

RESEARCH ARTICLE

Preliminary study on cryptobenthic fish assemblages affected by the mucilage event in the northeastern Aegean Sea

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Abstract

Cryptobenthic fishes form a major component of coastal fish communities. Due to their site fidelity, life strategies and habitat preferences, they can be considered as indicator organisms which some changes in the coastal ecosystem can be detected. In this study, the effects of the mucilage event were studied through cryptobenthic fish assemblages in the North Aegean Sea between May and August of 2021. During 12 dives, a total of 166 individuals of 19 cryptobenthic fish species were observed belonging to the families Gobiidae (7 species), Blenniidae (7), Gobiessocidae (2) and Tripterygiidae (3). Density of the cryptobenthic fish were estimated as 11.4 (ind. per hour) in May and June (while intense mucilage formation was observed in the area) and 17.8 (ind. per hour) in July and August. The overall result revealed that the effects of mucilage are destructive for the marine cryptobenthic fishes.

Keywords: Gobiidae, Blenniidae, North Aegean Sea, Gökçeada Island, Saros Bay

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Introduction

Cryptobenthic fishes that mainly include combtooth and threefin blennies, gobies and clingfishes are important members of coastal marine communities. They are comparatively small and somewhat difficult to identify, therefore these fish did not occupy the interests of researchers for a long period of time (Patzner 1999;

Beldade and Gonçalves 2007). Nonetheless, cryptobenthic fishes form a major component of coastal fish communities throughout the tropics and subtropics (Gonçalves and Faria 2009). Their short lifespans and high reproductive abilities result in rapid generational turnover rates. Among cryptic fishes, gobies and blennies achieve a numerical superiority in terms of species number (Nelson *et al.* 2016). Gobiid fishes are generally carnivorous (algae or other plants are often preferred as secondary food) while blennies display a variety of feeding strategies and trophic niches (Wilson 2009; Zander 2012). Some blennies feed on algae and detritus which forms a vital link between primary consumers and higher trophic levels (Townsend and Tibbetts 2000), while some species are being detritivores or feeding on smaller fish, or the scales, mucus and fins of other larger fish (Willis 2001). These feeding modes, combined with high abundances, are believed to have profound impacts on the environment in which they inhabit.

Due to the site fidelity, life strategies and habitat preferences of cryptobenthic species (Munday and Jones 1998; Depczynski and Bellwood 2004; White and Brown 2013), they offer us an opportunity to measure the impact of any positive or negative changes in the ecosystem (Ahmadia *et al.* 2012) and can be considered as indicator organisms in which some changes in this ecosystem can be detected (Engin *et al.* 2018). More comprehensive data are needed to understand ecosystem loss, the factors that cause this loss, and their impact on the structure and function of biodiversity, as well as to be more accurate on biodiversity measures. However, most studies on ecosystems do not cover cryptobenthic fish species, therefore results are being far from a holistic approach. Although there is no study that evaluates the coastal ecosystem on cryptobenthic fish communities in the Mediterranean Sea, some studies had been conducted in the world's seas (Munday 2004; Munday *et al.* 2004; Bellwood *et al.* 2006; Goatley *et al.* 2016; Böhm and Hoeksema 2017; Brandl *et al.* 2017; Brandl *et al.* 2018; Cadena-Estrada *et al.* 2019).

The mucilage event, also known as the sea snow, is often considered to be one of the most damaging factors to benthic assemblages such as corals, coralligen beds and seagrass meadows, as it causes anoxia over time by covering facies and suspends physiological processes (Castelli and Prevedelli 1992; Rinaldi *et al.* 1995; Mistri and Ceccherelli 1996; Giuliani *et al.* 2005; Aktan *et al.* 2008; Topçu and Öztürk 2015; Cramer *et al.* 2018; Piazzzi *et al.* 2018; Özalp 2021). It is known to be a mucus-like exopolymeric organic matter formed in the marine environment due to the overgrowth of algae (Precali *et al.* 2005; Balkis-Ozdelice *et al.* 2021). The origin of mucilage in the marine environment mainly refers to two agents, planktonic organisms and benthic filamentous algae (Schiaparelli *et al.* 2007). It is often triggered by human-induced pressures such as domestic, agricultural and industrial wastes, insufficient biological/chemical treatment of the discharges, overfishing. A mucilage problem, which can be considered as an ecological disaster for the Marmara and North Aegean seas, started in November

2020 in the Sea of Marmara (Özalp 2021) and affected the North Aegean Sea as well.

The North Aegean Sea harbours variety of habitat types which makes it even more suitable for many / different species of cryptobenthic communities to inhabit. The purpose of the study is to examine the cryptobenthic communities in the North Aegean Sea and to evaluate whether these species are an ecological indicator showing the health of the coastal ecosystem as in the case of mucilage outbreak.

Materials and Methods

The samplings were conducted in Saros Bay and Gökçeada Island coasts located in the northeastern Aegean Sea (Figure 1).

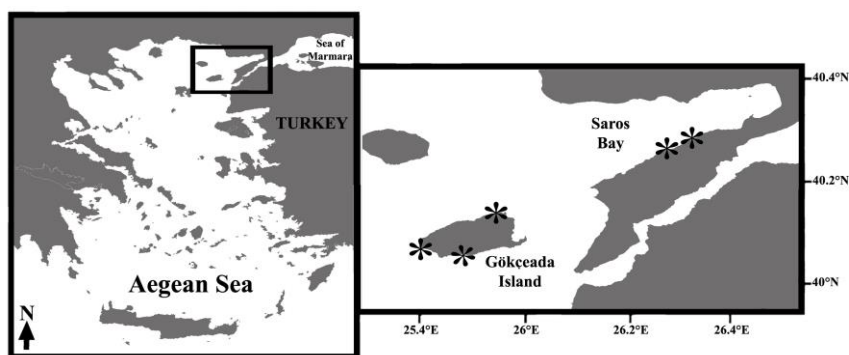


Figure 1. The study area and diving stations (*) in the northeastern Aegean Sea

Only the species of the families Blenniidae, Gobiidae, Gobiiesocidae and Tripterygiidae were studied. Sampling and observations were carried out at 5 localities (Figure 1), with at least two SCUBA divers to a depth of 30 m. All dives were performed during daytime 9:00-18:00, between May and August 2021. The total diving time spent for 12 dives were about 10 hours. The studied habitats were classified as Sand and Rocks (10–50 cm), Rocky Blocks (>1.5 m in diameter) and Bedrocks, according to Kovačić *et al.* (2012). The underwater visual census (UVC) technique was adopted as the study methodology. Fish were sampled using an anaesthetic solution (Quinaldine-2-Methylquinoline) which was diluted 1: 15 with 96% ethanol, then mixed 1 : 3 in 500 mL bottles with sea water (Kovačić *et al.* 2012). Initial observations pointed to the scarcity of cryptobenthic fish, therefore the time-transect method (Engin *et al.* 2018) was preferred. The observed number of individuals during a dive time was proportioned to an hour (ind/h). The anesthetized fish were collected using a plastic bag. Specimens were temporarily preserved in 4% formalin, stored in 50% ethanol afterwards. Cryptobenthic specimens, which could not be identified to a species level underwater, were later identified in the laboratory.

Frequency and dominance analyses were performed with the estimated value. Frequency analysis is the ratio of the number of dives in which the species was observed to the total number of dives. Soyer (1970) evaluated this value as very common ($F \geq 50$), common ($25 \geq F < 50$) and rare ($F < 25$). Moreover, dominance analysis is the ratio of the observed number of individuals of the species to the total number of individuals.

Results

Intense mucilage mass, between 0 and 30 m depth, was encountered in May and June at the diving points. However, mucilage was not found during the dives conducted in July and August. Observations in June at Gizli Liman (located in the southwest of Gökçeada) showed that the effects of mucilage were destructive for the marine ecosystem. The beds of *Posidonia oceanica*, *Acetabularia acetabulum* and *Mytilus galloprovincialis* had almost disappeared (Figures 2 and 3). The effect of mucilage event on Cryptobenthic fish was also visually recorded (Figure 4).

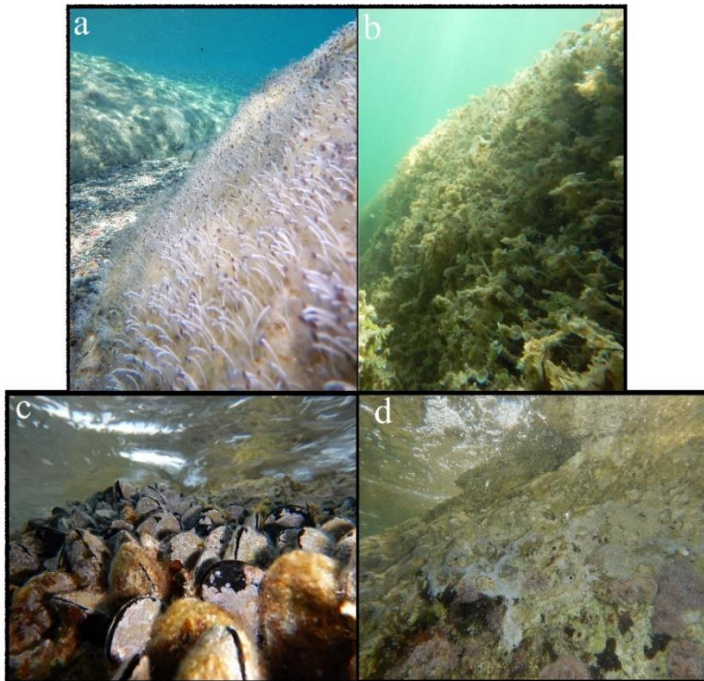


Figure 2. a-b *Acetabularia acetabulum* bed in June-2019 and June-2021; c-d a small clump of *Mytilus galloprovincialis* in June 2019 and June 2021 (photos: C. Dalyan)



Figure 3. *Posidonia oceanica* (Linnaeus) Delile 1813 clump damaged by mucilage (Photo: C. Dalyan)

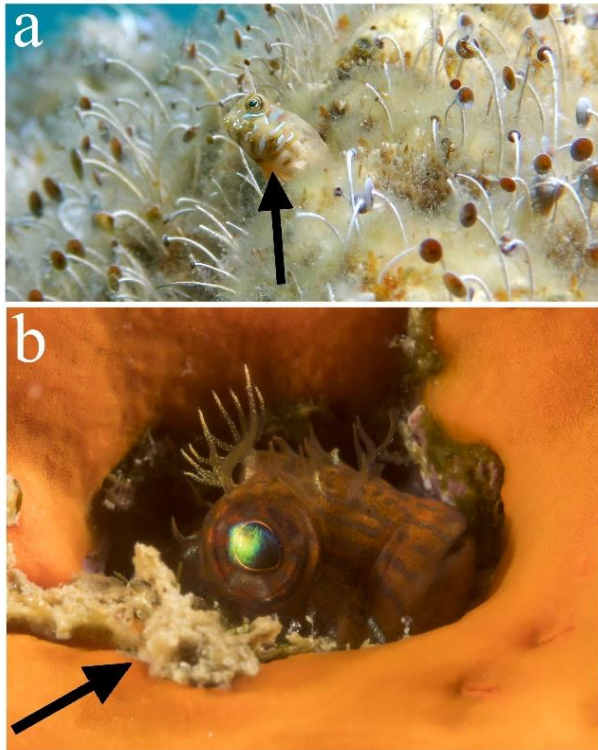


Figure 4. a: *Aidablennius sphynx* inhabiting *Acetabularia* beds; **b:** The aggregation of mucilage in the the cavity of *Parablennius zvonimiri* in Saros Bay (Photos: M. Orkun)

During 12 dives, 19 cryptobenthic fish species were observed. Members of the families Gobiidae (7 species), Blennidae (7), Gobiesocidae (2) and Tripterygiidae (3) are included in the species list (Table 1). The abundance data were standardized by the diving time. In total, 166 individuals were observed, with the highest number belonging to *Gobius incognitus* (29 ind.), followed by *Tripterygion delaisi* (24 ind.).

Table 1. Families and species of cryptobenthic species observed

Family	Species
Gobiesocidae	<i>Lepadogaster candolii</i> Risso, 1810 <i>Lepadogaster lepadogaster</i> (Bonnaterre, 1788)
Gobiidae	<i>Gobius auratus</i> Risso, 1810 <i>Gobius cobitis</i> Pallas, 1814 <i>Gobius cruentatus</i> Gmelin, 1789 <i>Gobius geniporus</i> Valenciennes, 1837 <i>Gobius incognitus</i> Kovačić & Šanda, 2016 <i>Gobius vittatus</i> (Vinciguerra, 1883) <i>Pomatoschistus bathi</i> Miller, 1982
Tripterygiidae	<i>Tripterygion delaisi</i> Cadenat & Blache, 1970 <i>Tripterygion melanurum</i> Guichenot, 1850 <i>Tripterygion tripteronotum</i> (Risso 1810)
Blennidae	<i>Aidablennius sphyinx</i> (Valenciennes, 1836) <i>Microlipophrys canevae</i> (Vinciguerra, 1880) <i>Parablennius incognitus</i> (Bath, 1968) <i>Parablennius gattorugine</i> (Linnaeus, 1758) <i>Parablennius sanguinolentus</i> (Pallas, 1814) <i>Parablennius rouxi</i> (Cocco, 1833) <i>Parablennius zvonimiri</i> (Kolombatović, 1892)

Observations of blennid species were limited to a maximum depth of 2 m (except for *Parablennius rouxi*), while Gobiesocids and Tripterygiids were encountered up to 4 m depth. *Gobius vittatus* and *P. rouxi* were the species with the deepest record of the study with a depth of 26 m.

In Gökçeada Island, 44 individuals belonging to 8 species were observed, while in Saros Bay, these numbers were 122 and 14, respectively.

Discussion

Engin *et al.* (2018) mentioned the presence of 33 gobiid species down to 50 m depth while Kesici and Dalyan (2020) observed 25 cryptobenthic fish species around Gökçeada Island down to the depths of 15 m. In this study, 19 cryptobenthic fish species were found between the depths of 0-30 m.

This study showed that *G. incognitus* (Frequency of occurrence: 42%), *T. delaisi* (42%), *G. geniporus* (33%), *L. lepadogaster* (33%) and *P. gattorugine* (25%) were estimated to be common (Figure 5). According to the frequency analysis estimated by Kesici and Dalyan (2020), *G. incognitus* (78%) and *T. tripteronotum* (59%) were considered as very common, while *C. galerita* (37%), *T. delaisi* (29%) and *P. incognitus* (25%) were presented as common species. Moreover, Engin *et al.* (2018) mentioned that *G. incognitus* were encountered in almost every dive. It can be stated that the frequency of *G. incognitus* has decreased when compared to other studies results in the region. Moreover, since Kesici and Dalyan (2020) used a quadrat for standardization, the lower probability of obtaining results compared to time transect should also be taken into account.

In terms of dominancy, *G. incognitus* (19%), *T. delaisi* (17%), *G. auratus* (14%) and *G. vittatus* (10%) had the highest values in this study (Figure 5) while *G. incognitus* (21%), *T. tripteronotum* (17%) and *C. galerita* (11%) were found to be the highest in Kesici and Dalyan (2020). The results in both frequency and dominance analyses indicated that the species composition has changed. This change is considered to be occurred under the influence of mucilage event.

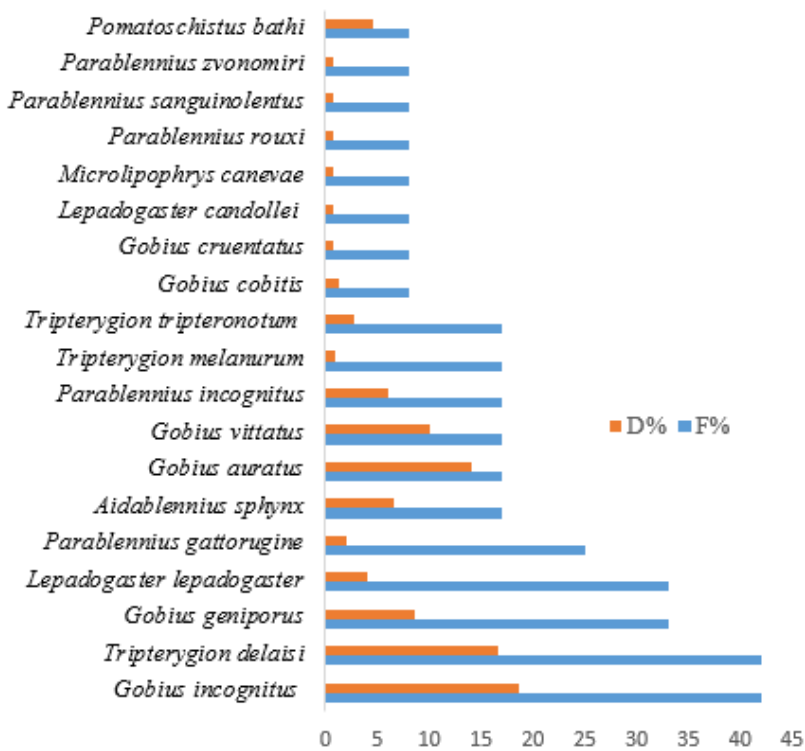


Figure 5. Frequency of occurrence (F%) and dominancy analyses (D%) of cryptobenthic fishes in the northeastern Aegean Sea

While 11.4 individuals of cryptobenthic fish were found per hour in May and June dives, this number increased to 17.8 in July and August. In addition to the reduction of mucilage effect visually observed in July and August, Kesici and Dalyan (2020) indicated that the unit area (1m²) included 3.7 individuals in Gökçeada Island in the similar season. On the other hand, the values 11.4 and 17.8 represented a low number of individuals, considering that a dive area of approximately 200 m² was surveyed per hour.

Although comparatively higher habitat diversity observed in Saros Bay might be the driving factor in this situation, the prevailing currents from the Marmara Sea carried the mucilage to the coasts of Gökçeada Island, which can be shown as another reason for the intense effects on the area.

The changes in cryptobenthic fish composition may indicate that these species were intensely affected by the mucilage event occurred in the Sea of Marmara. With a long-term investigation of its further effects, it may be possible to use cryptobenthic fish assemblages as indicators in determination of such possible disasters in the future.

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Kuzeydođu Ege Denizi'ndeki deniz salyası olayından etkilenen kriptobentik balık toplulukları üzerine bir ön çalışma

Öz

Kriptobentik balıklar, kıyı balık topluluklarının önemli bir bileşenini oluşturmaktadır. Alan koruma davranışları, yaşam stratejileri ve habitat tercihleri nedeniyle ekosistemdeki tüm değişikliklerin tespit edilebildiđi indikatör organizmalar olarak kabul edilebilirler. Bu çalışmada, Kuzey Ege Denizi'nde 2021 yılı Mayıs-Ağustos ayları arasında, deniz salyası (müsilaj) olaylarının etkileri kriptobentik balık toplulukları üzerinden incelenmiştir. Gerçekleştirilen 12 dalışta Gobiidae familyasına ait 19 kriptobentik balık türünden toplam 166 birey gözlemlenmiştir: Gobiidae (7), Blenniidae (7), Gobiessocidae (2) ve Tripterygiidae (3). Kriptobentik balıkların yoğunluğu Mayıs ve Haziran aylarında 11.4 (bölgede yoğun müsilaj oluşumu gözlenirken) ve Temmuz ve Ağustos dalışlarında 17.8 olarak tahmin edilmiştir. Genel sonuçlar, müsilajın etkilerinin deniz ekosistemi için yıkıcı olduğunu ortaya koymuştur.

Anahtar kelimeler: Gobiidae, Blenniidae, Kuzey Ege Denizi, Gökçeada, Saros Körfezi

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