SOIL TESTACEAN RHIZOPODS IN SOILS OF SECONDARY FORESTS IN THE SPIŠ-GEMER PART OF THE SLOVENSKÉ RUDOHORIE MTS

KATARÍNA MONIŠOVÁ, IVANA VYKOUKOVÁ, KATARÍNA HARNOVÁ

Department of Soil Science, Comenius University, Faculty of Natural Sciences, Mlynská dolina B–2, 842 15 Bratislava, Slovak Republic; e-mail: vykoukova@fns.uniba.sk, harnova@fns.uniba.sk

Abstract

Monišová K., Vykouková I., Harnová K: Soil testacean rhizopods in soils of secondary forests in the Spiš-Gemer part of the Slovenské rudohorie Mts. Ekológia (Bratislava), Vol. 26, No. 2, p. 115–121, 2007.

In secondary pine and spruce forests of the Spiš-Gemer region several chemical soil parameters, biomass of micromycetes and especially the occurrence of soil testacean rhizopods were studied. Studied soils (Dystric Cambisols) were found extremely to ultra acid and extremely unsaturated (Table 1). The biomass of micromycetes, since the samples consisted of forest litter mixed with humus horizon was relatively high, about 380 $\mu g.g^{-1}$ in the pine stand, and 280 $\mu g.g^{-1}$ in spruce stand. To acid soil conditions reacted the soil microfauna community as well. Species abundance was not high, we noted species such as *Trigonopyxis arcula, Cyclopyxis eurystoma, C. kahli* and *Nebela tincta.* Probably species *Arcella conica* is also present which, however, is not presented in the Data bank of Slovak fauna (Anonymous). A quantitatively higher abundance was found in spruce stands, what is probably related to higher soil moisture.

Key words: secondary spruce and pine forests, acid unsaturated soil, biomass of soil micromycetes, soil testacean rhizopods, *Arcella conica*

Introduction

Forests in the middle part of the Hnilec river watershed are affected by spatial prevalence of secondary spruce stands suffering from various extent of forest damage. Less frequently occur secondary pine forests. Quality of these stands may be judged not only based on the state of vegetation, but also on the state of soil being a part of plant communities environment. In this contribution we tried to find relations between several chemical soil parameters, biomass of micromycetes and abundance of soil testacean rhizopods in these forest stands.

Material and methods

Field work and soil sampling was performed in October 2002. Nomenclature of plant associations is taken from works of Toholová (1983), who was the first to characterize secondary pine forests from the Smolník creek area, and Šimurdová (2001), who described secondary spruce forests in this area. Nomenclature of vascular plants is according to Marhold et al. (1998). Soil samples were taken from the ochric Ao horizons (partially mixed with the litter O horizon) in locality Kvečahy. Soils were classified (according to Collective, 2000 in WRB terminology) as Dystric Cambisols. Soil parameters – active and exchange soil reaction (pH_{H2O}, pH_{KCl}), then soil adsorption complex characteristics: hydrolytical acidity (H), cation exchange capacity (S), base content (T) and base saturation (V%) were determined according to Hraško et al. (1962). For determination of micromycetes biomass the method modified by Bernát et al. (1984) was used. For calculation of micromycetes biomass we used the following formulas:

Calculation of mycelium length [$\mu m.g^{-1}$]:

$$L = \frac{\Sigma l * P}{n * m * p} * \frac{102}{a}$$

Σl – total length of mycelium in all ocular screen fields of particular preparation
P – molecular filter surface [mm^2]
n – number of screen fields of particular preparation
m – weight of soil sample [g]
p – screen field area at certain magnification [mm^2]
102 – 2ml anilin blue + 100ml distilled water [ml]
a – amount of suspension carried onto the membrane filter [ml].

Calculation of mycelium volume [cm^3]:

$$V = l * \Pi * r^2 * 10^{-12}\ cm^3$$
$$r = 2.5\ \mu m.$$

Calculation of mycelium weight [$\mu g.g^{-1}$]:

$$M = V * p$$
$$p = 1.05\ g.cm^{-3}.$$

In particular preparations we observed the length of micromycetes mycelium using a light microscope, digital camera and the Impor 3.0 software.

Presence of testate amoeba was discovered in preparations produced for the determination of micromycetes biomass. We measured diameter of the shells (tests), their height and the diameter of shell aperture. Species identification proceeded according to work of Bartoš (1954), also according to available related internet pages as well as personal communication with V. Balík from the Institute of Soil Biology of the Czech Academy of Sciences in České Budějovice. Most significant species of soil testacean rhizopods found were documented in microphotographs created by means of light microscope, digital camera and the Impor Pro 3.0 software.

Soil sampling site:

Nálepkovo village – Kvečahy, bellow-ridge forest stands of altitude 660 m a.s.l., slope aspect: NW, slope gradient: 10°, forest age: 80–100 years, date: 3 Oct., 2002.

Results and discussion

Dominant in the investigated area are secondary spruce forests, which can be classified into association *Avenello flexuosae – Piceetum cult.* (Šimurdová, 2001). Less represented are secondary pine forests of the association *Trientalio – Pinetum sylvestris culti ass. prov.*, in this region described by Toholová (1983). A typical feature for these stands is a high abundance of acidophilous plant species, such as *Vaccinium myrtillus, V. vitis-idaea, Avenella flexuosa, Luzula luzuloides, Maianthemum bifolium, Dryopteris carthusiana, Calluna vulgaris, Trientalis europaea* etc. A more detailed view on comparison of secondary pine and spruce forests from the phytocoenological and ecological point of view is presented in the paper of Šomšák et al. (2003).

Results obtained from chemical analyses are presented in Table 1.

T a b l e 1. Chosen soil parameters – Kvečahy locality.

	Pine stand Rhizosphere 0–7 cm O – AO horizon	Spruce stand Rhizosphere 2–3 cm O – AO horizon
pH_{H2O}	2.84	3.52
pH_{KCl}	2.67	3.10
S (mval/100g)	6.80	4.00
H (mval/100g)	26.00	25.00
T (mval/100g) (T=S+H)	32.80	29.00
V (%)	20.73	13.79

According to the extended USDA scale the studied soil samples from pine stand are presented as ultra acid (pH < 3.5) and from secondary spruce stand as extremely acid (pH 3.5–4.4) (Čurlík, Šurina, 1998). Regarding adsorption complex values the samples are considered extremely unsaturated. Chemical analyses results confirm unfavourable sanitary conditions of soils in this region, which is displayed into significant deterioration of forest stands with various extent of damage.

Values of soil micromycetes biomass (Table 2) were relatively high, what is in accordance with other authors (Šimonovičová, 1990) stating that the upper horizons (topsoil – litter and humus) are the richest with microbial biomass.

T a b l e 2. Biomass of soil micromycetes – Kvečahy locality.

	Mycelium length ($\mu m.g^{-1}$)	Mycelium volume ($cm^3.g^{-1}$)	Mycelium weight biomass ($\mu g.g^{-1}$)
Pine stand Rhizosphere O – A_O horizon	18.49.106	3.62.10-4	380.90
Spruce stand Rhizosphere O – A_O horizon	14.04.106	2.75.10-4	289.26

A more complete view of life in soil includes also the observation of soil fauna. Soil testacean rhizopods represent a group common in our soils, having an important role in decomposition of organic matter in soil. Testate amoebas are known to specialize to

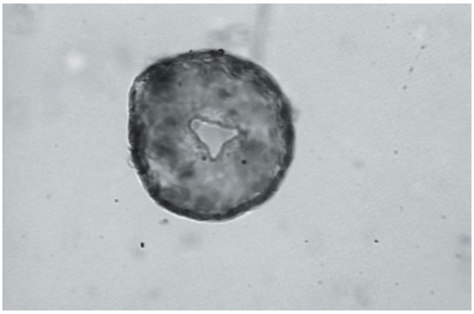

Fig. 1. *Trigonopyxis arcula*.

Test diameter: 83,5–86 µm
Test aperture diameter: 20 µm

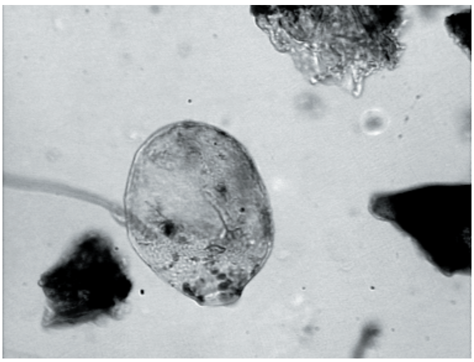

Fig. 2. *Nebela tincta*.

Test diameter: 95 µm
Test aperture diameter: 20 µm

individual types of biotopes (Balík, 2002). Soil moisture is the main ecological factor influencing their occurrence and abundance. Soil acidity is another important factor. Many soil testacean rhizopods belong to acidophilous organisms, such as *Trigonopyxis arcula* (Fig. 1) e.g., a species considered to be typical and the most numerous amoeba representative of oligotrophic spruce forests. We also marked the occurrence of *Nebela tincta* (Fig. 2), which belongs to typical amoeba species of humus layer in forest soils (occurring in all forest types). The occurrence of species *Trigonopyxis arcula* and *Nebela tincta* is probably related also to high biomass of micromycetes and organic matter, since hyphae and spores of microscopic fungi are their main nourishment source. Besides the above mentioned species also *Cyclopyxis eurystoma* and *C. kahli* (Figs 3a,b, 4a,b) were determined. All of the mentioned species occurred in both studied secondary habitats. In spruce forest we probably also documented the species *Arcella conica* (Fig. 5) in addition, which is more typical for active peatland and water biotopes and its sporadic occurrence refers to higher soil moisture. The Databank of Slovak fauna (Anonymous) does not include this species at present.

It is assumed that mainly phytocoenological diversity may affect the species representation of soil amoeba (Balík, 1994), which however is not rich in the investigated area. Both localities are of monocultural character with low vegeta-

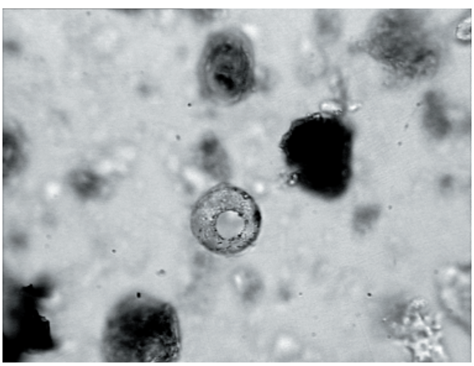

Fig. 3a. *Cyclopyxis eurystoma*.

Test diameter: 34–35 µm
Test aperture diameter: 15–16 µm

tion diversity. In 2g of soil 155 amoeba individuals in secondary spruce stand, and in the pine stand 46 individuals were found. Testacean rhizopods observed in the soil samples can be classified into zoological taxonomic system (according to Matis et al., 2002) as follows:

Kingdom: *ANIMALIA*
Subkingdom: ***Monocytozoa***
Phylum: *Sarcomastigophora*
Subphylum: *Sarcodina*
Superclass: *Rhizopoda*
Class: *Lobosea*
Order: *Testacealobosida (Arcellida)*

The group of testacean rhizopods from the *Testacealobosida* order deserves a closer

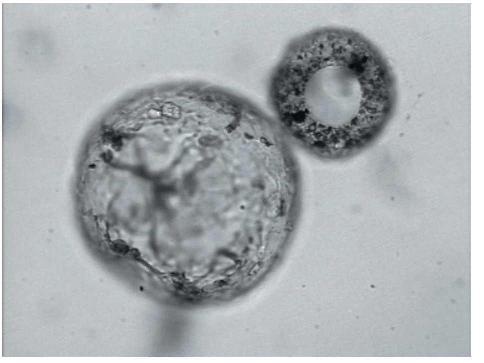

Fig. 3b. *Cyclopyxis eurystoma*.

Test diameter: 61–66 µm
Test aperture diameter: 32 µm
Trigonopyxis arcula (with undistinguished test aperture)
Test diameter: 110–113 µm

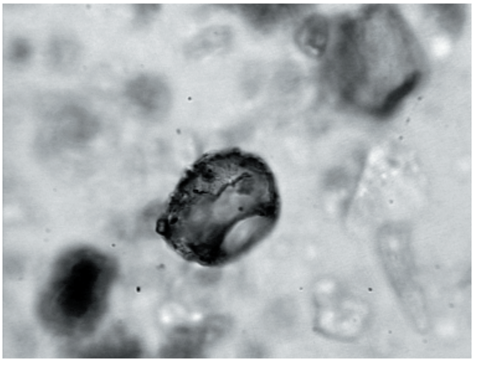

Fig. 4a. *Cyclopyxis kahli*.

Test diameter: 62 µm
Test aperture diameter: 32 µm

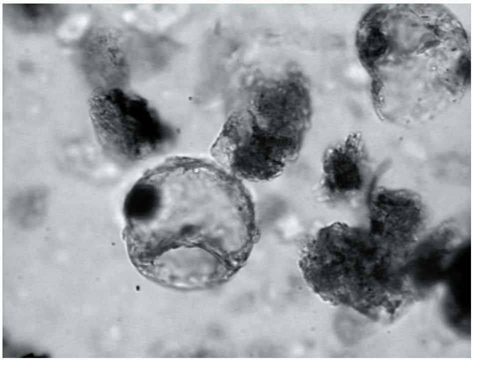

Fig. 4b. *Cyclopyxis kahli*.

Test diameter: 66 µm
Test aperture diameter: 42 µm

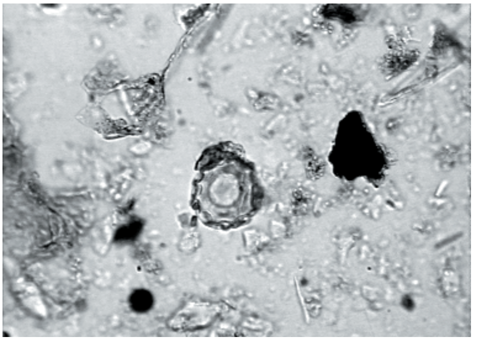

Fig. 5. *Arcella conica*.

Test diameter: 37–40 µm
Test aperture diameter: 16.5 µm

attention especially since the specialization of many of these soil amoebae to different environments might in the future enable their practical utilization in the bioindication field.

Conclusion

The study of chosen soil parameters, biomass of micromycetes and soil testacean rhizopods in secondary spruce and pine stands leads to following conclusions:

– observed soils (dystric cambisols) were extremely to ultra acid and extremely unsaturated, what refers to very unfavorable conditions,
– biomass of soil micromycetes was relatively high (higher in the pine stand), samples consisted of a mixture of litter and humus horizons; with increasing depth of soil profile these values would probably decrease significantly,
– low pH values and poor vegetation diversity also evoked reaction of soil microfauna community. We determined species *Trigonopyxis arcula, Cyclopyxis eurystoma, C. kahli, Nebela tincta* and in spruce forest probably also species *Arcella conica,*
– higher number of soil testacean rhizopods was found in spruce stands what leads to an assumption of better moisture conditions for rhizopods than in pine stands.

Translated by the authors

Acknowledgements

This work was supported by grant VEGA, Slovakia No. 1/2411/05. We wish to thank to M. Mrva of the Department of Zoology, Faculty of Natural Sciences, Comenius University, Bratislava.

References

Anonymous: Databank of Slovak Fauna. http://www.dfs.sk.

Balík, V., 1994: Testate amoebae (*Rhizopoda, Protozoa*) of the Great basin area (Jeseníky, Czech Republic) (in Czech). Čas. Slez. Muz. Opava (A), *43*: 234–252.

Balík, V., 2002: Communities of soil testate amoebae (*Protozoa, Rhizopoda*) in National nature preserve Žofínský prales (Novohradské Mts., Czech Republic) (in Czech). In Papáček, M. (ed.), Biodiversity and nature conditions of Novohradské Mts. Jihočeská univerzita and Entomologický ústav AV ČR, 285 pp.

Bartoš, E., 1954: Rhizopods of the *Testacea* order (in Slovak). Vydavateľstvo SAV, Bratislava, 187 pp.

Bernát, J. et al., 1984: Determination of the microfungal biomass. Acta Fac. Rerum. Nat. Univ. Comenianae, Microbiol., *10*: 21–30.

Collective, 2000: Morphogenetic soil classification system of Slovakia (in Slovak). VÚPOP, Bratislava, 76 pp.

Čurlík, J., Šurina, B., 1998: Handbook on field work and soil mapping (in Slovak). VÚPÚ, Bratislava, 134 pp.

Hraško, J. et al., 1962: Soil analyses (in Slovak). SVPL, Bratislava, 342 pp.

Marhold, K. (ed.), 1998: *Pteridiophyta* and *Spermatophyta* (in Slovak). In Marhold, K., Hindák, F. (eds), Checklist of non-vascular and vascular plants of Slovakia. Veda, Bratislava, p. 333–687.

Matis, D. et al., 2002: Zoology system scheme (in Slovak). Katedra zoológie, Prírodovedecká fakulta UK, Bratislava, 16 pp.

Šimonovičová, A., 1990: Micromycetes in alpine soils (in Slovak). PhD thesis. Ústav ekobiológie SAV, Bratislava, 171 pp.

Šimurdová, B., 2001: Secondary spruce forests in the Hnilec river watershed (in Slovak). Bull. Slov. Bot. Spol., *23*: 141–147.
Šomšák, L. et al., 2003: Comparison of some soil-ecological and phytocoenological properties of secondary pine and spruce forests in the Slovenské rudohorie Mountains. Phytopedon (Bratislava), *2*, 1: 27–33.
Toholová, J., 1983: Vegetation characteristics of lower part of Smolník creek alluvium (in Slovak). Diploma thesis. Katedra botaniky, geobotaniky a pedológie, Prírodovedecká fakulta UK, Bratislava, 66 pp.

Received 16. 3. 2005