Algae of Ballıca Cave (Tokat-Turkey)

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Abstract

In this research, the composition in the algae of Ballıca Cave (Tokat-Turkey) was studied between June 1997 and May 1998. A total of 77 taxa were identified. Of those, 56 belong to *Cyanophyta*, 18 to *Bacillariophyta* and 3 to *Clorophyta* respectively. *Cyanophyta* has been dominant in algal composition. *Cyanophyta* is followed by *Bacillariophyta* and *Chlorophyta* respectively. *Chroococcus turgidus (*Kutzing) Nageli, *Synechococcus aeruginosus* Nageli, *Synechococcus major* Schröter, *Oscillatoria subbrevis* Schmidle, *Oscillatoria amphibia* Agardh ex Gomont, *Phormidium foveolarum* (Mont.) Gomont, *Nostoc disciforme* Fritsch, *Nostoc microscopicum* Carm ex Born. & Flah. And *Pseudanabaena catenata* Lauterb. are more common and denser than other taxa.

Key words: Ballıca Cave, Turkey, *Chanophyta, Chlorophyta, Bacillariophyta*

INTRODUCTION

Although the alga composition of running waters, lakes and sea have been studied in worldwide and Turkey in details, the algal flora of caves have received a little attention [1-3]. In fact only the surface of the rocks in the caves which are exposed to enough light can support some algae completely or partly. It has been seen that the dominative part of algae within the epilitic composition is comprised of *Cyanophyta*. The algae on the rocks take moist from the air and they show great similarity to the algae species on the plants.

Ballıca cave is located in Pazar (Tokat-Turkey). This place attracts many tourists and it has a natural beauty. The cave is comprised of crystallized chalk stones which have more than %80 $CaCO_3$. Due to dissolving of chalk stones by rain drops the rocks of the cave appear to be a structure with limestones. Thus this structure holds a good habitat for algae to be grown.

It is surprising that some alga species have been found even in the darkest part of the cave in Yugoslavia (*Hapalosiphon intricatus* and *Aphanocapsa sp.*). While the surface of the rocks outside the same cave was dominated by *Scytonema myochrous, Chroococcus* and *Aphanocapsa* genera were found in other parts of the cave receiving partial light. Most of the epilitic algae found in that cave in Yugoslavia are very much similar to the ones detected in Alps in Switzerland. The dominant algae in Alps were the members of *Cyanopyhta* and in some areas diatome colonies were found [4-5]. A few works done on tropical rocks Zehnder [5] showed that *Stigonema* and *Gloeocapsa* members have been dominant on the rocks. As it is clearly seen that there is no special difference between tropical region rocks and the other epilitic flora habitat. The fact that 34 epilitic algae species have been detected on the rocks in Antarctica is very significant revealing that these algae are found in every type of habitats [3].

In this research the purpose was to examine the epilitic algae grown on the rocks which are located at the entrance and inside the cave. According to literature, this study is the second work about the algae of caves and shows that if the physical and chemical conditions are satisfied (enough light, moisture and nutritional minerals), especially at the entrances of caves, relatively different and significant algae can be produced.

MATERIAL AND METHODS

Samples were collected monthly from 10 stations between June 1997 and May 1998. In those stations of Ballica Cave, the algae are according to other places very well colonized. The first and second stations are entrance of the Ballıca Cave which are exposed to enough light. The third and fourth station stations are Big Damlataş Hall which is moisture and concise light. The fifth and sixth stations are Column Hall which are moisture and the seventh, eighth and tenth stations are New Hall which are enough moisture (Figure 1).

The algae samples were taken from the surface of the rocks by scraping. Many temporarily preparations were prepared from the samples, epilitic samples were studied and photographs were taken through light microscope.

Diatoms were specified by permanent preparations after clearing of organic substances and their photographs were taken through light microscope [6-7].

RESULTS

The analyses of samples have shown that the flora has been consisting of 77 taxa belonging to the division *Bacillariophyta, Chlorophyta Cyanophyta.* Taxa were written in Table 1 according to the Round's [8] system and alphabetic order. Necessary sources were used for identification [9-19].

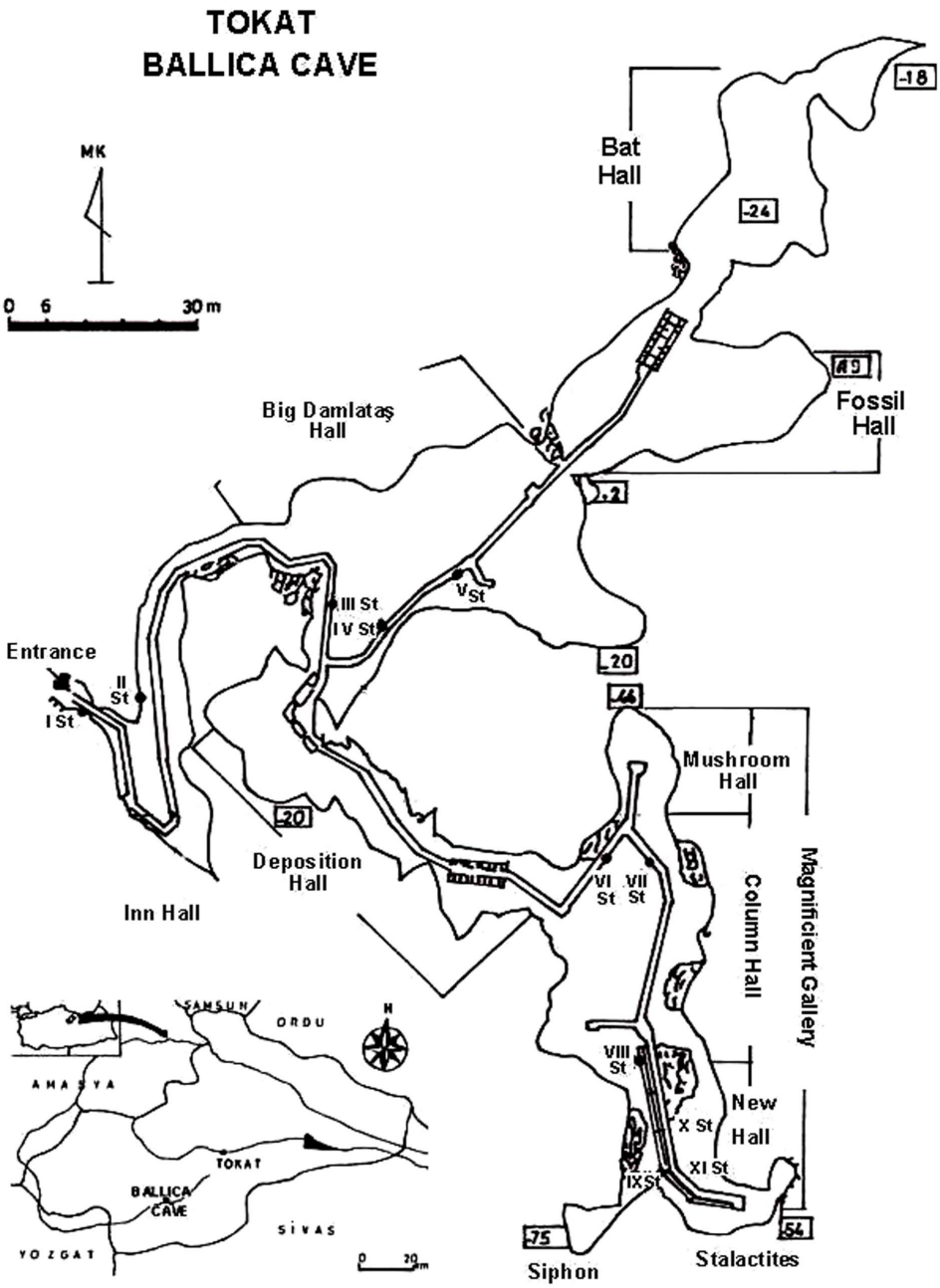

Figure 1. The map of Ballıca cave and Study Stations

DISCUSSION

77 taxa which belong to the divisions *Bacillariophyta, Chlorophyta* and *Cyanophyta* were determined in Ballıca Cave. *Cyanophyta* had the highest frequency rate with 56 species, and the rest had the species numbers of 18 for *Bacillariophyta* and 3 for *Chlorophyta* divisions.

Oscillatoria and *Nostoc* from *Cyanophyta* were dominant with respect to species variety. Some species in genera *Achnanthes, Diadesmis, Luticola, Navicula, Orthoseira, Pinnularia, Hantzschia* and *Nitzschia* from division of *Bacillariophyta* were determined.

Each of the genera *Chlorococcum, Chlorella* and *Euastrum* in *Chlorophyta* was represented with a single taxon. Some taxa belonging to *Chroococcus, Aphanocapsa, Microcystis, Gloeocapsa, Gloeothece, Synechococcus, Syctonema, Gomphoshaeria, Oscillatoria, Phormidium, Lyngbya, Pseudanabaena* and *Nostoc* have been observed in the division of *Cyanophyta.* Members of *Cyanophyta* were much more than *Chlorophyta* as to variety and density of taxa. *Chroococcus turgidus, Synechococcus aeruginosus, Synechococcus major, Oscillatoria subbrevis, Oscillatoria amphibia, Phormidium foveolarum, Nostoc disciforme, Nostoc microscopicum* and *Pseudanabaena catenata* were dominant species (Figure 2).

Well-colonized epilitic algae were found of the surfaces of rocks exposed to enough light around the entrance of Ballıca Cave. This colonization was encountered on the surfaces of all the rocks at the entrance.

Table 1. Algae of Ballıca Cave

CYANOPHYTA
Anabaena affinis Lemmermann
Aphanothece clathrata W.West & G.S.West
Aphanocapsa biformis A. Braun
Aphanocapsa elachista W.West & G.S. West
Aphanocapsa grevillei (Hassall) Rabenhorst
Aphanocapsa montana Cramer
Chroococcus minutus (Kutzing) Nageli
Chroococcus turgidus (Kutzing) Nageli
Chroococcus westeii (W. West) Boye-Peterson
Gloeocapsa nigrescens Nageli
Gloeocapsa magma (Brebisson) Kutzing
Gloeocapsa montana Kutzing
Gloeocapsa compacta Kutzing
Gloeocapsa sanguinea (Agardh) Kutzing
Gloeocapsa sp.
Gloeothece rupestiris (Lyngb.) Bornet
Gloeothece samoensis Wille
Gomphosphaeria aponina Kutzing
Lyngbya lagerheimii (Möb.) Gomont
Lyngbya martensiana Meneghini ex Gomont
Lyngbya scotti Fritsch var. *minor* Fritsch
Microcystis aeruginosa (Kutzing) Kutzing
Microcystis elabens (Brebisson) Kutzing
Nostoc *sphaeroides* Kutzing
Nostoc commune Vaucher ex Bornet & Flah.
Nostoc disciforme Fritsch
Nostoc insulare Borzi.
Nostoc muscorum Agardh ex Born. & Flah.
Nostoc microscopicum Carm ex Bornet & Flah.
Nostoc pruniforme Agardh
Nostoc sp.
Oscillatoria amoena (Kutzing) Gomont
Oscillatoria amphibia Agardh ex Gomont
Oscillatoria animalis Agardh ex Gomont
Oscillatoria chlorina Kutzing ex Gomont
Oscillatoria formosa Bory ex Gomont
Oscillatoria granulata Gardner
Oscillatoria nigroviridis Thwaites
Oscillatoria pseudogeminata G. Schmidle var *unigranulata* Biswas
Oscillatoria rubescens DC. ex Gomont
Oscillatoria subbrevis Schmidle
Oscillatoria tenuis Agardh ex Gomont
Oscillatoria tenuis Agardh ex Gomont. var. *tergestina* (Kutzing) Rabenhorst
Oscillatoria willei Gardner ex Drouet
Phormidium bigranulatum Gardner
Phormidium foveolarum (Mont.) Gomont
Phormidium fragile (Meneghini) Gomont
Phormidium frigidum Fritsch
Phormidium molle (Kutzing) Gomont
Phormidium rotheanum Itzigsohn
Pseudanabaena catenata Lauterb.
Spirulina major (Kutzing) Gomont
Syctonema myochrous (Dillwyn) Agard ex Bornet
Synechococcus aeruginosus Nageli
Synechococcus major Schröter
CHLOROPHYTA
Chlorella vulgaris Beyerinck
Chlorococcum humicola (Nageli) Rabenhorst
Euastrom sp.
BACILLARIOPHYTA
Achnanthes coarctata Brebisson
Achnanthes lanceolata var. *elliptica* Cleve
Achnanthes minutissima Kutzing var. *minutissima*
Diadesmis contenta (Grunow ex Van Heurck) D.G. Mann
Hantzschia amphioxys (Ehrenberg) Grunow
Luticola nivalis (Ehrenberg) D.G. Mann
Navicula cocconeiformis Gregory
Navicula crytocephala Kutzing
Navicula gallica (W. Smith) Lagerstedt var. *perpusilla* (Grunow) Krammer and Lange- Bertalot
Navicula gothlandica Grunow
Navicula sp.
Nitzschia angustuta var. *antiqua* (Schum) Cleve
Nitzschia inconspicua Grunow
Nitzschia palea (Kutzing) W.Smith
Nitzschia pusilla Grunow.
Orthoseira dendroteres (Ehrenberg) Crawford var. *dendroteres*
Pinnularia borealis Ehrenberg
Pinnularia globiceps Gregory var. *krookei* Grunow

Furthermore the surfaces of some rocks have been covered completely by the colonies of blue-green algae. Sheaths with mucilage and gelatinous covering these algae have caused the rocks to have a very slippery surface. Epilitic algae on the rocks were not found so rich in the composition of species and the results showed that there had been plenty of *Cyanophyta* but little *Chlorophyta* and *Bacillariophyta.* Other species of algae groups were not seen on the rocks the whole during year. The colonies of epilitic algae has been seen on the surfaces of the inner rocks which only receive artificial light in the cave.

The examination of the samples from the rock surfaces in Ballıca Cave showed that the first, second and third dominant species were *Chroococcus turgidus, Synechococcus aeruginosus* and *Nostoc disciforme,* respectively.

The extensiveness of *Chroococcus* species on the terrestrial rocks have been found out as the result of various researches

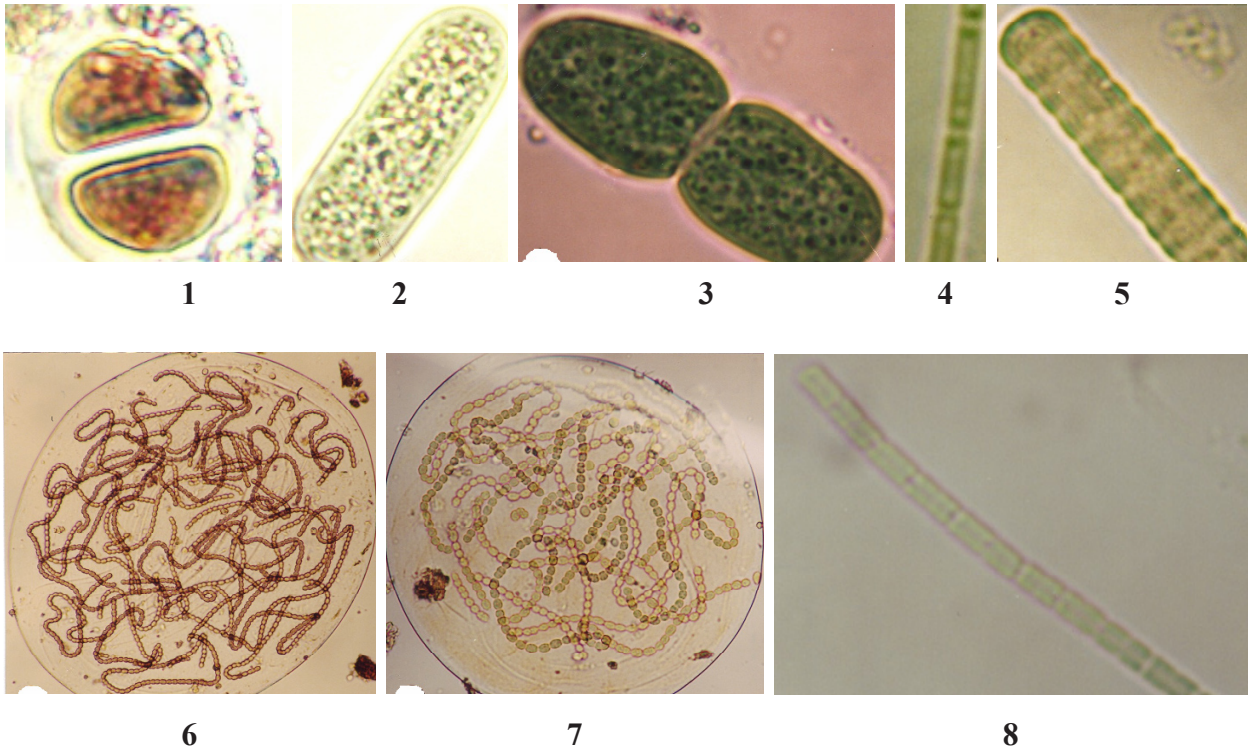

Figure 2. Only photographed species were dominant organisms in the results section.

1. *Chroococcus turgidus* (Kutzing) Nageli 2. *Synechococcus aeruginosus* Nageli

3. *Synechococcus major* Schröter 4. *Oscillatoria amphibia* Agardh ex Gomont

5. *Oscillatoria subbrevis* Schmidle 6. *Nostoc disciforme* Fritsch

7. *Nostoc microscopicum* Carm ex Bornet & Flah. 8. *Pseudanabaena catenata* Lauterb.

realized on different parts of the world. These species were observed on the limestone rocks at the entrance of a cave in Yugoslavia [2] and Cennet Cave in Turkey [1]. That the species of *Chroococcus* has been identified in the epilitic flora on the surface of the limestone rocks in Ballıca cave clearly proves that the members of this genus are probably common ones seen on the limestone rocks in different parts of the world. These three researches stated that the species of *Chroococcus* could be well-colonized on the surfaces of limestone rocks.

The species of epilitic algae in the lakes and rivers are closely related to chemical properties of water and sometimes rocks and stones where epilitic algae appear on. In addition, both waves and water movements have also an effect on the type of epilitic composition .On the other hand, the epilitic algae on the terrestrial rocks are primarily affected by the chemical structure of the rocks, moisture and light. Though it is known that epilitic algae develop widely without depending on the kind of rocks, those kinds should be studied well [1].

Monostroma quaternarium (*Chlorophyta*) may only be on the stones which are rich in ferric and *Hydrurus* (*Chrysophyta*) on limestone stone; however it is clearly stated that *Batrachospermum* (*Rhodophyta*) didn't give preference to special substrate in Glacier Park and Montana running waters [20-21]. In our research *Gloeocapsa sanguinea* and *Nostoc microscopicum* from the epilitic algae have been found with some species belonging to *Stigonema, Schizotrix, Scytonema, Calotrix* and *Microcoleus* (*Cyanophyta*) on the rocks which are 40-600 cm above the water level, in the Lake Vrana [1]. That the rocks in Australia are limestone like the rocks in Ballıca Cave proved the importance of substrate conformity for some species of epilitic flora.

Epilitic algae especially macroscopic forms are known to spread out as far as the inner parts of caves near seaside. Therefore, the effects of poor light on epilitic algae can be investigated in very poor-lighted areas. Underwater caves are rather widespread on the Mediterranean coast [1]. In a macroscopic alga study carried out in one of these caves, first *Cytoseira* community has disappeared, and then *Dictyopteris*, *Udotea Peysonnelia* have disappeared, finally several red melobesioid algae have been identified in the darkest part where it receives no light [22].

Both *Oscillatoria* and *Lyngbya* which were found in algae flora in Ballıca Cave are widespread planktonic forms as they are in the [23] and Bafra Fish Lake [24]. The species of *Oscillatoria, Lyngbya* and *Phormidium* which have been observed in this study are relatively rich in variety but poor in density.

Schorler's in a study carried out on a rocky habitat in Norway, desmids species of *Mesotaenium* (*Chlorophyta*) has been found [25]. In the study carried out in Ballıca Cave was found a little desmid of *Euastrum sp.* (*Chlorophyta*) was identified in our own study as well.

In the researches which are carried out on the surface of the rock in Iceland and Norway the taxa of the *Oscillatoria,*

Phormidium (*Cyanophyta*) and *Melosira* sp., *Diatoma sp., Pinnularia globiceps, Achnanthes coarctata* var. *elliptica, Navicula mutica, Nitzschia palea (Bacillariophyta)* were identified. Furthermore, the *Cyanophyta* were dominantly found especially *Gloeocapsa gelatinosa* and *Nostoc sp.* In the studies realized on the marble surface, but *Bacillariophyta* and *Chlorophyta* are rare. Very similar identifications have been made on rocks and stones in the study carried out in various parts of the world as well [3]. Nearly similar results were found in our study of the algae on the habitat of the rocks in the Ballıca Cave.

The members of the *Cyanophyta, Bacillariophyta* and *Chlorophyta* are not only the algae which take part on the terrestrial rocks and stones, but also are the main algae which constitutes epilitic algae of the lakes and running [26-28]. The members of the *Bacillariophyta* are known to constitute dense epilitic population on subject habitats especially in the early spring and summer. *Bacillariophyta* were identified in our study in Ballıca Cave. The degree of the density and the variety of the species was very low. This is probably due to lack of silica, which is needed for diatom growth in the moisture part of the caves. However, in order to determine the precise effect of physical and chemical factors, they need to be comprehensively studied in the cave.

This research has stated that the algae and ecology of the cave could be point out and also impressed the need for surveys to investigate the algae as well as other habitats in caves.

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