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Ecological characteristics of sessile algal communities in the Olczyski stream (Tatra Mts, Poland) with special consideration of light and temperature*

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Abstract — The shade thrown by a bridge and the inflow of water from a natural hot spring were used in an investigation on the reaction of algae to changes in light intensity and temperature. *Hydrurus foetidus, Homoeothrix janthina*, and *Caratoneis arcus* were found to be sensitive to light deficiency. *Chantransia pygmea, Amphora ovalis* var. *pediculus*, and *Achnanthes lanceolata* grew in the shade. *Rhoicosphaenia curvata, Cocconeis placentula* var. *euglypta, Navicula gracilis* grew in shade and at a raised water temperature. The species *Achnanthes minutissima, A. pyreneica, Cymbella ventricosa*, species of the genus *Gomphonema*, and *Diatoma hiemale* with the variety *mesodon* had a wide spectrum with regard to light.

Key words: ecology of algae, sessile algae, influence of light, influence of temperature.

1. Introduction

Because of a natural character of water and a great differentiation of life conditions, mountain streams present an ideal subject in investigations on the ecology of sessile algae. Light and temperature are among the most important factors responsible for the differentiation of algae

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communities. However, knowledge of the requirements of organisms with regard to these two factors are insufficient, especially scarce information being available on the demand for light. In the present work a shade of the bridge and the inflow of waters from a natural hot spring were used in a study of the reaction of algal communities to changes in light intensity and water temperature.

2. Study area

The investigation was carried out in the Olczyski stream (fig. 1). This stream flows out of the Olczyski vauclusian spring (at 1067 m above sea level) in the Tatra National Park, in its upper course flowing across a mountain pasture and then entering the mountain forest zone. In the middle course the stream leaves the Tatras and flows across an area which is partly afforested and partly built over. The stream drains into the Zakopianka stream at an altitude of 760 m. On the border of the Tatra National Park in the area of Zakopane called Jaszczurówka there is a natural hot spring on the left side of the stream. This hot spring is harnessed and utilized in the summer for filling swimming pools. The waters from the hot spring are fed to the Olczyski stream through a system of pipes with an outlet under a bridge on the Zakopane — Morskie Oko road.

The studied sector of the stream was about 15 m in length. It was partly shaded by the bridge and fed with waters from the hot spring. Particular attention was paid to algal communities developing in the left current of the stream, directly affected by the hot spring.

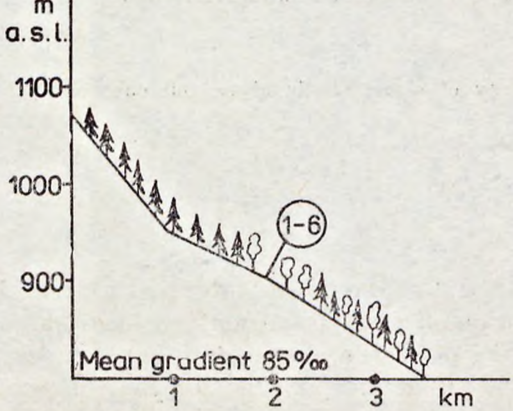

Fig. 1. Profile of the Olczyski stream; distribution of stations

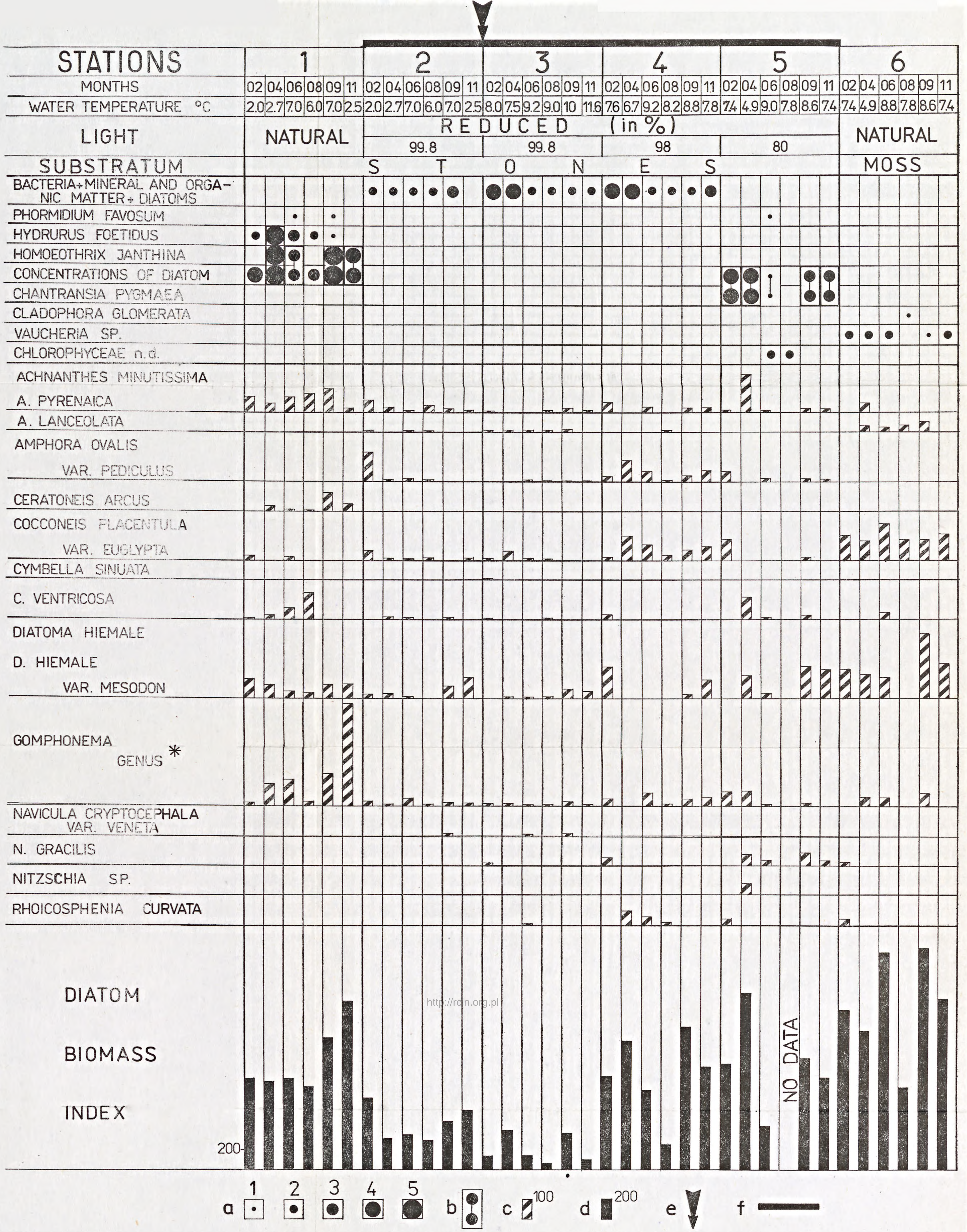

Fig. 2. Algae forming macroscopic aggregations and the predominating species of diatoms under various living conditions in the Olczyski stream. a — scale of coverage; b — coverage includes a group of organisms; c — number of cells; d — index of diatom biomass; e — inflow of waters from the hot spring; f — the bridge. Adominant species: ***Chamaesiphon fuscus*** **(Rostaf.)** Hansg., *Ch. incrustans* Grun. var. *elongatus* (Starmach) Hollerb., *Ch. polonicus* (Rostaf.) Hansg., *Phormidium favosum* (Bory) Gom., *Achnanthes lanceolata* (Bréb.) Grun. var. *capitata* O. Müll., *Ceratoneis arcus* (Ehr.) Kütz. var. *amphioxys* (Rabh.) Grun., *Cocconeis placentula* Ehr. var. *intermedia* (Hérib. et Perag.) Cl., *Cymbella affinis* Kütz., *C. naviculiformis* Auerrsw., *Denticula tenuis* Kütz. var. *crassula* (Näg.) Hust., *Diatoma elongatum* (Lyngb.) Ag. var. *tenue* (Ag.) V. H., *D. vulgare* Bory var. *ehrenbergii* (Kütz.) Grun., *Eunotia exigua* (Bréb.) Rabh., *Fragilaria intermedia* Grun., *F. pinnata* Ehr., *Fragilaria* sp., *Frustulia rhomboides* (Ehr.) De Toni var. *saxonica* (Rabh.) De Toni, *Gomphonema olivaceum* (Lyngb.) Kütz. var. *calcareum* Cl., *Melosira* sp., *Meridion circulare* Ag., *Navicula exigua* (Greg.) O. Müll., *N. mutica* Kütz., *N. laterostrata* Hust., *Nitzschia dissipata* (Kütz.) Grun., *N. hantzschiana* Rabh. *N. linearis* W. Sm., *N. palea* (Kütz.) W. Sm., *Nitzschia* sp., *Surirella ovata* Kütz., *S. ovata* Kütz. var. *pinnata* (W. Sm.) Hust., *Surirella* sp., *Synedra minuscula* Grun., *S. ulna* (Nitzsch) Ehr., *Tabellaria flocculosa* (Roth) Kütz., *Cladophora glomerata* (L.) Kütz.

The investigation was carried out at six stations (fig. 2). Station 1 lay above, stations 2—4 under, station 5 on the margin of the bridge, and station 6 below it. Stations 3—6 lay below the inflow of hot waters. The bottom of the stream was stony but at station 6 the stones were moss covered. The intensity of light was strongly reduced under the bridge, better light conditions being found near the egress, while at its border they were almost natural, similar to those found in the deep shadow of a forest. Below the bridge light conditions were natural, though the station was in some periods overshadowed by it. In the natural environment the water temperature was 2—7°C, the temperature of waters fed from the hot spring being 13—16.8°C. These hot waters flowed in the left current and the temperature in that part of the stream was 4.9—11.6°C. Directly below the inflow of hot spring waters differences in the water temperature reached 9.1°C as compared with the natural environment. Further from the mouth of the hot spring the temperature gradually became more uniform, the differences reaching 5.4°C.

Table I. Chemical composition of waters in the Olczyski stream (according to Bombówna, unpubl. results)

Factor	Station	
	above the inflow of hot spring waters	below the inflow of hot spring waters
pH	7-7.3	7-7.4
CO_2 dm^{-3}	0.1-5.5	0.2-7.7
Conductivity µS 18°C	110-163.7	181.8-256.1
Total hardness °G	4-5.5	5.1-8.1
Chloride Cl dm^{-3}	1.75-4.25	3-7.25
Sulphate SO_4 dm^{-3}	9.89-18.51	17.9-31.06
Silicate SiO_2 dm^{-3}	9.81-10.82	10.48-12.7
Calcium Ca dm^{-3}	17.87-25.73	20.01-37.16
Magnesium Mg dm^{-3}	6.51-12.14	8.67-13.01
Potassium K dm^{-3}	0.0-0.3	0.1-0.7
Sodium Na dm^{-3}	0.2-1.12	2.31-4.38
Ferrum Fe dm^{-3}	0.0-0.02	0.0-0.04
Oxidability O_2 dm^{-3}	1.12-2.64	1.12-2.64
Dissolved oxygen O_2 dm^{-3}	11.52-13.44	7.36-12
Oxygen saturation O_2 %	94.5-101.6	70.3-100
BOD_5	0.96-2.56	0.8-2.08
Ammonia $N\text{-}NH_4$ dm^{-3}	0.197-0.244	0.197-0.386
Nitrite $N\text{-}NO_2$ dm^{-3}	0.001-0.009	0.002-0.008
Nitrate $N\text{-}NO_3$ dm^{-3}	0.758-1.038	0.659-0.946
Phosphate PO_4 dm^{-3}	0.00-0.092	0.00-0.060

The stream flows in a calcareous area and its waters have a mesotrophic character (Table I). At the time of the investigation the reaction of the water was 7—7.4. Calcium and magnesium predominated among cations while carbonates and sulphates, accounting for the fairly high water hardness, prevailed among anions. The content of chlorides was small but that of silica considerable. The iron content was extremely low, while nitrates and phosphates were found in trace amounts. The low values of oxygen consumption and BOD_5 indicated that the content of organic matter in the stream water was small. Below the inflow of hot spring waters the concentration of the chief macroelements increased and the content of chlorides was slightly raised, this causing an increase in the electric conductivity.

3. Method

The investigation was carried out in the period February-November 1982 at 6 week intervals. In August at station 5 no material could be sampled owing to the high water level. Algae were collected from stones, mosses also being taken, and the material was then preserved in a 4% solution of formalin.

In order to obtain the diatom material part of each sample was macerated in a chromic acid cleaning mixture (composed of sulphuric acid and potassium dichromate) during 1—2 days and then centrifuged at 3000 R/min. Pure shells of diatoms were kept in distilled water. Solid preparations were then made with "pleurax" synthetic resin. The algae were examined under a Zeiss microscope with a Zeiss micrometric net in the eyepiece.

The communities of algae were characterized by the number of species, their abundance and coverage, and the biomass index of diatoms.

The abundance of algae was estimated according to the Starmach method (1969 and unpublished data).

A. The coverage of algae which formed macroscopic aggregations was determined at the stations on about 2 m^2 of the stream area. A 5-grade scale of coverage was applied:

1. Organisms form small aggregations.
2. Organisms cover less than 25% of the bottom.
3. Organisms cover 25—50% of the bottom.
4. Organisms cover 50—75% of the bottom.
5. Organisms cover 75—100% of the bottom.

B. The number of diatoms was determined under the microscope. For this purpose the number of specimens of each species was counted in 10 fields of the microscope, delimited by the lines of the micrometric net (at magnification 17×40). When a species was noted in the preparation but was then not found in 10 fields of vision it was given the value of 0.1. On the basis of the abundance of species their percentage share in the community was determined.

The organisms which in the scale of coverage reached a value of at least 2 and the species whose share in the community was 5% or more were regarded as dominants, the remaining species being determined as adominants.

Next, the cell size of each diatom species was determined by comparing it with the net mesh size. The magnitude was expressed in multiples or parts of the net mesh. Owing to the great variability of cell size, the average size of the cell of each species was computed.

By multiplying the number by the size of the cell the coefficient of coverage was obtained. The conventional assimilation surface of organisms was found from this value multiplied by 2.

The sum of coefficients of coverage gave the index of diatom biomass.

Light was measured using a Type 102 luxmeter.

4. Results

4.1. The communities of algae in the natural environment (fig. 2)

The communities of algae developing here were characteristic for mountain streams, with *Hydrurus foetidus*, *Homoeothrix janthina*, and diatoms as dominants. The development of *Hydrurus foetidus* was most abundant in the spring, while later it was less vigorous. *Homoeothrix janthina* developed most abundantly in the spring and also in the autumn. Diatoms formed large communities throughout the year and the number of their taxa exceeded all other groups of algae (Table II). Species of the genus *Achnanthes*, *Gomphonema*, *Diatoma hiemale* with the variety *mesodon*, *Cymbella ventricosa*, and *Ceratoneis arcus* predominated among diatoms. The index of diatom biomass reached average values.

Table II. Floristic spectrum of the Olczyski stream. In the upper part of each space the number of species, in the lower part their percentage share in the community

Taxa	Stations					
	1	2	3	4	5	6
Cyanophyta	4 12.1				2 5.9	1 3.1
Chlorophyta					1 2.9	2 6.3
Rhodophyta				1 3.0	1 2.9	
Bacillariophyceae	28 84.9	36 100	28 100	33 97.0	30 88.3	29 90.6
Chrysophyceae	1 3.0					
Total number of species	33	36	28	34	34	32

4.2. Algae communities developing in the changed environmental conditions

Under the bridge, in conditions of lower light intensity, the number of taxa was similar to that in the natural environment, though significant qualitative changes were observed. Among algae *Hydrurus foetidus* and *Homoeothrix janthina* disappeared while only diatoms survived. They accompanied the aggregations of bacteria forming delicate yellowish coatings on stones. Dead cells were frequently noted in the samples. At stations 2 and 3 a pronounced reductions of the diatom population was manifested by the drastic fall in the index of their biomass. The reaction of the different species of diatoms was varied. Here, independently of the water temperature, *Ceratoneis arcus* passed from the group of dominant to adominant species. *Achnanthes minutissima* and *A. pyrenaica, Cymbella ventricosa,* and also the species of the genus *Gomphonema* remained in the group of dominants but their population abundance was markedly decreased, while that of *Diatoma hiemale* with *D. hiemale* var. *mesodon* sometimes exceeded the level observed in the natural environment. *Amphora ovalis* var. *pediculus* and also *Achnanthes lanceolata,* which were found in the group of adominants in the natural environment, passed to the group of dominants under the bridge, with a considerable development of *Amphora ovalis* var. *pediculus*.

In the sector of the stream nearer the egress of the bridge (station 4) a quantitative increase in the numbers of *Cocconeis placentula* var. *euglypta* and *Rhoicosphaenia curvata* occurred, bringing about an increase in the index of diatom biomass.

At the margin of the bridge (station 5) the number of taxa was maintained at the level at other stations. Abundant coatings of algae appeared here. *Chantransia pygmaea*, which was not found in the natural environment, prevailed at this station. Unindentified green algae formed fairly abundant aggregations, also penetrating about 1 m under the bridge. The index of diatoms biomass rose and reached a similar level to that found at station 1. This was caused by the fairly abundant development of *Diatoma hiemale* with the variety *mesodon*. Also *Navicula gracilis* appeared in large number, there, while in the natural environment it was only sporadically observed.

Below the bridge (station 6) the number of taxa was maintained at a level approximating that at other stations. However, considerable qualitative changes were observed here. Neither, *Hydrurus foetidus* nor *Homoeothrix janthina* developed again at this station. *Chantransia pygmaea* and unidentified green algae disappeared. *Vaucheria* sp. developed fairly numerously on mosses and *Cladophora glomerata* occurred sporadically, two species which did not appear above the bridge. Diatoms developed abundantly and the index of their biomass exceeded the average value found in the natural environment. This was chiefly caused by a further increase in the population of *Diatoma hiemale* with the variety *mesodon* whose abundance considerably exceeded that found in the natural environment. The populations of *Achnanthes lanceolata* also slightly increased. On the other hand, the species *Achnanthes minutissima, A. pyrenaica, Cymbella ventricosa,* and species of the genus *Gomphonema* which appeared abundantly at station 1, did not rebuild their populations.

5. Discussion

In observing the behaviour of organisms under different living conditions certain conclusions concerning their ecological requirements may be drawn.

Homoeothrix janthina is widely distributed in high-mountain streams, being particularly numerous in forest shaded sectors (Kawecka 1980). In the Olczyski stream this species completely disappeared from the algae community under the bridge, independently of the water temperature. Therefore, it can be inferred that, in spite of being observed in a wide range of illumination, this organism seems to prefer temperate shade while it is not able to exist under conditions of too drastic a limitation of light.

Hydrurus foetidus is also widely distributed and numerous in high-mountain streams (Kawecka 1980). It developed abundantly in the streams of Swedish Lapland in the summer, this probably being associated with the extended daylight in the period of arctic summer. Hovasse, Joyon (1960) claim that *H. foetidus* needs a good and long illumination for its development but Squires et al. (1973) found *H. foetidus* also under ice. In the Olczyski stream this organism disappeared under the bridge, regardless of the temperature of the water. The above information suggests that although this organism lives in a wide spectrum of light it prefers good illumination and a too pronounced deficiency of light inhibits its development completely.

The two species did not reappear below the bridge under natural light conditions and at a slightly higher water temperature reaching 4.9—8.8°C. An increase in the temperature should not have limited their development there. *H. foetidus* was frequently noted as a predominating species at temperatures from 0.1—10.7°C and *Homoeothrix janthina* at those from 0.4—9°C (Kawecka 1980). Bursa (1934) determined the optimum temperature for *Hydrurus foetidus* as being from 2—12°C. Both species develop abundantly in streams flowing on granite and calcareous substrates. *H. foetidus* also grew in an eutrophicated stream (Kawecka 1974). In the Olczyski stream, therefore, the enrichment of waters with macroelements flowing in with the water from the hot spring, need not inhibit their development. The absence of these organisms here was most probably due to a change of the substrate, since the bottom was overgrown with mosses. The two mentioned species live directly on stones and were never encountered in a mossy habitat.

Diatoms are the most widely distributed and very abundantly developed species in high-mountain streams. In the Olczyski stream most species predominating in the natural environment, remained in the dominant group under the bridge but in reduced numbers. There were some species whose number increased, this pointing to their high ability of adaptation to changes in light intensity, as already reported by Cholnoky (1968).

Ceratoneis arcus is frequent and numerous in high-mountain streams both in the alpine and forest zone (Kawecka 1980). In the Olczyski stream it passed under the bridge to the group of adominants, independently of the water temperature. Thus, it may be assumed that the species is characterized by a wide spectrum of light requirements, though it cannot exist where there is a severe light deficiency.

Contrary to *Ceratoneis arcus, Achnanthes minutissima, A. pyrenaica, Cymbella ventricosa* and the species of the genus *Gomphonema (G. angustatum, G. intricatum* var. *pumilum, G. olivaceum)* remained under the bridge in the group of dominants, both at normal and raised temperature, though their population abundance was considerably lower than that in the natural environment. This might indicate their high adaptation potential with regard to changes in light intensity. In the case of *A. minutissima* this observation is also supported by the observations of Hickman, Klarer (1974), who claim that this organism needs more light and greater day length, and also the findings of Clair et al. (1981), who frequently encountered the discussed species in the caves of the Oregon National Park. *Cymbella ventricosa* is noted among the most widely distributed organisms in montane streams and seems to be euryphotic. It is difficult to say more about light requirements of other diatom species. It would be interesting to know why these organisms did not regenerate their populations below the bridge to the abundance noted under natural conditions. An increase in temperature should not have inhibited their development there, since they are a eurythermic species; Wasylik (1971) found most of them at 4.5—25°C. Nor should the enrichment of waters with chemical constituents flowing in with the water of the hot spring have inhibited their growth, as they live both in oligotrophic and eutrophic waters. Moreover, the substrate should not have disturbed their development since they were frequently noted in the environment of mosses. It seems that the factor of competition played an important role and the species were suppressed by the abundantly developing *Diatoma hiemale* with the variety *mesodon* and *Cocconeis placentula* var *euglypta,* which found better living conditions there than in the natural environment (fig. 2).

In high-mountain streams *Diatoma hiemale* and *D. hiemale* var. *mesodon* appeared in large numbers both in the woodless area and in forest zones (Kawecka 1980). In the Olczyski stream they remained under the bridge in the group of predominants, attaining relatively large numbers in some periods. Hence, it may be supposed that they have a wide range of light requirements, though they developed the largest populations below the bridge at temperatures from 4.9—8.6°C and were particularly numerous at 8.6°C (fig. 2). Also in high-mountain streams the greatest abundance of these species was found at temperatures from 8—11°C (Kawecka 1980). These organisms are known as cold water species and while the present observations do not contradict the statement it seems that their optimum can rather be found within the range 8—10°C. Also, it cannot be excluded that their development in the Olczyski stream was stimulated by the inflow of additional nutrients with the water of the hot spring.

In high-mountain streams *Cocconeis placentula* var. *euglypta* formed large populations only in sectors within forest areas (Kawecka 1980). In the Olczyski stream it remained in the group of dominants under the bridge and its population much greater than that in the natural environment. This may indicate that the organism prefers shade. Toppet (1969), cited by Hickman, Klarer (1974), postulates that the development of *C. placentula* is inhibited by high light intensity. Castenholz (1960), investigating algal communities in warmed waters, found that *C. placentula* reached maximum growth at higher temperatures and low light intensity. The present results also seem to suggest that higher temperatures stimulate the development of *C. placentula* var. *euglypta,* since in the Olczyski stream its population increased and considerably exceeded the level noted in the natural environment below the inflow of hot spring waters at temperatures from 4.9—9.2°C. Hickman, Klarer (1974) also state that higher temperatures stimulate the development of *C. placentula* whose maximum was found at 12°C. Moreover, the stimulating action of nutrients (chiefly Ca) brought in with the waters of the hot spring cannot be excluded. *C. placentula* var. *euglypta* likes fairly rich waters and is frequently encountered in the sectors of streams where the final phase of mineralization of wastes takes place (Butcher 1947, Friedrich 1973, Kawecka 1980).

Amphora ovalis var. *pediculus*, which sporadically occurred in the natural environment of the Olczyski stream, was found in the group of dominants under the bridge, its numbers being fairly large. This supports the opinion of Hickman (1974) that this variety is especially well adapted to very low light intensity and/or is able to adopt a heterotrophic way of living.

Rhoicosphaenia curvata, an organism sporadically encountered in high-mountain streams, was noted periodically in the Olczyski stream in the group of dominants under the bridge and below the inflow of hot spring waters (at temperatures from 6.7—9.2°C). An increase in the temperature would not play any great role, *R. curvata* being an eurythermic species (S c h e e l e 1952). Hence, it is possible that it prefers the shade and found a favourable chemical environment here. According to *Cholnoky* (1968), this species represents the type of alkaline waters.

Achnanthes lanceolata is widely distributed in high-mountain streams but forms larger populations in some places only (K a w e c k a 1980). In the Olczyski stream it appeared in the group of adominants above the bridge while it was noted in the dominant group under it, though the population was not large. This suggests that the light deficiency did not inhibit its growth, a view supported by the occurrence of *A. lanceolata* in a system of caves in the state of Oregon (C l a i r et al. 1981). In the Olczyski stream its best growth below the bridge was probably also associated with the well developed habitat of mosses. It seems that this species prefers this type of habitat.

Navicula gracilis is sporadically encountered in high-mountain streams. In the Olczyski stream not only was it found in the group of dominants but it developed fairly abundantly at the margin of the bridge at temperatures from 4.9—9°C. This fact may indicate that *N. gracilis* is a shade-loving species. Its growth may also be stimulated by nutrients brought in with the waters of the hot spring (a marked increase in Ca content), since *N. gracilis* finds the best conditions of development in eutrophic waters (C h o l n o k y 1968). The increased temperature would not play any great role since it is a eurythermic organism and grows abundantly at temperature from 5.5—25°C (W a s y l i k 1971).

Chantransia pygmaea, which is sporadically found in high-mountain streams, was not noted at station 1 in the Olczyski stream but it developed at the margin of the bridge at temperatures from 4.9—9°C, this supporting the opinion that the group of red algae is shade-loving.

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6. Polish summary

Ekologiczna charakterystyka zbiorowisk glonów osiadłych w potoku Olczyskim (Tatry, Polska) ze szczególnym uwzględnieniem światła i temperatury

Badania prowadzono w potoku Olczyskim (ryc. 1, tabela I). Wykorzystano tu zabudowę mostu oraz dopływ wód z ciepłych źródeł w Jaszczurówce dla prześledzenia reakcji glonów na zmiany intensywności światła oraz temperatury wody.

W środowisku naturalnym dominował *Hydrurus foetidus*, *Homoeothrix janthina* wraz z okrzemkami, wśród których przeważały gatunki z rodzaju *Achnanthes*, *Gomphonema*, *Diatoma hiemale* z odmianą *mesodon*, *Cymbella ventricosa* oraz *Ceratoneis arcus*. Wskaźnik biomasy okrzemek osiągnął średnie wartości (ryc. 2).

Pod mostem zniknął całkowicie *Hydrurus foetidus* oraz *Homoeothrix janthina*, przy życiu pozostały jedynie okrzemki, jednakże ich wskaźnik biomasy obniżył się znacznie. *Ceratoneis arcus* przeszedł z grupy dominantów do adominantów. Gatunki z rodzaju *Achnanthes*, *Gomphonema* oraz *Cymbella ventricosa* pozostały okresowo w grupie dominantów, ale znacznie obniżyły swoje populacje. *Diatoma hiemale* z odmianą *mesodon* zachowały liczebność na dość wysokim poziomie, natomiast *Amphora ovalis* var. *pediculus* i *Rhoicosphaenia curvata* weszły do grupy dominantów i rozwinęły się dość licznie (ryc. 2).

Na granicy mostu glony tworzyły już dobrze rozwinięte powłoki. Obfite skupienia tworzyła *Chantransia pygmea*, a dość licznie rozwinęła się także *Navicula gracilis*, organizmy w środowisku naturalnym nie spotykane. Wskaźnik biomasy okrzemek wzrósł i osiągnął poziom podobny jak w środowisku naturalnym.

Poniżej mostu zniknęła *Chantransia pygmea*, a *Hydrurus foetidus* oraz *Homoeothrix janthina* nie pojawiły się ponownie. Natomiast na mchach dość obfite skupienia tworzyła *Vaucheria* sp., sporadycznie wystąpiła też *Cladophora glomerata*, oba gatunki nie spotykane w środowisku naturalnym. Nastąpił dalszy rozwój okrzemek, w tym głównie *Cocconeis placentula* var. *euglypta* oraz *Diatoma hiemale* z odmianą *mesodon*. Wskaźnik biomasy okrzemek przekroczył poziom spotykany w środowisku naturalnym. Nie odnowiły swoich populacji liczne powyżej mostu gatunki z rodzaju *Achnanthes*, *Gomphonema* oraz *Cymbella ventricosa* (ryc. 2).

Na podstawie własnych obserwacji oraz danych z literatury scharakteryzowano większość dominujących organizmów pod kątem ich wymagań ekologicznych.

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