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Full Length Research Paper

Macroscopic Algal Growths and Concomitant Micromycetes in the Agrocenosis of Adjara, Georgia.

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Abstract

This paper presents results of the investigation of interrelations between autotrophic (algae) and heterotrophic (micromycetes) microorganisms inhabiting soil surface, bark of trees and on the leaves. In addition, conditions and characteristics of the formation of microbionts consortia on identified macrophyte algae and macroscopic fungi in the study area are analyzed. Studies have shown that algae are the initiators in the creation of a consortium in which two large groups of microbionts, such as algae (protists) and fungi involved and this is well reflected on the surface of round, large slime colonies of *Nostoc commune Vauch.* 12 algal species (*Clorella vulgaris Beiyer, Clorococcocus sp., Phormidium autumnale (Ag.) Gom., Plectonema bagyanum Gom.,*and others) and 6 mycobionts (*Aspergilus niger Thiegh., Mucor sp., Penicilium citrinum Thom.,* and others) populate on this habitat. The researches have shown that consortia are formed on macroscopic fungi (such as *Ganoderma lucidum (Curtis: Fr.) P. Karst*) by nearly the same algal and fungal genera. As well asthe observations have shown that consortia are formed by different groups of microbionts on stems and leaves of subtropical plants (from algal species: *Cephaleuros, Pleurochlori, Trentepohlia* and from fungal species: *Botritys, Colleotetrichum, Pestalotia*). Thus we can make the conclusion that a certain group of microbionts are specific to a certain agroecosystems and they are common for others.

Key words: Algae, Consortia, Fungi, Mycobiont, Nostoc, Soil.

Introduction

Algae occupy a leading place among the microbionts. Algae (Autotroph Protist–Reivn, Evert, Aikhorn, 1990*)* play a vital role in ecosystems functions. Apart from the reservoirs, they are widely spread to soils, the stems (bark) and foliage of plants. Favorable conditions of abiotic factors (frequent rains, warm and wet weather, excess moisture of soil, etc.) maintain their widespread in the region. They often play the major role in the formation of microbiota consortium. They are those active autotrophic parts of microbiota which have the usual relationship to the heterotrophic organisms. Hence, the task of biocenotic studies was to find out their role and place in a consortium where the algae play the crucial roles (Shtina, Gollerbakh, 1976; Celinov, 1981; Pivovarova, 1988; Patova, 1993; Rabotnov, 1994).

The aim of research was to determine the algal species composition spreading to the soil surface and the stems of plants and foliage of subtropical cultures and also to define the biological and ecological aspects of microbiota involved in a consortium.

Materials and Methods

Study Area

Adjara is an autonomous republic of Georgia. Adjara, located in the southwestern corner of Georgia, is on the eastern end of the Black Sea and is bordered by Turkey to the south. (Fig. 1).

Geography and climate

Adjara is located on the south-eastern coast of the Black Sea and extends into the wooded foothills and mountains of the Lesser Caucasus. It has borders with the region of Guria to the north, Samtskhe-Javakheti to the east and Turkey to the south. Most of Adjara's territory either consists of hills or mountains. The highest mountains rise more than 3,000 meters (9,800 feet) above sea level. Around 60% of Adjara is covered by forests. Many parts of the Meskheti Range (the west-facing slopes) are covered by temperate rain forests.

Climate

Adjara is well known for its humid climate (especially along the coastal regions) and prolonged rainy weather, although there is plentiful sunshine during the Spring and Summer months. Adjara receives the highest amounts of precipitation both in Georgia and in the Caucasus. It is also one of the wettest temperate regions in the northern hemisphere. No region along Adjara's coast receives less

than 2,200 mm (86.6 in) of precipitation per year. The west-facing (windward) slopes of the Meskheti Range receive upwards of 4,500 mm (177.2 in) of precipitation per year. The coastal lowlands receive most of the precipitation in the form of rain (due to the area's subtropical climate). September and October are usually the wettest months. Batumi's average monthly rainfall for the month of September is 410 mm (16.14 in). The interior parts of Adjara are considerably drier than the coastal mountains and lowlands. Winter usually brings significant snowfall to the higher regions of Adjara, where snowfall often reaches several meters. Average summer temperatures are between 22–24 degrees Celsius in the lowland areas and 17–21 degrees Celsius in the highlands. The highest areas of Adjara have lower temperatures. Average winter temperatures are between 4–6 degrees Celsius along the coast while the interior areas and mountains average around -3–2 degrees Celsius. Some of the highest mountains of Adjara have average winter temperatures of -8–(-7) degrees Celsius.

Fig 1: Map of the Study area

Methods

The District was selected purposely due to its diverse altitude range of 1- 500 meter above sea level. Samples of algae were taken from the surface of soil (1-10 cm) in a period of so-called "algal bloom" and as for aerophilic algae, they were taken from the stem of plant (from height 1-10 cm) and also the foliage inhabited by algae was collected. Collected materials - Nostoc commune, Ganoderma lucidum, Bark of trees, Plant of leaves and related to them micromycetes were analyzed by known methods algology (Shtina, Göller Plantbakh, 1976; Aleksakhina, Shtina, 1984; Kuziakhmetov, Dubovik. 2001).

The analysis of algae was carried out according to life forms (Shtina, Gollerbakh, 1976; Aleksakhina, Shtina, 1884). The pure culture and the direct microscopic methods were used during the identification of algae. The test-tubes were filled with the culture media to obtain the pure cultures, their caps were corked with cotton-wool stoppers and covered with aluminium foil. After sterilization, the algae were transferred into culture medium and placed in the artificial or natural light. Besides the liquid medium, solid medium was used (Agar-agar 1.5%).

The traditional and modern handbooks were used to identify the *algae* (Vasser, 1989; Gorbunova, 1991; Vasser, Tsarenko, 2000). The modern handbooks were used to identify micromycetes (*Garett,* 1963; Raper, Fennell, 1965; Raper, Thom, 1968; Watanbe, 2000). Coloured illustrations, tables and other means were used for the identification of species.

Results and Discussion

As a result, algological Studies in the years 2009-2014, it was found that the *Nostoc commune Vauch* characterized by widespread among detected macroscopic species. Although it considered *Nostoc* algae Arctic, sub-Arctic, steppes and savannas, so it is quite common in the subtropical zone of Adjara, especially on the surface of the inclined soil soaked with moisture. The strong growth of large, round slime colonies of *Nostoc commune* was observed in study area all the year (Fig.2) .

The studies have shown that consort algae inhabit on the colonial slime of *Nostoc*. 22 species are identified (Tab. 1) on this habitat in any periods of seasons. *Clorella vulgaris Beiyer, Clorococcocus sp., Phormidium autumnale (Ag.) Gom., Plectonema bagyanum Gom*. occur in any periods of seasons. The most species such as *Dictyochloris frugrans Vish. Ex Starr., Macrochloris dissecta (Korsch.) Fott., Pleurochloris magna Boye-Pet., Tribonema nitens (Klebs.) Hazen., Phormidium tenue (Menegh.) Gom.* are fixed on this habitat in summer. The species *Oscillatoria limnetica Lemm., Oscillatoria brevis (Kutz.) Gom., Chlamidomonas sp.* are widespread in summer. Only two species *Heterothrix exilis Pasch.*and S*pongicoccum tetrasporum Deas.* occur in a period of autumn.

The research carried out in different study areas have shown that *Clorella vulgaris* is widespread to various soils and in any periods of seasons among the species spreading on the slime of *Nostoc commune*. The long observations have shown that besides the algae, 8 microscopic fungi *(Aspergilus granulosu Raper et Thom., Aspergilus niger Thiegh., Aspergilus fumigatus Fresen, Mucor sp., Penicilium citrinum Thom., Fusarium moniliforme Sheldon, Rhodoturula glutinous Thom* და *R. rubra Fres*) are found on the colonial slime of Nostoc commune. These fungi have been firstly recorded on this habitat in Georgia.

The analysis has shown that total number of fungi is not changed, but the variation of species composition occurs according to the seasons. Such species as *Aspergilus granulosus Raper et Thom., Aspergilus niger Thiegh., Penicilium citrinum Thom.*always were found. The fungus - *Aspergilus fumigatus Fresen*. was as the summer consort for *Nostoc commune*, but as for species *Fusarium moniliforme Sheldon*was found in a period of autumn.

The studies have shown that consort algae such as *Clorella vulgaris Beiyer, Phormidium autumnale (Ag.) Gom., Plectonema bagyanum Gom., Dictyochloris frugrans Vish. Ex Starr., Macrochloris dissecta (Korsch.) Fott., Pleurochloris magna Boye-Pet., Tribonema nitens (Klebs.) Hazen.* develop on the macroscopic fungus-*Ganoderma lucidum (Curtis: Fr.) P. Karst.* (Fig. 3).

The members of same fungal genera (*Aspergilus, Penicilium Fusarium*) take part in the formation of a consortium. Although aerophilic algae are characterized with usual features of life, they grow very well on any substrates. Their growth-development and spread depend on the warm, rainy and cloudy days. In such conditions the members of *Chlorophyta: Cephaleuros virescens, Cephaleuros filamentous* and *Cephaleuros parasiticus* have been first found on mandarin trees- *Citrus nobilis Lour*. and tea brushes -*Thea sinensis L.* They form the slime or powdery spots especially on foliage (Fig. 4). At first the brownish-redish spots appear on foliage and they look like greenish- greyish lichens later.*Cephaleuros virescens Kunce ex E.M. Fries* and *Cephaleuros specis*don't cause the significant damage on plants, but as for *CephaleurosparasiticusKarsten,* it cause the necrosis of foliage in the plantations planted on the ground soaked with moisture.

Table 1. Taxonomic structure of algal satellite *Nostoc commune Vauch.*

Phylum	**Quantity**				
	Class:	Order	Family	Genus	Species
Cyanophyta	1	2	2	3	6
Chlorophyta	3	5	2	9	11
Bacillariophyta	1	1	1	2	2
Xanthophyta	2	2	3	3	3
Total	7	10	12	17	22

It was cleared up that the following fungi such as *Botritys citricola Br., Colleotetrichum gloeosporoides, Pestalotia sp* take part in damaging of foliage together with *Cephaleuros parasiticus.* On the bark of Citrus nobilis Lour., Citrus limonia Osbeck., Thea sinensis L. (Tab. 3) revealed clearly visible growths of algae. From them following types of algae are actively involved in the creation of the consortium: *Pleurochloris Magna Boye-PET, Trentepohlia umbrina Kuts, Trebouxia arboricola Europe* ... and, like mushrooms - *Alternaria oleraceae Rap. et Tom, Aspergillus raperi (Corda) Sacc., Aspergillus niger Thiegh* and other take part in it.

Table 2. Determinants of consortia and their consorts on trees

Consort	**Determinant**	**Algae - satellite**	**Micromycetes**
Citrus nobilis Lour.	*Desmococcus vulgaris* (Nag.) Brand emend. Vischer., *Trentepohlia umbrina* Kutz., *Trebouxia arboricola* Pium.	*Radiosphaera sphaerica* (Korsch.) Fott.	*Aspergillus raperi* (Corda) Sacc., *Aspergillus niger* Thiegh
Citrus limonia Osbeck.	*D. vulgaris, Trentepohlia umbrina, T. arboricola*	*Stichococcus minor* Nag., *Chlamydomonas minutissima* Korsch.	*Trichoderma viride* Pers. Fr.
Thea sinensis L.	*Anabaena variabilis* f. *rotundospora* Hollerb.	*Synechococcus elongates* Nag., *Plectonema boryanum* Gom., *Ulothrix variabilis* Kutz., *Pleurochloris magna* Boye-Pet., *Neospongiococcum* sp.	*Alternaria oleraceae* Rap. et Thom., *Aspergillus raperi* (Corda) Sacc.

It should be noted that studies of biological and ecological aspects for the formation of consortium from microbionts have not completely studied yet and it requires a complex study. Also, It should be noted that such research has been conducted for the first time in Adjara, Georgia. Consequently the subject is topical.

Conclusion

The researches have shown that formation a consortia depends on ecological factors. If there is the excess moisture the soil and air then the formation of consortia is well visible. It has been cleared up that certain group requires the certain agroecosystem. That's why the fungal and algal species compositions on the soil surface, stems of plants and foliage are significantly changed. The members of *Cyanobacteria* are dominant species on the surface of soil and members of *Clorophyta* are dominants on stems and foliage. As for fungi, members of *Deuteromycota* are dominants all the year.

It is ascertained that not only algae as well as fungi form the consortium. But the algae should be considered to be the initiators to form the consortium. All of this contributes to protect the biodiversity in the world.

Fig.2. *Nostoc commune* at a different stage of development

Fig. 3. Mycobiontsspread on- *Ganoderma lucidum (Curtis: Fr.) P. Karst*

Fig. 4. Algae *(Cephaleuros species, C. parasiticus, C virescens) spread On (left) Citrus nobilis Lour*. and On (right) *Thea sinensis L.*

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