

Karol Starmach

## Communities of algae in frog spawn

### Zbiorowiska glonów w żabim skrzeku

Wpłynęło 5 kwietnia 1979 r.

**Abstract** — In the course of some years the occurrence of algae in frog spawn assembling in the spring season in the pools and ponds in the vicinity of the town of Mszana Dolna, in the district of Nowy Sącz was investigated. 8 species of *Chrysophyceae*, 22 of *Xanthophyceae*, 106 of *Bacillariophyceae*, 12 of *Chlorophyceae*, 19 of *Cyanophyceae* were found as a whole. The following new species or forms were described: *Chrysocapsa vernalis* Starm. f. *minor* n.f., *Heterothrix mucicola* Ettl f. *major* n.f., *H. mollis* sp. nova ad interim, *H. moniliformis* sp. nova ad interim, *Bumilleria quadrata* sp. nova ad interim, *Chlamydomonas subconica* sp. nova. The gelatinous masses of frog spawn are often inhabited by numerous species of algae, no species, however, develops in masses. In the author's opinion it is an environment in which the algae are to a certain extent, mechanically arrested, but have no greater chance of development.

On warm days by the end of March or early in April spawning of the frog *Rana temporaria* takes place in the vicinity of the town of Mszana Dolna (district of Nowy Sącz); subsequently, as water temperature increases and the days become warmer and warmer, other species of frogs begin spawning. In spring the frog spawn covers abundantly almost every water pool and pond; especially favoured are the small, shallow, sun-warmed pools in the valley of the River Raba. In these shallow pools or little ponds which in summer dry out almost completely the frog spawn is coated with a green or yellow-brown cover of algae already after 2 to 3 weeks. The algae develop on the surface and partly grow deep into the gelatinous egg areola which becomes looser and looser as the eggs develop. At the time when moving larvae are already visible in the whole mass of the spawn, the algae reach their developmental climax and colour very distinctly the already flabby patches of spawn. The colours differ

greatly and are associated with the substrate and the surrounding of the pools and water bodies. In pools where the bottom is overgrown with aquatic plants, and still more often in pools formed in spring by the melting snow, when the water submerges the concavities of the terrain, the frog spawn is distinctly green or yellow-green. In summer, as a rule, these pools dry up. In the pools, also mostly transitory, near the river between the river stones, or on the first river terrace, on a sandy or gravel subsoil, the spawn adopts, as a rule, a yellow-brown colour from the diatoms developing in masses. While in the first case the main bulk of the algae are *Xanthophyceae* and, to a certain extent, *Chlorophyceae*, in the second case *Bacillariophyceae* dominate. In these two cases *Chrysophyceae* and *Cyanophyceae*, especially of the order *Hormogonales* constitute an admixture, varying as to quantity.

Algae had been found in frog spawn for a number of years (1966—1976) in the vicinity of the town of Mszana Dolna, mainly in the region of the mouth of the stream Mszanka into the River Raba and on the stream Kamienica at the locality Rzyki. Some more interesting species have been described previously (Starmach 1972 a); the present list comprises algae found during a number of years in the gelatine of the frog spawn. It is interesting to note how willingly the algae accumulate in the frog spawn. No other place so rich in algae is found in the same pool or pond. This does not mean, however, that the algae find especially favourable developmental conditions in the frog spawn. The environment, viscous or transparent and exposed to light, always present at the water surface no doubt plays, a certain part here. Of course it is not excluded that some not quite known substances nutritive for mixotrophic algae play also some part, though this does not result clearly from the inhabiting structure. The gelatine of the frog spawn can be, to a certain extent, compared to artificial agar substrates which are applied in algae cultures. Then frog spawn would constitute something like artificial gelatinous substrates, encountered in the waters at certain periods, in which algae accumulate and develop.

## Systematic part

### Chrysophyceae

In 1972 new species (Starmach 1972 a, 1972 b) were described from frog spawn collected in the River Raba and on the stream Kamienica: *Chryso-sphaera stigmatica*, *Chrysocapsa vernalis*, and *Chrysocapsella mucophila*. These three species were found also in other years. Recently a slightly different form of *Chrysocapsa vernalis* was found in

the gelatine of the frog spawn collected from a small pool on the River Raba at the town of Mszana Dolna. These were small, more or less spherical colonies to 34  $\mu\text{m}$  in diameter, protected with a colourless, diffuent gelatine of indistinct outer contour containing 16 to 32 cells. The cells were globose, bare, 4—5—(6)  $\mu\text{m}$  in diameter, with one or sometimes, before cell division, with two brownish parietal and wide ribbon-like chromatophores, rolled up slightly at both ends or gutter-shaped. In the transparent cell protoplasm there were not numerous, small glossy grains and oil drops. No stigma or contractile vacuoles or zoospores and cysts were found. Cells reproduced by division.

Cells and colonies were similar to *Chrysocapsa vernalis*, though smaller. Their diameter was 4—5  $\mu\text{m}$  with a fair deal of accuracy and only some cells were 6  $\mu\text{m}$  in diameter. The chromatophore of a wide ribbon-like band was more distinct than in *Ch. vernalis*. These specimens are considered by the author as:

*Chrysocapsa vernalis* S t a r m. f. *minor* n. forma

*Cellulae globosae, nudae, 4—5—(6)  $\mu\text{m}$  diameter; chromatophoris singulis, taeniaeformibus vel rarius cupuliformibus, propagatio divisione cellulae matricalis in duas cellulas filiales.*

*Habitat in ovis ranarum in aquis stagnantibus prope fluvium Raba in Mszana Dolna, district Nowy Sącz.*

*Chrysocapsa maxima* G e i t l e r

Colonies irregular, lump-like, cells 12.8—16.0  $\mu\text{m}$  in diameter, with one gutter-like chromatophore, at the edges often lobe-like. A species not reported from Poland, found in two samples of frog spawn collected on the River Raba at Mszana Dolna.

*Chrysocapsa gallica* B o u r r e l l y

The species was sampled several times in frog spawn from a pool on the River Raba at Mszana Dolna and on the stream Kamienica at the locality Rzyki. It had been reported previously from several habitats in the vicinity of the town Krynica and Mszana Dolna (S t a r m a c h 1966).

*Tetrapion gloeocystiformis* P a s c h e r

Colonies of 2 to 8 cells, enclosed by a colourless, finely layered mucilage. Cells slightly narrower at one end, hence, almost pyriform, 7—8—(9)  $\mu\text{m}$  long, 4—4.5—(5.4)  $\mu\text{m}$  wide, with one chromatophore.

A species not reported from Poland, found in frog spawn on the stream Kamienica at the locality Rzyki.

*Stephanoporus epiphyticus* (S c h e r f f e l) P a s c h e r

Cells located in lorica bearing 4 to 5 apertures at the sides through

which thin rhisopodia come outside. The loricas were 7 to 8  $\mu\text{m}$  in diameter, protected additionally with a fairly large layer of a loose gelatine slightly impregnated with iron hydroxide.

An epiphytic species, described previously from the lake Szczyrbskie in the Tatra Mts, where it occurred on filaments of *Microspora* sp. In the frog spawn at the town of Mszana Dolna it was encountered rather occasionally, on the entangled filament of *Ulothrix* sp.

#### Xanthophyceae

##### *Pleurochloris polychloris* Pascher

Cells globose, 7.8—10  $\mu\text{m}$  in diameter, chromatophores 6—10. It occurred in small groups in frog spawn collected in muddy pools on the River Raba at the town of Mszana Dolna.

##### *Chloridella neglecta* (Pascher et Geitler) Pascher (*Chlorobotrys neglecta* Pascher et Geitler)

Cells irregularly spherical, (6)—8—12  $\mu\text{m}$  in diameter, chromatophores usually 4.

It was found in pools on the River Raba at the town of Mszana Dolna.

##### *Ellipsoidion regulare* Pascher

Cells shortly elliptic, 10—14  $\mu\text{m}$  long, 8—10  $\mu\text{m}$  wide, occurred singly or several together. Chromatophores usually 4 (2—4—5). During reproduction they form 4—8 autospores. On some cells small spherical parasitic fungi of the genus *Rhizopodium* were visible.

Frog spawn from a pool on the River Raba at the town of Mszana Dolna.

##### *Monallantus brevicylindrus* Pascher

Cells shortly cylindrical, rounded at the ends, 11  $\mu\text{m}$  long, 6  $\mu\text{m}$  wide, chromatophores 2 to 3.

It occurred singly in frog spawn in muddy pools at the town of Mszana Dolna. A species not reported from Poland.

##### *Excentrochloris gigas* Pascher

Cells longitudinally oval, usually curved, 31—24  $\mu\text{m}$  long, 13—15  $\mu\text{m}$  wide, chromatophores numerous, membrane thickened at the cell ends.

It occurred sporadically in frog spawn in the pools on the River Raba at the town of Mszana Dolna.

##### *Mischococcus pleiochloris* Pascher

Cells spherical, 7—8—(10)  $\mu\text{m}$  in diameter, chromatophores usually 3—5, colonies compact, particular branches were poorly visible.

It was found in small groups only in some samples of frog spawn from muddy pools on the River Raba at the town of Mszana Dolna. This species had been already known from Poland.

*Characiopsis acuta* (A. Braun) Borzi

Cells 20—25  $\mu\text{m}$  long, 6—6.8  $\mu\text{m}$  wide, chromatophores 2, less frequently 3.

It occurred individually in the frog spawn from a pool on the River Raba and on the stream Kamienica. The species was known from a few localities in Poland.

*Characiopsis borziana* Lemmerman

Cells 23—26  $\mu\text{m}$  long, 5.4—8  $\mu\text{m}$  wide, chromatophores usually 5—8.

It was found in frog spawn from a pool on the River Raba at the town of Mszana Dolna. It has been known from Poland for some time now.

*Bumilleriopsis simplex* Pascher

Cells longitudinally oval, straight or slightly curved, sometimes somewhat thicker in the middle part, 11—20  $\mu\text{m}$  long, 5—7  $\mu\text{m}$  wide. Chromatophores usually 2. During reproduction 2—4 zoospores are formed which liberate after the membrane bursts in the middle part of the cell. Zoospores have each 2 chromatophores with a stigma on one of them.

A species not reported yet from Poland; known from Czechoslovakia and Denmark. It was found in frog spawn from meadow pools on the River Raba at Mszana Dolna.

*Bumilleriopsis terricola* Matvienko

Cells elliptical, at one end slightly elongated, 13.6—14.5—(16)  $\mu\text{m}$  long, 6.4  $\mu\text{m}$  wide. Chromatophores 3—5. Zoospores and autospores were not noticed.

So far, the species was known from the Ukraine where it was isolated from the soil. It was found in a sample of frog spawn from meadow pools at Mszana Dolna.

*Bumilleriopsis incrassata* Pascher

Cells straight or curved, at the ends slightly elongated with a little thickened membrane, to 65  $\mu\text{m}$  long, mostly, however, 36—46  $\mu\text{m}$  long, (5)—8—9  $\mu\text{m}$  wide. Chromatophores numerous, plate.

A species so far not reported from Poland; it was found in frog spawn samples from meadow pools on the River Raba at Mszana Dolna.

*Ophiocytium parvulum* (Perty) A. Braun  
(*Brochidium parvulum* Perty)

Cells curved, at the ends rounded and usually a little capitate, without spines, 5—6  $\mu\text{m}$  wide.

A common species, reported several times from Poland. It was found in frog spawn in a muddy pool at Mszana Dolna.

*Heterothrix stichococcoides* P a s c h e r — form!

Filaments short, 2—8 cells, slightly curved, usually easily split into single cells which are often curved, 7—11  $\mu\text{m}$  long, 4.5—6  $\mu\text{m}$  wide. Chromatophore one, parietal, gutter-like, sometimes lobe-like at the edges. Zoospores were not found.

Cell dimensions are somewhat larger than in P a s c h e r' s diagnosis where the cells are 2—3  $\mu\text{m}$  wide and up to 8  $\mu\text{m}$  long.

This species, hitherto not known from Poland, occurs fairly often in Czechoslovakia as a terrestrial alga. It was found in frog spawn from meadow pools at Mszana Dolna.

*Heterothrix mucicola* E t t l f. *major* n. forma

Filaments up to 1 mm long (or shorter), cells at the cross walls incised, 10—11  $\mu\text{m}$  wide, up to 28  $\mu\text{m}$  long, cell membrane thin, Chromatophores two, plate, situated one above the other along the long cell axis. Zoospores were not observed.

The species was found in frog spawn from a meadow pool on the River Raba at Mszana Dolna; in shape it resembles *H. mucicola* Ettl, described from Czechoslovakia also from frog spawn. By its larger dimensions it differs distinctly from the form described by E t t l (1978). The latter has filaments 3.5  $\mu\text{m}$  wide, cells up to 15  $\mu\text{m}$  long. The arrangement of cells and chromatophores in the form found at Mszana Dolna is, however, similar, hence the present author treats it only as a new, larger form.

*Heterithrix mucicola* E t t l f. *major* n. forma

Filis circa 1 mm longis, 10—11  $\mu\text{m}$  latis, ad 28  $\mu\text{m}$  longis. Chromatophoris binis, laminiformibus.

Habitat in ovis ranarum in equis stagnantibus prope fluvium Raba in Mszana Dolna.

*Heterothrix exilis* (K l e b s) P a s c h e r  
(*Bumilleria exilis* K l e b s)

Filaments short, easily splitting, cells 4  $\mu\text{m}$  wide, 4—8  $\mu\text{m}$  long, chromatophores usually 2, gutter-like, situated at the walls opposite each other.

Found in frog spawn from the pool on the River Raba at Mszana Dolna and on the stream Kamienica at the locality Rzyki.

This species is fairly common in Europe as a terrestrial alga. From Poland it had been reported from humid ditches at Mszana Dolna (S t a r m a c h 1966).

*Heterithrix debilis* Vischer

Filaments splitting into short segments or individual cells. Cells 3.7—4  $\mu\text{m}$  wide, 7.5  $\mu\text{m}$  long, chromatophores plate arranged one above the other parallel with the long cell axis.

It was found in frog spawn from a pool on the River Raba at Mszana Dolna. A species not reported from Poland so far; occurs, as a rule in stagnant waters, on damp soil, also in frog spawn. Austria, Switzerland.

*Heterothrix mollis* sp. nova ad interim

Filaments relatively short, not branched, aggregate in small, loose bundles, or occur singly, fragile, splitting easily into several cell fragments, less frequently into individual cells. Cells are square or at the most one half longer than wide, 3.8—4.2  $\mu\text{m}$  wide, 4—4.5—6  $\mu\text{m}$  long. Cell membrane thin. The cells are slightly incised at the cross walls but are not evidently barrel-shaped, although their sides are often convex. The apical cell is rounded, domelike. Chromatophores 4, parietal plate or kneading trough-shaped, with no pyrenoids. Protoplasm transparent containing not numerous glossy grains and oil drops, sometimes red. Zoospores were not found.

It occurred in frog spawn from a small meadow pool on the bank of the River Raba at Mszana Dolna.

A species similar to *H. pascheri* Ettl, which has long, slimy filaments, joined in bigger, slimy small bands, cells short-cylindrical, 6—8  $\mu\text{m}$  wide and equally long, chromatophores 4, kneading through-shaped or plate. Zoospores form from 2—4 per cell and have 2 chromatophores, a stigma, 2 contractile vacuoles and 2 very unequal flagella.

The difference between the proposed species *H. mollis* and *H. pascheri* consists above all in smaller cell dimensions in *H. mollis*, their shape not quite cylindrical and short, easily splitting filaments.

*Filis non ramosis, sat fragilibus, solitarris vel in parvis fasciculis laxis junctis. Cellulis subquadratis vel dimidio longioribus quam latis, leviter dolioliiformibus, 3.8—4.2  $\mu\text{m}$  latis, 4—4.5  $\mu\text{m}$  longis. Membrana cellularum tenuis. Chromatophoris 4, parietalibus, alveiformibus vel tabelliformibus. Cellula apicalis rotundata. Cytoplasma hyalinum, cum sparsis granulis minutis fulminantibus et guttulis oleosis saepe rubris.*

*Heterothrix moniliformis* sp. nova at interim

Filaments long, straight or slightly curved, easily falling into several cell fragments or into individual cells which easily detach, especially at the ends of the filaments. Cells are almost as long as wide, 11—16  $\mu\text{m}$  long barrel-shaped giving the filaments a bead-like appearance. Protoplasm transparent with not many small, glossy grains and oil drops. No zoospores were found.

Table I. List of diatoms identified in frog spawn samples in the years 1966-1977 from the vicinity of the town of Mszana Dolna, in the district of Nowy Sącz. The number of specimens in the total number of 246 specimens counted from 5 samples of frog spawn in 1977 was given in per cent

Tabela I. Lista okrzemek oznaczonych w próbach żabiego skrzeku z lat 1966-1977 z okolic Mszany Dolnej, województwo Nowy Sącz. W procentach podano ilość okazów na ogólną liczbę 245 okazów wyliczonych z 5 prób żabiego skrzeku z 1976 r.

Species - Gatunek	%	Species - Gatunek	%
<i>Cyclotella meneghiniana</i> Kuetz.		<i>Pinnularia molaris</i> Grun.	0.4
- <i>Kuetzingiana</i> Thw.		- <i>mesolepta</i> (Ehr.) W.Sm.	0.8
<i>Tabellaria flocculosa</i> (Roth) Kuetz.	0.4	- <i>mesolepta</i> f. <i>angusta</i> Cleve	0.4
<i>Meridion circulare</i> Ag.	0.8	- <i>viridis</i> var. <i>sudetica</i> (Hilse) Hust.	
<i>Diatoma vulgare</i> Bory	0.8	<i>Neidium iridis</i> f. <i>vernalis</i> Reichelt	
- <i>hiemale</i> var. <i>mesodon</i> (Ehr.) Grun.	1.7	<i>Caloneis amphibaena</i> (Bory) Cleve	0.4
- <i>elongatum</i> (Lyngb.) Ag.	0.4	- <i>clevei</i> (Lagerst.) Cleve	
- <i>anceps</i> (Ehr.) Kirchn.		- <i>silicula</i> var. <i>alpina</i> Cleve	
<i>Fragilaria capucina</i> Desm.	1.2	<i>Gyrosigma scalproides</i> (Rabenh.) Cleve	0.4
- <i>bicipitata</i> Mayer	0.4	<i>Amphora ovalis</i> Kuetz.	
- <i>crotonensis</i> Kitt.	0.4	<i>Cymbella cesatii</i> (Rabenh.) Grun.	
- <i>intermedia</i> Grun.	0.8	- <i>amphicephala</i> Näg.	
- <i>gracillima</i> Mayer		- <i>naviculiformis</i> Auerw.	1.7
<i>Symedra vancheriae</i> Kuetz.	0.4	- <i>prostrata</i> (Berkeley) Cleve	
- <i>affinis</i> Kuetz.		- <i>turgida</i> (Greg.) Cleve	
- <i>ulna</i> (Nitzsch) Ehr.	1.7	- <i>ventricosa</i> Kuetz.	12.2
- <i>scus</i> Kuetz.	0.4	- <i>aequalis</i> W.Sm.	2.9
- <i>amphicephala</i> Kuetz.	0.8	- <i>sinuata</i> Greg.	0.4
- <i>rumpens</i> Kuetz.	0.4	- <i>tumidula</i> Grun.	
<i>Banotia diodon</i> Ehr.		- <i>affinis</i> Kuetz.	0.4
<i>Cocconeis placentula</i> var. <i>lineata</i> (Ehr.) Cleve	0.8	- <i>parva</i> (W.Sm.) Cleve	0.4
- <i>placentula</i> var. <i>euglypta</i> (Ehr.) Cleve	0.4	- <i>cistula</i> (Hempr.) Grun.	0.4
<i>Achnanthes linearis</i> (W.Sm.) Grun.		- <i>lacustris</i> (Ag.) Cleve	
- <i>linearis</i> var. <i>pusilla</i> Grun.	0.4	- <i>caespitosa</i> Kuetz.	
- <i>affinis</i> Grun.	9.8	<i>Gomphonema acuminatum</i> Ehr.	0.4
- <i>lancoelata</i> (Bréb.) Grun.	0.4	- <i>parvulum</i> (Kuetz.) Grun.	0.4
- <i>lancoelata</i> var. <i>rostrata</i> Hust.	0.8	- <i>parvulum</i> var. <i>micropus</i> (Kuetz.) Cleve	
- <i>flexella</i> (Kuetz.) Brun.	0.4	- <i>angustatum</i> (Kuetz.) Rabenh.	
- <i>exilis</i> Kuetz.	2.0	- <i>intricatum</i> Kuetz.	0.8
<i>Diploneis puella</i> (Schum.) Cleve	0.4	- <i>constrictum</i> var. <i>capitata</i> (Ehr.) Cleve	0.4
<i>Amphipleura pellucida</i> Kuetz.		- <i>bohemicum</i> Reich. et Fricke	1.2
<i>Frustulia vulgaris</i> (Thw.) De Toni	0.4	- <i>olivaceum</i> (Lyngb.) Kuetz.	0.4
<i>Stauroneis phoenicentron</i> Ehr.	0.4	<i>Denticula elegans</i> Kuetz.	1.2
- <i>anceps</i> Ehr.	0.4	<i>Nitzschia apiculata</i> (Greg.) Grun.	
- <i>legumen</i> Ehr.		- <i>denticulata</i> Grun.	0.8
- <i>smithii</i> Grun.	0.4	- <i>sinuata</i> (W.Sm.) Grun.	0.4
<i>Navicula mutica</i> Kuetz.		- <i>sinuata</i> var. <i>tabellariae</i> Grun.	
- <i>binodis</i> Ehr.	0.4	- <i>linearis</i> W.Sm.	7.8
- <i>pupula</i> Kuetz.	0.8	- <i>acicularis</i> W.Sm.	0.4
- <i>cryptocephala</i> Kuetz.	12.2	- <i>dissipata</i> (Kuetz.) Grun.	1.2
- <i>cryptocephala</i> var. <i>veneta</i> (Kuetz.) Grun.	0.4	- <i>frustulum</i> (Kuetz.) Grun.	
- <i>rhynchocephala</i> Kuetz.	5.7	- <i>frustulum</i> var. <i>perminuta</i> Grun.	0.4
- <i>viridula</i> Kuetz.	2.0	- <i>hantzschiana</i> Rabenh.	
- <i>viridula</i> var. <i>capitata</i> Mayer	0.8	- <i>fonticola</i> Grun.	0.4
- <i>cineta</i> (Ehr.) Kuetz.		- <i>palea</i> (Kuetz.) W.Sm.	6.5
- <i>radiosa</i> Kuetz.	1.2	- <i>kuetzingiana</i> Hilse	0.8
- <i>gracilis</i> Ehr.	0.8	- <i>gracilis</i> Hantzsch.	
- <i>peregrina</i> (Ehr.) Kuetz.	0.4	- <i>sigmoidea</i> (Ehr.) W.Sm.	0.4
- <i>dicoepala</i> (Ehr.) W.Sm.		- <i>clausii</i> Hantzsch	
- <i>lancoelata</i> (Ag.) Kuetz.	2.9	- <i>epithemioides</i> Grun.	0.4
- <i>gracilipes</i> Mayer		<i>Cymatopleura solea</i> (Bréb.) A.Sm.	0.4
<i>Pinnularia microstauron</i> (Ehr.) Cleve	0.4	<i>Surirella angustata</i> Kuetz.	0.4
- <i>microstauron</i> var. <i>brebissonii</i> (Kuetz.) Hust.		- <i>ovata</i> var. <i>pinnata</i> (W.Sm.) Hust.	1.2



It was found in frog spawn collected from a slightly muddy little pond at the town of Rabka, in the district Nowy Sącz.

*Filis moniliformibus, longis, rectis aut incurvatis, nonnumquam in partes paucicellulares aut in cellulas singulas dissolvuntur. Cellulis subquadratis, 11—11.5  $\mu\text{m}$  latis, 11—16  $\mu\text{m}$  longis dolioliformibus. Chromatophoris 2—4, parietalibus aut tabelliformibus. Cytoplasma hyalinum cum sparsis granulis minutis fulminantibus et guttulis oleosis.*

The proposed species *H. moniliformis* is similar to *H. debilis* Vischer, which, however, has much narrower and longer cells, 4—5  $\mu\text{m}$  wide, 5—10  $\mu\text{m}$  long and only 2 chromatophores. It is rather similar to *Bumilleria sicula* Borzi, having, however, no H-shaped membranes.

*Bumillaria quadrata* sp. nova ad interim

Filaments short, or sometimes fairly long, easily splitting into 4-cell fragments in places where parts of membranes under the form of the letter H are visible. Cells square or in places shorter than wide, incised at the cross walls, a little barrel-shaped, 6.5—8.0  $\mu\text{m}$  wide, equally long or sometimes shorter, 5—6—8  $\mu\text{m}$  long. Chromatophores always 2, kneading through-shaped or large ribbon-like with rolled up ends, parietal, arranged one above another parallel with the long axis of the cell. Protoplasm transparent with not numerous, glossy grains and oil drops. Zoospores were not found.

A species observed for 3 years running in frog spawn from meadow pools on the River Raba at Mszana Dolna.

*Filis variae longitudinis, fragilibus, leviter in partes 4-cellulares dissolvuntur. Cellulis subquadratis, nonnumquam longitudine sua brevioribus, 6.5—8.0  $\mu\text{m}$  latis, 5—6—7  $\mu\text{m}$  longis ad dissaepimenta leviter constictis. Chromatophoris semper duobus, alveiformibus aut latae laminiformibus parietaliter alio super alium discumbente. Cytoplasma hyalinum, cum sparsis granulis fulminantibus or guttulis oleosis.*

The species *B. quadrata* resembles most the species *B. klebsiana*; the difference consisting in that it has always only 2 chromatophores (no division of chromatophores into more parts has been observed), short cells whose width reaches only sometimes 8  $\mu\text{m}$ , i. e. the lower limit of the width of *B. klebsiana*.

Here also belongs probably the formerly described form from a small pond at the town of Krynica (Starmach 1966, fig. 39) under the name *Heterothrix quadrata* Pascher var. *angustata* Starm. The description made at that time had overlooked the presence of distinct sections of H-shaped membranes, separating 2—4 cell segments of the filaments.

The remains of the membranes under the form of the letter H indicate that this form belongs to the genus *Bumillaria* and not to the genus *Heterothrix*.

*Tribonema elegans* P a s c h e r

Filaments frail, occurring individually or in small groups. Cells 2.8—3.5  $\mu\text{m}$  wide, 10—22  $\mu\text{m}$  long, chromatophores usually 2, less frequently one or three, small, plate, or wide ribbon-like, rather pale yellow-green.

Found in frog spawn in pools on the River Raba at Mszana Dolna.

*Tribonema minus* H a z e n

Filaments occur individually, cells, cylindrical, at the cross walls slightly incised, chromatophores 2, ribbon-like, parietal, rolled up annularly, yellow-green. Cells 5—6  $\mu\text{m}$  wide, 12—16  $\mu\text{m}$  long.

Found in frog spawn in meadow pools on the River Raba at Mszana Dolna.

*Tribonema aequale* P a s c h e r

Filaments single or several in small bundles, cells cylindrical, at the cross walls not incised, 5—6  $\mu\text{m}$  wide, 25—29  $\mu\text{m}$  long. Chromatophores 4, yellow-green, situated in pairs one above the other.

In comparison with the diagnosis given by P a s c h e r the cells were 2—5 times longer than wide; the diagnosis states that the cells are 2.5—3 times longer than wide.

Found in frog spawn in pools on the River Raba at Mszana Dolna.

*Tribonema vulgare* P a s c h e r

Filaments individual or in small groups, cells cylindrical, of slightly convex at the sides, poorly incised at the cross versal walls, cell membrane thin. Cells 6.8—7.2  $\mu\text{m}$  wide, usually 3 times longer. Chromatophores 4—8, irregularly lobe-like, ribbon-like, or plate.

Found in frog spawn in pools on the River Raba at Mszana Dolna.

#### Bacillariophyceae

The diatoms identified in the samples of frog spawn from 1966 to 1977, collected in the vicinity of the town of Mszana Dolna were listed separately (Table I). The list, includes 106 species and forms. The diatoms occurred specially in large numbers in pools formed between the river stones on the River Raba and the stream Mszanka. They covered the gelatinous masses of frog spawn with a distinctly visible yellow-brown film. To get an idea of the quantitative relations of these numerous species, the number of specimens belonging to particular

species were counted in 5 microscopic preparations from the spring of 1976. It proved that in the total number of 245 counted specimens, most of the species occurred as single specimens, and there were only 10 which appeared in quantities of 2 to 12 per cent. These were:

<i>Achnantes affinis</i>	9.8 per cent
<i>A. exilis</i>	2.0 " "
<i>Navicula cryptocephala</i>	12.2 " "
<i>N. rhynchocephala</i>	5.7 " "
<i>N. viridula</i>	2.0 " "
<i>N. lanceolata</i>	2.9 " "
<i>Cymbella ventricosa</i>	12.2 " "
<i>C. aequalis</i>	2.9 " "
<i>Nitzschia linearis</i>	7.8 " "
<i>N. palea</i>	6.5 " "

The gelatines of the frog spawn are, thus, inhabited by greatly varying species of diatoms from which only some few develop in greater numbers. Hence, this specific environment is not particularly attractive for diatoms and it includes a rather occasional composition of species arrested in the slime. In the total number of 106 identified taxonomic units, 73 were found in 5 preparations from the year 1976. This shows that the set of species found in different years is, however, to a great extent similar.

#### Chlorophyceae

From the green algae various species of the genera *Chlamydomonas* and *Chloromonas* occurred earliest and most abundantly; these, however, disappeared after 2—3 weeks. Other species were not numerous and occurred not often only as individual specimens.

In the following list only some identified species were given. There were some more but the author did not succeed in determining them.

##### *Chloromonas rhodei* Skuja

Cells oval, at the anterior end a little narrowed with a blunt low papilla, a longitudinal stigma, 10.8—12.6  $\mu\text{m}$  long, 8.0  $\mu\text{m}$  wide.

It occurs fairly numerous early in spring in frog spawn in meadow pools on the River Raba at Mszana Dolna.

##### *Chloromonas paradoxa* Koršikov

Cells oval, narrowed towards the anterior, without papilla, membrane thin, chromatophore cup-shaped, with a stigma more or less lying about the half of the cell.

It occurs in spring in frog spawn in meadow pools on the River Raba at Mszana Dolna.

*Chloromonas dahlemensis* Gerloff

Cells elliptical with a thin mebrane and a blunt, conical papilla. Chromatophore cup-shaped, does not reach the apex of the cell. Cells 14.4—16  $\mu\text{m}$  long, 8.4—12  $\mu\text{m}$  wide.

Found in frog spawn in muddy pools on the River Raba at Mszana Dolna.

*Chlamydomonas angulosa* Dill

Cells elliptical or slightly oval, anteriorly with a semispherical papilla. Chromatophore massive with an angular pyrenoid, stigma, longitudinally elliptical in the anterior end of the cell. Cells 14—16—18  $\mu\text{m}$  long, 8—10  $\mu\text{m}$  wide.

It occurred in masses by the end of April in frog spawn in pools on the River Raba at Mszana Dolna.

*Chlamydomonas snowiae* Printz

Cells oval, at the anterior end conically narrowed with a fairly sharp papilla. Chromatophore cup-shaped with a well developed lower part, a spherical pyrenoid and stigma in the anterior part. Cells 11—11.6  $\mu\text{m}$  long, 6.6—9  $\mu\text{m}$  wide.

It was found in the course of some of the years numerously in the frog spawn from the pools on the River Raba at Mszana Dolna.

*Chlamydomonas oblongella* Lund

Cells longitudinally elliptical, with a low, truncate papilla. Chromatophore cup-shaped with a round pyrenoid, without stigma. Cells 10—13  $\mu\text{m}$  long, 5  $\mu\text{m}$  wide.

It was often found in frog spawn in pools on the River Raba at Mszana Dolna.

*Chlamydomonas komma* Skuja

Cells ovaly-elliptical, with a thick membrane and a large papilla. Chromatophore with a large pyrenoid and comma-like stigma in the anterior part. Cells (10)—14.4—16  $\mu\text{m}$  long, 10.8—12  $\mu\text{m}$  wide.

Found in frog spawn in meadow pools at Mszana Dolna.

*Chlamydomonas subconica* sp. nova

Cells reversely conical, anteriorly flatly rounded with a little thickened mebrane, but without a distinct papilla. Flagella twice longer than the cell. Chromatophore massive, its lower part reaches  $\frac{1}{2}$  to  $\frac{2}{3}$  of the cell and has a large, round pyrenoid. Nucleus with nucleoid is situated a little in the anterior half of the cell and is partly visible in the incision of the chromatophore. Stigma small, elliptical, located in the upper half

of the cell. Two contractile vacuoles at the base of the flagella. Cells 9—11  $\mu\text{m}$  long, 7—9  $\mu\text{m}$  wide.

Found in some of the years in frog spawn in meadow pools on the River Raba at Mszana Dolna.

From *Ch. conica* Dangeard (Ettl 1976, p. 293, Table 6, fig. 7) it differs by its much smaller dimensions, longer flagella, slightly thickened membrane toward the anterior and a generally thicker cell membrane.

*Cellulae inverse coniformes apice plane rotundato, cum membrana leviter incrassata, sine papilla, 9—11  $\mu\text{m}$  longae, 7—9  $\mu\text{m}$  latae. Flagellis duplo longioribus quam cellula. Chromatophorus in parte basali crassus, cum pyrenoide globoso et stigmatate rubro. Nucleus nucleatus in parte anteriore cellulae positus. Vacuolis contractilibus apicalibus, binis.*

*Habitat in ovis ranarum in aquis stagnantibus temporalis prope fluvium Raba in Mszana Dolna, circuitus Nowy Sącz.*

*Palmellops gelatinosa* Koršikov

Cells globose, 12—14.5  $\mu\text{m}$  in diameter, with a cup-shaped chromatophore having in its thickened base a pyrenoid bearing a starch sheath. 4—8 cell colonies, up to 28  $\mu\text{m}$  in diameter.

Found in frog spawn in pools on the River Raba at Mszana Dolna, infrequently.

*Microthamnion strictissimum* Rabenh.

Small, loosely branched thalli, cells 3—4  $\mu\text{m}$  wide, mostly twice as long as wide.

Found in several exemplars in frog spawn in meadow pools on the River Raba at Mszana Dolna.

*Spongoplastidium proliferum* Vischer

Thalli filamentous of irregular structure, filaments composed of short, swollen, or longitudinally cylindrical cells, 6—10  $\mu\text{m}$  wide, up to 40  $\mu\text{m}$  long.

It was found in several samples of frog spawn from meadow pools on the River Raba at Mszana Dolna.

*Coenocystis subcylindrica* Koršikov

Cells more or less cylindrical, 11.6  $\mu\text{m}$  long, 6.5—7  $\mu\text{m}$  wide, arranged in gelatinous, spherical colonies in groups of 4—8. Chromatophore cup-shaped with a lateral pyrenoid. Reproduces by autospores formed by 4 in mother cells.

It was found in one sample of frog spawn collected from a meadow pool on the River Raba at Mszana Dolna.

## Cyanophyceae

*Aphanothece clathrata* W. et G. S. West

Colonies irregular, above 60  $\mu\text{m}$  in diameter, cells blue-green, 0.8  $\mu\text{m}$  wide, 2.3  $\mu\text{m}$  long.

Found in one sample from a slimy pool on the River Raba at Mszana Dolna.

*Cylindrospermum stagnale* (Kuetz.) Born. et Flah.

Small balls of grey-blue-green filaments were found in a few samples of frog spawn from a pool at Mszana Dolna.

*Oscillatoria amphibia* Agardh

Trichomes curved, cells 2.4  $\mu\text{m}$  wide, 3.5  $\mu\text{m}$  long with few grains at the cross walls.

Found rather often in frog spawn in the pools at Mszana Dolna.

*Oscillatoria terebriformis* Agardh

Trichomes 4.5  $\mu\text{m}$  wide, cells 3.6  $\mu\text{m}$  long, blue-green, granulated at the cross walls, distinctly incised.

It was found rather often in frog spawn from pools on the River Raba at Mszana Dolna.

*Oscillatoria nigra* Vaucher

Trichomes dark olive, 8.2  $\mu\text{m}$  wide, cells 3.5—4  $\mu\text{m}$  long, granulated at the cross walls, apical cells rounded, covered with calyptra.

Occurred sporadically in samples of frog spawn on the River Raba at Mszana Dolna.

*Oscillatoria limosa* Agardh

Trichomes olive or brownish, 14—15  $\mu\text{m}$  wide, cells about 3.3  $\mu\text{m}$  long.

It was found under the form of individual filaments or small bundles, rather occasionally attached to the gelatine of the frog spawn from muddy pools in which dark patches of that algae floating on the water surface were seen at the same time. Pools on the River Raba at Mszana Dolna.

*Oscillatoria simplicissima* Gom.

Trichomes individual, 8.1—9  $\mu\text{m}$  wide, cells 2.7—3  $\mu\text{m}$  long, granulated at the cross walls, not incised, the apical cell rounded with a lunate calyptra.

It was found quite often in samples of frog spawn from pools on the River Raba at Mszana Dolna.

*Oscillatoria ornata* (K u e t z.) G o m.

Trichomes solitary, 10  $\mu\text{m}$  wide, cells 2—3  $\mu\text{m}$  long, blue-green, poorly granulated at the cross walls, not incised. Trichomes variously curved at the apices, rounded, without calyptra.

It was found once in frog spawn from a meadow pool on the River Raba at Mszana Dolna.

*Oscillatoria redeckeii* V a n G o o r

Trichomes 2—2.7  $\mu\text{m}$  wide, cells 7—9  $\mu\text{m}$  long, at the cross walls they have one or two gas vacuoles.

Found only once in frog spawn from the vicinity of the town of Mszana Dolna, it also occurs normally on water bottom in the mud.

*Oscillatoria pseudoacustissima* G e i t l e r

Trichomes mobile, 1.8  $\mu\text{m}$  wide, cells 5.4  $\mu\text{m}$  long with single grains of carotin at the cross walls.

The species was described from the littoral zone of the Upper Lake at Lunz (Austria), and, as it seems, was not reported any more. It was found in a sample of frog spawn from a meadow pool at Mszana Dolna.

*Oscillatoria mougeotii* (K u e t z.) F o r t i

Trichomes dark blue-green, solitary, curved, 4.5—5.5  $\mu\text{m}$  wide, 2.7—3  $\mu\text{m}$  long, slightly incised at the cross walls, with scattered grains inside the cells, but not granulated at the cross walls.

Found in several samples of frog spawn from the vicinity of Mszana Dolna.

*Oscillatoria cortiana* (M e n e g h.) G o m.

Trichomes blue-green, or olive-green, at the apex conically narrowed, cells at the cross walls somewhat incised, 5—6  $\mu\text{m}$  wide, 5—7—8  $\mu\text{m}$  long, with scattered granulations at the cross walls.

Found sporadically in frog spawn from the vicinity of Mszana Dolna.

*Oscillatoria agradhii* G o m.

Trichomes 4.5—5  $\mu\text{m}$  wide, cells 4.5—6  $\mu\text{m}$  long, narrowed at the apex of the trichomes, ended capitately, or rounded, covered with a calyptra. Granulations scattered in the cells.

It occurred individually only in some samples of frog spawn from pools on the River Raba at Mszana Dolna.

*Spirulina laxissima* G. S. W e s t

Trichomes pale blue-green, spirally twisted, with great distances between the turns, 0.8  $\mu\text{m}$  wide. Intracellular septa not visible.

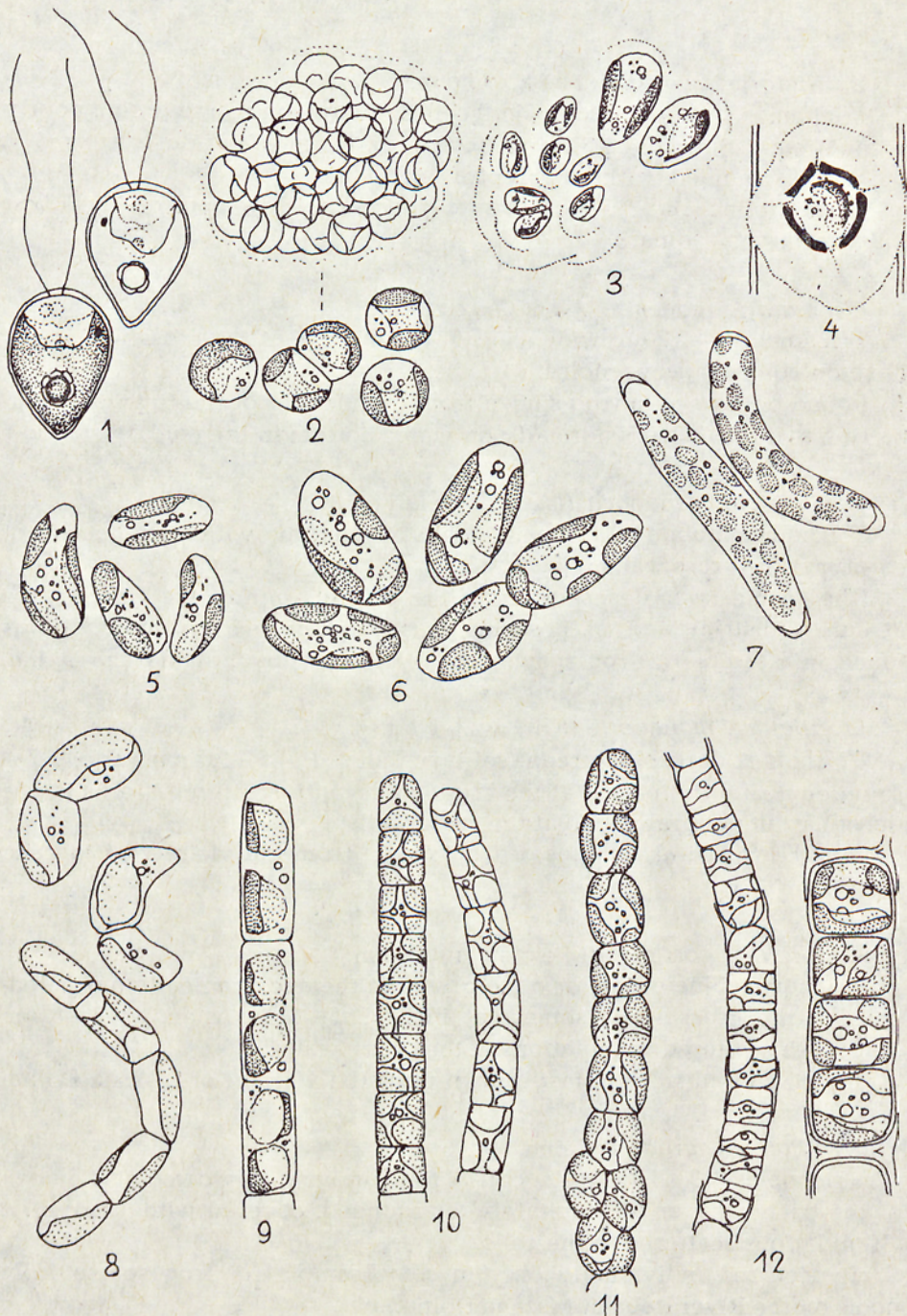


Fig. — Ryc. 1. *Chlamydomonas subconica* n.sp. Fig. — Ryc. 2. *Chrysocapsa vernalis* f. *minor* n.f. Fig. — Ryc. 3. *Tetrapion gloeocystiiforme*. Fig. — Ryc. 4. *Stephanoporos epiphyticus*. Fig. — Ryc. 5. *Bumilleriopsis simplex*. Fig. — Ryc. 6. *Bumilleriopsis terricola*. Fig. — Ryc. 7. *Bumilleriopsis incrassata*. Fig. — Ryc. 8. *Heterothrix stichococcoides*. Fig. — Ryc. 9. *Heterothrix mucicola* f. *major* n.f. Fig. — Ryc. 10. *Heterothrix mollis* n.sp. Fig. — Ryc. 11. *Heterothrix moniliformis* n.sp. Fig. — Ryc. 12. *Bumilleria quadrata* n.sp.



A species rarely reported from Europe, yet fairly characteristic. It was found in two samples of frog spawn from pools on the River Raba at Mszana Dolna.

*Pseudoanabaena catenata* Lagerheim

Trichomes solitary, short, 1.6—2.5  $\mu\text{m}$  wide, apical cells rounded.

Found sporadically in frog spawn in the vicinity of Mszana Dolna.

*Lyngbya lagerheimii* (Möbius) Gom.

Filaments curved, or irregularly spirally twisted, 2—2.4  $\mu\text{m}$  wide, cells 1.2—3  $\mu\text{m}$  long, at the apices of the trichomes rounded.

Found sporadically in several samples of frog spawn from the pools on the River Raba at Mszana Dolna.

*Lyngbya digueti* Gom.

Filaments not particularly long, curved, occur sporadically or several together. Trichomes 2.5—3  $\mu\text{m}$  wide. Cells 2—3.7  $\mu\text{m}$  long, at the apices of the trichomes rounded.

Found in small numbers in samples of frog spawn from slimy pools on the River Raba.

*Lyngbya attenuata* F. E. Fritsch

Small aggregations of filaments 6.5—6  $\mu\text{m}$  wide, with trichomes 5—5.5  $\mu\text{m}$  wide, narrowed or not narrowed at the ends, sometimes capitate.

It was found in one sample of frog spawn from a pool on the River Raba at Mszana Dolna. A species rarely reported from Europe.

### Floristic picture of the community

During the several years of investigations in the vicinity of the town of Mszana Dolna, the following species were found in the abundantly occurring frog spawn, in all: *Chrysophyceae* — 8 species, *Xanthophyceae* — 22 species, *Bacillariophyceae* — 106 species, *Chlorophyceae* — 12 species, and *Cyanophyceae* — 19 species.

A constant recurrence of numerous species of *Xanthophyceae* and *Bacillariophyceae* was a characteristic trait. The species of *Chrysophyceae* were found in smaller quantities; they included however, 3 newly described species, recorded for a number of years and one variety in the total number of 8 more or less constantly appearing species. Among the 22 species of *Xanthophyceae* there were 3 species and one variety newly described. The environment of frog spawn seems, thus, especially favourable for yellow-brown algae and yellow-green algae. The question, seems, however, to consist more in the mechanical possibilities of the settling and development of algae in the with age increasingly flabby gelatine of the frog spawn, and later in an easier collecting of the algae

from it than from the detritus and the mud surface at the bottom of the pool where the same species live normally. In the gelatine of the frog spawn the algae are, so to say, densified, arrested. It is unknown whether they also use organic matter, abundantly contained in that environment. The question calls for separate investigations.

Equally abundant are diatoms arrested in the frog spawn. In the course of some years 106 taxons were identified, these were, however, without doubt not all yet. The attempt of estimation of the quantitative composition of particular species showed, however, that it is also an environment arresting rather mechanically numerous species, not giving, a chance of their mass development. For the 106 taxons there were only 10 such ones, which occurred in greater numbers of exemplars and never in great quantities.

Green algae were not rich in species. The earliest, but transitory developed were the species of the genera *Chloromonas* and *Chlamydomonas* (not all of them were identified), but they disappeared after 2—3 weeks. Of the other genera few individuals were only encountered, rather occasionally arrested in frog spawn. Green algae, are, thus, not a characteristic component of the flora of the frog spawn and its green colour comes mainly from yellow-green algae.

Blue-green algae never occurred in masses and did not colour in a specific way the gelatine of the frog spawn. The presence of numerous species of the genus *Oscillatoria* was characteristic. These are, in fact, ubiquitous species, found commonly in waters, in mud, on aquatic plants, and in the soil. They are not attached to a strictly definite environment. It seems even somewhat strange that in the environment of the decomposing slimy masses surrounding the frog eggs the typically mixotrophic blue-green algae do not occur in masses. Could the frog spawn gelatine contain some substances inhibiting the development of the blue-green algae?

It results from the above review, certainly not yet complete in spite of several years of investigations, that the frog spawn as an environment does not present particularly favourable conditions for the development of algae. Gelatinous masses of frog spawn rather act as a mechanical means to arrest and bind small algae species, giving them, however, no chance of a more abundant development. It is also possible that the seasonal character of that environment, prevailing early in the spring for 6 to 8 weeks, also plays a certain part in that case.

#### STRESZCZENIE

W ciągu 10 lat (1966—1977) badano występowanie glonów w żabim skrzeku, gromadzącym się wiosną w kałużach i stawach w okolicy Mszany Dolnej, wojew. Nowy Sącz. Znalezione ogółem 8 gatunków *Chrysophyceae*, 22 *Xanthophyceae*, 106 *Bacillariophy-*

ceae, 12 Chlorophyceae i 19 Cyanophyceae. Opisano nowe gatunki wzgl. formy: *Chrysocapsa vernalis* Starm. f. *minor* n.f., *Heterothrix mucicola* Ettl f. *major* n.f., *H. moniliformis* sp. nova ad interim, *Bumilleria quadrata* sp. nova at interim, *Chlamydomonas subconica* sp. nova.

Galaretowate masy żabiegu skrzesku zasiedlane bywają przez liczne gatunki glonów, przy czym jednak żaden gatunek nie rozwija się masowo. Autor jest zdania, że jest to środowisko, w którym glony są poniekąd mechanicznie więzione, lecz nie mają w nim większych szans rozwoju.

#### REFERENCES

- Ettl H., 1978. *Xanthophyceae*. 1. Süßwasserflora von Mitteleuropa, Jena, G. Fischer Verl.
- Starmach K., 1966. Nowe i rzadsze złotowiciowce (*Chrysophyceae*) we florze glonów Polski — Über neue und seltene *Crysophyceae* in der Algenflora Polens. Acta Hydrobiol., 8, 5—14.
- Starmach K., 1972 a. *Chrysocapsa stigmatica* n.sp. (*Chrysophyceae*). Bull. Ac. Pol. Scie., Sér. Scie. Biol., 20, 517—519.
- Starmach K., 1972 b. *Chrysocapsa vernalis* n.sp. and *Chrysophaerella mucophila* n.sp. (*Chrysophyceae*). Bull. Ac. Pol. Scie., Sér. Scie. Biol., 20, 671—675.

Author's address — Adres autora

Prof. dr Karol Starmach

Instytut Botaniki, Polska Akademia Nauk, ul. Lubicz 46, 31-512 Kraków