Available online at www.sciencedirect.com
ScienceDirect
European Journal of Protistology 63 (2018) 51–61
European Journal of PROTISTOLOGY
www.elsevier.com/locate/ejop

Seasonal dynamics in the community structure and trophic structure of testate amoebae inhabiting the Sanjiang peatlands, Northeast China

Lihong Song[a,b], Hongkai Li[c], Kehong Wang[b,d], Xiumin Yan[b,e], Donghui Wu[b,f,g,*]

[a]*College of Agriculture, Guizhou University, Guiyang, 550025, China*
[b]*Key Laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun 130102, China*
[c]*Institute for Peat and Mire Research, Northeast Normal University, Changchun 130024, China*
[d]*College of Resources and Environmental Science, Chongqing University, Chongqing 400044, China*
[e]*School of Geography and Tourism, Guizhou Education University, Guiyang 550018, China*
[f]*Key Laboratory of Vegetation Ecology, Ministry of Education, Northeast Normal University, Changchun 130024, China*
[g]*Jilin Provincial Key Laboratory of Animal Resource Conservation and Utilization, Northeast Normal University, Changchun 130117, China*

Received 25 August 2017; received in revised form 25 January 2018; accepted 29 January 2018
Available online 6 February 2018

Abstract

Peatlands cover 3% of the earth's land surface but contain 30% of the world's soil carbon pool. Microbial communities constitute a crucial detrital food web for nutrient and carbon cycling in peatlands. Heterotrophic protozoans are considered top predators in the microbial food web; however, they are not yet well understood. In this study, we investigated seasonal dynamics in the community and the trophic structure of testate amoebae in four peatlands. Testate amoebae density and biomass in August were significantly higher than those in May and October. The highest density, 6.7×10^4 individual g^{-1} dry moss, was recorded in August 2014. The highest biomass, 7.7×10^2 $\mu g\,C\,g^{-1}$ dry moss, was recorded in August 2013. Redundancy analyses showed that water-table depth was the most important factor, explaining over one third of the variance in fauna communities in all sampled seasons. High trophic position taxa dominated testate amoebae communities. The Shannon diversity index and community size structure index declined from August to October in 2013 and from May to October in 2014. These seasonal patterns of testate amoebae indicated the seasonal variations of the peatlands' microbial food web and are possibly related to the seasonal carbon dynamics in Northeast Chinese peatlands.

Keywords: Diversity; Microbial food web; Size structure; Testate amoebae; Trophic position; Wetland

Introduction

The imbalance between litter inputs and carbon outputs has resulted in peatlands containing one-third of the world's pool of soil carbon (Limpens et al. 2008). Given the impact of climate change, the feedback of biogeochemical plant-soil microbes has been identified as a critical process for carbon storage in peatlands (Bragazza et al. 2013). During the past decades, bacteria and archaea contributing to greenhouse gas fluxes have been extensively studied in peatlands (e.g., Bridgham et al. 2013; Kim et al. 2008; Peltoniemi et al. 2016). Previous studies describe the microbial loop, which includes heterotrophic protozoans, as playing a central role

*Corresponding author at: KeyLaboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun 130102, China.
E-mail address: wudonghui@iga.ac.cn (D. Wu).

https://doi.org/10.1016/j.ejop.2018.01.005
0932-4739/

in the pathway of carbon flow and nutrient cycling at the surface of peatlands (Gilbert et al. 1998; Jassey et al. 2013; Mitchell et al. 2003). Thus, changes in specific microbial groups could lead to destabilization of the microbial loop and potentially influence the function of the peatland ecosystem.

Testate amoebae, the predominant peatland protozoa by biomass, are small (20–200 μm), abundant (10^3–10^4 individuals g^{-1} dry peat) and diverse (2000 species described, 10–30 species per sample) organisms (Mitchell et al. 2008). Several studies over the last decades on the ecology of testate amoebae in peatlands have identified the water-table depth (WTD) as the primary factor in determining the amoeba community composition and distribution (Amesbury et al. 2016; Li et al. 2015; Mitchell et al. 2008). In addition, testate amoebae have been widely used as a proxy for palaeohydrological reconstruction in peatlands (Diaconu et al. 2017; Gałka et al. 2017; Mitchell et al. 2008). Due to their short regeneration time and high degree of sensitivity to environmental changes, testate amoebae are ideal ecological indicators (Mitchell et al. 2008; Jassey et al. 2013). They prey upon and modify microbial populations (e.g., bacteria, fungi, microalgae, micro-metazoan and even smaller testate amoebae) and have the most important role in organic matter mineralization and biogenic compound recycling (Gilbert et al. 1998; Wilkinson 2008; Wilkinson and Mitchell 2010). Despite the great quantity of known information and their ecological importance, much less is known about the impact of seasonal variation on testate amoebae in peatlands.

A few studies have investigated seasonal patterns of testate amoebae communities in peatlands. Heal (1964) first reported the population dynamics of testate amoebae in peatlands during one growing season, showing that peak abundance occurred during the spring-summer periods. Similar fauna seasonal patterns were also reported by studies carried out in Europe (e.g., Gilbert et al. 2003; Marcisz et al. 2014). These authors contributed this fauna seasonal pattern to the favorable hydrological conditions during this period. Conversely, the study carried out in a Poland bog showed low testate amoebae abundance in summer, due to the low moisture content in this season (Niedzwiecki et al. 2016). Some studies also reported a bimodal pattern of testate amoebae density among seasons in Switzerland peatlands (Lamentowicz et al. 2013) or no clear seasonal patterns in a peatland in North America (Warner et al. 2007). It is therefore unclear how seasonal variation influences the testate amoebae annual population dynamics.

The seasonal patterns of testate amoebae are important for understanding species-environment relationships as well as nutrient cycling and energy flow. Protist size determines their trophic position in the microbial loop (Gilbert et al. 1998). Recently, functional trait-based approaches were progressively used in testate amoebae ecological studies (e.g., Fournier et al. 2015; Lamentowicz et al. 2015; Marcisz et al. 2016; Van Bellen et al. 2017). Depending on the testate amoebae shell-aperture size/body size ratio, Jassey et al. (2013) separated the amoebae into high and low trophic level groups. Low trophic level species primarily feed on bacteria and algae, while high trophic level species primarily feed on protists and micro-metazoans in the microbial loop (Jassey et al. 2013). Similarly, Lamentowicz et al. (2013) described seasonal trophic patterns of testate amoebae using their high vs. low trophic position and community size structure. These trait-based indices are closely related to the ecological functions of testate amoebae. These approaches are providing new ways to study testate amoebae community structures and their trophic role in microbial food webs in relation to micro-environmental patterns and biogeochemical processes (Lamentowicz et al. 2013).

The present study was conducted during two growing seasons in four Chinese peatlands to bridge the gap in our understanding of the seasonal characteristics of testate amoebae community structures. We explored the patterns of testate amoebae community structure and trophic structure in Northeast Chinese peatland and hypothesized that testate amoebae community structure and trophic structure varied in seasons and that these patterns were closely related to seasonal variations in moisture conditions and water chemistry.

Material and Methods

Study site

The peatlands studied were located in Honghe National Natural Reserve (list of Ramsar wetlands of international importance in Northeast China: 133°41′E, 47°41′N; 55 m a.s.l.) (Fig. S1 in Supplementary material). The climate is temperate humid to sub-humid continental monsoon with a mean annual temperature of 1.9 °C and a mean annual precipitation of 600 mm. The average monthly temperature is −21 °C in January and 22 °C in July (Fig. S2 in Supplementary material). More than 60% of the annual precipitation falls in July and August (Fig. S2). This site is situated in a seasonally frozen zone with a frost-free period of 125 days. Four peatlands were selected based mainly on their similarities in vegetation type, which are dominated by the genus *Sphagnum* (*S. palustre*, *S. oligoporum* and *S. squarrosum*) in moss and *Carex* (*C. pseudo-curaica* and *C. lasiocarpa*) in herbaceous plants. The hydrological regimes of these peatlands are mainly driven by rainfall. Details of these peatlands were described by Song et al. (2014).

Field work and laboratory analyses

Transects were designed to cover all the possible microforms: 3 transects were located in each peatland with 3–4 sampling sites in each transect. Field work was carried out in five seasons during two growing seasons, i.e. August 2013, October 2013, May 2014, August 2014 and October 2014.