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TWO YEAR PHYTOBENTHOS INVESTIGATION OF PETRIFIED FOREST CREEK AT MARITIME ANTARCTIC KING GEORGE ISLAND - PRELIMINARY STUDY

ONDŘEJ KOMÁREK[1], JIŘÍ KOMÁREK[2]

[1]*Department of Ecology and Zoology, Faculty of Science, Masaryk University, Kotlářská 2, CZ - 611 37 Brno, Czech Republic*

[2]*Department of Botany, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ - 370 05 České Budějovice, Czech Republic*

ABSTRACT

Freshwater stream phytobenthos (cyanobacteria and algae) from Petrified Forest Creek, Arctowski station, King George island, was studied during the summer season 1995 – 96, 1996 – 97. The main solved question was: Are there any differences or frame of the distribution of algal species in the longitudinal gradient and time as well as in each sampling profile. The distinct differences in the species composition in several defined microbiotopes within each profile were found. The list of identified species is included. The seasonal changes in phytobenthos was studied, and the evaluation of diversity by Detrended Correspondence Analysis is presented. The dynamics within the year was not recognised, but the microbiotop specificity and possibly further study of successional changes of spatial distribution of algae assemblages can better tell us about influences and be better recognized. The differences in species composition between years was quite small but there occur several new species and several disapired. This is not easily interpretable. The last point needs further study.

KEY WORDS: Cyanobacteria - algae - diversity - periphyton - ecology - running water - Antarctica

INTRODUCTION

Algae and cyanobacteria play important role in succession and biological function of the Antarctic running waters .

The short life cycles and high turnover rates classify cyanoprokaryotes and algae among the main primary producers of organic matter in coastal regions of subantarctic islands. The phototrophic microflora is particularly important in the succession process in deglaciated regions where conditions change very quickly.

Several taxonomic groups of algae (Beljakova, 1987, Kawecka, Olech, 1993, Luscinska, Kyc, 1993, Broady, 1996, etc.) were studied and floristic and ecological data from South Shetland Islands and similar Antarctic biotopes were published (Vinocur, Pizarro, 1995, etc). However, the oxyphototroph microflora in Antarctica is still little known (Olech, 1993). The greatest problem is, that there do not exist good identification books for freshwater Antarctic algae, and the identification of Antarctic species according to populations from temperate or tropical zones is questionable. The amount of published algal species, originally known from very different niches, is too large in Antarctic literature and the data about different species from various papers are not comparable without precise documentation (Komarek, Komarek, 1999).

In the year 1995 we started with a complex investigation of terrestrial and freshwater algae in the area of Polish Antarctic Arctowski station, Admiralty Bay, King George Island, South Shetland Islands (62°10'S, 58°28'W) (Fig. 1).

The aim of this preliminary study was to identify differences in species composition due to sampling site character and seasonal changes by DCA.

STUDY AREA

The area of the Polish Antarctic Arctowski station (Admiralty Bay, King George Island, South Shetland Islands) (Fig. 1) was described in detail in several papers (see, e.g., Myrcha et al., 1991, Kawecka, Olech, 1993).

MATERIAL AND METHODS

The samples were collected regularly at intervals of 10-16-days during the Antarctic summer season (12.12.1995 - 16.2.1996 and 18.01.96 - 27.01.97) in 7 localities of Petrified Forrest Creak The ecological parameters, temperature, radiation, conductivity and pH were measured and the main data are included in the following descriptions of biotopes. From all the samples, cyanoprokaryotic and algal populations were identified, which correspond morphologically to traditional species from various taxonomic groups. The recognized taxa were compared with descriptions and literary data, and identified only in cases, when our populations corresponded well both in phenotype and ecological characteristics. The fully unidentified species are designated only by generic names. For cyanoprokaryotes, the names from the prepared taxonomic revision of this group from South Shetland Islands are used (Komárek J., in prep.). The community species composition and diversity was evaluated by TWINSPAN clustering method and by Detrended Correspondence Analysis (CANOCO software) according to Ter Braak and Prentice (1988). For checking possible pattern in distribution of species we classified samples in DCA ordination diagram due to several characteristics (sample site, time and for comparison mathematical classification by TWINSPAN.

RESULTS AND DISCUSSION

The rich system of streams in the Arctowski station region represents particularly important biotope in which the algae develop in high quantities. Petrified Forrest Creek as well as others from the region is in the continual supply of nutrients from the environment in streams of the Arctowski station region, which enables the continual increase of the biomass. In contrast, the clear dependence of the development of algal communities on temperature and water supply was evident.

Petrified Forest Creek, belongs to the main type of creeks in Arctowski station region (Fig. 1). All of them are supplied from the melting snow fields in the first period of the summer season, and later on from the melting permafrost. They all range in length from several hundred meters up to 1.5 km, and they flow through areas without vegetation. The Petrified Forest Creek was chosen as our model stream, in which we studied regularly the changes in algal vegetation during the whole summer season 1995/1996. Other creeks were studied occasionally.

From our results the following characteristics were derived:

a) One of the most important factors influencing the development of algal vegetation is temperature. It increases continuously from the values slightly above 0°C near the source up to 8.7°C further down the stream. The highest values in the lowest section were 10.3°C in Petrified Forest Creek, The highest temperatures in the water of the streams were measured on sunny days; in contrast, the temperature on cloudy days remained very low along the whole stream. The limit, in which the macroscopic mats of algae started to develop, was the average daily temperature of 3 to 3.8°C. The colouration of stones changed during the summer season, in agreement with the upward shift of this average temperature value.

b) pH ranged from 7 to 9.5, with the exceptionally measured values of 6.5 and 10.4 respectively. The pH values increased only indistinctly along the stream with the development of algal vegetation. The conductivity was low just down from the snowfields (sometimes only about 20 μS), and it increased irregularly along the stream during the whole vegetation season. The mean values changed from 40 to 140 (up to over 250); in the second part of the summer season, they were slightly higher on the average.

c) The algal succession on the substrate and seasonality occurred in dependence on the temperature along the stream as well during the whole summer season. The first stage beginning in temperatures around 3°C was characterized by small diatoms (mainly *Nitzschia frustulum*, *Achnanthes lanceolata* and *A. marginulata*), which were accompanied with *Hydrurus foetidus* (minimum limit about 4°C) and *Phormidium pseudopristleyi* in slightly higher temperature (from about 4 to 5°C). In water with the average temperature from 5 to 6°C characteristic community developed forming a mosaic on the stony bottom, with locally dominating *Hydrurus foetidus, Klebsormidium* sp. and the cyanoprokaryotes *Phormidium amoenum, P. pseudopristleyi* and *P. pristleyi*, near the water surface zone also with *Gloeocapsopsis aurea*.

DETRENDED CORRESPONDENCE ANALYSIS OF SAMPLES AND SPECIES

The Detrended Correspondence Analysis (Fig. 1 - 4) divided the localities according to the species composition. The main differences occurred between the species composition of first and second year. For DCA we used all the algal taxons instead of diatoms. The analysis down weighted rare species ant the data was not transformed.

The DCA result in very high Eigenvalues but on the other hand the total variance described by four axes was 25.9 %, but the variance was 8.1%, 7%, 5.9% and 4.9% for 1.2.3. and 4.-rth axis. It means that the situation is extremely complicated and we are not able to see any clear pattern of species (or species assemblages) distribution in time and space or gradients of conditions simply influencing the system.

This is caused mainly by sampling focussed on species composition more than on spatial distribution of algae in sampling profile, non similar sampling design in the first year (species diversity) and second year (chemical and physical modelling of biotops). The second year was also influenced by higher amount of samples but rare sampling (only two sampling in season). The next problem in this study was that the years following the study was climatically different and the second year was warmer. These changes are not only in weather but also in geomorphology, and variability of water demand for freshwater bodies. The succession of algae is changing the whole character of the stream. We observed that in first year the Petrified Forest Creek flow from snow field and after words the stream drying up from the upper part, and become shorter during the season. On the other hand the second year stream was quickly shorted (1/4) up to level of new seapage which occur suddenly after the winter on the upper part of stream and didn't dried up till the end of the season. Also problematic could be excluding of diatoms from the analysis. This was done because of poor literature during the first year of study.

We mentioned all the possible influences to the study, but it still reminds to tell, that ecosystem of maritime Antarctica is quite complex and quickly changing and it evoke beside fascination also our highest respect for study.

The next DCA diagrams show checking several possible simple reasons for distribution of species and samples in ordination space of the first and second ordination axis. We tested the seasonal changes, difference between years and differences in longitudinal profile of stream.

At least there is possible to campare the results with twinspan classification which was also not significant.

Never the less there has to be the pattern we do not see from our data. The observation of the localities show very high diversity in shapes and character of the bottom area of the stream. There were high and spatially structured algal mats in the lower parts of the stream corresponding with the development of the filamentous green algae, parts with Hydrurus not allowing other algae to live in surrounding and colour full cyanobacteria mats of different kind. On the upper part of stream was free soft substrate usually with diatoms.

Several other information can be found in diagrams. The highest species diversity was found in the middle of the season when the spectrum of microbiotops were highest (Fig. 2). On the other hand the differences in species composition were quite high (Fig. 3). Twinspan classification show distinct interaction between first and second axis in influence to species composition. The position of groups are in diagonal direction.

CONCLUSION

Our results from Petrified Forest Creek in the region of Arctowski station, maritime Antarctica, confirmed the following information about freshwater microflora:

1. There does not exist any spatial, temporal pattern in the distribution of algae and cyanobacteria assemblages which can be found by this simple sampling design and by DCA.
2. Algae distribution is dependent on interaction between species and environment.
3. The diversity is also influenced by the interactions between different algal species.
4. There exists direct influence of algae to its environment.

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Tab. 1 List of species found in Petrified Forest Creek and its abbreviations.

Species	Abbreviation
Chamaesiphon austro-polonicus	Chaapo
Chlorogloea sp.	Chlsp.
Gloeocapsa sp.	Glesp.
Gloeocapsopsis aurea	Glpaur
Gloeocapsopsis sp.	Glpssp
Heteroleibleinia sp.	Hetsp.
Cyanosarcina sp.	Cyasp.
Jaaginema sp. 1	Jagsp1
Leptolyngbya antarctica	Lepant
Leptolyngbya glacialis	Lepgla
Leptolyngbya borchgrevinkii	Lepbor
Leptolyngbya sp. 1	Lepsp1
Leptolyngbya sp. 2	Lepsp2
Lyngbya sp.1	Lynsp1
Lyngbya antarctica	Lynant
Lyngbya sp. 4	Lynsp4
Lyngbya sp. 5	Lynsp5
Microcoleus sp.	Micsp.
Oscillatoria subproboscidea	Oscsbp
Phormidium cf. amoenum	Phoamo
Phormidium pseudopristleyi	Phopspr
*Phormidium scottii	Phosco
*Phormidium attenuatum	Phoatte
*Phormidium pristleyi	Phopri
*Phormidium cf. Retzii	Phoret
Schizothrix sp.	Schsp.
Anabaena sp. 2	Anasp2
Nodularia harveyana	Nodhar
Calothrix sp.	Calsp.
Heteroleibleinia sp.	Hetlbsp
Prasiola sp	Prasp
Klebsormidium sp. 1	Klebsp1
Klebsormidium sp. 2	Klebsp2
Gonatozygon brebissoni	Gonatzg
Hydrurus foetidus	Hydrur
Achnanthes delicatula	Achdel
Achnanthes lanceolata	Achlan
Achnanthes marginulata	Achmar
Navicula muticopsis	Navmut
Navicula atomus	Navato
Navicula digitula	Navdig
Navicula tuscula	Navtus
Nitzschia sp.	Nitzsp
Nitzschia capitellata	Nitcap
Nitzschia gracilis	Nitgra
Nitzschia frustulum	Nitfru
Pinnularia sp.	Pinsp.
Pinnularia microstauron	Pinmic
Fragilaria capucina	Fracap
Fragilaria alpestris	Fraalp
Gomphonema parvulum	Gompar
Hantzschia sp.	Hansp.
Diat. epifyt	Diaepi
Cymbella sp.	Cymsp.

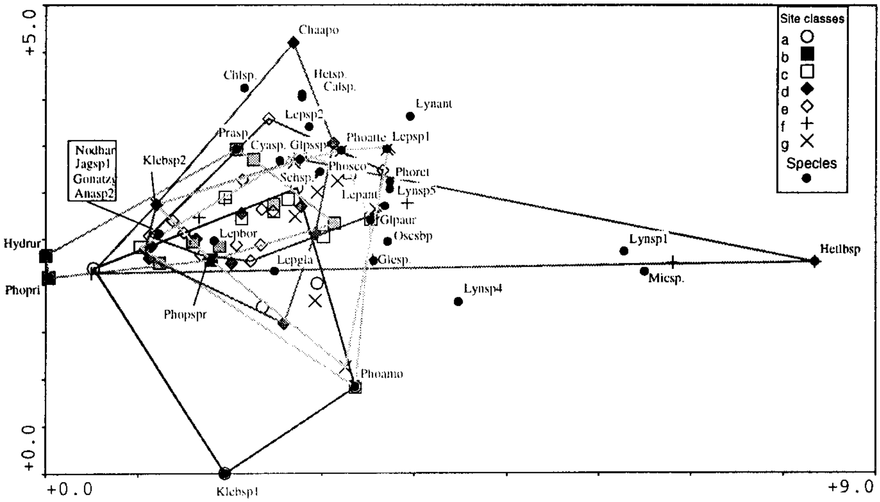

Fig. 1 The distribution of species and samples in the due to first and second ordination axes. The classification is made due to longitudinal profile.

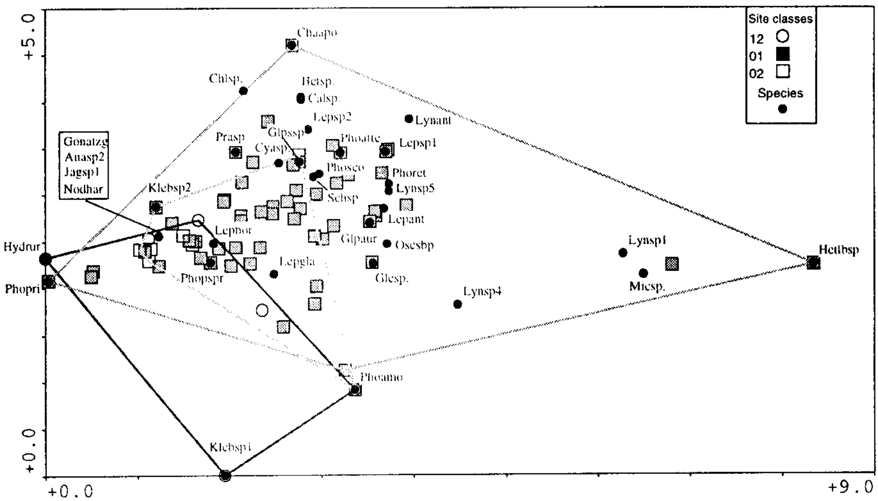

Fig. 2 The distribution of species and samples due to first and second ordination axes of DCA. The classification is made due to season (number of month).

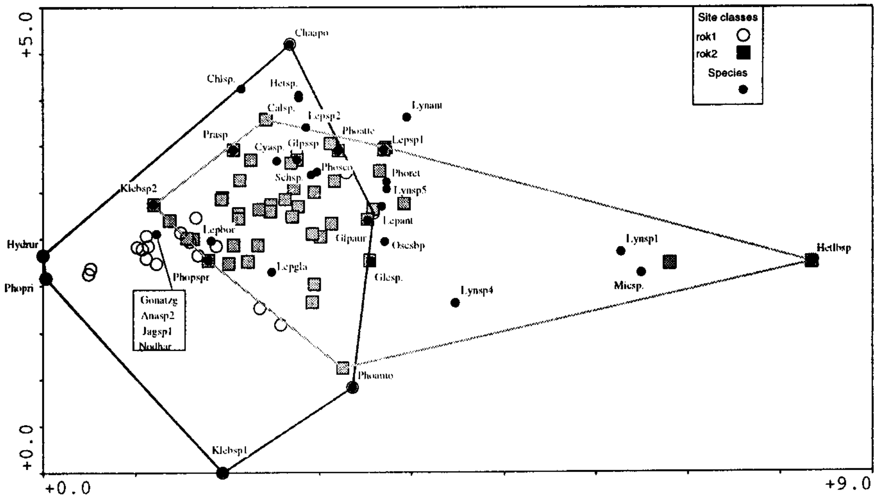

Fig. 3 The distribution of species and samples due to first and second ordination axes of DCA. The classification is made due to years of measuring.

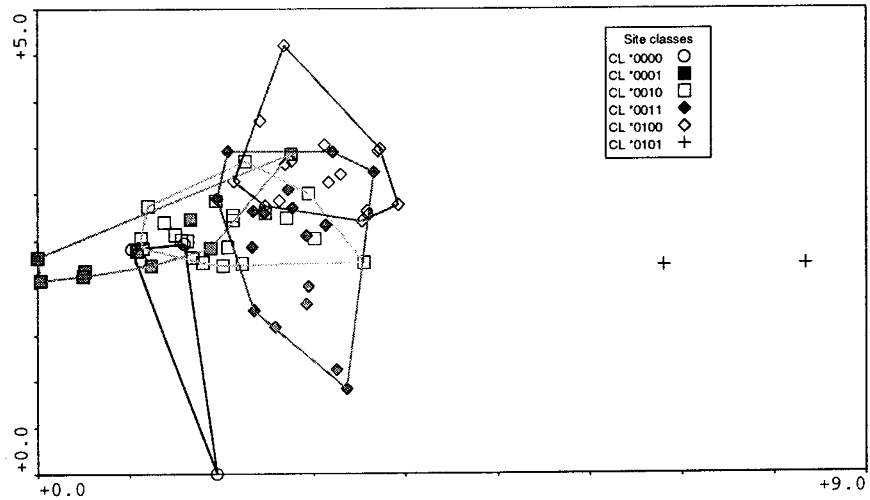

Fig. 4 The distribution of species and samples due to first and second ordination axes of DCA. The classification is made by Twinspan.