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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

Distribution of phytoplanktonic species in the sea snot in 2021 in the Marmara Sea

Marmara Denizi'nde 2021 yılında görülen deniz salyası içerisindeki fitoplanktonik türlerin dağılımları

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Abstract: Sea snot, which was seen and reported in the Adriatic and Tyrrhenian Seas in the early 1990s, had been on Turkey's agenda as an environmental massive disaster from the winter months of 2021 until the end of summer in the Sea of Marmara. Due to the magnitude and topicality of the subject, the samples collected from the coastal areas where sea snot is observed in Marmara from January until July were examined. According to the results obtained, 5 classes were determined in sea snot. Species of algae that secrete mucilage, which provides stickiness to the formation, were also been identified in sea snot. These are 1 dinoflagellate, 2 Prymnesiosides, 5 diatoms, and 2 cyanobacteria species. 8 toxic planktonic species were detected in sea snot: 1 causing PSP poisoning and 3 of dinoflagellate causing DSP poisoning; 1 of prymnesiophisid that releases ichthyotoxin to the sea environment, and 3 of diatoms that cause ASP poisoning.

Keywords: Mucilage, sea snot, dinoflagellates, diatoms, Cyanobacteria

Öz: 1990'lı yılların başlarında Adriyatik ve Tiren Denizlerinde görülüp raporlanan deniz salyası, Marmara Denizi'nde 2020 kış aylarından itibaren yaz sonuna kadar bir çevre felaketi olarak Türkiye'nin gündemini oluşturmuştu. Konunun öneminin büyüklüğü ve güncelliği sebebiyle 2021 Ocak ayından itibaren Marmara'da deniz salyası görülen kıyısal bölgelerden Temmuz ayına kadar toplanan örnekler incelenmiştir. Elde edilen sonuçlara göre deniz salyası içerisinde planktonik olarak 5 sınıf, bu sınıflara ait 8 tür tespit edilmiştir. Deniz salyasında bulunan, oluşumun yapışkanlığı sağlayan müsilajı salgılayan türler de oluşumun içerisinde tespit edilmiştir. Bunlar; 1 dinoflagellat, 2 prymnesiosid ve 5 diyatome türüdür. Bunlara ilave olarak 2 tür müsilaj salgısı yapan siyonabakteri görüşmüştür. Deniz salyasında 8 toksik planktonik tür müsilaj içerisinde tespit edilmiştir: PSP zehirlenmesine yol açan 1 ve DSP zehirlenmesine yol açan 3 tür dinoflagellat; denize ihtiyotoksin salan 1 tür prymnesiofisid, ASP zehirlenmesine yol açan 3 tür diyatomdur.

Anahtar kelimeler: Müsilaj, deniz salyası, dinoflagellat, diyatome, siyanobakteri

INTRODUCTION

Climate change affects all living things on earth. In addition to global warming, the other thing that affects vibrancy is pollution. As dramatic examples of these environmental problems on a global scale, we observe algal blooms of several colors seen in certain periods in our seas, Sargassum macroalgae patterns detected from time to time in Dikili, planktonic algae, and sea lettuce overgrowth in the Gulf of Izmir, cyanobacteria-induced breakage, dead fish and jellyfish on our shores. In addition, the sea snot or mucilage phenomenon, which began in the winter of 2020, has increased in the Marmara Sea during the summer since the spring of 2021 and has been added to these negative processes.

In Türkiye, sea snot was first seen on the northeast coast of the Marmara Sea in the autumn of October 2007, around the shores of Izmit and Erdek (Tüfekçi et al., 2010), and reported in the following years. The unseen formation to create a major environmental disaster was reported in January 2008, and the snot structure was recorded to form filamentous structures in the Gulf of Izmit and on the shores of Erdek (Tüfekçi et al., 2010).

Since December 2020 and January 2021, it has been distributed from the Gulf of Izmit to Çanakkale. After 2007 and in 2020, the study of the species *Gonyaulax* of the dinoflagellate was intensely detected and reported in the sea snot body in the winter months (Aktan et al., 2008a). Its cyst formed after the summer months and is never seen until winter. The type of dinoflagellate that is releasing a direct tap into the sea environment *G. fragilis* was also reported as the most dominant species in the environment in the haulage studies in the Adriatic Sea (Pompei et al., 2003; Pistocchi et al., 2005).

Chrysophaeum taylorii I.F. Lewis and H.F. Bryan, 1941 species attracted attention by overgrowth in coastal areas of Florida. This species has been detected in sea snot in the Tyrrhenian Sea. This species was detected in the thick slimy tissue covering the seabed and marine plants, mainly *Posidonia oceanica* (Linnaeus) Delile, 1813, on the eastern coast of Sardinia Island and reported in 2007. It has been reported that *C. taylorii* species forms clusters and covers the seafloor by overgrowth on the seabed on the shores of Bodrum in the Eastern Mediterranean. This species, which is capable of producing slimy mucilage, accumulated at the bottom, and formed clumps in the middle water, but was not seen on the surface (Aktan and Topaloğlu, 2011). In the research conducted on the sea snot content, it was reported that some types of predominant, mucilage-capable dinoflagellate and diatom were not directly responsible for the creation of the sea snot environmental disaster (Negro et al., 2005). Similarly, certain planktonic species detected in the sea snot formations seen in different parts of the world are not directly responsible for the sea snot (Sherr and Sherr, 1987). *G. fragilis* (=*G. hyalina* (Mackenzie et al., 2002), which is densely detected in the sea snot in the Gulf of Tasmania; *Phaeocystis* sp. (Lancelot, 1995), which is seen in the winter sea snot on the shores of the North Sea; In the Adriatic, (Pompei et al., 2003) and the appearance of the *G. fragilis* (Aktan et al., 2008b; Tüfekçi et al., 2010; Balkis et al., 2011; Toklu-Alicli et al., 2020) species seen during the spring period in Marmara Sea are other examples in terms of species that are not responsible for the formation of direct sea snot.

Starting in the 18 st century in the Adriatic, 19th century irregularly the formation of the sea snot continues to be seen in the 21st century. By the early 20th century, it was one of the things that was not studied very much (Innamorati et al., 1995). In 1977, in the North Sea (Lancelot, 1995), mainly on the beaches of France, Belgium, the Netherlands, and Germany; in 1981 in the Gulf of Tasmania in New Zealand (Bradstock and Mackenzie, 1981), 1988 in the Adriatic (Rinaldi et al., 1995; Vollenweider et al., 1995) was observed in Tiren Bay (Melley et al., 1998) in 1991, in the Ligurian Sea (Schiaparelli et al., 2007) in 2003, in Marmara Sea (Aktan et al., 2008a; Tüfekçi et al., 2010; Balkis et al., 2011, 2013; Toklu-Alicli et al., 2020; Balkis-Ozdelice et al., 2021) and in the North Aegean (Nikolaidis et al., 2008) in 2008. In the Adriatic, Tiren Sea, Mediterranean, and Marmara Sea, the frequency of the sea snot is shown in Figure 1.

The aim of this study is to determine the phytoplanktonic species in the sea snot, which became an environmental disaster in the Marmara Sea in 2021, to create a list, to determine the species that directly secrete mucilage and release marine toxins, and to determine their rates.

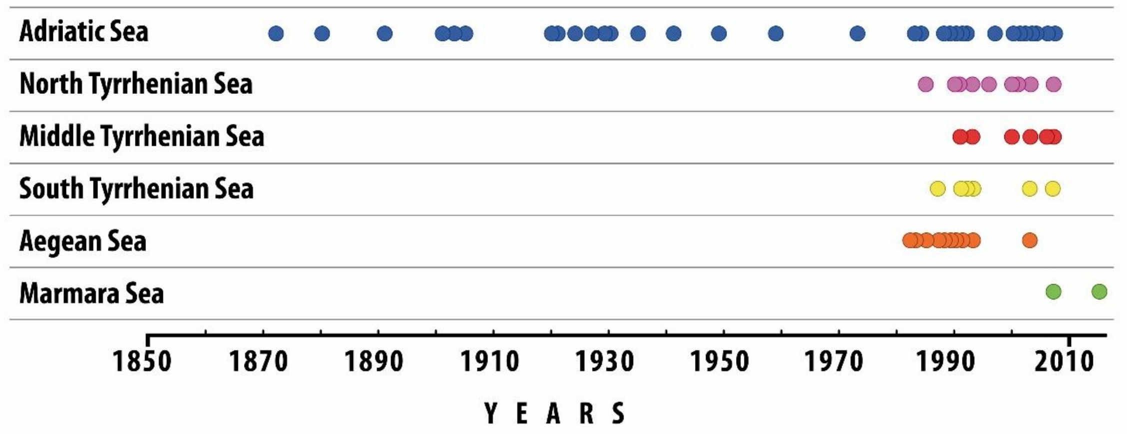

Figure 1. Frequency of sea snot appearance (by changing from Danovaro et.al., 2009)

MATERIAL AND METHODS

At the beginning of 2021, samples were collected monthly from 6 stations between January and July (Figure 2), when the stratification of marine snot began to be observed in the Marmara Sea, and the species list was formed by combining the results of the 7-month examination (Table 2).

Sea snot formation from the sea surface and up to 10 cm below the surface was collected with gloves for protection from pathogens in its content and put in 5-liter containers with seawater. Samples fixed in situ with 4% formaldehyde were brought to the laboratory on ice in an ice storage container within 6 hours at the latest. Samples stored at +4 degrees were examined with Olympus BX-50 and Olympus CX-31 microscopes. For identification of diatoms and dinoflagellates, Anderson et al. (1995), Balech (1988), Cupp (1943), Delgado and Fortuno (1991), Dodge (1982), Hasle and Syaten (1997), Hendey (1964), Koray et al. (2007), Lebour (1930), Marshall (1969), Rampi and Bernhard (1978, 1980), Ricard (1987), Steidinger and Williams (1970), Steidinger and Tangen (1997), Sournia (1968, 1976, 1986), Taylor (1976), Tomas (1997), Trégouboff and Rose (1957), and Wood (1954).

The studies of Anderson et al. (1995) and Landsberg (2002) were also used for HAB types. The current naming of the taxa was checked from the AlgaeBase web page (Guiry and Guiry, 2022).

Figure 2. Stations from which sea snot samples were taken between January and July (Illustrated by Yurga, 2022)

RESULTS

By examining the sea snot samples collected in the Marmara Sea between January and July 2021, a total of 55 taxa and 44 genera belonging to 5 algae classes were determined. These genera are: 14 Dinophyceae, 2 Prymnesiophyceae, 1 Dictyochophyceae, 26 Bacillariophyceae, and 1 Euglenophyceae. In addition to these classes, 2 species from the cyanobacteria class, 1 from the Florideophyceae class, 1 from the Ulvophyceae class, and 1 from the Pelagophyceae class are other species detected in the sea snot structure. The species belonging to the largest class, which was detected with a rate of 59.1% in sea snot, belong to the class Bacillariophyceae, followed by Dinophyceae with a rate of 31.8%. Prymnesiophyceae is 4.5%, and Dictyophyceae is 2.3% (Table 1).

A species list of 55 taxa and 44 genera, belonging to 5 classes detected in sea snot, was created (Table 2).

In the sea snot, 3 non-phytoplanktonic classes were determined as present in the salivary structure. These species, which release the mucilage slime structure to the marine environment, are the species that contribute to the thickening of the sea snot (Table 3).

The distribution of the species detected in sea snot, 19 taxa belonging to the Dinophyceae class. 2 taxa Coccolithophorid *Emiliania huxleyi* (Lohmann) W. Hay & H. P. Mohler, 1967 and *Phaeocystis pouchetii* (Hariot) Lagerheim, 1896 of the Prymnesiophyceae class. *Octactis speculum* (Ehrenberg) F.H.Chang, J.M.Grieve & J.E.Sutherland, 2017 is the only taxa detected in sea snot belonging to the class Dictyochophyceae. 32 taxa of the class Bacillariophyceae were detected in sea snot. *Eutreptiella gymnastica* Throndsen 1969 is the only taxa identified belonging to the class Euglenophyceae.

Table 1. The frequency of the types of classes detected in the period, the frequency of detection, and the percentage of the types secreting toxins in the environment

Class	Frequency of detection				Frequency %		
	G	T	PTM	TX	T	PTM	TX
DINOPHYCEAE	14	19	1	4	31.8	12.5	80.0
PRYMNESIOPHYCEAE	2	2	2	1	4.5	25.0	20.0
DICTYOCHOPHYCEAE	1	1	0	0	2.3	0.0	0.0
BACILLARIOPHYCEAE	26	32	5	0	59.1	62.5	0.0
EUGLENOPHYCEAE	1	1	0	0	2.3	0.0	0.0
Total	**44**	**55**	**8**	**5**	**100**	**100**	**100.0**

G: Genus, T: Species, PTM: Produces the mucilage, TX: Toxic

Table 2. Classes and species detected in sea snot

DINOPHYCEAE	**Phylum**
Alexandrium minutum Halim, 1960	Myzozoa
Cochlodinium polykrikoides Margalef, 1961	
Dinophysis caudata W.S.Kent, 1881	
Dinophysis tripos Gourret, 1883	
Gonyaulax fragilis (Schütt) Kofoid, 1911	
Gymnodinium simplex (Lohmann) Kofoid & Swezy, 1921	
Gyrodinium fusiforme Kofoid & Swezy, 1921	
Noctiluca scintillans (Macartney) Kofoid & Swezy, 1921	
Oxytoxum scolopax Stein, 1883	
Phalacroma rotundatum (Claparéde & Lachmann) Kofoid & J.R.Michener, 1911	
Pronoctiluca pelagica Fabre-Domergue, 1889	
Prorocentrum micans Ehrenberg, 1834	
Prorocentrum scutellum Schröder, 1900	
Protoperidinium bipes (Paulsen, 1904) Balech, 1974	
Pyrophacus horologium F.Stein, 1883	
Scrippsiella acuminata (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S.Soehner, Kirsch, Kusber & Gottschling, 2015	
Tripos furca (Ehrenberg) F.Gómez, 2013	
Tripos fusus (Ehrenberg) F.Gómez, 2013	
Tripos muelleri Bory de Saint-Vincent, 1826	
PRYMNESIOPHYCEAE	**Phylum**
Emiliania huxleyi (Lohmann) W.W.Hay & H.P.Mohler, 1967	Haptophyta
Phaeocystis pouchetii (Hariot) Lagerheim, 1896	
DICTYOCHOPHYCEAE	**Phylum**
Octactis speculum (Ehrenberg) F.H.Chang,J.M.Grieve & J.E.Sutherland, 2017	Ochrophyta
BACILLARIOPHYCEAE	**Phylum**
Asteromphalus flabellatus (Brébisson) Greville, 1859	Ochrophyta
Cerataulina pelagica (Cleve) Hendey, 1937	
Chaetoceros teres Cleve, 1896	
Coscinodiscus lineatus Ehrenberg, 1841	
Coscinodiscus radiatus Ehrenberg, 1840	
Cylindrotheca closterium (Ehrenberg) Reimann & J.C.Lewin, 1964	
Dactyliosolen fragilissimus (Bergon) Hasle, 1996	
Ditylum brightwellii (T.West) Grunow, 1885	
Grammatophora marina (Lyngbye) Kützing, 1844	
Guinardia flaccida (Castracane) H.Peragallo, 1892	
Leptocylindrus danicus Cleve, 1889	
Licmophora abbreviata C.Agardh, 1831	
Licmophora flabellata (Grev.) C.Agardh, 1831	
Navicula tripunctata (O.F.Müller) Bory de Saint-Vincent, 1822	
Nitzschia longissima (Brébisson) Ralfs, 1861	
Nitzschia sigma (Kützing) W.Smith, 1853	
Pleurosigma elongatum W.Smith, 1852	
Proboscia alata (Brightwell) Sundström, 1986	
Pseudo-nitzschia delicatissima (Cleve) Heiden, 1928	
Pseudo-nitzschia pseudodelicatissima (Hasle) Hasle, 1993	
Pseudo-nitzschia pungens (Grunow ex Cleve) Hasle, 1993 *(Nitzschia pungens)*	
Pseudosolenia calcar-avis (Schultze) B.G.Sundström, 1986	
Rhizosolenia setigera Brightwell, 1858	
Skeletonema costatum (Greville) Cleve, 1873	
Stephanopyxis palmeriana (Greville) Grunow, 1884	
Striatella unipunctata (Lyngbye) C.Agardh, 1832	
Surirella ovata Kützing, 1844	
Synedra undulata (Bailey) W.Smith, 1956	
Thalassionema nitzschioides (Grunow) Mereschkowsky, 1902	
Thalassiosira pseudonana Hasle & Heimdal, 1970	
Thalassiosira rotula Meunier, 1910	
EUGLENOPHYCEAE	**Phylum**
Eutreptiella gymnastica Throndsen, 1969	Euglenozoa

Table 3. Non-phytoplanktonic classes detected in sea snot and species belonging to these classes

FLORIDEOPHYCEAE	**Phylum**
Ceramium diaphanum (Lightfoot) Roth, 1806	Rhodophyta
ULVOPHYCEAE	**Phylum**
Cladophora laetevirens (Dillwyn) Kützing, 1843	Chlorophyta
PELAGOPHYCEAE	**Phylum**
Chrysoreinhardia giraudii (Derbès & Solier) C.Billard, 2000	Ochrophyta
Nematochrysopsis marina (J.Feldmann) C.Billard, 2000	Ochrophyta

Two taxa belonging to the class Cyanobacteria were detected in sea snot. These are *Leptolyngbya lagerheimii* (Gomont ex Gomont) Anagnostidis and Komárek, 1988, and *Pseudanabaena rutilus-viridis* H.J.Kling, H.D.Laughinghouse and J.Komárek, 2012. Both species are known to secrete the slimy and sticky mucilage into the marine environment, causing thickening of the salivary structure of sea snot.

Planktonic species responsible for secreting mucilage and providing stickiness in sea snot were determined in the sea snot content (Flander-Putrle & Malej (2008). These are *G. fragilis* of the class Dinophyceae; *E. huxleyi* and *P. pouchetii* from the class Prymnesiophyceae; *C. closterium, L. flabellata, S. palmeriana, S. ovata,* and *T. pseudonana* species from Bacillariophyceae class.

Some of the species detected in the examined sea snot samples produce mucilage themselves and secrete mucilage into the marine environment. The number of mucilage-producing species detected in sea snot was 14, and the number of classes belonging to these species was 7. Of these 14 classes, only 3 are planktonic and one is bacterial (Table 4).

Table 4. Mucilage-producing classes and strains identified in mucilage

Class	**Mucilage producing species**
Dinophyceae	1
Prymnesiophyceae	2
Bacillariophyceae	5
Florideophyceae	1
Ulvophyceae	1
Pelagophyceae	2
Cyanobacteria	2
Total	**14**

8 toxic species, which cause the death of living things by releasing toxic chemicals into the marine environment, have been detected in the formation of sea snot. 4 toxic species belonging to Dinophyceae class were determined. These are: *Alexandrium minutum* Halim, 1960, which causes paralytic shellfish poisoning (PSP), *Dinophysis caudata* Saville-Kent, 1881, which causes diarrheal shellfish poisoning (DSP) *Dinophysis tripos* Gourret, 1883, and *Phalacroma rotundatum* (Claparéde and Lachmann) Kofoid and J. Michener, 1911.

Phaeocystis pouchetii (Hariot) Lagerheim, 1896, of the class Prymnesiophyceae, is a normally harmless species. However, when fish larvae and zooplankton become abundant, they release ichthyotoxin into the environment (Danovaro et al., 2008).

It has been detected that 3 species that secrete domoic acid biotoxin belonging to the Bacillariophyceae class cause Amnesic shellfish poisoning (ASP). These are: *Pseudo-nitzschia delicatissima* (Cleve) Heiden 1928, *Pseudo-nitzschia pseudodelicatissima* (Hasle) Hasle 1993 and *Pseudo-nitzschia pungens* (Grunow ex Cleve) Hasle 1993.

In addition to these; *Cochlodinium polykrikoides* Margalef, 1961 is another non-armored dinoflagellate species that is detected as a cyst, although it is inside the sea snot. Even though these are not alive in the environment, their cysts are ichthyotoxic (Tang and Gobler, 2009, 2012).

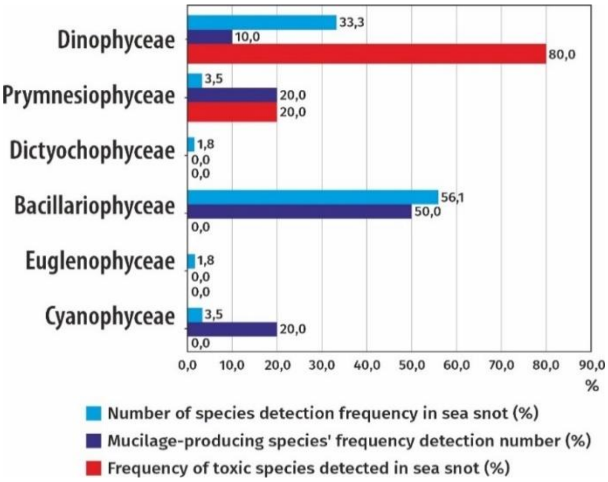

Figure 3. Frequency of occurrence of 5 planktonic groups and species of cyanobacteria detected in sea snot, distribution of species capable of producing mucilage, and toxic species in the sea snot

The frequency of occurrence of the species of 5 planktonic groups detected in the sea snot the mucilage producers of these species and the species detected in the sea snot that have the feature of releasing toxic toxins to the sea (Figure 3). The most dominant class and mucilage-producing species in sea snot belong to the class Bacillariophyceae. The toxin-releasing classes found in sea snot are the species belonging to the Dinophyceae and Bacillariophyceae classes. The most toxic species in sea snot was Dinophyceae (80%). The incidence of cyanobacterial species, which are capable of producing mucilage and detected in sea snot, was calculated as 3.5%. In terms of mucilage-producing species in sea snot, the incidence rate of cyanobacteria was determined as 20%. (Figure 3).

DISCUSSION

Mass accumulations of mucilage aggregates, which are not commonly seen in the oceans, and large, several meters in size, light and dark green cloud clusters in the water column can only be seen periodically in heavily polluted seas such as the Adriatic and Marmara Seas (Aktan et al., 2008a; Najdek et al., 2005). An example of a major oil spill in the Gulf of Mexico is the triggering of sea snot formation in an area where sea snot has never been seen before as a result of excessive pollution in the sea. The major oil spill on the BP-operated platform in the Gulf of Mexico on April 20, 2010, is an example of a major marine pollution disaster. The leak was fixed only after 18 months, on 19 September. It is estimated that approximately 780 thousand cubic meters of oil leaked into the sea during this period. This pollution is the largest oil spill in history. After the disaster, most of the native species in the region came to the point of extinction. Due to the great stress on the marine ecosystem, the formation of sea snot in square kilometers has been observed temporarily in the region (Passow et al., 2012).

Some of the cyanobacteria species detected in sea snot are capable of producing mucilage themselves (Durai et al., 2015). Some of these cyanobacterial species can release toxic biotoxins into the sea. *Lyngbya majuscula* Harvey ex Gomont, 1892, which covers the deep, stones, sea plants, and macroalgae on the seabed in coastal areas, is one of the dermatotoxic alkaloids that cause the formation of inflammatory wounds on the skin (Yüksel, 2021). In addition, it is stated that lipopolysaccharides, which are structural elements of bacterial species such as *Escherichia coli* and *Vibrio harveyi* (Danovaro et al., 2009) detected in sea snot, may cause irritation and blisters in case of contact with the skin (Durai et al., 2015).

In this study, 8 HAB-forming species, four of which belong to the Dinophyceae class, were detected in sea snot and were reported in a study conducted in the Sea of Marmara (Taş et al., 2016).

In another study conducted in 2021 on sea snot, 83 phytoplankton species were identified and the dominant class was Bacillariophyceae. The most concentrated species of this class in terms of its concentration per liter was determined as *S. costatum* (11200 l^{-1}) (Ergul et al., 2021).

The distribution of phytoplanktonic species in the sea snot of the Sea of Marmara was made by Balkis-Özdelice et al., 2021 for the first time. 47 species were reported in the study. Three new records were given for these species *and P. pouchetii* was responsible for the mucilage on the surface, and *C. taylorii* and *N. marina* were responsible for the benthic mucilage. When this study was compared with the researchers, 41 common species were determined (74.5%). Researchers also referred to the abundance situation in the environment and stated that coccolithophorids also play an active role in this formation. *C. laetevirens*, belonging to the class Ulvophyceae, was noticed and reported on the Southwest coast of Istanbul in the early summer of 2010 as it is over-proliferated and formed a sea snot-like structure on its own (Taş et al., 2016; Balkıs et al., 2013; Balkis-Ozdelice et al. 2021). This species was detected in sea snot during our examination of samples in the Sea of Marmara. *P. puchetti* from Prymnesiophyceae, *C. giraudii* and *N. marina* from Pelagophyceae have been actively detected and reported in sea snot in the Sea of Marmara were also found responsible for the benthic mucilage (Balkis-Ozdelice et al., 2021).

The first official step in our country in the fight against sea snot is the Marmara Sea Action Plan Coordination Meeting held in Kocaeli on June 6, 2021. In the declaration prepared at the end of the meeting, the Sea of Marmara was declared a protection zone. Monitoring action plans have been initiated regarding the inspection of industrial facilities that discharge wastewater into flowing streams and the installation of biofilters, the problems that may occur in the strait and the difficulties experienced by the fishing industry, and the collection of ghost nets, and sea snot. At the Marmara Municipalities Union (MBB), Marmara Sea Action Plan Sea Snot Science and Technical Board meeting held on April 19, 2022, the situation of sea snot after it is collected from the sea surface and an action plan of 22 items planned to be made urgently were created. Within the scope of the Action Plan for the Protection of the Marmara Sea, carried out at TÜBİTAK Marmara Research Center (MAM) on June 29, 2021, all aspects of combating sea snot and the process were discussed. Turkish Academy of Sciences (TÜBA), Marmara Marine Ecology; and prepared a 249-page study called Marmara Marine Ecology; Sea Snot Formation, Interactions and Suggestions for Solutions. In the study, solution suggestions are given for the problem, formation, causes, and prevention of sea snot in Marmara (Öztürk and Şeker, 2021).

CONCLUSION

Sea snot formation, which was intensely observed for the first time in the Adriatic in 1988 (Vollenweider et al., 1995; Rinaldi et al., 1995) and in the Tyrrhenian Sea in 1991 (Melley et al., 1998), was observed in the Marmara Sea in 2007 (Aktan et al., 2008a; Tüfekçi et al., 2010; Balkis et al., 2011) and in 2008 in the North Aegean (Nikolaidis et al., 2008). The formation, which was observed in Marmara and North Aegean in the following years, continued its existence until the winter months of 2021. In the elapsed time, the physico-chemical parameters in the places where sea snot is seen, and the species in the snot formation have been determined and reported. Action plans were created for the phenomenon thought to be caused by global warming and pollution, online evaluation meetings were held at universities during the pandemic process and final declarations were prepared. This phenomenon, which closely affects tourism, fisheries, and marine life, should be followed seriously.

The sea snot environmental disaster is nothing but a remarkable warning for our understanding of Marmara. All living things in our seas, whether they have commercial value or not, are indispensable for a balanced and healthy ecosystem. In addition to events that affect the whole world such as global warming, pollution in the sea affects all living things in the sea. Thanks to canals such as the Suez opened by the shortening of commercial sea routes (Ben-Tuvia, 1973), already endangered species are forced to compete with invasive species. The Marmara Sea is perhaps the most valuable of our seas, where fish are fished, as an ecosystem. Bluefish are also added to the anchovy and sardines, which have decreased due to intense overfishing in the Marmara and Black Seas. This fish, which can barely reach the size of a chinekop, will soon be considered among the endangered species in Marmara (Artüz, 2021).

In conclusion, sea snot is an environmental disaster and wreaking havoc caused by both global warming and human-induced marine pollution. It occurs in heavily polluted seas where there is no food and oxygen left in the environment and is a process initiated by bacteria. The process initiated by the enzymes of the bacteria is a rich stinking viscous slimy coenose, rich in nutrients and oxygen in an oxygen-free and nutrient-free environment, but containing toxic species, and colonies of bacteria and viruses that are harmful to the environment and human health. However, when we control and reduce pollution, we will be able to leave clean seas for future generations.

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CONFLICT OF INTEREST STATEMENT

The author declare that there is no known financial or personal conflict that may affect the research article.

ETHICS APPROVAL

The author declare that all applicable guidelines for sampling, care, and experimental use of animals in this study have been followed.

DATA AVAILABILITY

The data sets generated during and/or analysed during the current study will be provided by the corresponding author upon the request of the editor or reviewers.

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