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Contributions to the flora of the Hungarian caves II. Flora of three caves near Beremend, Hungary

by

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Abstract: Green flora of three small caves near Beremend in S Hungary were studied. Besides the floristic data the climatic and light conditions are reported as well. 49 algal and 17 bryophyte taxa were identified from the three caves, namely: Beremendi-ördöglyuk, Nagy Vizes-barlang and Kis Vizes-barlang. *Asplenium adiantum-nigrum* L. (Pteridophyta) was found in one of them though this species was known as a calciphobous one.

INTRODUCTION

The second part of our series intended to present the flora of Hungarian caves (the flora of lamp-lit areas of show caves as well as the flora of entrances) deals with the cryptogamic plants of the entrances of three small caves near Beremend. The first part of our work (RAJCZY et al. 1987) gave a short literatural summary of the floristic results of the Hungarian cave research. During the past three years we presented some floristic data and the changes of the vegetation of a show-cave in Budapest (RAJCZY et BUCZKÓ 1989).

Description of the caves: All the three caves studied are situated in a limestone quarry near Beremend, Southern Hungary (Fig. 1). They were discovered 30–50 years ago in course of exploitation of the quarry. They had been formed in triassic limestone due to hydrothermal activity. All of them had a lake (or lakes) at their bottom representing the karstic water level. The biggest cave, Beremendi-ördöglyuk nowadays lacks them because it had been used as a depot for waste for a long while.

By the time of our study they had a completely developed, climax vegetation. Unfortunately, these three caves have been dynamited by the continuation of the mining by now. This study was carried out to document the botanical wealth of these caves before their destruction.

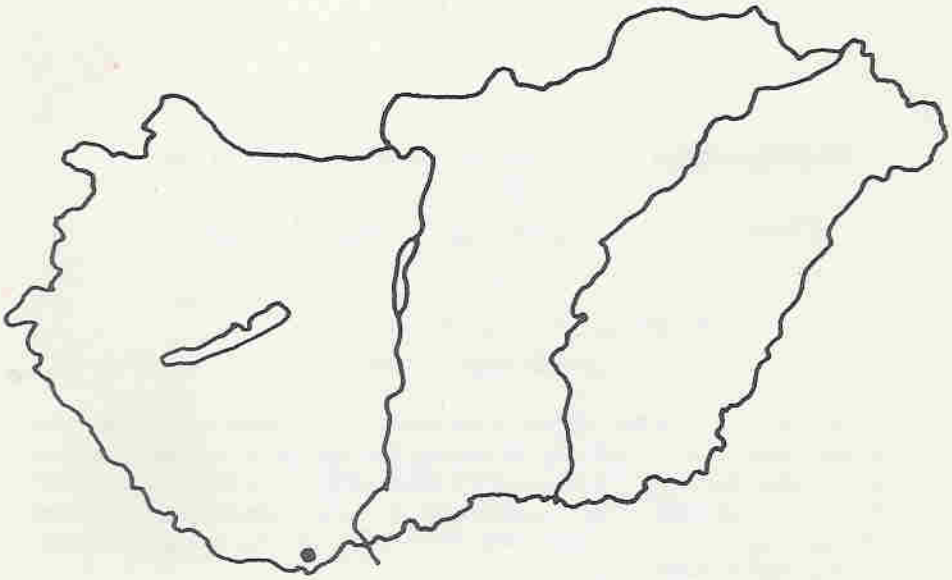

Fig. 1. Location of Beremend in Hungary

METHODS

The algological samples and the bryophytes were collected in 16th and 17th June 1986 as well as in 9th and 10th September 1986 in cave Beremendi-ördöglyuk (Fig. 2). To explain the distribution pattern of the different species, for the first approach we measured the climatic and light conditions of the caves. In September 1986 we did these measurements there. Sampling procedure and measurements were carried out on 9th September 198 and 25th February 1987 in caves Nagy Vizes-barlang (Fig. 3) and Kis Vizes-barlang (Fig. 4).

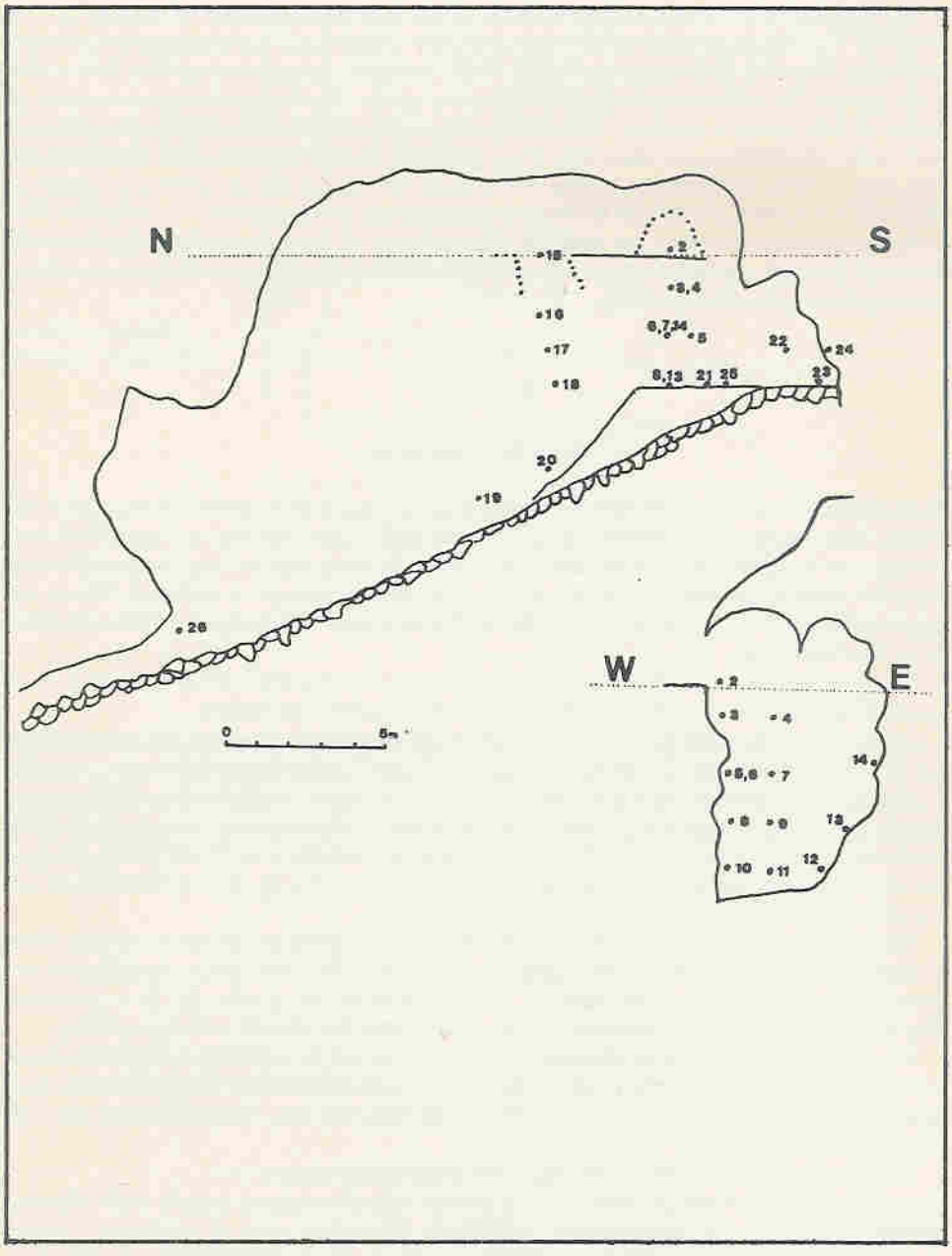

Fig. 2. The measuring and sampling points in Beremendi-ördöglyuk. Points 2–14 represent the first, points 15–18 the second entrance of the cave. Dotted line shows the 120 m height above sea level. Longitudinal section (N–S) of the main hall and cross-section (W–E) of the first entrance. (Redrawn from Rónaky 1975)

We used similar cultivation and observation methods as in our previous work (RAJCZY et al. 1987). The algological samples were scraped off by presterilized instrument into algological sterile jars filled with Bold medium (STEIN 1973) from the green spots as well as from visibly intact places. The samples were divided into three parts. The first parts were preserved by means of formaldehyde solution. The second part of the samples were cultivated in glass jars filled with Bold medium, the third ones were cultivated on solid agar-plates in the laboratory. The algal cultures were examined after 30–90 days. Permanent diatom slides were made by HORVÁTH's method (HORVÁTH 1975) as well as in our previous study.

An Assman psychrometer was used for measurement of the temperature and relative air humidity. The light conditions were measured by a Cosilux-2 photometer with three repetitions referring to actual surface radiation.

RESULTS

Beremendi-ördöglyuk

Though this cave has two entrances, its climate is not strange at all as both of them open at the ceiling. This way we do not give the detailed climatological data. Its lake had been filled with the waste of the quarry, but the thermal water affects the climate of the cave. In the innermost parts the temperature was 12.0 °C, which is 3–4 °C more than usual in Hungary. Due to the upper entrances (Fig. 2) the first hall of the cave is very well illuminated, therefore this place had a rich vegetation.

32 algal taxa (Table 1) were detected from this cave. Comparing it to other caves a lot of Cyanobacteria lived here, and a few Chromophyta and Chlorophyta species.

Cyanobacteria is represented by 16 taxa, half of them occur in hot springs and greenhouses. It is not surprising because the cave is very close to the level of thermal water.

The most common species were: *Navicula contenta, Plectonema schmidlei* and *Gloeocapsa punctata*. This *Gloeocapsa* species formed thick, black carpet around 23 sampling point. We could not distinguish, according to algae, smaller or larger habitats of different species, because the algal distribution was sporadic in this cave. A lichen, *Lepraria* sp. lived in the cave on clay and on mosses.

There were 13 moss and 1 hepatic species (Table 2) living in this cave. Among them *Campylium calcareum, Didymodon rigidulus var. glaucus* and *Eucladium verticillatum* are remarkable. *Schistidium apocarpum* is not a characteristic taxon in cave entrances (H.–KOVÁCS 1985) but its occurrence in the sunny second entrance is not too surprising.

The most characteristic moss was *Amblystegium serpens var. juratzkanum*, living both on clay and on stone as well. Where the relative light intensity was more than the tenth of the total light this species fell into the background. Where the light was less, it was practically the only pleurocarpous moss.

The following habitats could be distinguished according to mosses:

1. The Eastern rock surfaces of entrances: *Rhynchostegium murale* and *Hypnum cupressiforme* were the characteristic species in the upper part of entrances, deeper *Amblystegium serpens var. juratzkanum* and the acrocarpous *Bryoerythrophyllum recurvirostrum* were common. Accompanying species were *Eurhynchium schleicheri* and *Fissidens pusillus* (3, 5, 5–6, 6, 8, 16, 17–18, 18 sampling points – Fig. 2).

2. The opposite rock of the first entrance: beside the mass forming *Asplenium*, several acrocarpous mosses lived there. Instead of *Bryoerythrophyllum*, the troglophil *Eucladium*

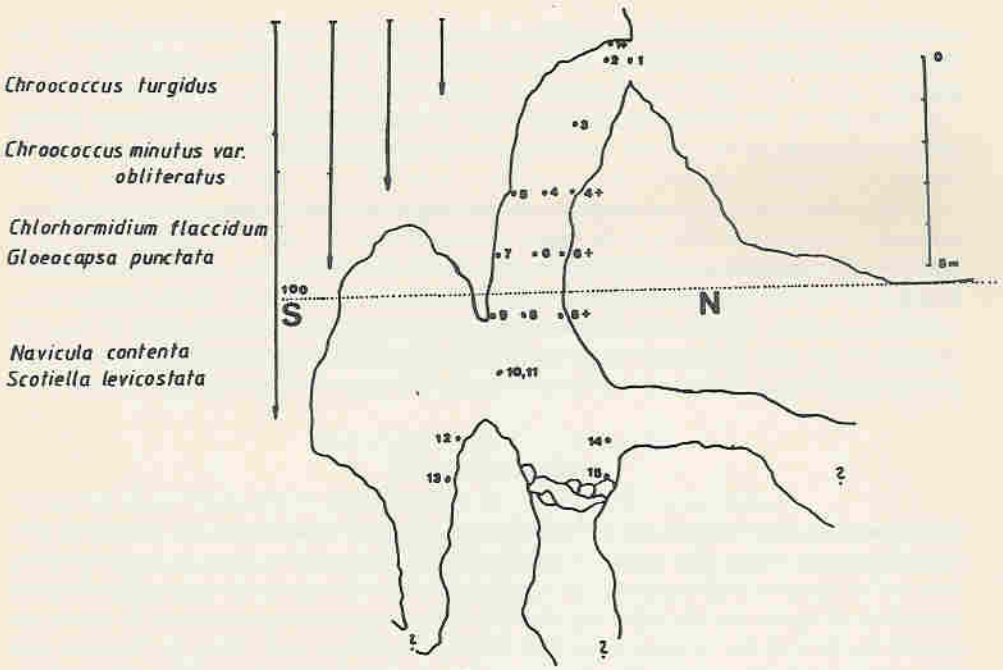

Fig. 3. The measuring and sampling points in Nagy Vizes-barlang, and the summer distribution of the most common species (e.g. *Navicula contenta* and *Scotiella levicostata* were found at full length of the cave). Dotted line shows the 100 m height above sea level. Longitudinal section (N–S) of the cave – the lowest points represents the actual water level. (Redrawn from Kérdő et al. 1975)

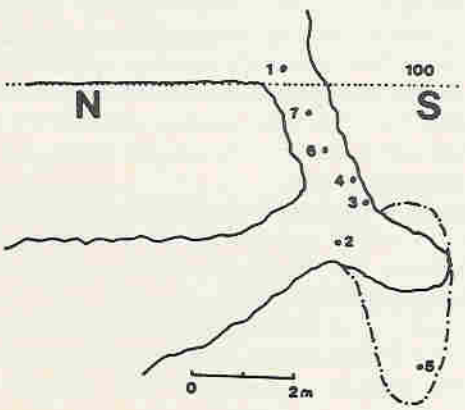

Fig. 5. The measuring and sampling points in the Kis Vizes- barlang. Dotted line shows the 100 m height above sea level. Longitudinal section (N–S) of the cave – the lowest points represents the actual water level. (Redrawn from Kérdő et al. 1975)

verticillatum was found in a great mass. The other mass species was *Leptobryum pyriforme* (6a, 14, 21a, 22 sampling points; though 6a is situated on the E wall, it belongs floristically to this group).

3. The clay on the bottom of the cave: *Pellia endiviifolia* formed thick crust on the clay. *Didymodon rigidulus var. glaucus* and *Pohlia melanodon* accompanied it (12, 13, 21, 23, 25 sampling points).

The fern flora was very poor. Only one species was found, but it was a mass forming taxon. *Asplenium trichomanes* covered the walls, especially those of the first entrance in every exposure. The prothalliums of *Asplenium* were found all over the cave, where there was not enough light for the life of the sporophyte.

Gallium mollugo L. was the only flowering plant near the 5. sampling point in the first entrance of this cave. This point was on a sloping stone surface at 2.5 m depth, the seeds of the plants could fall on it. A few unidentifiable monocotyledonous seedling lived there as well.

Nagy Vizes-barlang

There were two deep lakes on the bottom of this cave (Fig. 3) which had direct connection with the thermal karst water. The surface of the lake was large enough to the cubic capacity of the cave, so the karst water determined the climate of the cave. In winter the water (24.2–24.4 °C) heated the air quite near the entrance, and determined a definite current of air. In winter the cold air flowed into the cave along the Southern wall, and went away along the Northern wall (Fig. 4). Due to this current the Northern wall was dry, visibly intact. The result of the microscopic observation of this wall was very poor, only a few cells of *Navicula contenta* were found.

Although the number of algal species of the cave was low (24), there were some very particular properties of the distribution of taxa (Table 3.). *Scotiella levicostata*, which had not been noticed in Hungarian cave entrances as yet, was one of the most common species, it lived at full length of the cave during the summer. Besides it the characteristic species were: *Gloeocapsa punctata, Navicula contenta, Chlorhormidium flaccidum*. In spite of the Cyanobacteria predominance in the Beremendi-ördöglyuk, predominance of Chlorophyta was found here. The distribution of some characteristic species is shown on Fig. 3.

The seasonality in the floristic composition and the distribution of taxa was unexpected. We supposed that the conditions in the cave were constant independently of season. In contrast to it, seasonal changes were detected, moreover the summer distribution was more regular. The distribution of algae was sporadic on winter.

The surfaces of the stones in the lake at the bottom of the cave were covered by fluffy brown carpet. This material mainly consisted of bacteria (filamentous and coccoid) and unicellular animals but no algae. The concentration of organic material must have been very high because of the many frogs which lived there.

No flowering plant was detected in this cave. Three fern species: *Asplenium trichomanes* L., *Phyllitis scolopendrium* (L.) Newman and *Dryopteris filix-mas* (L.) Schott lived there. *Asplenium* formed mass vegetation here until the point 5 (Fig. 3) as in the Beremendi-ördöglyuk.

The moss vegetation was more or less continuous on the walls of the upper part of the cave, but we could identify 7 species only (Table 4). There were only rock surfaces in this cave, so the mosses which prefer the soil or clay surfaces were lacking. *Fissidens taxifolius* and *Plagiomnium cuspidatum* were found in this cave only.

This was the smallest among the caves studied, its vegetation was poor, but it was the most interesting from the floristic point of view.

The climate was determined by the karst water as in the Nagy Vizes-barlang (Fig. 5). Among the 11 algal species, *Nitzschia amphibia* is remarkable. 5 moss species were recorded here. It is interesting, that the typical troglobiont moss, *Rhynchostegiella tenella* was found only here (Table 5).

The fern flora of this cave was rich and interesting. *Asplenium adiantum-nigrum* L., a calciphobous species, lived here on limestone. *Polystichum aculeatum* (L.) Roth is protected in Hungary it was found also only here. *Asplenium, Dryopteris* and *Phyllitis* species which were found in the other two caves were also recorded here.

THE LIGHT LIMIT OF PLANTS

According to the result of light measurements we found the following limits:

1. Ferns: the last *Asplenium trichomanes* sporophyte was found in Beremendi-ördöglyuk at point 8, where the highest light measured was 426 lux. The last sporopyhte of this species in Nagy Vizes-barlang was found at point 5, with 125 lux.

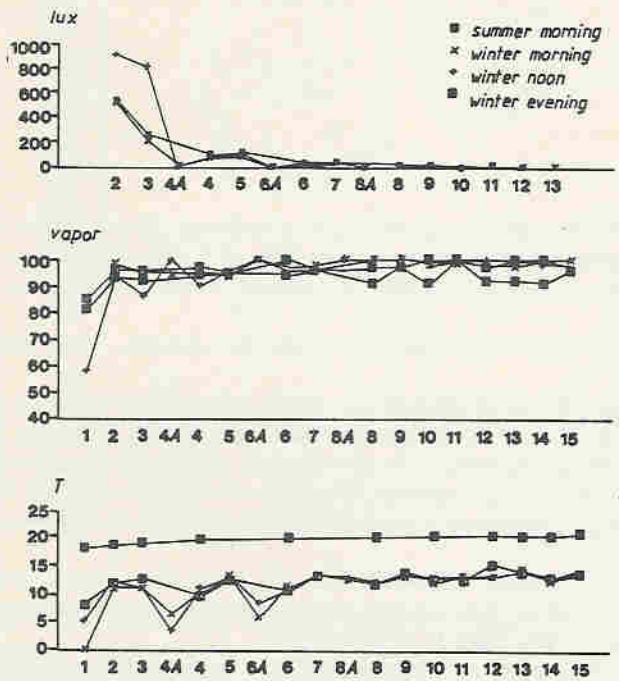

Fig. 4. The change of the relative air humidity (A), temperature (B) and light (C) in Nagy Vizes-barlang.

2. Mosses: *Amblystegium serpens var. juratzkanum* was the last moss in Beremendi-ördöglyuk, at point 20, where the maximum light was 232 lux.

3. Algae: 73 lux was enough for the life of *Navicula contenta* and an unidentified Chlorococcales species in Beremendi-ördöglyuk. Our last algological samples (9 in Nagy Vizes-barlang, maximum light 20 lux; 3–4 in Kis Vizes-barlang, max. light 82 lux) contained several species, therefore we could not determine the light limit of algae there.

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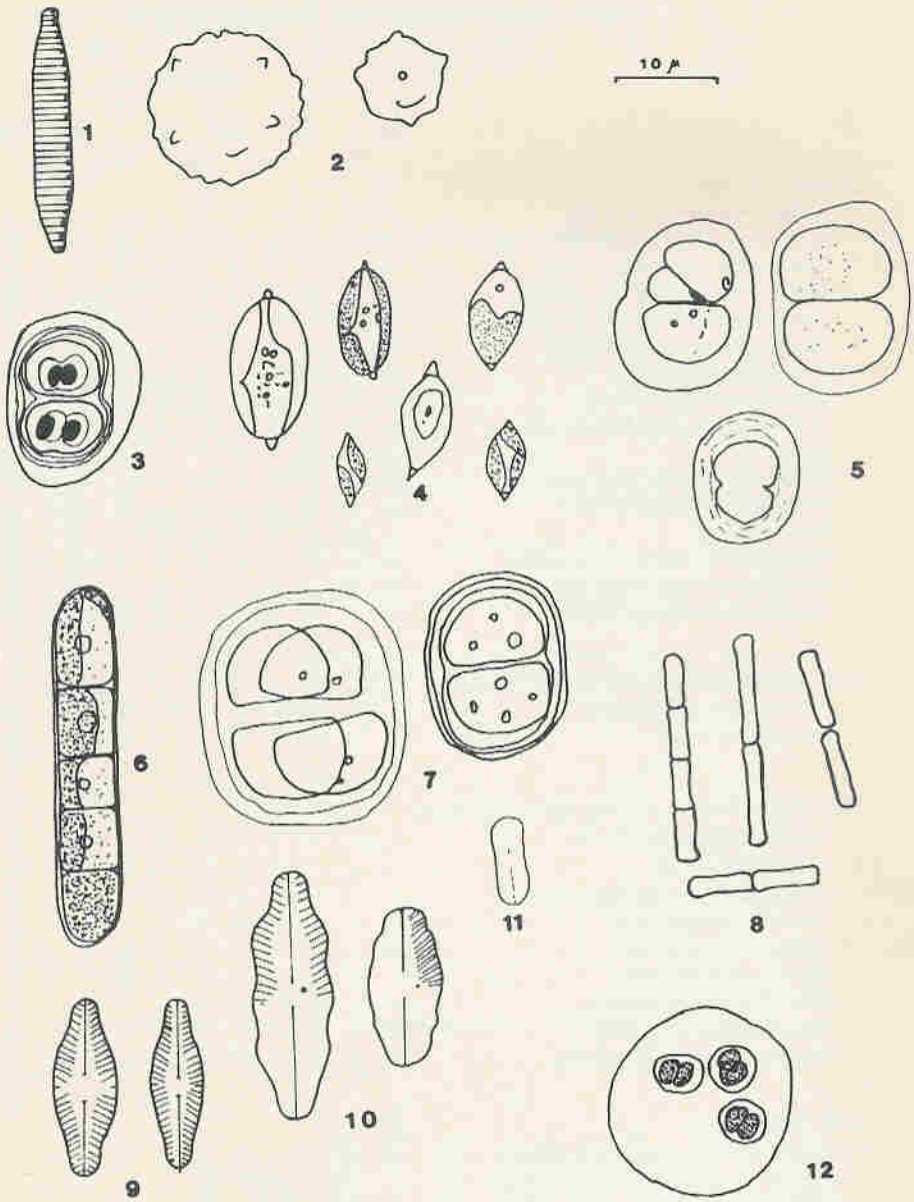

Fig. 6. Some characteristic algae from the caves. 1. *Nitzschia amphibia* Grun., 2. *Vischeria stellata* (Chodat) Pascher, 3. *Gloeocapsa alpina* Naeg., 4. *Scotiella levicostata* Hollerb., 5. *Chroococcus minutus* (Kg.) Naeg., 6. *Chlorhormidium flaccidum* (Kg.) Naeg., 7. *Chroococcus turgidus* (Kg.) Naeg., 8. *Synechococcus cedrorum* Naeg., 9. *Navicula paramutica* Bock, 10. *Navicula nivalis* Ehr., 11. *Navicula contenta* Grun., 12. *Gloeocapsa rupicola* Kg. (1–2. from Kis Vizes-barlang, 3–5. from Nagy Vizes-barlang, 6–12. from Beremendi-ördöglyuk).

Table 1. The list of algal taxa from Beremendi-ördöglyuk.

Species	Sampling sites												
	3–4	5	15	16a	16b	16c	17	23	24	25	20a	20b	19
CYANOPHYTA													
Aphanocapsa biformis A. Br.	+	–	–	–	–	–	–	–	–	–	–	–	–
cf. Chlorogloea microcystoides Geitl.	–	–	–	–	–	–	–	+	+	–	–	–	–
Chroococcus minor (Kg.) Naeg.	+	–	–	–	+	–	–	+	–	–	+	–	–
Chroococcus minutus (Kg.) Naeg.	–	+	–	–	–	–	–	–	–	–	–	–	–
Chroococcus turgidus (Kg.) Naeg.	+	–	–	–	–	–	–	+	–	–	–	–	–
Gloeocapsa granosa (Berk.) Kg.	–	–	–	–	–	–	–	+	–	–	–	–	–
Gloeocapsa rupicola Kg.	+	–	–	–	–	–	–	–	–	–	–	–	–
Gloeocapsa punctata Naeg.	+	+	–	–	–	+	+	+	+	+	+	–	–
cf. Gloeotricha spiroides Kondrat	–	+	–	–	–	–	–	–	–	–	–	–	–
Nostoc sp.	–	–	+	–	–	+	–	–	–	–	–	–	–
Oscillatoria amoena (Kg.) Gom.	–	–	–	+	–	–	–	–	–	–	–	–	–
Phormidium jadinianum Gom.	–	–	+	–	–	–	–	–	–	–	–	–	–
Phormidium sp.	–	–	–	+	–	–	–	–	–	–	–	–	–
Plectonema schmidlei Limanowska	+	–	–	–	–	–	+	+	+	+	+	–	–
Synechococcus cedrorum Sauv.	–	–	–	–	–	–	–	–	+	–	–	–	–
Synechococcus elongatus Naeg.	–	–	–	–	–	–	+	–	–	+	+	–	–
CHROMOPHYTA – XANTHOPHYCEAE													
Monodus unipapilla Reisigl	–	–	–	–	–	–	–	+	–	–	–	–	–
Xanthophyceae sp.	–	–	–	–	–	–	–	–	–	–	+	–	–
CHROMOPHYTA – BACILLARIOPHYCEAE													
Achnanthes lanceolata Bréb.	–	–	–	+	–	–	+	–	–	–	–	–	–
Amphora veneta Kg.	–	–	–	+	–	–	–	–	–	–	–	–	–
Hantzschia amphyoxis (Ehr.) Grun.	–	–	–	+	+	–	+	–	–	–	–	–	–
Melosira roeseana Rabh.	–	–	–	+	+	+	–	–	–	+	+	–	–
Navicula contenta Grun.	+	–	–	+	+	+	+	–	+	+	+	+	+
Navicula minima Grun.	–	–	–	+	–	–	–	–	–	–	–	–	–
Navicula nivalis Ehrenberg	–	–	–	+	+	–	–	–	–	–	–	–	–
Navicula paramutica Bock	–	–	–	+	–	–	–	–	–	–	–	–	–
Pinnularia borealis Ehrenberg	–	–	–	–	+	–	–	–	–	–	–	–	–
CHLOROPHYTA													
Chlorella minutissima Fott & Novák	–	–	–	–	–	–	–	+	+	–	–	–	–
Chlorhormidium flaccidum (Kg.) Fott	–	–	–	+	–	–	–	–	–	+	–	–	–
Chlorococcales sp.	–	–	–	–	–	–	–	–	–	–	–	+	+
Chlorococcum sp.	–	–	–	–	–	–	–	–	–	+	–	–	–
Stichococcus sp.	–	–	–	–	–	–	–	–	+	–	–	–	–

Table 2. The moss flora of Beremendi-ördöglyuk (+ sterile; * fertile; few; + middle; ++ frequent)

Species	Sampling points																	
	3	5	5–6	6	6a	14	8	13	12	16	17	17–18	23	22	25	21	21a	20
HEPATICOPHYTINA																		
Pellia endiviifolia (Dicks.) Dum.	–	–	–	–	–	*	–	++	–	–	–	–	++	–	++	+	–	–
BRYOPHYTINA																		
Amblystegium serpens (Hedw.) B., S. & G. var. juratzkanum (Schimp.) Rau & Herv.	+	+	++	++	–	++	++	–	–	++	++	++	++	–	–	–	–	++
Bryoerythrophyllum recurvirostrum (Hedw.) Chen	**	*	**	.	–	.	–	–	–	**	–	–	–	–	–	–	–	–
Campylium calcareum Crundw. & Nyh.	.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Didymodon rigidulus Hedw. var. glaucus (Ryan) Wijk & Marg.	–	–	–	–	–	–	–	+	++	–	–	–	–	–	++	–	–	–
Encalypta vulgaris Hedw.	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–
Eucladium verticillatum B., S. & G.	–	–	–	–	++	++	–	–	–	–	–	–	–	++	–	–	++	–
Eurhynchium schleicheri (Hedw. f.) Jur.	+	+	–	–	–	–	–	–	–	++	–	–	–	–	–	–	–	–
Fissidens pusillus (Wils.) Milde	–	–	+	–	–	+	+	–	–	–	–	+	–	–	–	–	–	–
Hypnum cupressiforme Hedw.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Leptobryum pyriforme (Hedw.) Wils.	–	–	–	–	–	++	–	–	–	–	–	–	–	–	–	–	++	–
Pohlia melanodon (Brid.) J. Shaw	–	–	–	–	–	–	–	+	++	–	–	–	–	–	–	–	–	–
Rhynchostegium murale (Hedw.) B., S. & G.	**	**	+	–	–	–	.	–	–	–	–	–	–	–	–	–	–	–
Schistidium apocarpum (Hedw.) B. & S.	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–

Table 3. The list of the algal species found in Nagy Vizes-barlang. The first column contains the result of the summer collecting trip, the second one shows the species living there in winter time (we collected from point 1+only in winter).

Species	Sampling prints					
	1+	1	3	5	7	9
CYANOPHYTA						
Chroococcus minutus var. obliteratus (Richt.) Hansg.	–	+–	+–	—	—	—
Chroococcus turgidus (Kg.) Naeg.	–	++	—	—	—	—
Gloeocapsa alpina Naeg.	+	—	—	—	—	—
Gloeocapsa punctata Naeg.	–	+–	+–	++	+–	—
Nostoc sp.	–	–+	—	—	—	—
Phormidium ambiguum Gom.	–	—	—	+–	—	—
Phormidium foveolarum (Mont.) Gom.	–	—	—	—	—	+–
Plectonema gracillimum (Zopf.) Hansg.	–	—	+–	—	—	—
Plectonema nostocorum Born.	–	—	—	–+	—	—
Plectonema schmidlei Limanowska	–	+–	—	+–	+–	—
CHROMOPHYTA – BACILLARIOPHYCEAE						
Cymbella sp.	–	+–	—	—	—	—
Gomphonema olivaceum (Lyngbye) Kütz.	–	—	—	+–	+–	—
Hantzschia amphyoxis (Ehr.) Grun.	–	+–	—	+–	—	–+
Navicula contenta Grunow	–	+–	++	+–	++	++
Navicula nivalis Ehrenberg	–	+–	—	—	—	—
Pinnularia borealis Ehrenberg	–	—	—	+–	—	—
CHLOROPHYTA						
Chlamydomonas sp.	–	—	–+	—	—	—
Chlorhormidium flaccidum (Kütz.) Fott.	+	+–	+–	+–	+–	—
Chlorhormidium sp.	–	—	+–	—	—	—
Chlorococcales sp.	–	–+	+–	–+	—	+–
Gongrosira sp.	–	+–	—	—	–+	—
Scotiella levicostata Hollerb.	–	+–	+–	+–	+–	+–
Stichococcus bacillaris	–	–+	—	—	—	—
Trochiscia sp.	–	—	+–	—	—	—

Table 4. The moss species from Nagy Vizes-barlang

Species	Sampling points		
	N/1	N/2	N/5
BRYOPHYTINA			
Amblystegium serpens (Hedw.) B., S. & G. var. juratzkanum (Schimp.) Rau & Herv.	–	–	++
Bryum sp.	+	–	–
Encalypta vulgaris Hedw.	++	–	–
Eucladium verticillatum B., S. & G.	++	++	–
Eurhynchium schleicheri (Hedw. f.) Jur.	++	++	++
Fissidens taxifolius Hedw.	–	–	++
Plagiomnium cuspidatum (Hedw.) T. Kop.	++	–	–

Table 5. The list of algal and moss taxa found in Kis Vizes-barlang (there was no algological sample at K/1).

Species	Sampling points			
	K/1	K/7	K/6	K/3–4
CYANOPHYTA				
Chroococcus minutus var. obliteratus (Richt.) Hansg.		–	–	+
Gloeocapsa punctata Naeg.		+	+	+
Nostoc sp.		+	–	+
Phormidium foveolarum (Mont.) Gom.		+	+	+
CHROMOPHYTA – BACILLARIOPHYCEAE				
Melosira roeseana Rabh.		+	–	+
Navicula contenta Grunow		+	+	+
Nitzschia palea (Kg.) W. Smith		+	–	–
CROMOPHYTA – XANTHOPHYCEAE				
Vischeria stellata (Chodat) Pascher		+?	–	–
CHLOROPHYTA				
Chlorella homosphaera Skuja		–	+	+
Chlorhormidium flaccidum (Kütz.) Fott		+	+	+
Gongrosira sp.		–	+	+
BRYOPHYTINA				
Eucladium verticillatum B., S. & G.	–	–	+	–
Eurhynchium schleicheri (Hedw. f.) Jur.	–	–	++	–
Fissidens taxifolius Hedw.	–	++	–	–
Rhynchostegiella tenella (Dicks.) Limpr. var. tenella	–	–	++	++
Rhynchostegium murale (Hedw.) B., S. & G.	++	–	–	–