

Seasonal Dynamic of Soil Ciliates of the North Eastern Azerbaijan

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Received: April 17, 2015

Accepted: June 12, 2015

ABSTRACT

The seasonal dynamic of soil ciliates of the North Eastern Azerbaijan was carry out. Studies have shown that the soil ciliates seasonal total number dynamics is a bimodal curve with two maximum in spring and autumn and two minimum in winter and summer. It should be noted that certain community of species of ciliates is typical for each season of the year.

KEYWORDS: ciliates, soil, seasonal dynamic, Azerbaijan

1. INTRODUCTION

It is known that the study of soil protozoa, particularly ciliates in Azerbaijan started much later than their aquatic groups. This is due to the following reasons. First of all the previous studies conducted with very primitive methods, the taxonomic identification was carried out on the basis of an *in vivo* studies only, without the use of methods of silver impregnation of kinetom. Consequently, several studies held in 60s-80s on soils of different regions of Azerbaijan have not identified the diversity of free living ciliates properly. Suffice it to say that since the late 80s of the twentieth century to the mid-90s there were recorded a total of 31 species of ciliates in the soils of Azerbaijan, of which 17 ones only were identified up to the species [1].

At present in Azerbaijan, a number of methodically modern researches were carried out on the free-living ciliates of soil of the different regions [2-4]. However, until now the fauna and ecology of soil ciliates in many regions of Azerbaijan have not been studied and there is a need for new modern research.

Based on the above, we have carried out a planned research on seasonal dynamics of species composition and abundance of soil ciliates of the Samur-Yalama National Park located in the North-East Azerbaijan.

2. MATERIALS AND THE METHODS OF STUDY

Collected from standard localities (Fig. 1) the soil samples were transported to the laboratory for further processing. In all 980 soil samples collected in the 2011-2014 years were investigated. Soil samples of 1 cm³ in volume were filled with distilled water.



Fig.1. Soil samples collectionpoints

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The number of individual species of ciliates was determined by counting in the Bogorov chamber under a binocular microscope with following recalculation per 1 dm². Some species of soil ciliates which were difficult to determine were caught by microcapillaries and fixed in Champy, or Buin fixative with following nitrate or silver proteinate impregnation of kinetom [5-6] in order to clarify the species identification.

For study of the communities structure of soil ciliates the Simpson's index of dominance and Margalef's index of species diversity were used. Processing and calculation of all above mentioned ecological parameters was carried out with the help of the computer program «Biodiversity Professional».

3. RESULTS AND THEIR DISCUSSION

In all 138 species of the soil ciliates were found. 15 species were recorded for a first time for Caucasus fauna. Studies have shown that the species composition of soil ciliates and number of certain species is changed by seasons. In general, it can be noted that the seasonal dynamics of the total number of soil ciliates is a bimodal curve with peaks in spring and autumn and troughs in winter and summer (Figure 2).

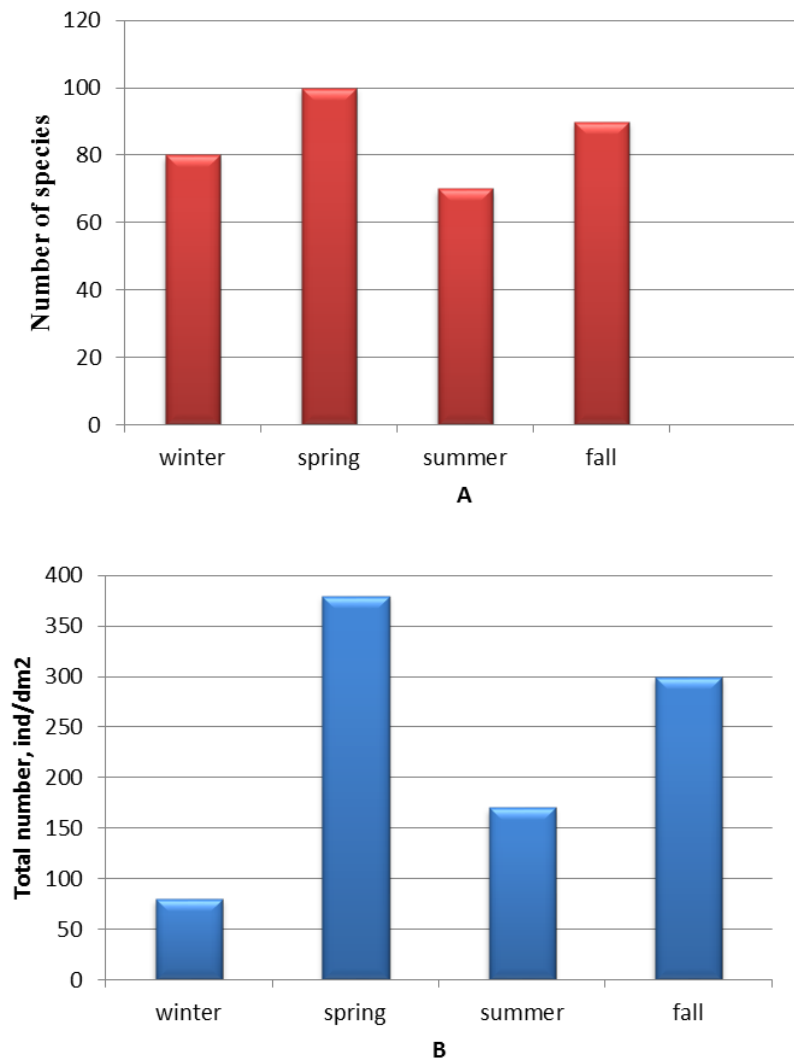


Fig 2. Seasonal dynamic of species composition (A) and the total number (B) of soil ciliates (2011-2014).

At the same time, it should be noted that certain community of species of ciliates is typical for each season of the year. For example, in the winter, when the total number of soil ciliates is extremely low, the soil ciliate community is represented by single only. These are the representatives of the following genera: *Avestina*, *Microdiaphanosoma*, *Bresslaia*, *Tillina*, *Colpoda* and *Colpidium*. The total number of ciliates as a whole does not exceed 40 - 80 ind/dm². An interesting fact is that in the winter time most of ciliates were observed by us in the soil horizons of 10-15 cm, i.e, in more protected from low winter temperatures soil layers. When the spring comes, the temperature of the environment and soil moisture increases in due to melting snow and rainfall, the

species diversity in soil communities of the Samur - Yalama National Park is greatly increased. Most of ciliates the representatives of the genera identified in the winter time is stored in the soil communities and greatly increases its number. However, apart from these common species in the spring season we have observed numerous representatives of hypotrichs in soil communities of the Samur- Yalama National Park. Among them the representatives of the genera *Aspidisca*, *Paraholosticha*, *Histiculus*, *Kahliella*, *Trachelochaeta* are the most characteristic for the spring complex. The maximum total number of ciliate communities of the spring complex was observed in mid-April and amounted to 380 ind./dm². Analysis of the data on the vertical distribution of soil ciliates has shown that with an increase in ambient temperature and warming of the soil, there is an active migration of most members of the soil ciliate communities to the upper soil layers, as well as the forest litter. In our opinion, in addition to the FIG.3 temperature factor, the high humidity of surface layers of the forest soil in the spring plays the role in this case.

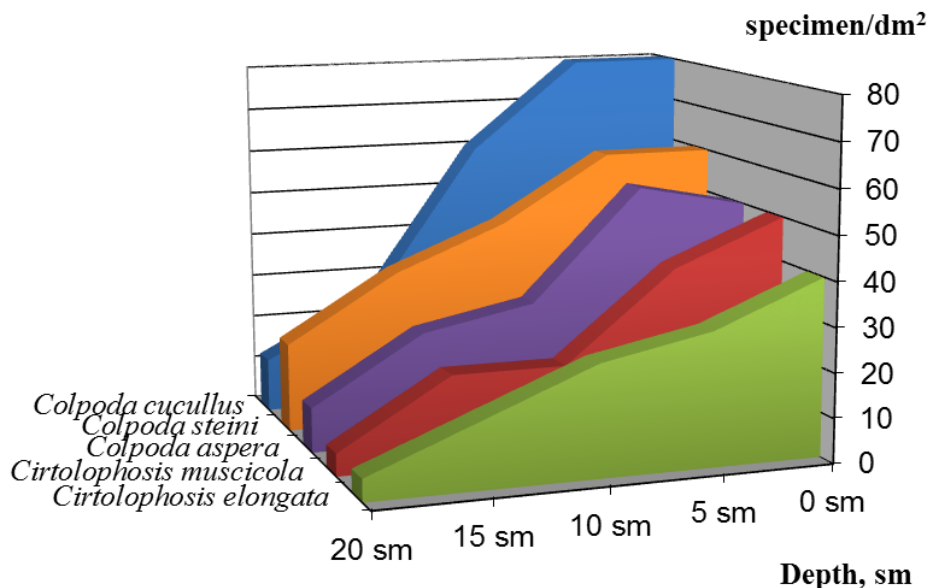


Fig. 3. Vertical Distribution of the Dominant Soil Ciliates Species in the Samur – Yalama National Park in 2011-2014.

Another interesting pattern of distribution and composition of soil ciliate communities of the spring complex is the presence in the community a number of facultative species that are commonly found in the freshwaters. We can explain this with high humidity (65% and above) of spring forest soil due to melting snow and usual precipitation at this time of the year. High humidity of the surface layers creates the possibility of temporary presence of a number of large (greater than 150 microns) representatives of freshwater fauna in the soil ciliate communities. In our opinion, there is another important environmental factor. It is well known that as a habitat for the protozoa, and especially ciliates, the soil is a complex system of micro reservoirs. At high humidity the soil micro-voids are filled with water and serve as a system of interconnected micro aquariums for ciliates. On the other hand the deeper soil horizon, the smaller the soil voids, since the soil density increases in the depth, and the sizes of voids are reduced accordingly. In our opinion, this explains the fact that the usually large facultative species of soil ciliate communities are usually localized in the most superficial layers of loose soil and forest soil litter.

The soil ciliate community has its own characteristics in the summer season. At this time, the total number of soil ciliates is markedly reduced, and depending on forest area does not exceed 170 ind./dm². In summer when the moisture in the upper layers of the soil is decreased there is observed localization of ciliates in the deeper layers (10-25 cm) which keep the moisture. The second important feature of the soil ciliate communities in the summer season is the full dominance of typical small, soil forms for example the representatives of the following genera: *Cyclidium*, *Homalogastra*, *Uronema*, *Plagiocampa*, *Protocyclidium* and *Stegochilum*. It is easy to see that all these ciliates are generally bacteriophages, and studies have shown that soil ciliates were concentrated near the root system of plants feeding on dead plant residues and bacteria developing here.

Analysis of data obtained during autumn period has shown that there is observed an increase in number of soil ciliate up to maximum - 300 ind./dm² beginning from September. Visible changes occur in the species

composition of soil ciliate communities in this period. Some species found in summer period are either reduced in the number gradually, or replaced completely by other species reaching high enough number, and by mid-October they constitute the core of autumn communities of soil ciliates of the Samur - Yalama National Park. Among the ciliates disappearing in autumn it should be first noted representatives of *Plagiocampa* and *Stegochilum*. Other smaller representatives of genera *Homalogastra*, *Uronema* and *Cyclidium* move to deeper soil horizons meeting with individual specimens in the soil samples taken from a depth of 20-30 cm. It should be noted the appearance of several major freshwater species in the litter and the upper horizons of the forest soils. However, in contrast to a similar phenomenon in spring, the facultative freshwater species appearing in autumn are very different. Among them numerically distinguished representatives of the genera *Frontonia*, *Dexiotricha*, *Urostyla* and *Birojimia*, remaining in soil ciliate communities until mid-November. However, since the end of November at almost all points of collection in the territory of the Samur-Yalama National Park there occurred a sharp decrease in species diversity of soil ciliate communities. Since that time, everywhere in the samples came across only a few specimens of a typical winter communities of soil ciliates.

Thus, our studies allow drawing the following conclusions:

1. Species composition and total number of soil ciliates in the territory of the Samur-Yalama National Park is changed both quantitatively and qualitatively depending on seasons.

In quantitative point of view it is expressed in consequent replacement of one species with other ones in the composition of the soil ciliates. For spring and autumn soil ciliate community complexes it is typical the appearance in communities a large number of facultative and as a rule large (over 100 mc) species usually inhabiting freshwater. In both cases, their appearance in the community because of sharp increase in moisture in the surface layers of soil and soil litter due to the spring and autumn rainfall, making the living conditions in the upper layers of the soil rich in voids close to fresh water.

2. At the same time it should be noted some regularities in the change of a number of species of soil ciliates in forest soils of the Samur - Yalama National Park. Studies have shown the presence of certain seasonal faunal complexes in the communities of the soil ciliates:

a) Eurybiontic species complex found in soils almost all year round. It is small, typically soil ciliates that on a cold winter and hot summer periods are moved from the surface layers of soil to depth, but are present in the soil communities year-round. Among them the representatives of such genera as *Avestina*, *Microdiaphanosoma*, *Colpoda*, *Tillina* and some *Cyclidium* should be noted in the first place.

b) Eurybiontic species complex are facultative in the spring and autumn communities of soil ciliates. It is usually quite large (over 100 mk) species are common in samples taken from freshwaters. Ciliates from this faunal complex are common during peak forest soil moisture periods, i.e. in the spring and autumn seasons are mainly found in the samples of upper forest soil litter (0-5 cm).

As already mentioned, we explain their short presence in soil communities with maximum moisture content of forest soil during the spring and autumn rainfall, making living conditions in the soil close to the water. These include mainly large Hypotrichida, as well as representatives of genera *Platyophrya*, *Grossglockneria*, *Calypotricha* et al.

c) The complex of stenobiontic species is presented in soil communities not more than 2 weeks, usually in the early spring and autumn seasons. It is rather large group including about 80 species of ciliates from a wide variety of taxa, as we estimated. The mass but short-term developments of the representatives of the faunal complex cause the spring-autumn peaks in the total number of soil communities. It is significant that, the composition of this group of ciliates is different in spring and autumn faunal complexes. Very rarely, the representatives of the spring faunal complex were registered by us in autumn, and vice versa.

In addition in studied spring and autumn seasons we were able to register no more than 50 or 70 species from this complex. Sometimes they were extremely rare, perhaps at times the number of those species were so small that we did not register them. At the same time the ciliates from this group (usually 5-15 species) with their maximum development cause the spring-autumn peaks in the total number of soil communities in the Samur-Yalama National Park. It is not possible yet to explain the reasons for the appearance and mass development of one or another species of soil ciliates of this faunal complex. However, our previous long-term studies have found a similar pattern for seasonal complexes of water ciliates [1]. The long-term observations in the same point of collection have shown that short-term mass development of one or another species in the freshwater ciliate communities is explained by a whole range of reasons, the main of which are trophic and temperature factors. Furthermore it was found that for stenobiotic species of this ecological complex in addition to the above factors the optimum condition and gas regime, particularly content of dissolved oxygen and pH are important. In our opinion for the species composition and quantitative development in the soil ciliate communities the major role is played by the same factors as in the freshwater communities. Since the freeliving ciliates are very sensitive to the slightest changes in the environment they are almost immediately reflected in structural changes of their communities. Thus, the reaction of the community of ciliates on occurrence in the environment of any toxic elements is expressed as an integral response of the whole community and depends on the presence slightest changes in environmental factors. It is known that freeliving ciliates extremely quick react to the slightest changes in environmental factors. This ability of ciliates has been used for a long time and successfully, (including in Azerbaijan) for bioassay of degree of contamination of marine and fresh water, and soil with oil and oil products, heavy metals, and insecticides.

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