released into the sea.

3. RESULTS AND DISCUSSIONS

The present study describes the presence of the *B. leachii* species in the coastal marine waters of the Black Sea.

Prior to this report, specimens of *B. leachii* had been reported in the Çanakkale Strait in the Turkish Straits system, just south of the Sea of Marmara (Özalp *et al.*, 2021). This is a habitat whose marine life and ecology are a mix of what can be observed in the Mediterranean and Black Seas (Culha and Sahin 2018).

During our study we observed a total of 484 specimens; 372 of which were found on the seabed of Kumbaba Beach and 112 on Uzunkum Beach. In our opinion, the substantial variation in number of specimens recorded on the bottom of the two beaches cannot be attributed to the days of delay between observations at the two study sites, or to other meteorological or water-dynamic conditions. We believe that, however, that the current large numerical difference between the number of *B. leachii* individuals observed at Kumbaba Beach (372) and Uzunkum Beach (112) is due to the difference in the type of seabed habitat and the availability of nutrients between the two sites. The Kumbaba Beach site, in fact, is located right near the mouth of the Türknil River and the terrigenous contributions that the river pours into the sea have created the ideal habitat for these Opisthobranchs which, being mainly herbivores and detrivores, find in the bottom sediments great availability of food. On the other hand, in the Uzunkum Beach site there aren't significant coastal terrigenous contributions as the bay is closed between two promontories and has no outlets of rivers or streams, even if of a seasonal nature. Therefore, in this bay the only source of organic material available for *B. leachii* is represented by the presence of marine plants (seaweeds and/or seagrasses).

During the observations, isolated specimens of *B. leachii* were always found in portions of the seabed covered by *Z. noltei* meadows, with sandy-muddy sediments between depths of approximately 1.0 – 4.0 m, or near rocks of the bottom covered with algae.

281 specimens, more than half of the total, were found on Kumbaba Beach, in the portion of the seabed closest to the mouth of the Türknil River. This shows that these animals prefer seabeds rich in debris for the ease of finding food.

Nevertheless, the data relating to the abundance of individuals per m^{-2} appears to be very low compared to what is reported in the literature. In the Şile coastal bottoms, in fact, an average density per square meter of 0.248 ind/m^{-2} in Kumbaba and 0.074 ind/m^{-2} in Uzunkum was detected (Table 1).

These average density values of ind/m^{-2} are far from what was found in the nearby Çanakkale Strait, in the Turkish Straits system, by Özalp *et al.* (2021) who report an average of 5 ind/m^{-2}. Indeed, other authors report extremely higher ind/m^{-2} values; for example, Ballesteros *et al.* (2022) report 5-10 ind/m^{-2}, Selfati *et al.* (2017) 50 ind/m^{-2}, Behera et al (2020) 150-200 ind/m^{-2} and even Rudloe (1971) report over 600 ind/m^{-2} (Table 3).

From the data collected, it is clear that the density of ind/m^{-2} is not comparable to what is observed in other seas (Table 3). However, considering the number of specimens found, it is possible to state that the presence of this species is not an occasional event for the Black Sea.

Table 1. Number of specimen of *B. leachii* per site and per sector

Area of sampling	**Kumbaba Beach**			**Uzunkum Beach**		
Sector of sampling	Sector 1	Sector 2	Sector 3	Sector 1	Sector 2	Sector 3
N specimens	91	145	136	37	35	40
Mean per sector	124			37.333		
N° of ind/m^{-2}	0.248			0.074		
Total	372			112		

Table 2. Morphometric characteristic of *Bursatella leachii* collected in Black Sea

Site	N specimen	Body length (mm)	Body width (mm)	Body weight (g)
Kumbaba Beach	1	87	39	40
	2	75	37	39
	3	82	41	39
	4	84	38	40
	5	72	34	30
	6	86	33	42
	7	69	29	39
	8	97	46	53
	9	94	79	55
	10	112	50	64
	11	81	39	47
	12	89	41	45
	13	81	37	41
	14	98	41	48
	15	103	39	50
Mean ±		**87.333**	**41.533**	**44.8**
St. dev.		**11.812**	**11.513**	**8.325**
Uzunkum Beach	1	70	39	27
	2	69	37	26
	3	74	41	22
	4	80	38	31
	5	56	34	19
	6	76	33	22
	7	59	29	18
	8	88	46	33
	9	85	79	30
	10	101	50	46
	11	79	39	34
	12	85	41	40
	13	74	37	33
	14	88	41	34
	15	93	39	38
Mean ±		**78.467**	**41.53**	**30.2**
St. dev.		**12.188**	**11.513**	**7.965**

Table 3. Number of ind/m^{-2} detected in present study and in other studies

Location	**Şile District** Black Sea	**Çanakkale Strait** Turkish Straits	**Balearic Islands** Mediterranean	**Morocco** Mediterranean	**Bay of Bengal** Indian Ocean	**Florida** Gulf of Mexico
References	Present study	Özalp *et al*., 2021	Ballesteros *et al*., 2022	Selfati *et al*., 2017	Behera *et al*., 2020	Rudloe *et al*., 1971
N° of ind/m^{-2}	0.16 ind/m^{-2}	5 ind/m^{-2}	5 – 10 ind/m^{-2}	50 ind/m^{-2}	150 - 200 ind/m^{-2}	> 600 ind/m^{-2}

We believe, in fact, that it is possible to hypothesize that *B. leachii* may have undertaken a phase of colonization of a new range and, for this reason, the expansion of this species in the Black Sea should be studied with adequate monitoring programs. In fact, an excessive presence of specimens of *B. leachii* could impact activities related to small-scale local fishing with gill nets.

In consideration of the ecological characteristics of *B. leachii*, which prefers estuarine and/or low salinity environments, and taking into account that the Black Sea has a lower salinity than the Mediterranean Sea, we believe that an ever-increasing number of Non-Indigenous organisms with broad ecological value can colonize the system of the Turkish Straits and, having overcome the natural "bottleneck" constituted by the Bosphorus, it will spread with ever greater success in the waters of the Black Sea (Özalp *et al.*, 2021).

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AUTHORSHIP CONTRIBUTION STATEMENT

Vincenzo DI MARTINO: Conceptualization, Methodology, Validation, Formal Analysis, Resources, Writing - Original Draft, Writing-Review and Editing, Data Curation, Supervision, Underwater Sampling. **Bessy STANCANELLI:** Methodology, Validation, Resources, Writing-Review and Editing, Data Curation, Underwater Sampling

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

ETHICS COMMITTEE PERMISSION

No ethics committee permissions is required for this study.

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ORCID IDs

Vincenzo DI MARTINO:
https://orcid.org/0000-0002-5987-0954
Bessy STANCANELLI:
https://orcid.org/0000-0001-7126-0633

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