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Epiphytic algae of *Lemna minor* L. growing in natural habitat and aquarium

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Introduction

Algae, which are one of the most relevant biological components in identification of environmental habitats in aquatic environments, are also used as bio-monitors in water quality detection. Diatoms, which are quite sensitive to changes in water chemistry, form a wide variety of niches in lotic environments. Most of them live on the rocks (epilithic), on the plants (epiphytic), on mud and silt (epiphelic), or on the sand (episammic). These are important feeding and resting grounds for angiosperms, waterfowls, fishes and other organisms (Palmer, 1980).

L. minor is tall aquatic plants with leaf-like stems floating on the water surface either on their own or in groups of a few. Their leaf-like stems are thick and they contain entrapped air, lined up in two layers. Their upper surface is dark green, they may also turn into colors like red or pink (Altinayar, 1988).

In Turkey, there are many studies on epiphytic algae (Elmaci and Obali, 1999; Akkoz *et al*., 2000; Albay and Aykulu, 2002; Soylu *et al*., 2005; Maraslioglu *et al*., 2007; Fakioglu *et al*., 2014; Ozer and Pala, 2014).

Epiphytic algae form the most part of the algal flora of particularly shallow lakes, and contribute to the productivity of lakes largely. In this study, the epiphytic algae of *L. minor* collected from its natural habitat and of *L. minor* grown in aquarium were compared, and the reasons for similarities and differences between these two habitats were discussed.

Materials and methods

Lemna minor was collected from ponds within the borders of Elazığ province (Turkey) between April-September 2016. It was ladled out with an effort not to stir its contents and was placed in nylon bags. Epiphytic algae were extracted from *L. minor* by means of washing up with distilled water. For species identification of diatoms, a sample of 20 ml was taken and treated by 10 ml HNO_3 + 10 ml H_2SO_4 acid. It was boiled on heat table at 120 ºC for 15 minutes and turned into permanent preparates through purification with distilled water until it turned neutral (Round, 1953). For the identification of algae other than diatoms, temporary preparates were prepared with glycerin. The related sources were used in identification (Bourelly, 1968; Germain, 1981; Grimes and Rushforth, 1982; Krammer and Lange Bertalot, 1986, 1988, 1991a, 1991b; John *et al*., 2002). Nikon-branded binocular microscope was used for counting the epiphytic diatoms and the results were given as "organism/ml". Sorenson Similarity Index was used to define the similarity between epiphytic algae.

Sorensen Similarity Index: Q= 2J/A+B

A=Total number of species in the first sample

B=Total number of species in the second sample

J=Number of species common to both samples (Sorensen, 1948).

Results and discussion

During this research, a total of 15 taxa, 1 belonging to Cyanophyta and 14 belonging to Bacillariophyta, were recorded for *L. minor* taken from aquarium, and a total of 36 taxa, 3 belonging to Cyanophyta, 5 belonging to Chlorophyta, 1 belonging to Euglenophyta, and 27 belonging to Bacillariophyta, were recorded for *L. minor* collected from natural habitat (Table 1).

While the algae recorded in samples taken from *L. minor* were the same for each month (Table 2), the algae recorded on *L. minor* collected from its natural habitat showed changes in some months (Table 3). This proves that natural habitat is affected by environmental conditions. Thus, Sorenson similarity index between the epiphytic algae of *L. minor* grown in aquarium and of *L. minor* collected from natural habitat was found as 39%.

In this study, a total of 41 epiphytic algal taxa have been recorded. While 15 taxa were recorded on *L. minor* in aquarium, 36 taxa were recorded on L. minor in natural habitat. This may be regarded as an indication of the fact that natural habitat is under the influence of environmental conditions, and the conditions of an aquarium environment are stable. The high individual numbers of diatoms on *L. minor* in both environments prove that the diatoms are cosmopolitan and make better use of environmental conditions in comparison to other algae. The diatoms represented by the most number of species among the epiphytic diatoms were Navicula (5 species) and Cymbella (4 species). While the algae represented by the most number of species on *L. minor* in aquarium was Navicula (3 taxa), the algae represented by the most number of species on *L. minor* grown in natural habitat were Navicula (4 taxa), Scenedesmus (3 taxa), Cyclotella (3 taxa) and Cocconeis (3 taxa). These findings point to the fact that the species belonging to these types can grow better in their habitats compared to other algae. It was also reported by

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Chessman (1986) that particularly the species Navicula and Nitzschia are cosmopolitan (Chessman, 1986). Moss (1988), underlined that although different algal groups can be found in epiphytic communities, diatoms are the permanent organisms of these communities.

Diatoms have been dominant organisms in epiphytic algae studies carried out in different regions of our country. Some of these studies are as follows: In the study titled Algal Flora of Beşgöz Lake (Sarayönü/Konya) by Akkoz *et al*. (2000), diatoms were the dominant organisms in the lake. In Pala (2014)'s study titled Epiphytic Diatom Flora in Hazar Lake (Suluçayır Plain), epiphytic algae were also completely composed of diatoms (Akkoz *et al*., 2000; Pala, 2014). The reason why the algae recorded on *L. minor* grown in aquarium were the same and less in number compared to those in natural habitat might be the fact that the conditions do not change in aquarium environment. On the other hand, in natural environment, physical and chemical parameters constantly change according to environmental conditions. In both environments, the centric diatoms on *L. minor* were inferior to pennate diatoms in terms of their number of species and number of individuals. Also in the study titled Epilithic and Epiphytic Diatoms in Pulur Creek (Erzurum) by Fakioglu *et al*. (2014), centric diatoms were far below pennate diatoms in terms of relative density (Fakioglu *et al*., 2014).
In Pala (2014)'s study on Epiphytic Diatom Flora in Hazar Lake (Suluçayır Plain), while *Amphora ovalis, Synedra ulna*, *Cymbella affinis* and *Epithemia turgida* were among important diatoms, on *L. minor*, the diatoms *Amphora ovalis* and *Cymbella affinis* were detected but *Synedra ulna* and *Epithemia turgida* were not detected (Pala, 2014).

This study shows that among the epiphytic algal community, diatoms make better use of the conditions when compared to other algal communities; they are cosmopolitan and may be found on any kind of substrata.

Table 1: Presence features of the algae recorded on *Lemna minor* L. in aquarium and in natural habitat.

Algal taxa	*L. minor* (Aquarium)	*L. minor* (Natural habitat)
Cyanophyta		
Chroococcus minutus (Kütz.) Nageli	+	+
Chroococcus turgidus (Kütz.) Nageli	–	+
Lyngbya diguetti Gomont	–	+
Oscillatoria tenuis C. Agardh ex Gomont	–	+
Chlorophyta		
Ankistrodesmus falcatus (Corda) Ralfs	–	+
Coelastrum microporum Nageli	–	+
Scenedesmus arcuatus (Lemmermann) Lemmermann	–	+
Scenedesmus naegelli Brebisson	–	+
Scenedesmus quadricauda (Turpin) Brebisson	–	+
Euglenophyta		

[DOR: 20.1001.1.15622916.2019.18.4.41.2]

Table 1 continued:

Euglena gracilis G.A. Klebs	–	+
Bacillariophyta		
Achnanthidium minutissimum (Kütz) Czarnecki	+	–
Amphora ovalis (Kütz.) Kütz.	+	+
Cocconeis disculus (Schumann) Cleve	–	+
Cocconeis pediculus Ehr.	+	+
Cocconeis placentula Ehr.	+	+
Cyclotella glomerata H. Bachmann	–	+
Cyclotella kützingiana Thwaites	+	+
Cyclotella meneghiniana Kütz.	–	+
Cymbella affinis Kütz.	–	+
Cymbella cistula (Ehr.) O. Kirchner	–	+
Cymbella laevis Nageli	+	–
Cymbella neoleptoceros Krammer	+	–
Diatoma elongata (Lyngbye) C.Agardh	–	+
Diatoma vulgaris Bory	+	+
Encyonema gracile Rabenhorst	–	+
Encyonema ventricosum (C.Agardh) Grunow	–	+
Fragilaria brevistriata (Grun.) Grunow	–	+
Gomphonema angustatum (Kütz.) Robenhorst	–	+
Gomphonema gracile Ehr.	–	+
Mayamae atomus (Kütz.) Lange-Bertalot	–	+
Navicula cincta (Ehr.) Ralfs	+	+
Navicula gregaria Donkin	+	+
Navicula minima Grunow	+	–
Navicula phyllepta Kütz.	–	+
Navicula radiosa Kütz.	–	+
Nitzschia dissipata (Kütz.) Rabenhorst	–	+
Rhoicosphenia abbreviata (C.Agarh) Lange-Bertalot	+	+
Surirella minuta Brebisson ex Kützing	–	+
Surirella robusta Ehr.	–	+
Tryblionella angustata W. Smith	+	–
Tryblionella apiculata W. Gregory	+	+

Table 2: Monthly (for 6 month) individual numbers in ml of the algae recorded on *Lemna minor* grown in aquarium.

Taxa	April	May	June	July	August	September
Cyanophyta						
Chroococcus minutus	6	8	2	2	2	4
Bacillariophyta						
Cyclotella kützingiana	5	7	3	5	4	5
Achnanthidium minutissimum	4	2	3	3	6	3
Amphora ovalis	3	1	5	3	3	4
Cocconeis placentula	2	6	5	7	7	6
Cocconeis pediculus	7	3	2	4	3	1
Cymbella laevis	1	3	1	1	2	1
Cymbella neoleptoceros	1	4	2	1	1	2
Diatoma vulgaris	2	1	3	2	2	1
Navicula cincta	1	3	2	3	3	1
Navicula gregaria	1	4	1	2	2	1
Navicula minima	3	4	3	2	4	5
Tryblionella angustata	2	2	1	1	3	1
Tryblionella apiculata	3	1	2	3	2	2
Rhoicosphenia abbreviata	2	1	1	4	1	2

Table 3: Monthly (for 6 month) individual numbers in ml of the algae recorded on *Lemna minor* grown in natural habitat.

Taxa	April	May	June	July	August	September
Cyanophyta						
Chroococcus minutus	3	2	–	2	2	2
Chroococcus turgidus	–	1	2	1	–	–
Lyngbya diguetti	2	3	3	–	1	4
Oscillatoria tenuis	7	2	3	2	1	5
Chlorophyta						
Ankistrodesmus falcatus	–	–	4	4	6	6
Coelastrum microporum	4	–	–	2	3	–
Scenedesmus arcuatus	–	–	4		8	4
Scenedesmus quadricauda	4	6	4	12	–	10
Scenedesmus longus	4	–	–	8	4	4
Euglenophyta						
Euglena gracilis	–	1	–	2	3	5
Bacillariophyta						
Cyclotella meneghiniana	2	9	17	5	4	8
Cyclotella kützingiana	7	13	2	4	1	3
Cyclotella glomerata	–	–	1	–	3	2
Amphora ovalis	4	3	21	9	7	6
Cocconeis placentula	42	14	8	6	10	7
Cocconeis pediculus	8	3	10	5	2	6
Cocconeis disculus	–	2	2	–	1	3
Cymbella affinis	4	11	5	24	50	38
Cymbella cistula	2	–	1	2	–	1
Encyonema gracile	–	3	2	2	7	–
Encyonema ventricosum	1	12	3	15	12	2
Diatoma elongata	5	4	19	6	2	3
Diatoma vulgaris	1	1	3	6	–	–
Fragilaria brevistriata	7	3	2	1	3	3
Gomphonema gracile	4	2	7	8	5	3
Gomphonema angustatum	2	3	1	2	7	5
Mayamae atomus	25	12	14	13	3	11
Navicula cincta	1	2	2	1	5	6
Navicula gregaria	–	3	1	2	4	6
Navicula phyllepta	8	4	7	6	5	3
Navicula radiosa	3	12	14	–	3	2
Tryblionella apiculata	1	2	5	–	–	–
Tryblionella angustata	12	8	–	3	–	–
Nitzschia dissipata	3	4	1	2	2	1
Rhoicosphenia abbreviata	2	2	3	4	8	8
Surirella robusta	–	–	2	2	3	2
Surirella minuta	1	1	2	–	1	2

Epiphytic diatoms are more readily available in the aquarium environment. Because the tap water is used in aquariums and the stones in the aquarium cause silicon to multiply and cause the diatoms to multiply. So the diatom type to be cultured can be obtained more easily than an aquarium.

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