

THE STUDY OF THE DIVERSITY OF ALGAE IN THE CASPIAN SEA SHORE: ASTARA REGION

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Abstract. The paper deals with the macrophytic algae in Astara region of Azerbaijan. Samples were collected in 2021 from the Caspian coast of Astara region. As a result of the study, 9 species (*Cladophora vagabunda*, *Cladophora prolifera*, *Cladophora laetevirens*, *Cladophora globulina*, *Cladophora sericea*, *Ulva clathrata*, *Erythrorichia bertholdii*, *Ceramium elegans*, *Kylinia virgatula*) of 5 genera were identified. These species are new for this region. GPS coordinates (38°27'10.05"K; 48°52'50.23"D) and ecological groups of algae have been determined.

Keywords: *Chlorophyta, Erythrorichia bertholdii, macrophytes, diversity, distribution, ecology.*

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1. Introduction

Macrophytic algae widespread from water to land, in very saline water, in extreme environments. Algae are involved in the process of photosynthesis and have a major impact on this ecosystem. Algae play an undeniable role in the marine ecosystem, as they increase the synthesis of oxygen in the process of photosynthesis and are considered as the food object of the aquatic life.

Macrophytes can be free-floating, submerged or rooted. Based on their dependency on the water column, different life forms are known. True aquatic plants permanently living in the water are hydrophytes. Helophytes have submerged basal sections, while amphiphytes are capable of living both in the water and a shore (Stankovic, Bubikova, 2021). Macrophytes inhabit various types of fresh-water, brackish-water, marine ecosystems are characterized by various growth forms and plasticity of metabolism depending on environmental conditions. Macrophytic vegetation plays an important role in the trophic, structural and functional aspects of aquatic ecosystems (Lesiv *et al.*, 2020).

As in the article "Marine macroalgae: Plant growth stimulators" "Macroalgae are rich in diversified chemical constituents such as amino acids, fatty acids, carbohydrates, proteins, lipids, vitamins, minerals, micro and macronutrients, hormones, enzymes, growth factors such as plant growth-promoting hormones, betaine, algin, etc." (Kalasariya *et al.*, 2021). Having active phycoconstituents, macroalgae can be used in various spheres of industry.

The Caspian Sea is an aquifer isolated from the world's oceans, a meridian-like body of water, located at the crossroads of Europe and Asia. It is divided into three parts according to hydrological conditions and the relief of the sea. The borders conditionally divide the North, Middle and South Caspian into three large independent areas.

The Caspian Sea is the largest inland salt water. In the twentieth century, the long-term decline in the Caspian Sea as a result of the negative impact of coastal countries resulted in two extreme events: an abnormal drop in sea level between 1930 and 1977, and then an increase in sea level from 1978 to 1995 (Roshydromet, 2016). The main sources of pollution in the Caspian Sea are oil products, raw industrial and agricultural flows, municipal sewerage and transportation of cities and settlements along the coast, oil extraction from the seabed and oil transportation. The main causes of contamination of river flows in the North Caspian (90%) is related to oil production and oil exploration drilling (Kotlyakov, 2004). Increased industrial and urban development could lead to pollution of the Caspian Sea. Climate change causes the temperature to rise, evaporate and water flow to decrease (IPCC, 2014).

The Caspian Sea borders many countries (Russia, Azerbaijan, Iran, Turkmenistan and Kazakhstan). Macroalgae are an integral component of the Caspian aquatic ecosystem and have different roles. Therefore, algae should be carefully studied and protected.

The aim of the investigation is to determine macroalgae and their characteristic features of Astara region, in the Caspian Sea.

2. Materials and Methods

Astara region is located in the southern part of Azerbaijan and consists of lowland and mountainous areas. It is bordered on the north by the city of Lankaran and on the south and west by Iran.

Field research. The study was conducted on macro-algae collected from the Caspian coast of Astara region in the spring-summer of 2021 (May, June, July, August). Initial morphological features (size, colour, structure, etc.) were recorded for each type of algae and photographs were taken.



Fig. 1. The majority of the species gathered in Astara region

Microscopic studies. All freshly collected specimens were dried and herbarium specimens were stored in the place where algae are kept. The observation of the samples is based on the classical approaches, and the main diagnostic features were tested under a microscope. Photographs of microscopic structures were obtained using a “Biomed” microscope and a “Lomo” stereomicroscopic magnifying glass.

Used in the paper Algae identification was based on existing literature: (Zinova, 1967; Afanasyev et al, 2016; Afanasyev *et al.*, 2020).

Nomenclature and taxonomy correspond to the Algaebase (Algae Database (World Algae List)) (<https://www.algaebase.org/>) database index.

3. Results and Discussion

As a result of sample analysis, 9 species of the collected area belonged to 5 orders (*Cladophorales*, *Ulvales*, *Erythropeltales*, *Ceramiales*, *Acrochaetiales*), 5 families (*Cladophoraceae*, *Ulvaceae*, *Erythrotrichiaceae*, *Ceramiaceae*, *Acrochaetiaceae*) and 5 genus.

Information on the registered species is given below.

1. Chlorophyta

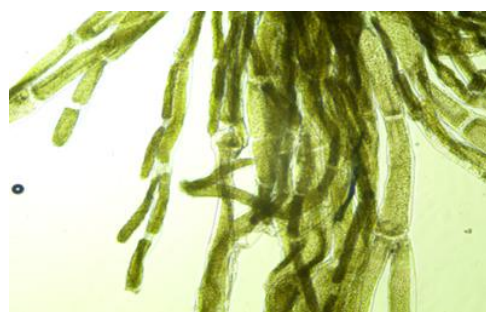
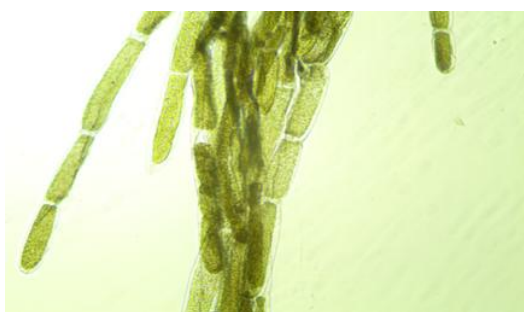
Cladophorales

Cladophoraceae

Cladophora vagabunda (Linnaeus) Hoek

The colour of thallus is from dark green to light green, filamentous, bushy, in the form of spherical masses, bunches or spongy bushes from 3 to 30 (50) cm tall, or gluing or free-floating. The cells of the main stems are cylindrical, 80–300 µm in diameter, their length is bigger 1.5–5.0 times from width. Cell wall 4–5 µm thick in apical cells and 7–9 µm thick in major axis cells. Thalluses are sometimes glued to pebbles, shells, or grow as epiphytes. They form floating masses on the surface of shallow estuaries and lagoons: they can lie on the surface of brackish shallow water (Afanasyev *et al.*, 2020).

Cladophora vagabunda occurs in the Black Sea, the Crimea, Romania, Bulgaria, the Caspian Sea, Atlantic coast of Europe, the Mediterranean Sea (Zinova, 1967).



2. Chlorophyta

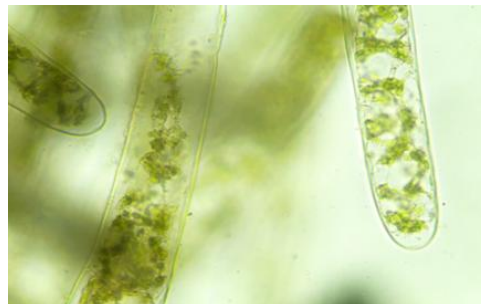
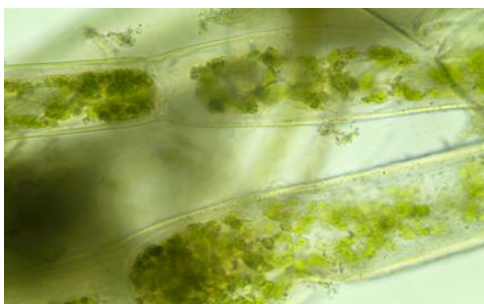
Cladophorales

Cladophoraceae

Cladophora prolifera (Roth) Kützing

The thallus is dark green, gets black while drying, the length is approximately 25 cm. Algae are in the form of coarse hard bushes, consisting of densely branched cone-shaped filaments. The growth is carried out through the division of apical cells and their subsequent increase. Each new cell produces a side branch, old cells may form secondary and sometimes tertiary branches. Apical cells are cylindrical, with rounded tips, 90-200 μm in diameter, their length is 2-6 times more than their width.

They are found throughout the year, but the largest number of findings refers to the summer period. It is a common species in the Black Sea of the Turkish shores (Afansyev *et al.*, 2020).



3. Chlorophyta

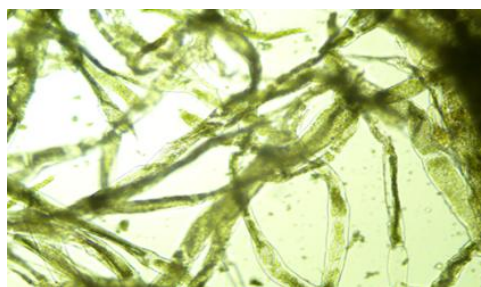
Cladophorales

Cladophoraceae

Cladophora laetevirens (Dillwyn) Kützing

It forms spongy or bushy bunches from 1 to 20-30 cm, from light to dark green. It is glued to the ground with the help of rhizoids under the thallus. Branching is uneven, in the apical part the cells form a branch, while the cells in the lower part of the thallus are 3-4 (5) branches (Afanasyev *et al.*, 2020).

Cell membranes are thinner in young branches and thicker in older ones. These species are found in crevices, in shallow depressions and in the rocks, near the water's edge and slightly below it, in rather open places. They are found in the Black Sea (North-West District, the Crimea, the Caucasus). - Atlantic coast of Europe, the Mediterranean Sea (Zinova, 1967).



4. Chlorophyta

Cladophorales

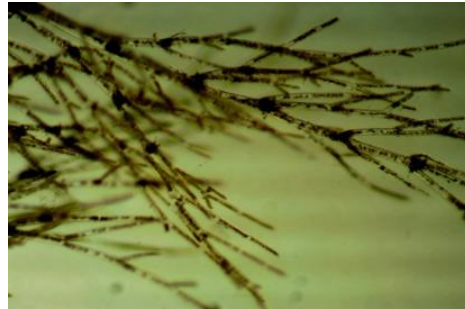
Cladophoraceae

Cladophora globulina (Kützing) Kützing

The thallus is represented by long thin unbranched or rarely branched filaments, usually not attached, sometimes attached with rhizoids. Young plants' branch more

densely, old ones don't branch more often. The growth is carried out by intercalary cell division. Apical cells are cylindrical or conical.

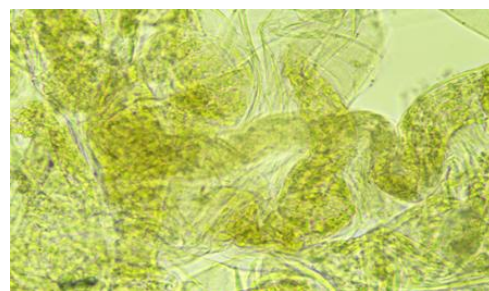
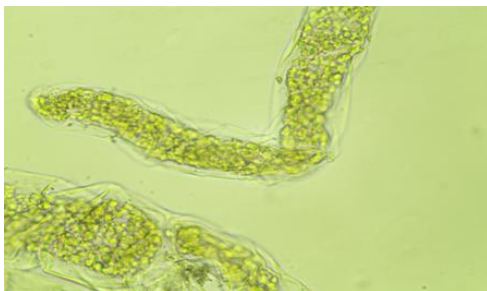
The freshwater and brackish species are usually found in the clean water, very rarely in the sea with full of salinity. Thallus are free-floating on the surface of the water or lying on the bottom, often forming mats with other algae. Given for the Black and the Caspian Seas (Afanasyev *et al.*, 2020).



5. Chlorophyta
 Cladophorales
 Cladophoraceae
Cladophora sericea (Hudson) Kützing

Thallus is light or dark green, often pale, whitish, soft and thin. It forms dense tufts 5-25 cm tall, glued to the substrate with rhizoids at the base of the thallus. The thallus is bushy or in the form of a mass of tangled threads, sometimes divided into indistinct strands and small tufts in the upper part. The thallus consists of pseudo-dichotomously branched of main axes, which are densely seated with lateral branches of various lengths.

It lives on stones and rocks in the coastal and sublittoral zones, both near closed and open shores; often grows at the base of larger algae. It comes across from the Black, Azov and Caspian seas (Afanasyev *et al.*, 2020).

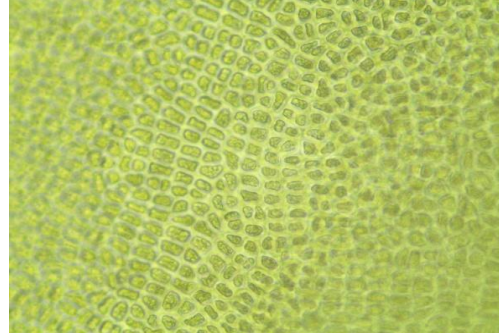


6. Chlorophyta
 Ulvales
 Ulvaceae
Ulva clathrata (Roth) C. Agardh

Thallus consists of long abundantly branching tubules that form tufts, in the length of 10-15 cm and its thickness is 0.25-5 (10) mm. The colour of thalli are from light to

dark green. Cells are generally located in longitudinal rows, sometimes transverse rows. The most abundant growth is observed in spring and summer (Afanasyev *et al.*, 2016).

They live on stones, shells, at shallow depths, in open and sheltered places. Black Sea: the Crimea, Romania, Azov Sea, the North of the Caspian Sea, the Arctic Ocean, North Atlantic and Pacific Oceans, the Mediterranean Sea (Zinova, 1967).



7. Rhodophyta

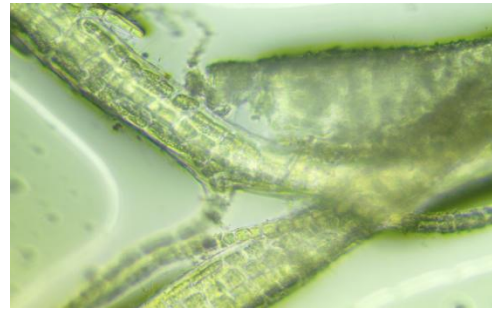
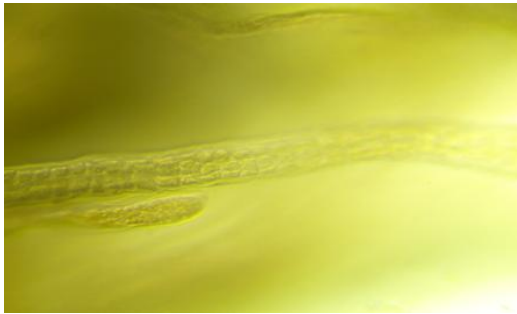
Erythropeltales

Erythrotrichiaceae

Erythrotrichia bertholdii (Dillw.) J. Agardh

The length of the threads are approximately 2 cm and the thickness is 10-33 μm , single- and multi-row (up to 4-8 cells wide), glued by a basal cell with small lobed rhizoidal outgrowths at the base.

They can be seen in the Black Sea, in the southern part of the Atlantic coast of Europe (Zinova, 1967).



8. Rhodophyta

Acrochaetiales

Acrochaetiaceae

Acrochaetium elegans (K.M.Drew) Papenfuss 1945

It forms bushes in the length of 7-8 cm, regularly dichotomously branched, with additional, sometimes numerous, rather long, simple or branched branches; the tops of the branches are almost straight or slightly curved-forked.

Black Sea: the Crimea, the Caucasus, Romania, Bulgaria, Turkey, the Caspian Sea, Atlantic coast of Canada, the Mediterranean Sea (Zinova, 1967).



9. Rhodophyta

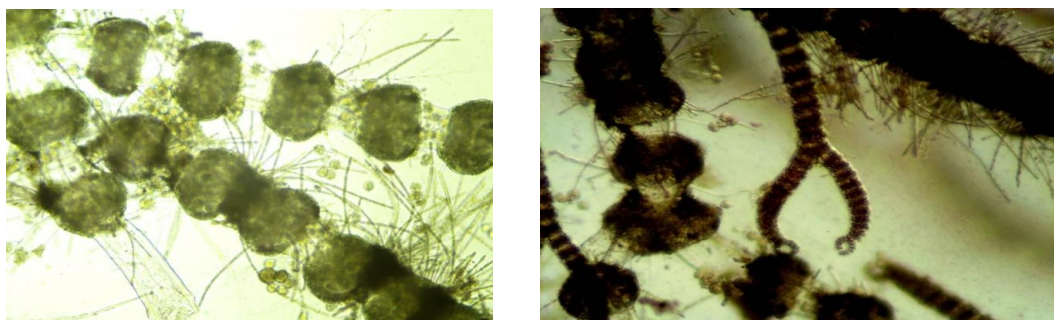
Acrochaetiales

Acrochaetiaceae

Acrochaetium virgatulum (Harvey) Batters 1902

Bunches are in the of 3-3.5mm. A plate develops at the base with uneven germinating edges. Several vertical shoots depart from the basal plate. The vertical thallus is long and straight, sparsely or abundantly branched and the branches are usually taper sharply at the apex and terminate in a very delicate unicellular hair.

The maximum development of it is seen in spring, sometimes all the year round. Black Sea: the Crimea, Romania, Bulgaria, Turkey. -Northern half of the Atlantic Ocean, Mediterranean and Sea of Japan (Zinova, 1967).



4. Conclusion

Macrophytic algae are widely spread in saline water, and in some extreme environments. They impact the photosynthesis and play a crucial role in the marine ecosystem. Macrophytic algae being an integral part of the Caspian aquatic ecosystem play an important role in the sea. Addressing the problems of important species in the Caspian Sea and studying their biodiversity is the priority issues.

9 species of the collected area belonged to 5 orders, 5 families, and 5 genus have been appointed during the investigation and their characteristic features (ecology, size, and spreading) have been remarked from the gathered examples of Astara region.

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