

## The effect of light deficiency on communities of sessile algae in the Olczyski stream (Tatra Mts, Poland)\*

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**Abstract** — The development of sessile algae in a montane stream in conditions of reduced light intensity was investigated using the shade thrown by bridges. *Homoeothrix janthina*, *Hydrurus foetidus*, *Prasiola fluvialilis*, *Achnanthes minutissima*, *A. pyrenaica*, *Ceratoneis arcus*, *Cymbella allinis*, *C. ventricosa*, *Diatoma hiemale* with the variety *mesodon*, *Gomphonema angustatum*, *G. intricatum* var. *pumilum*, *G. olivaceum* showed a negative tendency in their development while a positive one was observed in *Achnanthes lanceolata*, *Amphora ovalis* var. *pediculus*, *Cocconeis placentula* var. *euglypta*, and *Cymbella sinuata*.

**Key words:** stream, sessile algae, ecology of algae, effect of light.

### 1. Introduction

Despite numerous investigations on the ecology of algae in streams, little information is available concerning the effect of light intensity on the development of these organisms. The subject was undertaken in an earlier study (Kawecka 1985) and is continued in the present work. The shade thrown by bridges was made use of in both studies. The aim of the present work was to observe the development of algae in a moun-

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tain stream in conditions of reduced light intensity as compared with environments of natural light.

## 2. Study area

The investigation was carried out in the Olczyński stream (at alt. 1067—900 m); a more detailed description was previously given by the author (Kawęcka 1985). In a section of the stream of about 1 km, in the area of the Tatra National Park, stations were established at 5 successive wooden bridges (fig. 1). The material was collected above (Stations A) and below (Stations B) each of them. Stations A and B neighboured upon each other. Under the bridges the intensity of light was much lower (by about 95%) than in the natural environment. Other factors remained unchanged. At the different stations the pH of the water varied from 7—7.1 and the temperature from 4.6—4.9°C.

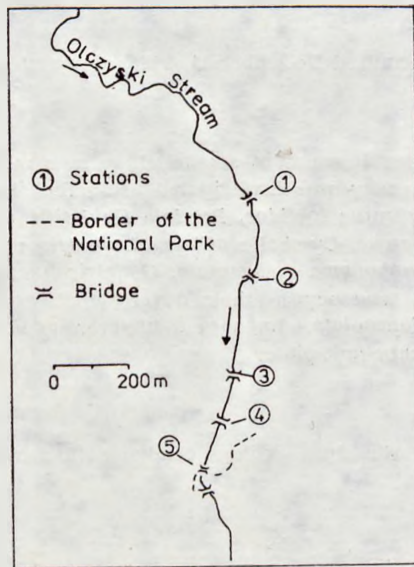


Fig. 1. Map of the Olczyński stream with sampling stations

## 3. Material and method

The material was collected on October 11, 1983. Algae were taken from stones and the samples preserved in a 4% solution of formalin. The preparation of diatoms and the quantitative elaboration of the material

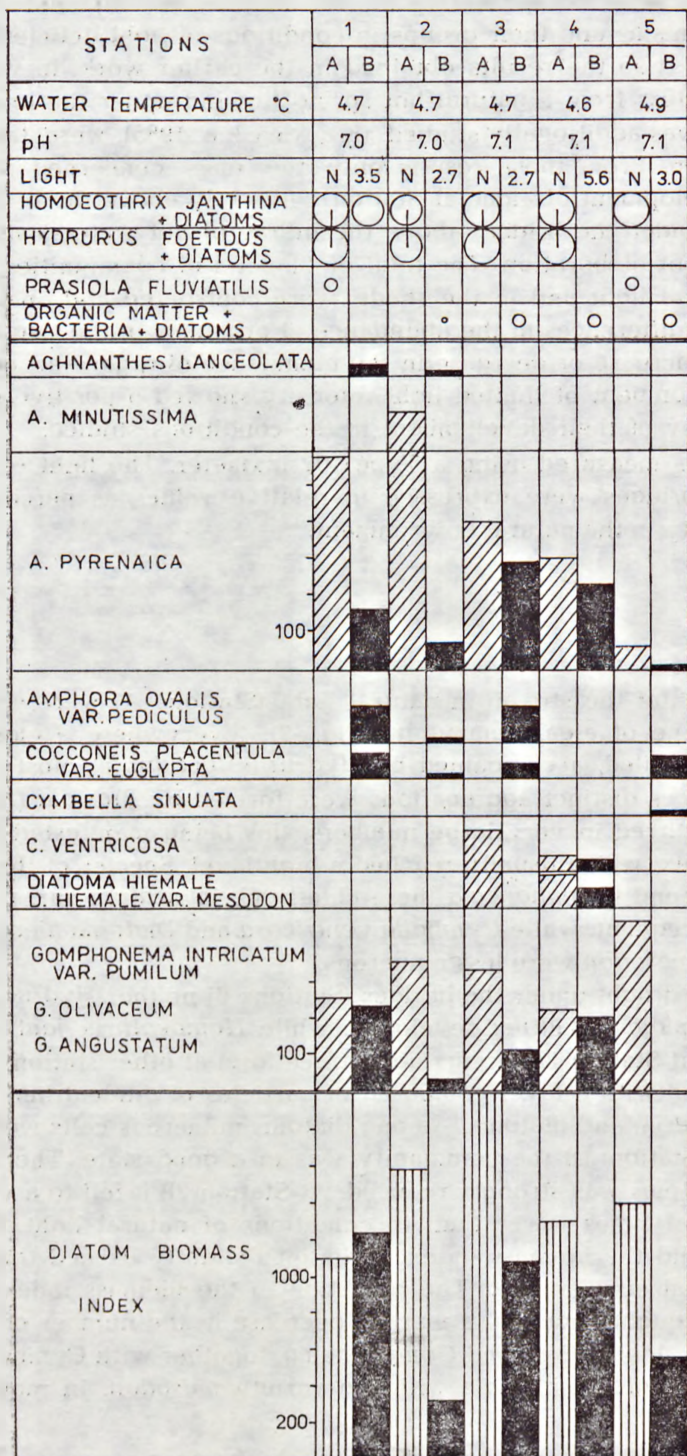
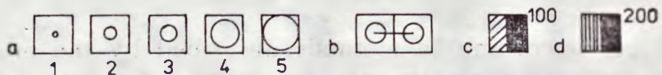
was carried out according to methods described by the author (K a w e c k a 1985). In recapitulating the results, the developmental tendencies of organisms and their groups in conditions of light deficiency were determined. Also the results obtained in the earlier work, in which the effect of waters from a natural hot spring flowing under the bridge into the stream was additionally studied (K a w e c k a 1985), were taken into consideration. From those results only the ones concerned with the annual development of algae at Station 1 (directly above the bridge) and Station 2 (under the bridge, above the inflow of hot waters) were used in the present elaboration. The total of 11 pairs of communities, occurring in natural light and in the shade, were confronted and analysed on the basis of differences in the abundance of organism in the two environments. An increase or decrease in the abundance of organisms occurring in the environment of limited light intensity showed a positive or negative tendency of their development in the conditions studied.

Light was measured using a Type 102 luximeter. The light conditions under the bridges were expressed in relative values as percentage of light intensity in the natural environment.

#### 4. Results

The areas of the stream in natural light (Stations A) were settled by the same type of algal community (fig. 2). Everywhere *Homoeothrix janthina* prevailed, accompanied by *Hydrurus foetidus* at most stations. In some places distinct aggregations were formed by *Prasiola fluviatilis*. Diatoms occurred in very large numbers, this being manifested by their biomass index, which usually reached a high level. Species of the genera *Achnanthes* and *Gomphonema* (here chiefly *G. intricatum* var. *pumilum*) were most frequent, while *Cymbella ventricosa* and *Diatoma hiemale* with the variety *mesodon* were less numerous.

In reduced light under the bridges (Stations B) neither *Hydrurus foetidus* nor *Prasiola fluviatilis* developed, while *Homoeothrix janthina* was found only at Station 1B, occurring in trace form at other stations. Stones were covered with a layer composed of particles of unidentified organic matter, bacteria, and diatoms. Among diatoms numerous cells were dead, though, at Station 1B the community was in a good state. The biomass index of diatoms was strongly reduced. At Station 2B it fell to a very low level, several times lower than in conditions of natural light. Only at Station 1B did the biomass index of diatoms slightly exceed that found in the natural environment. The reduction in the biomass index of diatoms was brought about by a marked decrease in the number of species of the genus *Achnanthes*, and *Gomphonema*, together with *Cymbella ventricosa*, and *Diatoma hiemale* with the variety *mesodon*. In most cases,



however, these species remained in the group of dominants. On the other hand, in the community of diatoms there appeared a new group of dominants which were only sporadically noted in conditions of natural light. These were *Achnanthes lanceolata*, *Amphora ovalis* var. *pediculus*, *Cocconeis placentula* var. *euglypta*, and *Cymbella sinuata*.

In characterizing general tendencies in the development of organisms in conditions of a lower light intensity, results obtained in the earlier study were taken into consideration. Using the community of algae developing in natural light as a point of reference, two groups of organisms were differentiated. One of them showed a tendency to decrease and the other to increase their abundance in conditions of light deficiency (Table I).

Table I. Development of algae in the Olczyski stream in conditions of reduced light intensity. Tendencies of development: - - negative; + - positive. \* - *Comphonema angustatum*, *C. intricatum* var. *pumilum*, *C. olivaceum*

Species	Response to reduced light
<i>Homoeothrix janthina</i>	-
<i>Hydrurus foetidus</i>	-
<i>Prasiola fluviatilis</i>	-
<i>Achnanthes minutissima</i> , <i>A. pyrenaica</i>	-
<i>Ceratoneis arcus</i>	-
<i>Cymbella affinis</i> , <i>C. ventricosa</i>	-
<i>Diatoma hiemale</i> , <i>D. hiemale</i> var. <i>mesodon</i>	-
<i>Comphonema</i> genus*	-
Diatom biomass index	-
<i>Achnanthes lanceolata</i>	+
<i>Amphora ovalis</i> var. <i>pediculus</i>	+
<i>Cocconeis placentula</i> var. <i>euglypta</i>	+
<i>Cymbella sinuata</i>	+

In the first group *Hydrurus foetidus* and *Prasiola fluviatilis* did not develop in the shade of bridges and the development of *Homoeothrix janthina* was strongly limited. In conditions of light deficiency diatom populations were markedly reduced and many dead cells were observed. However, most species survived and appeared in the group of dominants. Only the number of *Ceratoneis arcus* was several times smaller than that noted in the natural environment and this species appeared in the group of accidental species.

In the second group there were some species of diatoms of which *Achnanthes lanceolata*, *Amphora ovalis* var. *pediculus*, and *Cocconeis placentula* var. *euglypta* while noted among accidental species in the natural environment, entered the group of dominants in the shade of the

Fig. 2. Algal communities of the Olczyski stream (algae forming macroscopic aggregations, dominant diatom species, and their abundance). A — stations above the bridge; B — stations below the bridge. a — scale of coverage; b — coverage includes a group of organisms; c — numbers of cells in 10 fields of the microscope; d — biomass index of diatoms

bridges. Among them *Amphora ovalis* var. *pediculus* is particularly worthy of note since the number of its cells was many times greater in the shade of the bridges than in the natural environment.

## 5. Discussion

The present study yielded some new data concerning the light requirements of stream algae. *Hydrurus foetidus* and *Homoeothrix janthina* are among the organisms most frequently found in high-mountain streams but little is known about their light requirements. Field observations on the development of these species suggest that *H. janthina* prefers temperate shade while *H. foetidus* prefers good light (Kawecka 1985). The present study showed that these organisms did not tolerate light deficiency. In such conditions *Hydrurus foetidus* was unable to exist, while the growth of *Homoeothrix janthina* was severely reduced. The latter species showed a normal development only at Station 1B. Probably, sunshine penetrated there but this was not possible to check owing to the cloudy weather on the day of observation.

Also diatoms are among the organisms most frequently found in mountain streams. Opinions about their light requirements are varied. For example, Bursa (1961) claimed that they tolerated long periods of darkness, while Chandler (1942) and Patrick (1977) found a negative effect of water turbidity, which limited the penetration of light, on their development. The obtained results showed that light deficiency negatively affected the development of diatoms, this being manifested by a decreased value of their biomass index. However, this conclusion is a great simplification, since different species have individual demands for light. For example, current studies show that limited light intensity negatively affected the development of *Achnanthes minutissima*, *A. pyrenaica*, *Ceratoneis arcus*, *Cymbella ventricosa* accompanied by *C. affinis*, *Diatoma hiemale* with the variety *mesodon*, and species of the genus *Gomphonema* (chiefly *G. intricatum* var. *pumilum*). *Ceratoneis arcus* seems to respond most negatively to deep shade and its development is stopped in this environment. In the shade thrown by the bridges the abundance of the other species were reduced but they remained in the group of dominants. This observation suggests that these organisms are characterized by a wide spectrum of light requirements. Few data concerning the light requirements of these algae are available. Hickman and Klarer (1974) postulate that for the development of *Achnanthes minutissima* more light and extended daylength are necessary, while Clair et al. (1981) found the species in a cave in Oregon. These controversial observations confirm the suggestion of a wide adaptability potential of this species in environments of different light intensity. On the

other hand, light deficiency positively affected the development of *Achnanthes lanceolata*, *Amphora ovalis* var. *pediculus*, *Cocconeis placentula* var. *euglypta*, and *Cymbella sinuata*. The present results support earlier observations concerning the light requirements of these organisms. *Achnanthes lanceolata* was found in caves in the State of Oregon (Clair et al. 1981). Castenholz (1960) observed that, apart from a higher temperature, *Cocconeis placentula* var. *euglypta* required a low intensity of light for its development. According to Hickman (1974), *Amphora ovalis* var. *pediculus* is particularly well adapted to a severe light deficiency.

## 6. Polish summary

### Wpływ ograniczonego dopływu światła na zbiorowiska glonów osiadłych Potoku Olczyskiego (Tatry, Polska)

W badaniach wykorzystano cień rzucany przez mosty, co pozwoliło na obserwację rozwoju glonów potokowych w warunkach obniżonego dopływu światła.

Materiał do analizy stanowiły obserwacje prowadzone w Potoku Olczyskim na pięciu stanowiskach (ryc. 1, 2) oraz dane uzyskane we wcześniejszych badaniach autorki.

Przedstawiono ogólne tendencje w rozwoju gatunków glonów w warunkach ograniczonego dopływu światła w stosunku do środowiska naturalnego. Wyróżniono dwie grupy organizmów (tabela I). Pierwsza grupa wykazywała tendencję negatywną. Warunków tych nie tolerował *Hydrurus foetidus*, a także *Prasiola fluviatilis*, które w cieniu mostów nie rozwinęły się, oraz *Homoeothrix janthina* i *Ceratoneis arcus*, które bardzo ograniczyły rozwój. *Achnanthes minutissima*, *A. pyrenaica*, *Cymbella ventricosa* z towarzyszącą jej *C. affinis*, *Diatoma hiemale* z odmianą *mesodon*, *Gomphonema intricatum* var. *pumilum*, *G. angustatum*, *G. olivaceum* znacznie obniżyły swoje populacje, jednakże pozostały nadal w grupie dominantów. Druga grupa organizmów wykazywała tendencję pozytywną w rozwoju. Należały tu *Achnanthes lanceolata*, *Amphora ovalis* var. *pediculus*, *Cocconeis placentula* var. *euglypta*, *Cymbella sinuata*. Wśród nich wyróżniła się *Amphora ovalis* var. *pediculus*, liczebność bowiem jej komórek w cieniu mostów wielokrotnie wzrosła w stosunku do środowiska naturalnego.

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