

The Sea Slug *Tethys fimbria* Linnaeus, 1767 (Nudibranchia: Tethydidae) Expands its Distribution Northwards to the Sea of Marmara

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ABSTRACT

This study reports our observation of the large sea slug *Tethys fimbria* Linnaeus, 1767 in the northern-eastern Sea of Marmara (the Princes' Islands). We observed *T. fimbria* on the detrital bottom of the sea at a depth of 35 m in June 2022. This species had previously been reported during spawning in a recent study conducted in the southern part of the Çanakkale Strait (the Dardanelles Strait that connects the Marmara Sea with the Aegean Sea). Prior to 2022 there had been no reports of this conspicuous species from the Marmara Sea in the scientific literature or in photo-records among divers. Following our observation of the species in the sea around the Princes' Islands, underwater photographers reported pictures of *T. fimbria* from different locations in the Marmara Sea on social media platforms. The sea slug seems to extend its distribution northwards. The potentially new arrival of the large sea slug in the Sea of Marmara, rather than a distribution shift from deoxygenated deep Marmara basins or a climate-related northwards expansion, is discussed.

Keywords: Sea of Marmara, *Tethys fimbria*, Species Distribution, Nudibranchia, Mollusca

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INTRODUCTION

The Sea of Marmara is an inner sea with a complex geological history involving episodic connections located between the Black Sea and the Mediterranean Sea (Yanko-Hombach et al. 2007; Büyükmeriç 2016). The colonization of the Marmara Sea is therefore assumed to be relatively recent, following the establishment of the present-day two layered stratification system (Meriç and Algan 2007; McHugh et al. 2008). The inner sea connects two nearly isolated seas with highly different oceanographic features through two narrow channels (Beşiktepe et al. 1994). The Sea of Marmara along with the İstanbul Strait (the Bosphorus) and the Çanakkale Strait (the Dardanelles) is described as the Turkish Straits System and acts as a corridor for two-way translocation of species from their native habitats in the Black and Mediterranean Seas (Öztürk and Öztürk 1996). In recent years cli-

mate change has accelerated shifts of species from the Mediterranean Sea into the Sea of Marmara, and from there to the Black Sea under the process of 'Mediterraneanization' (Oğuz and Öztürk 2011; Öztürk, 2021). The presence of Atlantic-Mediterranean and Indo-Pacific species in the Sea of Marmara and the Black Sea could represent important signs of the process of Mediterraneanization (Turan et al. 2016). Changes in species distribution, shifts in range and introduction of alien species are increasing concerns in the marine environment related to climate driven factors, among others (Azzurro et al. 2019; Pinsky et al. 2020). Therefore, monitoring studies are essential in determining changes in marine communities (Bianchi and Morri 2000; Philippart et al. 2011). This study reports on the sea slug *Tethys fimbria* Linnaeus, 1767, observed in the northern part of the Sea of Marmara during a monitoring study in a place where there had been no previous records of



the species. This study briefly discusses the observation of the species in the Sea of Marmara, its potentially new arrival, and relations to climate driven or perturbation caused processes.

MATERIAL AND METHODS

The study site is in the north-eastern Sea of Marmara, in the Princes' Islands. In the Sea of Marmara an evident stratification is present; the upper layer is dominated by brackish waters from the Black Sea, while the lower layer is dominated by saline Mediterranean waters flowing northwards from the Aegean Sea (Beşiktepe et al. 1994). The two water masses are separated by a permanent halocline. The lower layer below the halocline does not undergo major seasonal variations and has a salinity of ‰38, a temperature of approximately 14 °C, and dim light.

The study was carried out in June 2022 during a monitoring study by SCUBA diving around the Burgazada, Kalpazankaya station in the Princes' Islands region, northeastern Sea of Marmara [Latitude: 40°52'40.84"N, Longitude: 29° 3'7.19"E] (Figure 1).

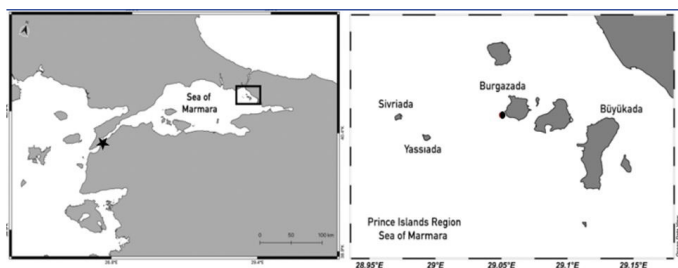


Figure 1. Location of the Princes' Islands and the monitoring station (black dot) where *T. fimbria* was observed. The location of the previous observation of the species (Özalp et al. 2022), where spawning was observed in January, is shown with a star.

RESULTS AND DISCUSSION

The specimen described here was observed on a sandy/muddy sea bottom at a depth of 35 m at midday (Figure 2). It was observed first on the seafloor and then swimming in the water column. The sea slug measured approximately 25 cm in length (Figure 1). An updated checklist of marine molluscs documents two species along Turkish coasts belonging to the Tethydidae family; *Melibe viridis* (Kelaart, 1858), and *T. fimbria* (Öztürk et al. 2014). The latter was first recorded from the Aegean Sea (Forbes, 1844) and later was reported from the Levantine coast (Swennen, 1961). Another study reports the large sea slug from the central Aegean Sea (Geldiay and Kocataş, 1972). Recently, Özalp et al. (2022) reported *T. fimbria* in the Dardanos MPA (southern coast of the Çanakkale Strait) between 10-28 m on soft substrate and around the Posidonia beds. The authors observed large numbers of sea slugs spawning in January. The species distribution ranges from the Mediterranean Sea (Domenech et al. 2006; Crocetta et al. 2020; Betti et al. 2021; Toma et al. 2022) to the Atlantic Ocean, including the Spanish coast off the Gulf of Biscay, the mainland coast of Portugal, the Andalusian Atlantic coast, the Andalusian Mediterranean coast, the Spanish Levant, from Cape Gata to

Catalonia, Catalonia, the Balearic Islands, the Canary and Selvagens Islands (Cervera et al. 2006) and the Cape Verde Islands (Wirtz et al. 2016).

The sea slug *T. fimbria* is one of the largest heterobranchs, with a length of up to 30 cm, and is the only species of the genus *Tethys*, closely related to the genus *Melibe*. Both have a large oral hood (velum) used in the capture of food, mainly represented by small crustaceans, ophiuroids and other invertebrates (Thompson and Brown, 1984). *Tethys* is characterized by a stout translucent white body, with a pair of small rhinophores and a series of five to six flattened cerata, whitish to yellowish in color, with orange marks and numerous black spots. The cerata of this sea slug possess great amounts of PG derivatives used in defense mechanisms (Marin et al. 1991) and can be autotomized.

T. fimbria is defined as a euribathic and euryphagous species since it has been observed both in deep and shallow areas (Toma et al. 2022 and references therein). The shallow (< 50 m) records of the species usually report one or few individuals (Sigovini et al. 2014; Trainito and Doneddu, 2015) while deeper reports generally include numerous individuals (Domenech et al. 2006; Crocetta et al. 2020; Toma et al. 2022). We should keep in mind that different sampling strategies have typically been used in each of the two layers. For example, studies in shallow waters were accomplished by SCUBA diving while studies in deeper waters utilized bottom trawling, except that of Toma et al. (2022) whose study was carried out by means of remotely operated vehicles. Photo-records of the species in underwater photography or marine life related websites (e.g. seaslugforum.net; opisthobranquis.info) also seem to report few individuals generally observed during night dives. *T. fimbria* is relatively common in the Adriatic Sea characterized by turbid waters and dim light conditions, as the Sea of Marmara (Sigovini et al. 2014; Zenetos et al. 2016; Betti et al. 2021).

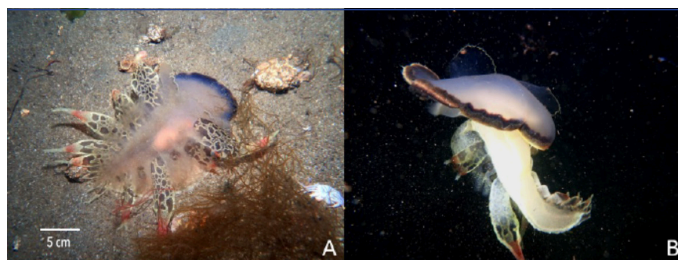


Figure 2. *Tethys fimbria* specimen encountered in June at Kalpazankaya resting on soft substrate (A); and swimming (B).

The Princes' Islands are the most favored diving spot of the Sea of Marmara. This large sea slug is very conspicuous and cannot be unnoticed to divers, particularly to underwater photographers, and yet we could find no observations of this sea slug prior to 2022. However, we encountered two entries on social media with photos of this species taken by underwater photographers and by diving clubs in summer 2022. These photos had been taken in the southeastern Marmara coastal waters. Hence, *T. fimbria* seems to be a late arrival in the Sea of Marmara, possibly due to ongoing Mediterraneanization.

A possible reason for the previous non-sighting of this species in the area could be that *T. fimbria* may have used exclusively deeper areas in the Sea of Marmara and thus gone unnoticed to divers. The sea slugs may have escaped the recent deoxygenation of deep Marmara basin (Mantıkçı et al. 2022; Yalçın et al. 2017) and shown up at shallow depths. However, under this scenario, the species would have been found in trawling surveys as in the Mediterranean, where it is usually reported in large numbers (Domenech et al. 2006; Crocetta et al. 2020; Toma et al. 2022). There are several surveys by towing gears undertaken in the Marmara Sea that report sandy/muddy bottom fauna from different depth layers (Altuğ et al. 2011; Bök et al. 2011; Zengin et al. 2017; Çolakoğlu, 2020 among others). However there are none that report *T. fimbria*.

In the Mediterranean Sea, climate-driven surface water warming, among other factors such as habitat degradation, competition with others and changing environmental parameters may alter the species abundances in a severe way by extending the species range and enhancing the poleward migrations (Azzurro et al. 2019; Yapıcı et al. 2016). Therefore, some species, especially invasive ones, may move to new regions to survive where they were absent before, and some native thermophilic species thus extend northwards (Azzurro et al. 2008, 2011, 2019). Similar warming trends are also present in the Sea of Marmara, an inner sea that connects the Black Sea and the Aegean Sea and acts as an ecological barrier in between. An increase of 2.11°C in sea surface temperature values and 0.95 PSU in surface salinity values was already reported in the small basin (Latif et al. 2022). Along with the ongoing warming trend from climate change, the semi-enclosed Marmara Sea might be subject to other warming contributors, such as warm industrial wastewater discharges and the loss of natural coasts with increasing coastal constructions (thus giving rise to the loss of natural cooling mechanisms through wave actions). However, *T. fimbria* is not a thermophilic species and its presumed new arrival in the Marmara Sea cannot be a consequence of the warming trend. We therefore relate the recent observation of *T. fimbria* in the Marmara Sea mainly to its recent arrival in this inner sea.

CONCLUSION

In this study a northern expansion of the distribution of the large nudibranchia *Tethys fimbria* was reported in the northeastern Sea of Marmara near Burgazada. The recent observation of this large sea slug in the Sea of Marmara seems to be related mainly to its new arrival in the Marmara Sea rather than to a distribution shift from deoxygenated deep basins or to a climate-related expansion.

Conflict of Interests: Authors declare that there is no conflict of interest.

Ethics committee approval: Authors declare that ethical approval is not required for this type of study.

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