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Research Article

Indicator Algae of Adrasan Stream (Antalya) Turkey

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Abstract

The economic importance of pollution indicator species of algae is investigated in Adrasan Stream, which runs in the nature of Tahtalı Mountains of Beydağları National Park and pours into the Adrasan Bay. The aim of the study is to determine the indicator algae in the stream and to make comparisons with those of the resource region. Two different stations are chosen in the Adrasan Streams and the estuary. Samples are collected from different habitats of the two stations (epilithic, epiphytic, epipelic, and plankton). In the study, a total of 115 algal taxa are identified. It is observed that Bacillariophyta division with 51.30%, is the most represented group, while Chlorophyta 26.08%, Cyanobacteria 16.52%, Euglenophyta 3.47% and Dinophyta 2.60% are also recorded, respectively. *Gomphonema parvulum, Cladophora fracta, Pediastrum boryanum, Pediastrum integrum, Tetradesmus lagerheimii, Scenedesmus* sp., *Ulothrix* sp., *Oscillatoria princeps, Oscillatoria splendida, Oscillatoria* sp., *Phormidium tenue* and *Euglena* sp. are identified as indicator species.

Key words: Adrasan Stream, algae, pollution, indicator species

Adrasan Deresi İndikatör Algleri (Antalya) Türkiye

Öz

Adrasan Deresi'nde kirlilik indikatörü ve ekonomik önemi olabilecek alg türleri araştırılan bu çalışmada, Beydağları Milli Parkı içerisinde bulunan Tahtalı Dağları'ndan doğan ve Adrasan Koyu'na dökülen Adrasan Deresi'ndeki indikatör algleri belirlemek ve aralarında karşılaştırma yapmak amacıyla, Adrasan Deresinin kaynak bölgesinden ve denize döküldüğü bölgeden olmak üzere 2 farklı istasyon seçilmiştir. Numuneler farklı habitatlardan (epilitik, epifitik ve epipelik plankton) toplanmıştır. Adrasan Deresi'nde dört habitata ait toplam 115 alg taksonu tespit edilmiştir. Bacillariophyta divizyosu %51.30'lik bir oranla en dominant grup olmuş, bunu %26.08 ile Chlorophyta, %15.52 ile Cyanobacteria, %3.47 Euglenophyta ve %2.60 Dinophyta divizyoları takip etmiştir. *Gomphonema parvulum, Cladophora fracta, Pediastrum boryanum, Pediastrum integrum, Tetradesmus lagerheimii, Scenedesmus* sp., *Ulothrix* sp., *Oscillatoria princeps, Oscillatoria splendida, Oscillatoria* sp., *Phormidium tenue* ve *Euglena* sp. taksonları indikator olarak belirlenmişlerdir.

Anahtar Kelimeler: Adrasan Deresi, algler, kirlilik, indikatör türler

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Introduction

71 % of the world is covered with water. While 97.4 % out of this percentage is sea water, the remaining 2.6 % is the ratio of the total water potential on land, yet water potential on lands theoretically provides only 10 % usable water potential, which covers only 0.3 % of total water potential of earth, and shared by 214 countries. Water, as the crucial factor for the continuation of life, enters all living structures, serves as the key in metabolic activities through its life-carrying characteristic, and also, being a medium for life, it has attracted the attention of mankind for centuries [1]. Therefore it is very important to learn about the features of water, as well as all organisms that adapts water medium and perform all its physiological activities in the aquatic environment.

Algae are biologically important organisms for being the first ring of the food chain and for being a source of nutrients and oxygen of autotrophic organisms in streams. The importance of the algae is not limited to this. These organisms are also utilized for medicine, paint, cosmetics, pharmaceuticals, textiles, fertilizer, food industry and biotechnology. Also in today's rapidly growing population which brought with it problems such as nutrition, industrial development and environmental pollution performing research on algae solutions are being sought. Species diversity and distribution of algae in water or in environments with heterotrophic organisms and nutrients are related to location. The determination of water pollution, pollution of the known types is used as indicators.

One of the biggest problems of our time as well as all over the world, environmental and water pollution, is increasing day by day in our country. Water resources, intense and distorted as a result of rapid population growth and industrialization, and thereby exploited clean polluted water sources are decreasing. Number of algae in aquatic ecosystems and riches, giving information about the efficiency of their water environment pollution indicator in some algal species, however, the degree of pollution in the environment is important in determining the criteria.

As photosynthetic organisms, algae represent the most significant group of aquatic ecosystems. Created colonies of microscopic single-celled or filamentous forms, thallus showing the structure or foreign parenchymatic textured macroscopic forms can be in so many ways. As can be found in free form in water as planktonic, benthic (epilithic (on stones), epiphytic (on aquatic plants) and epipelic (on sediments) as found in various habitats in bulk [2].

General Characteristics of the Study Area

In terms of wealth of freshwater resources our country has a great importance. Adrasan in the Mediterranean Region Municipality expressed through the bay of the same name Adrasan Stream (www.googleearth.com) [3] (Figure 1) flowing into the determination of the algal flora of Turkey will contribute to the inventory of algae. It is important to provide information about this wealth and uncover general properties of the identified species. In this study which investigates Adrasan Stream pollution in the indicator and algae species that may have economic importance, it aimed to reveal the flora composition in habitats of Adrasan Stream which is located in the Beydağları National Park arising from Tahtalı Mountains and spilling to Adrasan Bay, and to uncover economically important species.

In the region until now there has not been a scientific study on algae. Therefore, Adrasan bioindicators of stream types is important for the determination of the

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region. There are many different organisms which can be used as indicator. Bioindicator, is used to define to what extent the ecological impact of one type so that there is an absence or in this study which investigates indicators of algal species, the detection of algae in freshwater resources and the determination of Turkey in terms of freshwater algae is very important.

Fig 1. *General appearance and Adrasan Stream sampling stations*

Materials and Methods

In order to determine the pollution indicator of Adrasan Stream algae and make comparison, the two stations are determined on Adrasan Stream. In April - June 2013 sampling studies were conducted in different habitats (epilithic, epiphytic, epipelic and plankton) [4] and these samples were brought to the laboratory for species identification. Examined with a microscope Olympus CX41RF model, utilizing from various sources [5-15] species were determined and were photographed with Olympus C-7070 camera (Figure 2).

Species which were identified from samples taken from these areas, and listed according to their habitats, were compared the between source region and anthropogenic pollution exposed regions. Adapted to nutrient pollution and benefiting sufficiently from, and hence are plenty in number compared to other types of algae was to determine the indicator. Results were also compared with the pollution indicator species which are determined benefiting from similar studies conducted in Turkey until now.

Results

A total of 115 algae species have been identified in Adrasan Stream. Species identified in Table 1 below are listed in alphabetical systematic [15-16]. Water temperature, altitude, and the coordinates are given in Table 2.

Discussion

Characteristic of indicators algae relating different water quality are divided into zones as follows;

In the zone polysabrobic *Euglena, Oscillatoria, Phormidium,*

In the zone α -mesosabrobic *Gomphonema, Ulothrix, Oscillatoria, Stigeoclonium,*

In the zone β-mesosabrobic *Cladophora, Phormidium, Scenedesmus, Pediastrum, Ulothrix, Vaucheria,*

In the zone oligosabrobic genera of *Meridion, Lemanea, Batrachospermum* [17-25].

Similar algal species as specified in the above zoning has been identified in Adrasan Stream (Table 3). They are the species of the genera Gomphonema, *Pediastrum, Oscillatoria* sp., *Ulothrix* sp.,

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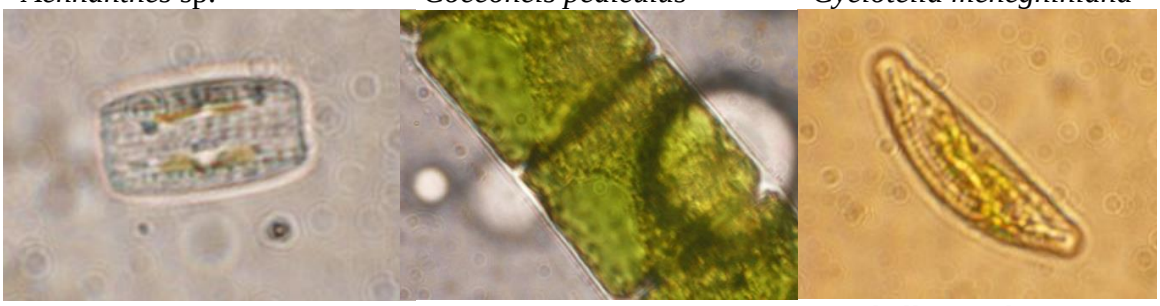
Phormidium sp. Some genera detected in algal species are more frequent in number. They are *Navicula* 5, *Cymbella* 7, *Nitzschia* 6, *Fragilaria* 6, *Gomphonema* 3, *Spirogyra* 4, *Pediastrum* 4, *Scenedesmus* 3, *Oscillatoria* 4, *Lyngbya* 3, respectively.

Divisio: Bacillariophyta

Achnanthes sp. *Cocconeis pediculus* *Cyclotella meneghiniana*



Cyclotella ocellata *Cyclotella* sp. *Cymbella cistula*

Cymbella cymbiformis *Cymbella helvetica* *Cymbella lanceolata*

Cymbella sp *Pinnularia* sp. *Diatoma vulgare*

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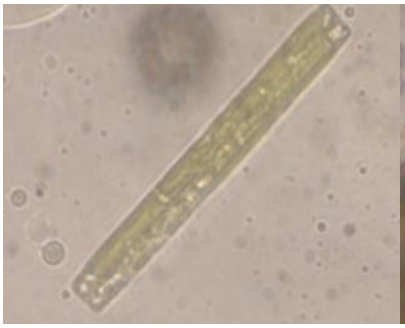
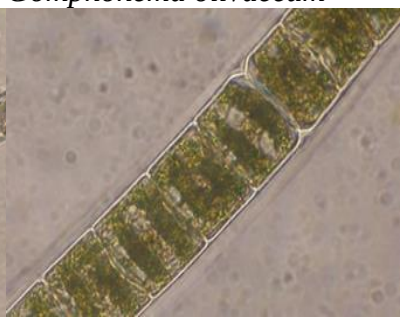

Fragilaria sp.


Gomphonema olivaceum

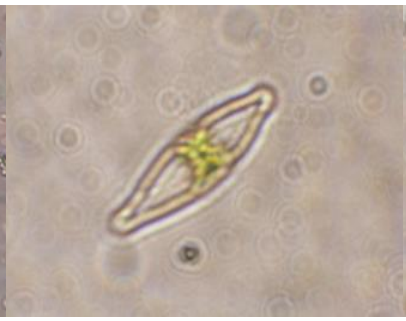

Gomphonema parvulum


Melosira granulata


Melosira italica


Meridion circulare


Pinnularia viridis


Navicula pupula


Navicula sp.

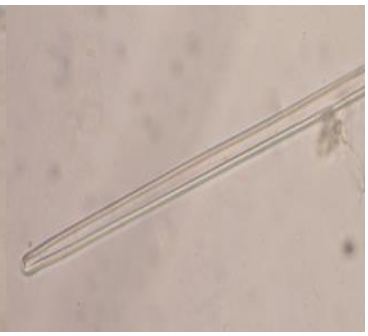

Navicula linearis


Nitzschia hungarica


Nitzschia linearis


Pinnularia brebissonii


Rhoicosphaenia curvata


Syndra acus

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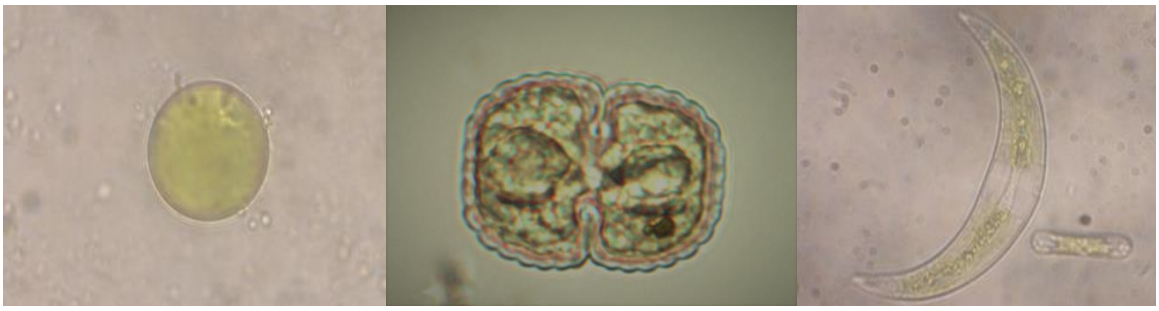
Divisio: Chlorophyta



Chlorella vulgaris *Cosmarium speciosum* *Closterium* sp.

Enteromorpha sp. *Oedogonium* sp. *Oocystis* sp.

Pediastrum boryanum *Pediastrum integrum* *Tetradesmus lagerheimii*

Scenedesmus sp. *Spirogyra gratiana* *Spirogyra princeps*

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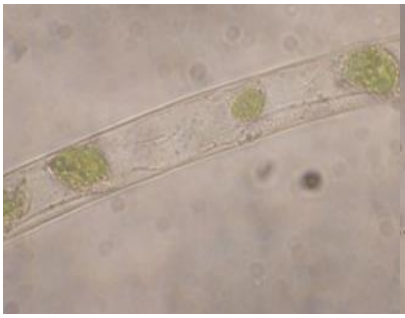
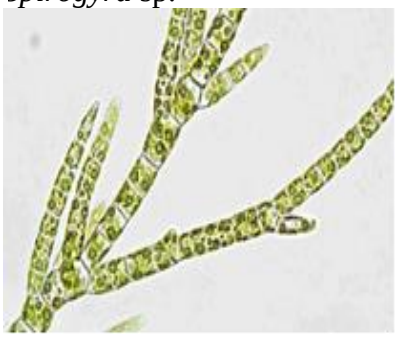
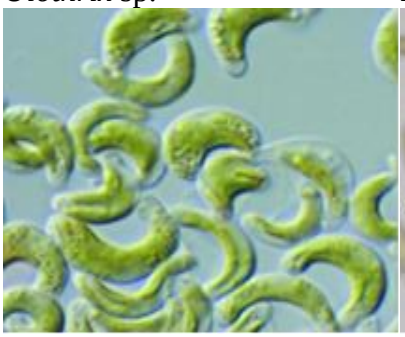
Spirogyra sp.


Ulothrix sp.

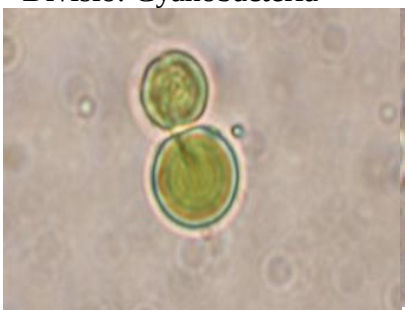

Zygnema sp.

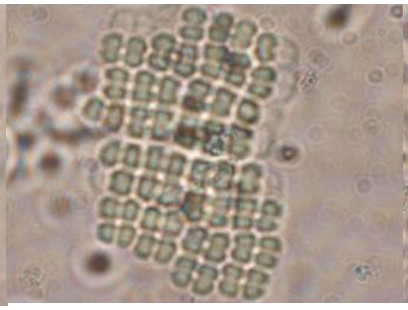

Stigeoclonium sp.

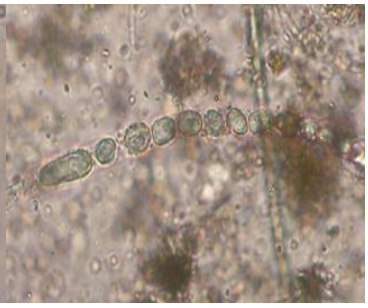

Selenastrum sp.


Cladophora glomerate

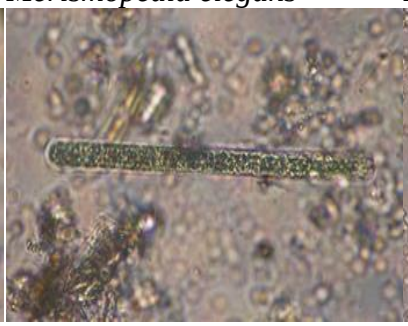
Divisio: Cyanobacteria


Chroococcus turgidus


Merismopedia elegans


Nostoc commune

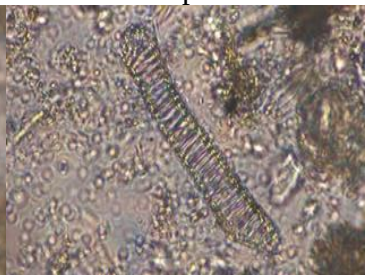

Oscillatoria splendida


Oscillatoria princeps


Oscillatoria sp.


Phormidium tenue


Spirulina subsalsa


Spirulina sp.

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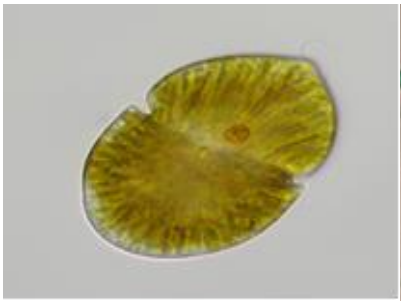
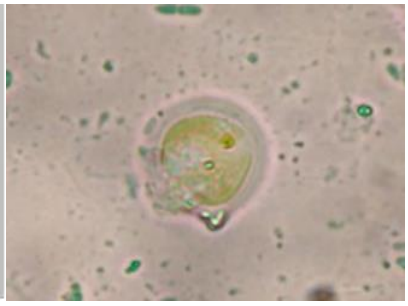
Divisio: Dinophyta



Gymnodinium sp.



Peridinium sp.

Divisio: Euglenophyta

Euglena sp.

Trachelomonas sp.

Phacus sp.

Fig 2. *Light micrographs and microscopic identification of samples.*

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Table 1. *Algae of Adrasan Stream*

Taxa	1. St.				2. St.			
	El	**Ef**	**Ep**	**Pl**	**El**	**Ef**	**Ep**	**Pl**
DIVISIO: BACILLARIOPHYTA								
Achnanthes sp.		+		+	+	+		
Achnanthes minutissima var. *gracillima* (Meister) Lange-Bertalot	+			+	+			+
Achnanthes petersenii Hustedt		+						
Caloneis liber var. *linearis* Cleve				+			+	
Cocconeis pediculus Ehrenberg	+	+			+			
Cocconeis placentula var. *acuta* F.Meister				+			+	
Cocconeis rugose Sovereign		+	+	+				
Cyclotella meneghiniana Kützing							+	
Cymatopleura solea (Brébisson) W.Smith				+			+	
Cymbella acuta (Lyngbye) C.Agardh	+		+	+	+			+
Cymbella cistula var. *angustior* Pantocsek	+	+	+	+			+	
Cymbella cymbiformis C.Agardh		+		+				
Cymbella helvetica Kützing				+				
Cymbella linearis Østrup		+	+					
Cymbella lanceolate Patrick				+	+			
Cymbella sp.	+	+	+		+	+	+	+
Diatoma vulgare Bory		+		+		+		+
Diatoma elongatum var. *minor* Grunow	+	+			+	+		
Fragilaria capucina Desmazières			+	+				
Fragilaria foliolum (Corda) Corda		+						
Fragilaria intermedia var. *continua* Mayer				+				
Fragilaria sp.	+	+					+	
Fragilaria tabulate var. *truncata* (Greville) Lange-Bertalot			+			+	+	
Fragilaria acus (Kützing) Lange-Bertalot	+							
Gomphonema angustum C.Agardh	+						+	
Gomphonema parvulum (Kützing) Kützing				+				
Gomphonema sp.		+			+	+	+	
Gyrosigma acuminatum (Kützing) Rabenhorst	+	+					+	
Gyrosigma attenuatum (Kützing) Rabenhorst		+					+	
Gyrosigma cali G.Reid		+	+					
Hantzschia amphioxys (Ehr.) Grunow				+	+			+

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Melosira *granulata* var. *circinalis* Playfair			+	+				
Melosira varians C.Agardh	+							
Melosira italica var. *valida* Grunow		+						
Meridion circulare (Greville) C.Agardh				+				
Meridion sp.	+	+					+	
Navicula acus Cleve		+	+					
Navicula lanceolate Ehrenberg		+	+					
Navicula pupula var. *undulata* Bristol					+		+	
Navicula splendida VanLandingham			+			+	+	
Navicula sp.	+				+		+	
Nitzschia acicularioides Hustedt		+						
Nitzschia palacea Grunow					+	+		
Nitzschia linearis W.Smith				+				+
Nitzschia sigmoidea (Nitzsch) W.Smith	+	+					+	
Nitzschia trybloniella Hantzsch				+	+			
Nitzschia sp.		+			+		+	+
Pantocsekiella ocellata (Pantocsek) K.T. Kiss & E. Ács	+				+	+	+	+
Pinnularia sp.	+	+					+	
Pinnularia brebissonii (Kützing) Rabenhorst		+	+					
Pinnularia viridis (Nitzsch) Ehrenberg	+	+			+		+	
Rhoicosphaenia curvata var. *gracilis* M.Schmidt	+	+					+	+
Sellaphora pupula (Kützing) Mereschkovsky			+	+				
Synedra acus var. *varipunctata* J.John				+		+		
Synedra balthica Ehrenberg	+	+					+	
Surirella angusta Kützing	+	+					+	
Surirella ovalis Brébisson						+		
Tryblionella hungarica (Grunow) Frenguelli	+	+						
Ulnaria ulna (Nitzsch) Compère	+	+	+	+				
DIVISIO: CHLOROPHYTA								
Chlorella vulgaris Beyerinck	+	+		+	+	+	+	
Cladophora fracta (O.F.Müller ex Vahl) Kützing	+				+	+		
Cladophora glomerata (Linnaeus) Kützing	+	+				+		
Closterium sp.	+	+			+			
Cosmarium speciosum P.Lundell	+	+			+			
Cosmarium sp.	+	+			+		+	
Enteromorpha coziana,P.J.L.Dang.					+			+
Kirchneriella sp.		+						

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Oedogonium sp.	+			+	+			+
Oocystis sp.	+	+					+	
Oocystis parva West & G.S.West			+		+	+		
Pediastrum boryanum (Turphin) Meneghini	+	+			+		+	
Pediastrum dublex Meyen	+				+	+		
Pediastrum integrum Nägeli			+	+	+		+	
Pediastrum sp.	+	+		+			+	
Scenedesmus armatus var. *boglariensis* Hortobagyi	+	+						
Scenedesmus obliquus (Turpin) Kützing			+					
Scenedesmus sp.	+	+						
Ulothrix zonata (F.Weber & Mohr) Kützing	+			+	+			
Selenastrum sp.					+			
Spirogyra gratiana Transeau	+	+		+	+		+	+
Spirogyra princeps (Vaucher) Link ex Meyen	+							
Spirogyra sp.	+		+		+			+
Spirogyra subsalsa Kützing	+	+			+	+		+
Stigeoclonium sp.			+					
Tetradesmus lagerheimii M.J.Wynne & Guiry					+	+		
Ulothrix sp.	+	+				+		
Ulothrix zonata (F.Weber & Mohr) Kützing	+		+					
Volvox sp.	+						+	
Zygnema sp.		+		+		+		
DIVISIO: CYANOBACTERIA								
Anabaena sp.	+	+			+			
Chroococcus turgidus (Kützing) Nägeli	+		+					+
Chroococcus sp.	+	+			+	+	+	
Lyngbya aestuarii Liebm. ex Gomont					+	+		
Lyngbya sp.		+	+	+	+		+	+
Lyngbya virescens Hassal	+	+						+
Microcystis aeruginosa (Kützing) Kützing	+		+		+		+	+
Microcystis flosaquae (Wittrock) Kirchner			+					
Merismopedia elegans A.Braun ex Kützing	+	+	+	+	+	+	+	
Merismopedia sp.	+	+						+
Nostoc commune Vaucher ex Bornet & Flahault				+	+	+		
Oscillatoria brevis Gomont		+						

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Oscillatoria princeps Vaucher ex Gomont		+				+		
Oscillatoria splendida Gravilla ex Gomont	+	+						+
Oscillatoria sp.							+	
Phormidium sp.	+	+			+			
Phormidium tenue Gomont	+	+						
Spirulina subsalsa Oersted ex Gomont			+	+				
Spirulina sp.						+		
DIVISIO: DINOPHYTA								
Peridinium cinctum (O.F.Müller) Ehrenberg				+				
Peridinium sp.	+			+	+			
Gymnodinium sp.			+					
DIVISIO: EUGLENOPHYTA								
Euglena sp.	+	+			+			
Euglena acus (O.F.Müller) Ehrenberg	+		+					
Phacus sp.					+		+	
Trachelomonas sp.				+			+	

Ep: Epipelic, Ef: Epihytic, El: Epilithic, Pl: Plankton

Table 2. *Stations temperature, elevation and coordinates of Adrasan Stream*

Station	**Temperature**	**Altitude**	**Location**
1.	21 °C	18 m	N36° 18′ 52.00 W30° 27′42.43
2.	26 °C	0 m	N36° 18′ 36.46 W30° 27′52.61

In a study conducted in Adrasan Stream Bacillariophyta division with 50.8 % of the group was the most represented, the other division, respectively, 27.9% Chlorophyta, 15.2 % Cyanobacteria, 3.38 % Euglenophyta and 2.5 % Dinophyta was found to be. Algae in determining the quality of water used in the long term is one of the basic groups of organisms [26-27].

In a study of Sakarya River [28] conducted epilithic algae; *Melosira varians*, *Nitzschia dissipata*, *Navicula exigua*, *Navicula cuspidata*, *Cymbella cistula*, *Gomphonema minutum*, *Gomphonema parvulum* and *Surirella ovalis* the most dominant species identified as species. The studies on all the habitats in the Çoruh River [29-30]. *Chroococcus, Merismopedia, Oscillatoria, Scenedesmus, Cladophora, Cosmarium, Spirogyra, Cyclotella, Diatoma, Melosira, Synedra, Achnanthes, Gyrosigma, Navicula, Cymbella, Gomphonema, Nitschia, Surirella* genera was also determined in Adrasan Stream.

In a study of Kızılırmak River [31] conducted *Navicula, Nitzschia, Cymbella, Surirella,* and *Pinnularia* belonging to taxa have been reported to be intense. In a study conducted in the Aksu River [32] to *Nitzschia, Navicula, Cymbella* and *Gomphonema* was found to be the dominant genera. In a study of Cimil Stream [33] *Nitzchia, Gomphonema, Navicula, Oscillatoria, Phormidium* was found to be adominant genera. Adrasan Stream was frequently encountered in *Chlorella vulgaris* which is dominant in Samsun-İncesu Stream [34].

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Table 3. *Zones of Adrasan Stream*

Indicator species	**Zones**
DIVISIO: CHLOROPHYTA	
Cladophora fracta	β-mesosabrobic zone
Pediastrum boryanum	β-mesosabrobic zone
Pediastrum integrum	β-mesosabrobic zone
Tetradesmus lagerheimii	β-mesosabrobic zone
Scenedesmus sp.	β-mesosabrobic zone
Ulothrix sp.	β-mesosabrobic zone
DIVISIO : CYANOBAKTERIA	
Oscillatoria princeps	Polysabrobic zon, α-mesosabrobic zone
Oscillatoria splendida	Polysabrobic zon, α-mesosabrobic zone
Oscillatoria sp.	Polysabrobic zon, α-mesosabrobic zone
Phormidium tenue	Polysabrobic zon, α-mesosabrobic zone
DIVISIO : EUGLENOPHYTA	
Euglena sp.	Polysabrobic zone

Of the types specified above; *Melosira, Nitzschia, Navicula, Cymbella*, *Surirella* and *Gomphonema* were also seen in Adrasan Stream. In the study area in first station melted snow waters fed by and anthropogenic effects unseen regions here because *Cyclotella meneghiniana*, *Cymbella helvetica*, *Melosira italica*, *Synedra ulna*, *Cladophora fracta*, *Chroococcus* sp., *Closterium* sp., *Oedogonium* sp., *Pediastrum integrum*, *Scenedesmus* sp., *Zygnema* sp., *Lyngbya* sp., *Spirulina subsalsa*, *Gymnodinium* sp. and *Trachelomonas* sp. taxa have been determined. However, that is very close to sea level, passing through residential areas and the effluent treatment plant is the third station *Pediastrum integrum*, *Spirulina subsalsa* and *Trachelomonas* sp. taxa were observed.

With pollution from anthropogenic sources of freshwater mixes organic and inorganic wastes. Anaerobic or aerobic decomposition of organic wastes as a result of the released phosphate and nitrogen compounds constitute an important food source for algae [25]. In this case, some types increase in freshwater. Pollution tolerant species can sustain life in both the clean water, and water that has been exposed to organic and inorganic contaminants. If the only source is clean water, species that prefer clean environment can survive. This study of freshwater algae Adrasan Stream has attempted to identify indicators and to determine pollution-tolerant algae. However, results of this study can be achieved more effectively if supported with the physical and chemical properties of water resources in the future.

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