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Arthrospira maxima (= *Spirulina maxima* (Stiz.) Geitl., 1930) Acı Lake Strain

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Özet: Arthrospira maxima *(= Spirulina maxima (Stiz.) Geitl., 1930) Acı Göl Suşu.* Yapılan çalışmada, Denizli Acıgöl'de ilk kez tespit edilen Siyanobakteri Arthrospira maxima (*Spirulina maxima*)'nın göldeki yıllık durumu incelenmiştir. Bu amaçla gölde aylık olarak nitel ve nicel inceleme yapılmış ve planktonik durum incelenmiştir. *Arthrospira*'nın bulunduğu aylarda göl suyunun kimyasal analizleri yapılmış ve suşun tercih ettiği su özellikleri saptanmıştır. Acıgöl, sığ bir tuz gölüdür. Kristalize suyun %55.9 unu $Na_2SO_4.10H_2O$ teşkil eder. Göl suyundaki Sodyum sülfat miktarı, Ağustos-Eylül aylarında 92.353 mg l^{-1}'e kadar çıkmaktadır. Tuzluluk, ‰117 ye ulaşmaktadır. Bu nedenle gölde yaşayan organizmalar, kısıtlı sayıdadır. *A. maxima*, Acıgöl'de yıl boyunca yapılan örneklemelerde, sadece Nisan ($67x\ 10^4$ filament l^{-1}) ve Ekim ($60x10^4$ filament l^{-1}) aylarında ve dominant tür olarak görülmüştür.

Anahtar kelimeler: Siyanobakteri, *Arthrospira maxima*, *Spirulina maxima,* Acıgöl.

Abstract: In this study, Cyanobacterium *Arthrospira maxima* (Stiz.) Geitl.; 1930 has been initially identified in Acı Lake and its annual existence in the lake determined. For that purpose, phytoplanktonic composition of the lake has searched with monthly qualitative and quantitative analyses. Chemical analyses have been done in months that cyanobacteria has been found in lake to obtain the water conditions that the organism prefers. Acı Lake is a shallow salt lake, 55.9% of whose chrystalized water contains $Na_2SO_4.10H_2O$. The sodium sulphate ratio in the lake rises up to 92,353 mg l^{-1} and its salinity could reach 117‰. In view of these conditions, the number of euryhalin organisms living in the lake is somewhat restricted. *A. maxima* has found only in April ($67x\ 10^4$ filament l^{-1}) and October ($60x10^4$ filament l^{-1}) as dominant organism in samples collected annually.

Key words: Cyanobacteria, *Arthrospira maxima*, Acı Lake.

Introduction

Arthrospira is a commercial microalgae due to fine chemicals in it's content. There are many studies done on the taxonomy of this organism. The taxonomy of cyanobacteria is quite more complex than the other prokaryota, because they could exhibit dissimilar behaviour of the plant form and the structure in nature to those of the laboratory cultures (Gupta and Changwal, 1992). There are a number of researches that agree the view that there are significant differences between *Arthrospira* and *Spirulina*. Therefore, they follow the separation of both genera, which will probably be classified even into yet previous taxonomic groups. Modern studies, particularly electron microscopy, show that the visibility of crosswalls is connected with a slightly different structure of the cell walls (Komarek and Lund, 1990). In respect of Guppta and Changwall, 1992, both *Spirulina* and *Arthrospira* are non-heterocystous, unbranched genera of order *Nostocales* and family

Oscillatoriaceae can be identified as two seperate genera on the basis of the following characteristics

Spirulina; Filaments double in a single unit and the two filaments coil very closely and helically single unit of filament, Filament (as a unit) straight, Cross walls not visible under the light microscope and do not form colonies but grow as a diffuse mass of filaments on the surface of the agar.

Arthrospira; filaments single in a unit which are straight or coiled variously, when coiled coiling not very close, Cross walls visible under the light microscope and form colonies on the surface of agar.

The aim of this study is description of morphologic and ecologic charecteristics of an initally identified strain of *Arthrospira maxima* in Acı lake Denizli-Turkey.

Materials and methods

The *Arthrospira maxima* isolated from Acı lake is a spiral shaped, filamentous organism with plenty of gas vacuoles, constriction between cells, very slight under the light microscope, they could hardly be seen when looked with 100 x objective with immersion oil. The size of the filaments was determined calculating the avarage measures of 50 individuals. The width of thricome is 10 μ; the length of cells, 5 μ; the width of spiral, 20-60 μ; the length of the filament found approximately 130 μ, however it varies a lot. There is no heterocystis and acinete existing on the filament. There couldn't be seen any sheet covering the filament when preperated with India ink. Originally drawn pictures of *A. maxima* could be seen in Figure 1.

Acı lake, located in Denizli, takes part of a graben existing on a tectonic fault. Acı lake is a salt lake whose salinity changes between 80‰ and 200‰. Frequent differences in salinity occur as it is a shallow lake. The south part of the lake which is named Akgöl completely dries in summer. The side of the lake is surrounded by a 2 km-long area containing a muddy buttom covered with a thick salt sheet.

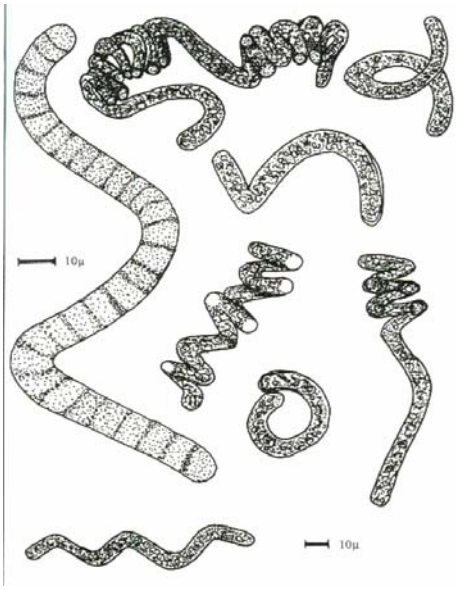

Fig. 1. Originally drawn pictures of the *Arthrospira maxima* from Acı Lake.

Quantitative and qualitative phytoplankton analyses of the lake were done between April 1994 and March 1995. Dominant zooplanctonic organisms have also been obtained over the same periods. Chemical analyses of the lake water were done in March, April, May, July, September and November 1995.

Three main methods have been used for isolating the *A. maxima* from Acı lake (Stein, 1975). Filtered and autoclaved water has been used as medium of isolation for all methods.

1) Pipetting method: One filament of *A. maxima* was taken by a micropipette into one drop of medium then the same procedure was repeated to eliminate the others. 2) Streaking on agar plates: The medium was prepared by adding 2% agar in the culture medium. 3) Dilution method: 9 ml culture medium was added into 10 tubes. 10 ml dense sample was taken with pipette from the surface of the water to collect mostly *Spirulina* which floats with the help of gas vacuoles. 1 ml from that sample was added into the first tube then stirred to homogenate; then 1 ml from the first tube was taken and added into the second one. Then the same prodecure was repeated 8 more times.

Results

Chemical analysis of the lake water has been carried out in the months of March, April, May, September, October and November. The results of these analyses could be seen in Table 1.

Phytoplanctonic analysis of lake water has been done between April 1994 and March 1995. Quantitative analysis could be seen in Table 2.

Table 1. Chemical composition of the Acı Lake water taken in Spring and Autumn.

Content	March	April	May	Sept.	October	Novemb.
NO_2^-(mg.lt^{-1})	0.107	0.033	0.034	0.014	0.026	0.035
NH_4^+(mg.lt^{-1})	0.089	0.205	3.486	0.1544	1.047	0.756
NO_3^-(mg.lt^{-1})	0.802	0.035	0.136	0.719	0.997	0.547
$PO_4^{\equiv}$ (mg.lt^{-1})	0.006	0.007	0.001	0.008	0.057	0.012
SBV	3.1	10	10.35	15.8	14	13.7
‰S	31.5	74.2	70.4	88.3	117	95.6
SiO_2(mg.lt^{-1})	0.368	1.682	1.448	0.357	0.418	0.867
pH (insitu)	8.37	8.16	8.02	7.81	7.67	8.10
$CO_3^{=}$ (mg.lt^{-1})	30	228	90	48	57	95
HCO_3(mg.lt^{-1})	128.1	146.4	549	963.8	840	755
Ca amount (mg.lt^{-1})	400.8	593.18	3783.5	4729.4	1306.6	2421.7
Mg amount (mg.lt^{-1})	1532.1	3896.0	1814.2	875.52	4071.1	3207.9
Ca Hrd. ($CaCO_3$)	1000	1480	9440	11800	3260	3540
Total Hardness	7300	17500	16900	15400	20000	18700
Temperature (°C) At 12 o'clock	10	27	34	37	32	25

Fabrea salina was determined as the dominant zooplanktonic organism in March-April and September-November periods while *Artemia salina* was dominant in February and June.

Acı Lake is also a very rich habitate for bacterial flora, mostly alcholophylic and Sulphur bacteria, which constitutes a part of *Fabrea salina* feed.

Three different methods have been tried for the isolation of the filaments. Single filaments did not live in the medium after being isolated. After streaking on agar plates, there were no colonies that occured on the surface of the agar. The dilution method was the only method where isolation was succesful.

Table 2. Annually analized quantitative phytoplankton in Acı Lake.
a) The first six month.

Date	4/94	5/94	6/94	7/94	8/94	9/94
Diatomophyceae						
Cymbella cistula (Hemprich) Grun.	-	25	5	-	-	15
Navicula ssp.	2.5	25	15	5	15	25
Epithemia zebra (Ehrborg.) Kütz.	-	-	-	-	-	-
Cyanophyceae						
Lyngbya rigidula (Kütz.) Hansg.	5	-	-	-	-	-
Pseudoanabaena catenata Lauter B.	2.5	-	-	-	-	-
Oscillatoria sancta (Kütz.) Gomont	-	25	-	-	-	5
Arthrospira maxima (Stiz.) Geitl.	670	-	-	-	-	-
Synechocystis aquatilis Sauvageau	3	-	5	27.5	10	25
Chlorophyceae						
Echinospharella sp.	-	-	-	-	-	-
Chlorella sp.	50	210	20	70	1040	85
Dunaliella salina Teodor	-	-	-	2.5	-	25
Tetraselmis cordiformis	-	-	-	-	-	-

b) The second six month.

Date	10/94	11/94	12/94	1/95	2/95	3/95
Diatomophyceae						
Cymbella cistula (Hemprich) Grun.	2.5	100	5	-	-	25
Navicula ssp.	-	-	5	5	10	25
Epithemia zebra (Ehrborg.) Kütz.	-	-	-	5	5	-
Cyanophyceae						
Lyngbya rigidula (Kütz.) Hansg.	-	-	-	-	-	-
Pseudoanabaena catenata Lauter B.	-	-	-	-	-	-
Oscillatoria sancta (Kütz.) Gomont	2.5	-	-	-	-	-
Arthrospira maxima (Stiz.) Geitl.	600	-	-	-	-	-
Synechocystis aquatilis Sauvageau	7.5	-	-	-	-	-
Chlorophyceae						
Echinospharella sp.	-	-	-	-	-	-
Chlorella sp.	75	1200	325	495	55	750
Dunaliella salina Teodor	35	1100	165	490	25	-
Tetraselmis cordiformis	-	30	-	-	-	-

Discussion

Some researchers use the identification methods depend on the measurement and the shape of the filament for identification (Desikachary and Jeeji, Bai, 1992; Gupta and Changwall, 1992; Komarek and Lund, 1990) while others advices genetic tests (Scheldeman *et al*., 1999). However, there are some other researchers who claim that the biochemical composition of algae could be a criterion for taxonomic identification (Cohen and Vonsak, 1990).

In this study, identification of *A. maxima* has been done in Natural History Museum - Paris after comparison with first other cyanobacteria then *Arthrospira* species and strains existing in their collection. There is not any genus which is assignable to Acı lake cyanobacteria except *A. maxima* however the medium and optimum temperature of this

organism was more different than other *Arthrospira* strains.

In this study the bioecological conditions of *A. maxima*,which had never been found in Turkey before (Aysel *et. al*.), has been determined.

This study constitutes a part of the doctorate thesis of the author. In this thessis, culture media and chemical composition of the organism have also been experimentally determined.

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