INFLUENCE OF LIGHT AND TEMPERATURE ON THE DEVELOPMENT OF PROTOCOCCAL ALGAE IN WATER BODIES OF CENTRAL ASIA

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Abstract
The influence of abiotic factors such as sunlight, temperature, water physicochemical properties, water level, fluctuations, etc. on the development and distribution of algae can be observed in both natural and artificial reservoirs. Many researchers have devoted their work to the ecology of algae. This study examined the effects of illumination and temperature on representatives of Protococcus algae as chlorophyll-containing organisms.

Keywords: Protococcal algae, solar radiation, illumination, photosynthesis rate, water temperature, water transparency.

Introduction

ВЛИЯНИЕ ОСВЕЩЕННОСТИ И ТЕМПЕРАТУРЫ НА РАЗВИТИЕ ПРОТОКОККОВЫХ ВОДОРОСЛЕЙ В ВОДОЕМАХ СРЕДНЕЙ АЗИИ

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Аннотация
Влияние абиотических факторов, таких как солнечный свет, температура, физико-химические свойства воды, её уровень, колебания и т.д. на развитие и распределение водорослей можно наблюдать как в естественных, так и в

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искусственных водоемах. Экологии водорослей посвящены работы многих исследователей. В данной работе изучалось влияние освещенности и температуры на представителей протококковых водорослей как хлорофиллсодержащих организмов.

Ключевые слова: протококковые водоросли, солнечная радиация, освещенность, интенсивность фотосинтеза, температура воды, прозрачность воды.

The annual amount of solar radiation reaching the water surface depends on latitude, atmospheric conditions, and season. A significant portion of the light falling on the water is reflected, depending on the surface conditions, and ranges from 5 to 30%. The annual amount of solar radiation is 114-117 kcal/cm2.

The penetration of solar energy into the water column depends on its depth and transparency. As turbidity increases from 2 to 15 mg/L, sunlight penetration in the 0.5-meter layer decreases from 45.7 to 21.9%, and with a 10% decrease in illumination, the rate of photosynthesis decreases by an average of 19.5%.

Solar radiation in the lowlands and highlands of Central Asia is higher than in the tropics, where high water vapor levels promote the absorption of thermal radiation. This is due to the fact that in Central Asia, the sun's altitude above the horizon reaches 78°C in summer, while in December, it does not drop below 25°C at midday. Total solar radiation over the year reaches 150-160 kcal/cm^2, which is three times higher than in the Leningrad Region and 1.5 times higher than in the Transcaucasus.

Central Asia not only receives more solar radiation but also receives twice as much sunshine as the European part of Russia. For example, Moscow receives only 1,954 hours of sunshine, compared to 2,870 hours in Tashkent, 2,916 hours in Samarkand, 3,043 hours in the Termez region, and even 2,900 hours in the northernmost region of Central Asia, Karakalpakstan. In Central Asia, the number of warm days reaches 236, while in the tropics, it reaches 365.6.

Winter in Central Asia also sees many sunny days. The frost-free period in high-altitude areas lasts on average about 56 days (Murghab region in the Pamirs), 256-267 days during the growing season in the foothills, and 138-202 days in the highlands, which is 1.5-2 times longer than in the Barrow region of Alaska, where it lasts 75 days. Here, the sun shines constantly, but the water temperature is below the optimal temperature, that is, the temperature needed for metabolism.

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The climate of Central Asia is sharply continental. Winters are dominated by temperate air masses, with the exception of isolated cold air intrusions, while summers are predominantly tropical. The main characteristics of the Central Asian climate include high insolation, a sharp continental climate, a dry climate, large daily temperature fluctuations, frequent inversions, and seasonally contrasting moisture conditions, including cold winters and hot summers. During daytime, surface water temperatures rise to 30°C to 32°C (sometimes as high as 35°C), which negatively impacts the development of planktonic forms. During this period, the bulk of plankton is concentrated at a depth of 0.5-2 m, which is not observed in northern waters. During the morning and evening hours, the concentration is 0.3-0.7 m.

In Central Asia, the beneficial intensity of solar radiation occurs in late spring and early summer. At this time, the water temperature in rivers and canals is +14 to +17 °C, in ponds, reservoirs and lakes +22 to +26 °C (foothill and flat areas), but water transparency in rivers and canals is quite low, 3-30 cm. Since this is the flood period, the transparency of ponds and reservoirs at this time is 0.5-1.0 m, which significantly delays the development of algae. In the banks of rivers and canals, the water temperature is +12 to +16 °C, small fouling of filamentous green algae and films of blue-green algae, as well as individual protococcal (Pediastrum duplex, Scenedesmus bijugatum, Scenedesmus quadricauda, Ankistrodesmus densus, etc.) are found (Fig. 1).

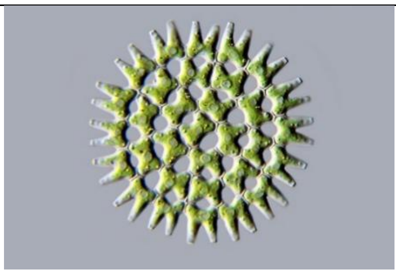
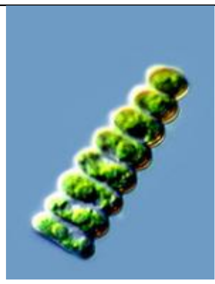
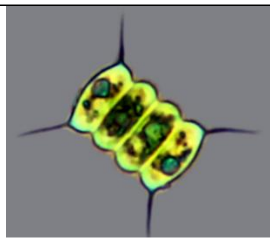
 Pediastrum duplex	 Scenedesmus bijugatum
 Ankistrodesmus densus	 Scenedesmus quadricauda

Figure 1 – Representatives of Protococcal algae

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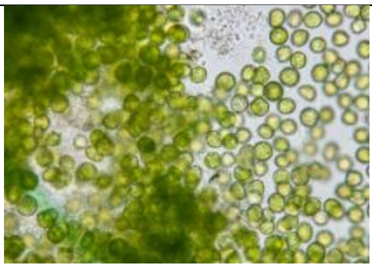
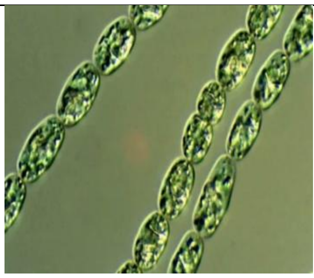
Protococcal representatives are more abundant in fish ponds and reservoirs, where the water warms up to +32°C (transparency 1.5-3.0 m, in some places 6-7 m. In such places, summer plankton is characterized by Coenococcus planctonica, Oocystis submarina, Elacatothrix lacustris, Coenocystis planctonica, Pediastrum duplex, Dictyocshaerium simplex, Ankistrodesmus brunii, Scenedesmus opoliehsis, etc.). These algae are abundant in late summer and early autumn, when the strength of solar radiation decreases, the water temperature in reservoirs of the southern part of Central Asia does not exceed +22 +26°C.

A total of 48 species of protococcal algae have been identified in summer plankton. Their development is most abundant in early autumn, but in winter, when temperatures drop to the minimum, most protococcal algae are absent or develop as isolated specimens. For example, in the wintering ponds of the Kalgan-Chirchik fish farm, the water is often covered with ice in December. Under this ice, with water temperatures ranging from 1.5 to 2.0°C, no protococcal algae were detected during the daytime. Diatoms and filamentous green algae of cold-water species are present.

It should be noted that different species respond differently to changes in light and temperature. For example, a study of photosynthesis and formation in phytoplankton showed that at low light intensities (approximately 1000 lux), the rate of photosynthesis is independent of temperature. Conversely, at higher light intensities (9000-10,000 lux), a clear dependence of photosynthesis on temperature is observed. At saturating light intensities, the temperature optimum for photosynthesis was +23°C for Synedra, +27°C for Anabaena cylindrica, +30°C for Chlorella ellipsoidea, and +34°C for Scenedesmus. At sufficiently high light intensities, the rate of photosynthesis was suppressed in all studied algae, except Chlorella ellipsoidea, if cultivated at high temperatures. At a water temperature of +40 °C, suppression of photosynthesis occurred at a light intensity of more than 15,000 lux, at +25 +30 °C for Anabaena cylindrica, and at +30 °C for Synedra (Fig. 2).


Chlorella ellipsoidea


Anabaena cylindrica


Synedra

Figure 2 - representatives of protococcal algae

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Thus, the development and distribution of algae in bodies of water depend on water clarity. Sunlight cannot penetrate deep into turbid water, creating unfavorable conditions for algae growth. Water turbidity is directly related to precipitation, wave action, water level, and current. Water clarity varies and fluctuates over time within a single lake, pond, or reservoir. Seasonal fluctuations in clarity are also observed. A decline in the qualitative and quantitative composition of algae species in reservoirs occurs during periods of low water clarity, while abundance occurs in summer and fall.

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