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SPECIES COMPOSITION OF THE PEDOBIONTS IN FOREST SOILS AROUND THE HAJIKAND REGION

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Abstract. The crucial role of infusoria-pedobionts in various biological processes occurring within the soil is widely acknowledged. These processes include interactions with pathogens, where ciliate activity contributes to bioregulation and organic matter production, ultimately enhancing soil fertility. Despite the recognized significance of studying soil infusoria, the ecological group of infusoria-pedobionts remains among the least explored aspects of these Protista. This gap in knowledge persists not only in Azerbaijan but also internationally. Considering the points mentioned above, we initiated the first studies aimed at identifying the species diversity of free-living pedobiont infusoria in the forest soils around Hajikand region. Among the identified groups, morphoecological characteristics are provided for four groups (Phacodiniidae Corliss, 1975; Amphisiellidae Jank., 1979; Oxytrichidae Ehrenberg, 1838; Kahliellidae Tuffrau, 1979), including five species: *Phacodinium mechnikoffi* Prowazek, 1900; *Hemiamphisiella terricola* Foissner, 1988; *Periholosticha lanceolata* Hemberger, 1982; *Kaliella Franziner*, 1982 and *Oxytricha formosa* Alekperov, 1984.

Keywords: *Forest, soil, infusoria, species, Protista.*

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1. Introduction

Representatives of the Ciliophora phylum inhabit a wide range of ecological niches. Many species of ciliates serve as hosts for bacterial ecto- and endo-commensals, fungi, algae and other protozoa. Free-living species occupy various layers in nature, found in freshwater, plains and marine environments, inhabiting both permanent and temporary water bodies. These include ponds, rivers, lakes (also salt marshes and saline roadside areas), seas, swamps, forest litter, sand, tree leaves and bark, melting ice and numerous other ecological layers. In these microhabitats, ciliates form a distinct and unique fauna, often found in plant crevices (Duran-Ramirez *et al*., 2014).

Most infusoria are heterotrophs, though some species form symbiotic relationships with green algae or even chloroplasts, which were originally ingested by primitive organisms. In return, these ciliates benefit from the food produced by these photosynthesizers. Infusoria exhibit remarkable diversity in their feeding habits-many are bacteriophages, algophages or fungophages, consuming plant-based food sources. Additionally, there are predatory species, histophages and even cannibals, found among

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coliphages, steno- and oligophages. At the same time, ciliates themselves serve as prey for small invertebrates like *Rotatoria, Cladocera* and others.

Thus, the abundance of infusoria in ecosystems (both aquatic and soil forms) makes them key players in the exchange of organic substances (Prikhodko, 2009; Buyvolova *et al.*, 2015; Finlay & Fenchel, 2001). A noteworthy collection of papers focuses on the relationships among free-living infusoria in both aquatic and soil communities, as well as their interactions with other animal groups (Zhao & Xu, 2016).

The theoretical and practical importance of research in this area is significant. Considering this, it was deemed appropriate to investigate the species composition of pedobionts in the forest soils around Hajikand.

2. Materials and methods

From 2020 to 2024, studies were carried out to assess the species diversity of free-living pedobiont infusoria in the forest soils around Hajikand region. A total of 100 soil samples were collected from five stationary collection points near Hajikand (1st point - vineyards of the Goy-Gol district, 2nd point - forest soil of the village of Ashigli, 3rd point - forest soil of Hajikand, 4th point - forest soil of Chaykend and 5th point - mountain-forest soil of Toganali village), each exposed to varying levels of human activity and analyzed under laboratory conditions. Additionally, 50 samples were collected from household plots, gardens and forest lands near populated areas. This was done to evaluate the impact of human activity on soil fauna, using infusor communities of pedobionts as an example (Alekperov & Mamedova, 2013; Foissner, 2016).

Samples from the upper soil surface were collected using clean, small plastic containers. For deeper layers, a 30 cm long tube with a 3 cm diameter was inserted into the soil. The study was conducted on monolithic layers extracted from the soil using a pipe. The methods employed in the study included taxonomic identification of free-living soil infusoria, counting unhardened samples and calculating the individual mass of the infusoria.

In addition to laboratory experiments, field experiments were carried out on 50x50 cm experimental plots of wet soil. These field experiments were conducted in 5 replicates. For each species, at least 10-25 individuals were measured. Both original materials and modern illustrations were used to depict the described species.

3. Results and discussion

Order *Phacodiniidae* Corliss, 1975 *Phacodinium metchnikoffi* Prowazek, 1900 (Figure 1)

One of the notable species of infusoria, though very rare in the lands of Azerbaijan, was redescribed by several researchers, including Pukalchik et al. (2014).

Due to the absence of a detailed description of this species in domestic literature, we provide its brief morphological characteristics based on the study of total preparations impregnated with silver nitrate.

The size of living infusoria ranges from 90 to 140 μm, with fixed cells measuring no more than 100 μm. The body is oval and slightly compressed laterally, featuring five ribs on its surface. The adoral field consists of 30-32 membranes and is covered by a protrusion on the right side of the body. The pellicle is dense and distinctly ribbed.

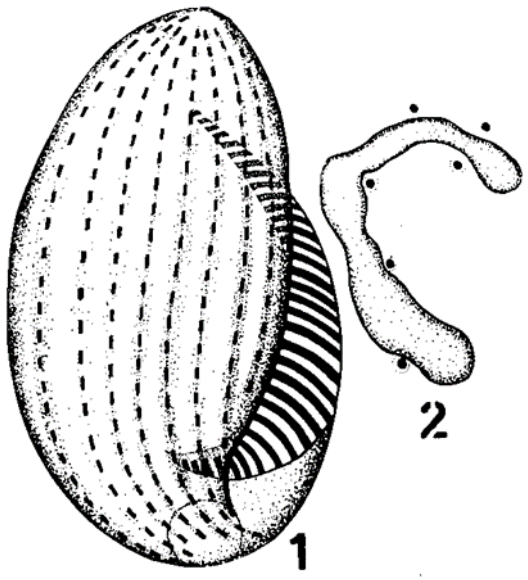

Figure 1. Phacodinium metchnikoffi
Note: 1 - general view, 2 - nucleus

When observed, fertilized cells appear like a negative photograph, likely due to the absence of cytoplasmic pigmentation. The somatic cilia are arranged in 8 rows between the pellicle's ribs, extending from the dorsal region of the membranelles on both the right and left sides. The kinetic rows in the adoral field are unipolar, with kinetosomes in somatic rows grouped into sets of 8 kinetes. The nuclear apparatus consists of a horseshoe-shaped macronucleus with 4-5 micronuclei. A folded vacuole is located at the caudal end of the body. This species differs slightly from descriptions found in the literature (Alekperov, 2012; Pukalchik *et al*., 2014), specifically in its smaller body size and fewer unipolar somatic rows. We first discovered this species in the forest thickets of Samur-Yalama National Park. During the study, it was observed only once, in the vineyards of the Hajikand area, among decaying plant debris.

Order *Amphisiellidae* Jank., 1979. *Hemiamphisiella terricola* Foissner, 1988 (Figure 2)

For amphisielids, only one species of the genus H*emiamphisiella* has been identified - *H. terricola* Foissner, 1988. This species has one cirrus to the left of the ventral row and a single cirrus located below the adoral region of the membranella, positioned between the ventral and short left marginal rows (Alekperov & Mamedova, 2013; Foissner, 2016). H. terricola Foissner, 1988 was first observed by us in the forests of Samur-Yalama National Park. Below is the description of H. terricola, as found in the forests near the village of Ashigli.

Living infusoria measure 180-230 μm in length and 50 μm in width, with fixed cells ranging from 160-200 μm. The body is dorsoventrally compressed and elongated, with a slightly wider anterior end. The adoral field comprises 40-46 membranes and to the right of the peristome, there is a single buccal cirrus. The upper region features four arcuate coronal veins. In the abdominal region, there are two ventral rows of antennae, with the right row being slightly shorter, containing only 8-10 antennae. The species has both left and right marginal rows. The right marginal row extends to the caudal end, while the

shorter left row starts below the adoral field and spirals, ending at the mid-body level. Between the left marginal row and the long ventral row is a single cirrus, characteristic of the genus *Hemiamphisiella*. The dorsal side contains four rows of spines and five caudal setae. The nuclear apparatus consists of 25-35 fragments and the endoplasm is transparent, often with a pale-yellow hue. The individuals we found in the soil were morphologically identical to those discovered in Austria.

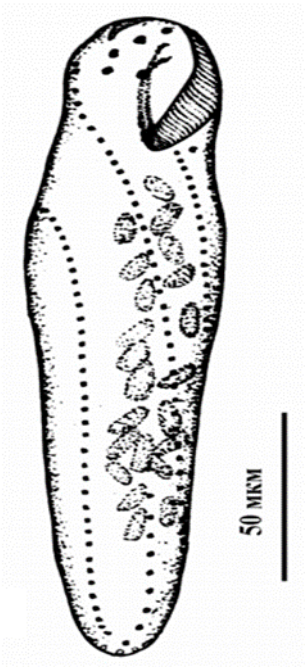

Figure 2. Hemiamphisiella terricola
Note: general view

***Periholosticha lanceolata* Hemberger, 1982 (Figure 3)**

The genus *Periholosticha* was first discovered and described from soils in Peru in 1982 (207). We identified two species, including the typological *P. lanceolata* Hemberger, 1982. Below is the description of *P. lanceolata*, which we first discovered in the forest soils of Hajikand.

Living infusoria range from 120-150 μm in size, with fixed cells measuring up to 120 μm. The body is elongated and significantly compressed in the dorsoventral direction. The tip of the antherids is distinctly cephalized. The adoral field is composed of 36-40 membranes and on the anterior end of the ventral side, there are three large anterior rows. Below this is a short row of 8 mid-ventral setae. There are no jugal or transverse sutures. The right marginal row consists of 24 pinnate rows, while the left has 21. The species also has three caudal fins. On the dorsal side, there are three rows of cirri. The entire body is covered by a fine argyromous mesh with argyroconts of various shapes. The pore of the contractile vacuole is impregnated at the lower edge of the adoral area.

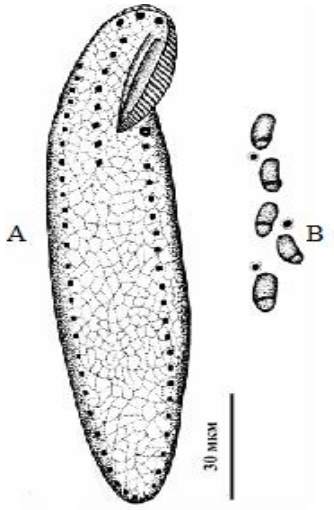

Figure 3. Periholosticha lanceolata
Note: A - general view, B - nucleus

The endoplasm is transparent, with a yellow or light brown hue. The nuclear apparatus consists of 4-7 macronuclei and 3 micronuclei. The *Periholosticha lanceolata* specimens we described differ from those found in Peru in several notable features. In our specimens, the mid-abdominal rows are arranged in a single row rather than two and their number is half that of the specimens described by Hemberger. Additionally, the number of macronuclei in our *P. lanceolata* specimens is three times fewer than those collected in Peru.

Order *Kahliellidae* Tuffrau, 1979. *Kahliella franzi* (Foissner, 1982) (Figure 4). The species was initially described by Foissner as *Gonostomum franzii* (Alekperov & Mamedova, 2014; Foissner, 2000). However, after a more detailed study of its morphogenesis, it was later reassigned to the genus *Kahliella* (Alekperov & Mamedova, 2013; Berger & Foissner, 1988). Below is the description of *K. franzi*, based on preparations impregnated with protargol.

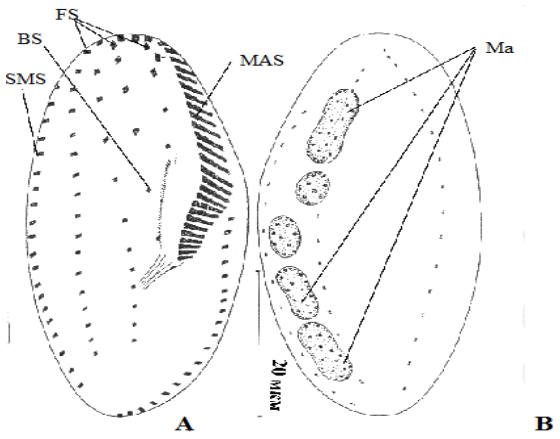

Figure 4. Kahliella franzi
Note: A - ventral part, B - dorsal part (FS - frontal cirri, BS - buccal cirri, RMR - right marginal row, AAM - adoral area of membranella, Ma - macronucleus)

The infusoria measure 90-110 μm in size, with an oval body shape compressed in the dorsoventral direction. The adoral region of the membranella consists of 30 elements, covering the left edge of the ventral side, starting from the apical end and extending beyond half of the body. There are 5 ventral rows of cirri, ranging from a single cirrus on the left side to 17 cirri on the right ventral side. Transverse cirri are absent. The right marginal row contains 17 cirri, while the left row has 20. There is no caudal cirrus. The dorsal cilia are arranged in 3 rows of varying lengths. The endoplasm is transparent with a light brown tint. The macronucleus, along with 3-7 micronuclei, is fragmented into up to 18 parts. We recorded this species in the forest soils of Chaykand.

***Oxytricha formoza* Alekperov, 1984 (Figure 5).** This species was originally discovered and described from the Uzunoba Reservoir (Alekperov, 2012; Alekperov & Mamedova, 2013). In our studies, it was observed in forest soil biotopes within the Samur-Yalama National Park and the village of Toganali.

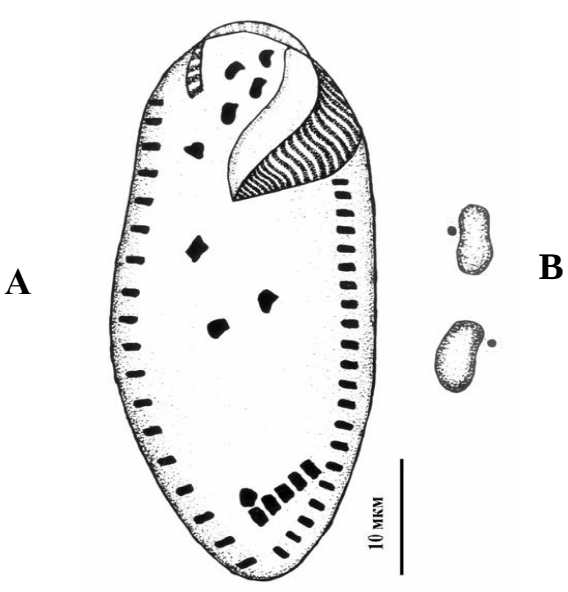

Figure 5. Oxytricha formoza
Note: A - general view, B - nucleus

Living infusoria measure 60-80 μm, while fixed cells range from 40-50 μm. The body is strongly compressed dorsoventrally. The adoral field consists of 30-35 membranes. On the ventral side, there are 8 ventral, 6 transventral and 2 marginal rows of cirri. The left marginal row contains 20-24 cirri, while the right row has 16-18. On the dorsal side, there are 2 rows of bristles, each comprising 15-18 bristles. The endoplasm is transparent and lacks appendages. The nuclear apparatus consists of 2 oval macronuclei and 2 micronuclei.

Morphologically, this species is closely related to *O. similis* Engelman, 1862, but differs in its smaller body size, having fewer than 3 ventral rows and a distinct arrangement.

4. Conclusion

In the forest soils around Hajikand region, 50 species of pedobiont infusoria were discovered for the first time, with 5 species being recorded for the first time in this area. A comparative analysis revealed that species diversity in soil infusoria communities is significantly higher in areas with minimal anthropogenic impact, such as the high-forest soils of the villages of Toganali and Chaykand, compared to areas under active human influence (including the vineyards of the Goy-Gol district and the forest soils of Ashigli and Hajikand).

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