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SHORT COMMUNICATION

Spongivore ecology in the Turkish seas: Notes on the first in-situ record of *Umbraculum umbraculum* ([Lightfoot], 1786) on Demosponge *Calyx nicaeensis* (Risso, 1826) populations from the mesophotic depths of Bozcaada (Aegean Sea, Türkiye)

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Abstract

The diversity and ecological importance of sea slugs (Heterobranchia) in the Turkish seas are largely unknown. This is particularly true for spongivorous invertebrates, whose roles in these ecosystems remain uninvestigated. These taxa, although often overlooked, play important roles in shaping benthic communities through selective predation on sponge species. The aim of this study is to contribute to the knowledge of spongivore ecology in the eastern Mediterranean by documenting the first in-situ observations of the rare heterobranch *Umbraculum umbraculum* feeding on the demosponges *Calyx nicaeensis* and *Suberites domuncula* at mesophotic depths around Bozcaada Island (Aegean Sea, Türkiye) and the Çanakkale Strait. This finding reveals a highly specialized predator-prey interaction and extends the known distribution of *U. umbraculum* in the region. By providing novel ecological data from an understudied depth zone and taxonomic group, this study underscores the importance of incorporating spongivorous species into broader benthic biodiversity assessments.

Keywords: Spongivory, sponge, Çanakkale Strait, Bozcaada, Gökçeada, Aegean Sea

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Sponge-feeding sea slugs have garnered increasing scientific interest across a range of biogeographic regions, spanning from the temperate coasts of North America (e.g., Mexico, the USA, and Canada) to tropical and subtropical marine environments. Among these, heterobranch mollusks stand out for their diverse feeding strategies and specialized trophic relationships with sessile invertebrates. Approximately one-third of the 3,000 described nudibranch species are known to be spongivorous. While many heterobranchs demonstrate a preference for sponges (Phylum: Porifera), others feed on bryozoans, cnidarians (e.g., anthozoans, hydrozoans), ascidians, and occasionally algae (Valdés and Gosliner 2001; Wägele and Klussmann-Kolb 2005).

Spongivory continues to be one of the most prevalent and ecologically meaningful feeding modes among heterobranchs. Several taxa exhibit specialized morphological and behavioural traits for sponge predation, often with high host fidelity. Dorid nudibranchs are the most intensively studied sponge predators (Belmonte *et al*. 2015; Mullins 2021), and species such as *Tylodina perversa, Berthellina citrina*, and *Umbraculum umbraculum* are widely cited examples of such specialization. Nevertheless, flexibility in feeding has also been observed. For instance, a dorid nudibranch *Bathydoris cinnabarina* primarily feeds on the deep-sea sponge *Thenea muricata* (Bouchet 1977; Cattaneo-Vietti 1991), but in shallower or mesophotic habitats, it may shift to alternative sponge species (Ballesteros and Valdés 1999). A similar pattern of ecological adaptability is noted in tritoniids, which may alter their prey preferences based on depth and habitat features (Toma *et al*. 2022). Tritoniid nudibranchs are also widely recognized for their coral-specialist feeding feature (Allmon and Sebens 1988; Cronin *et al*. 1995; Smith and Gosliner 2003; Bertsch *et al*. 2009; Trainito *et al*. 2021; Cirivasi 2024).

Although global interest in spongivorous Heterobranchia is increasing, studies focusing on Turkish marine ecosystems remain scarce. Specifically, in-situ data on trophic relationships in mesophotic zones are virtually non-existent. This study addresses this gap by documenting *U. umbraculum*'s predation on *C. nicaeensis* in offshore habitats of Bozcaada, thus offering a rare glimpse into sponge-slug dynamics in the eastern Mediterranean and reinforcing the need for continued faunistic and ecological research.

Benthic marine ecosystems are shaped by intricate trophic interactions, many of which involve sessile invertebrates and their specialized consumers (Calado and Leal 2015). Among these, spongivory plays a functionally significant role, particularly in sponge-dominated habitats where sponges regulate nutrient fluxes, influence microbial community dynamics, and provide structural habitat for a wide range of benthic organisms. Within this ecological context, heterobranch sea slugs, an evolutionarily diverse subgroup of opisthobranch mollusks, exhibit a broad spectrum of feeding behaviours. Nudibranchs, in particular, represent a taxonomically and ecologically rich lineage, with nearly one-third identified as

sponge feeders. This trophic specialization has led to the evolution of distinct morphological and behavioural adaptations, often associated with high host specificity. Species such as *Tylodina perversa* and *Berthellina citrina* exemplify these specialized predator-prey dynamics. Nonetheless, accumulating evidence indicates significant dietary plasticity within some lineages, where prey preferences may shift in response to environmental heterogeneity and depth-related gradients.

Recent observations have revealed unexpected feeding behaviors in the umbraculid molluscs *Tylodina perversa* and *Umbraculum umbraculum* along the central-eastern coast of Sicily. While *T. perversa* is typically described as a sponge feeder, preferentially associated with sponges of the genus *Aplysina*, recent surveys showed that local populations were exclusively found on algal substrates, supporting the hypothesis that this species can shift to cyanobacterial or algal feeding when sponges are scarce (Lombardo and Marletta 2022).

In contrast, *U. umbraculum* is a well-known sponge predator (Willan 1984, 1998) and was consistently documented feeding on the sponge *Crambe crambe*, causing significant tissue damage, which reinforces its role as an active sponge grazer within benthic communities (Lombardo and Marletta 2022). These findings underline the trophic plasticity and habitat-specific diet preferences of these two species, highlighting the need for further research on their ecological roles in Mediterranean coastal ecosystems.

Despite extensive research on spongivorous nudibranchs in the Atlantic and Indo-Pacific, the eastern Mediterranean remains largely understudied (Rizgalla *et al*. 2025). This gap is especially pronounced in mesophotic zones, where in-situ ecological observations of predator-prey interactions are extremely limited (Gönülal and Dalyan 2017; Valdés *et al*. 2018), primarily due to logistical challenges and the underrepresentation of soft-bodied taxa in biodiversity assessments (Albano *et al*. 2020; Furfaro *et al*. 2025).

The current work documents the first in-situ observations of *Umbraculum umbraculum* on *Calyx nicaeensis* and *Suberites domuncula*, the offshore waters of Bozcaada Island (Aegean Sea, Türkiye) and Çanakkale Strait, respectively. This novel finding contributes to the understanding of trophic ecology of *U. umbraculum* and represents the known sponge-mollusk interaction in this region. Although the feeding behaviour of species on *Tethya* sponges has been frequently reported (Caballer *et al*. 2015; Arias and Crocetta 2016), the data is lacking for the northernmost regions of the Turkish seas. Studies in New Zealand waters revealed that the genus *Umbraculum* primarily exhibits spongivory only on Demospongiae species (Willan 1984). In the Mediterranean Sea, observations showed the species feeding on various sponges such as *Tethya citrina*, *Jaspis johnstoni*, *Alectona millari*, *Agelas* sp., *Aaptos aaptos*, and *Spiratrella cunctatrix*, though *Calyx* and *Suberites* sponges were not among them (Ballesteros *et al*.

2025b). It underscores the importance of targeted ecological studies in mesophotic habitats, which remain among the least explored ecosystems in the Mediterranean.

Umbraculum umbraculum was found rasping on two separate individuals of *C. nicaeensis* in mesophotic depths (40-42 m) off Bozcaada by the technical scientific divers. The first observation revealed visible tissue damage on sponge body, while the second showed new basal buds, indicative of asexual reproduction (Cerrano *et al*. 2013). In another instance recorded in the Çanakkale Strait, more severe damage to a sponge species *Suberites domuncula* was observed at the site. Willan (1984) showed that a different *Umbraculum* species (*U. sinicum*) caused extensive damage on sponge *Ecionemia alata*. While contrasting *U. umbraculum* and *U. sinicum*, the observed damage cases appear similar. Photographic evidence shows *U. umbraculum* in direct contact with large sponge individuals, which are presumed to be its food source. The sponge's smooth, globular morphology and whitish-grey coloration are diagnostic characteristics.

Calyx nicaeensis, commonly known as the goblet sponge, was first recorded from Bozcaada (Aegean Sea, Türkiye) in 2019 (Özalp 2019), marking its initial occurrence in Turkish waters. Subsequent surveys have revealed its predominance in rocky sublittoral habitats, particularly at depths greater than 35 meters. In some localities, it forms dense aggregations; however, these habitats are increasingly threatened by the spread of the invasive alga *Caulerpa cylindracea*. More recently, *C. nicaeensis* was also reported around Marmara Island during the regional biodiversity surveys (Özalp 2025). Notably, mesophotic surveys off Bozcaada have documented exceptionally large individuals, with diameters of up to 60 cm and heights reaching 28 cm (see Figures 2 and 3). The species' overall distribution and habitat characteristics are illustrated in Figures 1 and 2, while additional records of sponge-feeding sea slugs from the Çanakkale Strait, Bozcaada, and Gökçeada are presented in Figure 3.

In 2023 and 2024, a marine survey aimed at monitoring sea slugs was conducted in three regions: two stations around the Çanakkale Strait and four stations in the North Aegean Sea (Bozcaada and Gökçeada). Within this framework, a total of 36 scientific technical dives (24 dives in Bozcaada Tuzburnu-Ayazma region, 5 dives in Gökçeada Kaleköy-Pirinç region, 7 dives in Çanakkale Strait, Havuzlar-Dardanos region) were carried out at mesophotic depths ranging from 40 to 55 meters. This study primarily focuses on the findings obtained from the Bozcaada stations (Aegean Sea, Türkiye). All underwater photographs and video recordings were captured using a SONY DSC-N1 underwater camera. The lengths of both sea slugs and sponge specimens were measured using a ruler and calliper.

To assess the general faunal condition, the manta tow technique was applied with the aid of an underwater scooter along the mesophotic zones of the study sites.

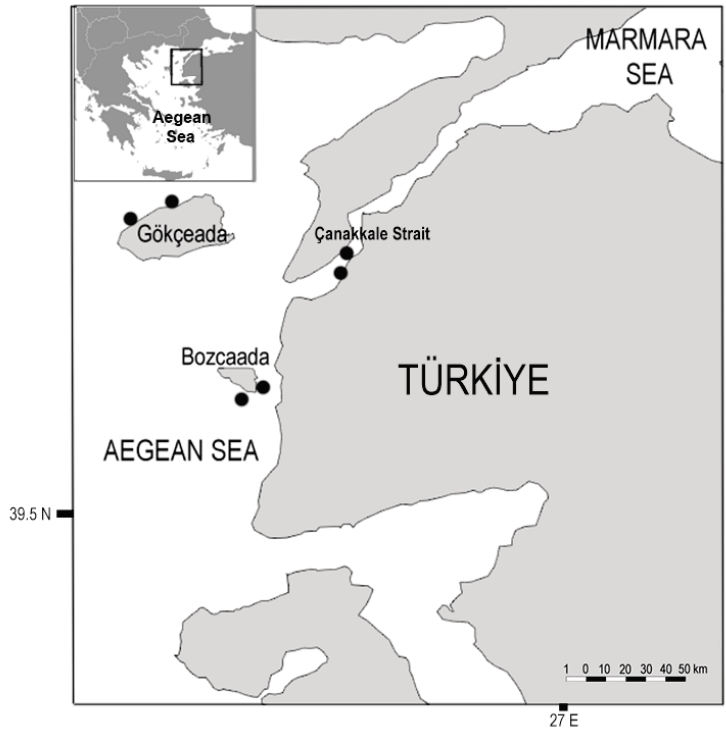

Figure 1. Map of the study area showing surveyed sites (dots) in the Çanakkale Strait, Bozcaada, and Gökçeada

During mesophotic dives off Bozcaada at different times, two individuals of *Umbraculum umbraculum* were observed in direct contact with *Calyx nicaeensis* at depths of 40 and 42 meters (Figure 2), while another individual was recorded embedded within the body of *Suberites domuncula* in the Çanakkale Strait, causing notable tissue damage to the sponge. During site surveys, divers conducted extended dives to observe the species' behaviour on individual sponges across different time intervals. The encounters in the rocky zones of Bozcaada revealed visible surface degradation on the sponge, consistent with rasping feeding behaviour. In the first observation, new basal buds were present, indicating a regenerative response. All observations were documented with close-up underwater photography (Figures 2 and 3).

Based on the known literature, this study provides the first in-situ evidence of the interaction between *Umbraculum umbraculum* and *Calyx nicaeensis* within the mesophotic ecosystems of the Aegean Sea, specifically in Bozcaada.

The spongivory behaviour of *U. umbraculum* was recently documented in the Çanakkale Strait, where severe damage was observed on a *Suberites domuncula* demosponge, whose entire body had been rasped by this species (Figure 3/F–G; Özalp 2025). The same study also recorded an encounter between the heterobranch mollusk *Dendrodoris limbata* and an individual of *S. domuncula* within the Dardanos Coral Reef Protected Area, highlighting the need for further research to fully understand sponge-feeding interactions.

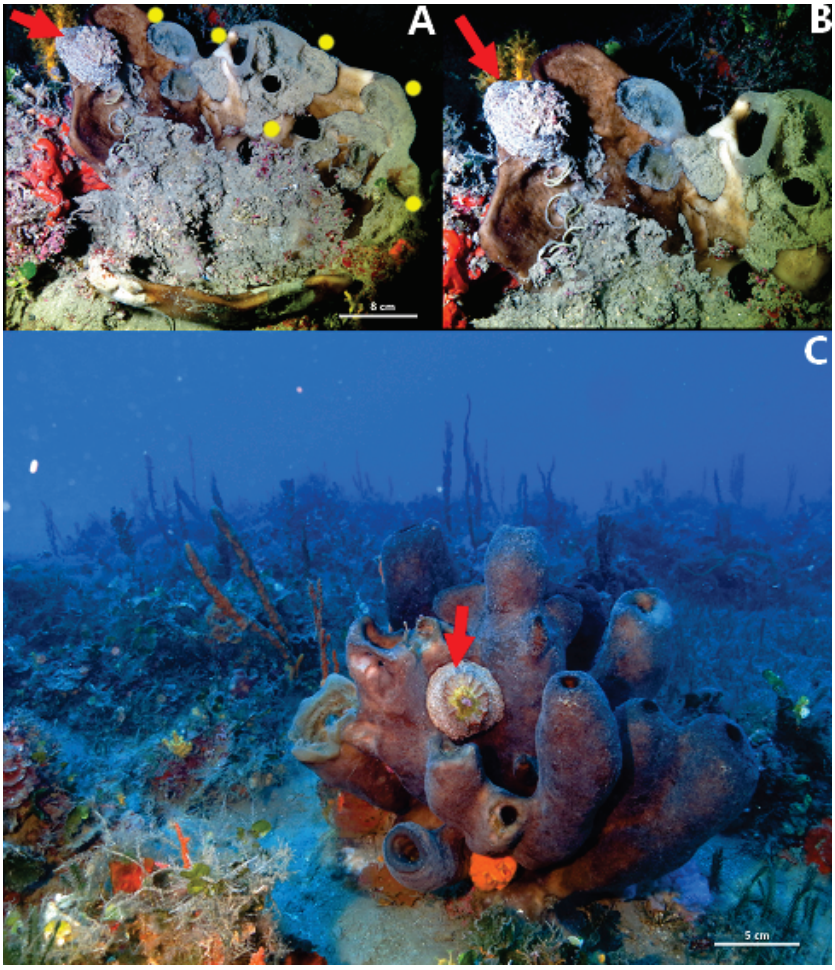

Figure 2. *Umbraculum umbraculum* on different individuals of *Calyx nicaeensis* recorded on rocky substrate off Bozcaada (North Aegean Sea, Türkiye). A-B: *U. umbraculum* (red pointer) and damaged sponge body (yellow spots), 42 m; C: *U. umbraculum* on an individual of *C. nicaeensis* showing asexual reproduction with the basal buds observed, 40 m.

Additionally, another study reported two *U. umbraculum* individuals closely associated with coralligenous habitats and *Chondrosia reniformis* sponge facies (Özalp *et al*. 2022). In the context of spongivory, species of the genus *Felimare* are also well known for their sponge-feeding habits. Several studies have documented *Felimare* species feeding on *Dysidea avara* (Pontes 2018; CIBSUB 2025; Ballesteros *et al*. 2025a). Notably, the most recent record of *Felimare* sea slugs feeding on *D. avara* in the Çanakkale Strait was reported by Özalp (2023).

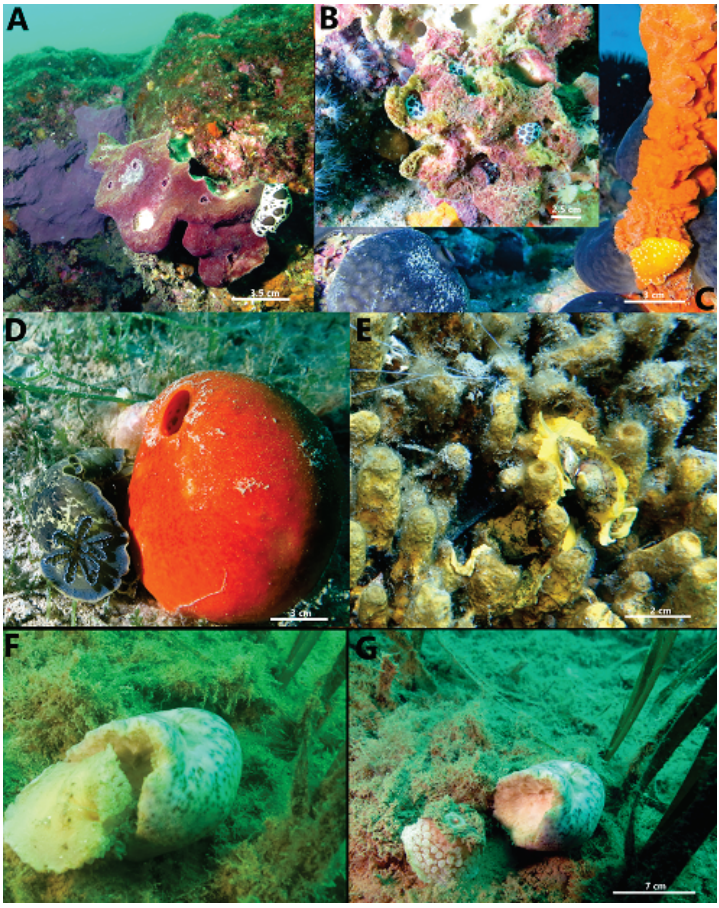

Figure 3. Spongivory behaviours observed at the survey sites. A–B: *Peltodoris atromaculata* feeding on *Petrosia* (*Petrosia*) *ficiformis*, showing extensive damage to the sponge body; C: *Phyllidia flava* on the sponge *Axinella cannabina*; D: *Dendrodoris limbata* near an individual of *Suberites domuncula*; E: *Tylodina perversa* on the sponge *Aplysina aerophoba*; F–G: *Umbraculum umbraculum* found embedded within the body of Suberites domuncula, with in-situ evidence of extensive damage such as a large hole in the sponge body (the individual shown here was removed by a scientific diver from inside the sponge). A, C, D, E, F, G: Çanakkale Strait (Özalp 2025); B: Gökçeada (North Aegean Sea, Türkiye).

The close physical association of *U. umbraculum* with visibly damaged *C. nicaeensis* individuals, along with localized tissue loss on the sponge surface, provides strong circumstantial support for active sponge predation. This observation is consistent with previous reports identifying *U. umbraculum* as a specialized spongivore capable of feeding on various demosponges and leaving discernible feeding marks (Toma *et al*. 2022). Consequently, *C. nicaeensis* can reasonably be considered among the dietary targets of this mollusk. While these field observations strongly indicate a trophic link, definitive verification would require additional analyses-such as gut content studies, molecular barcoding of ingested tissue, or stable isotope profiling-to confirm sponge ingestion at a physiological level. As such, the findings presented here should be interpreted as preliminary but valuable evidence that advances our knowledge of sponge–nudibranch ecological relationships in the eastern Mediterranean.

Given the limited ecological data from mesophotic habitats and the functional relevance of both taxa involved, this case emphasizes the necessity of comprehensive, multidisciplinary studies incorporating ecological, anatomical, and molecular approaches. Rocky substrates in the studied regions, some of which are recognised as biodiversity hotspots, are essential refuges for various invertebrates. These areas are characterized by endangered coral communities (*Cladocora caespitosa*, Tuzburnu Banks), coralligenous formations, and other substrate-forming sponge facies, which are predominantly found features demand urgent conservation due to threats from illegal fishing, trawling, seine fishing, and anchoring.

Moreover, it highlights the importance of integrating heterobranch mollusks into broader biodiversity monitoring programs and trophic network analyses, particularly in underexplored marine regions such as the Turkish Aegean coast.

In summary, this short communication contributes novel field-based insights into the feeding ecology of a rarely documented heterobranch species. When combined with existing literature and photographic records, these observations offer a foundation for future comparative research across Mediterranean biogeographic subregions.

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performed the laboratory work. All authors contributed to manuscript revision and approved the final version.

Türkiye Denizleri Spongivor Ekolojisi: Bozcaada (Ege Denizi, Türkiye) mezofotik derinliklerindeki Demosponge *Calyx nicaeensis* (Risso, 1826) popülasyonları üzerinde *Umbraculum umbraculum* ([Lightfoot], 1786) türünün ilk yerinde (in-situ) kaydına dair notlar

Öz

Türkiye denizlerinde deniz salyangozları (Heterobranchia) üzerine yapılan araştırmalar oldukça sınırlı olup, süngerle beslenen (spongivor) omurgasızlar ve bunların ekolojik rolleri hakkında bilgi eksikliği dikkat çekmektedir. İklim değişikliğine bağlı ısınma olayları, özellikle yumuşakçaların yayılım dengesini etkileyerek izleme çalışmalarını zorlaştıran faktörlerden biri olarak kabul edilmektedir. Bu taksonlar genellikle göz ardı edilse de, sünger türleri üzerinde seçici yırtıcı olarak bentik toplulukların şekillenmesinde önemli roller üstlenirler. Bu çalışmanın amacı, Doğu Akdeniz'de spongivor ekolojisine katkıda bulunmak amacıyla, nadir görülen heterobranch *Umbraculum umbraculum*'un, Bozcaada (Ege Denizi, Türkiye) çevresindeki mezofotik derinliklerde *Calyx nicaeensis* ve *Suberites domuncula* türleri üzerinde beslendiğine dair ilk yerinde (in-situ) gözlemleri sunmaktır. Bu bulgu, oldukça uzmanlaşmış bir yırtıcı–av etkileşimini ortaya koymakta ve *U. umbraculum*'un bölgedeki bilinen dağılımını genişletmektedir. Az çalışılmış bir derinlik zonu ve taksonomik grup hakkında yeni ekolojik veriler sağlayarak, bu çalışma spongivor türlerin daha geniş bentik biyoçeşitlilik değerlendirmelerine dahil edilmesinin önemini vurgulamaktadır.

Anahtar kelimeler: Spongivor, sünger, Çanakkale Boğazı, Bozcaada, Gökçeada, Ege Denizi

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