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Cladophora glomerata i glony towarzyszące w rzece Skawie. Rozmieszczenie i warunki występowania

Cladophora glomerata and concomitant algae in the river Skawa. Distribution and conditions of appearance

Mémoire présenté le 13 avril 1967 dans la séance de la Commission Biologique de l'Académie Polonaise des Sciences, Cracovie

Abstract — The studies aimed at a detailed working out of the distribution of *Cladophora glomerata* and concomitant algae in the River Skawa (a right Vistula tributary). An attempt was made to determine and describe the community with *Cladophora glomerata*. The paper also contains a short description of the terrain under study and gives the general characteristics of the environment in wich the investigation was carried out.

Algae of the river Skawa and its affluents were sporadically investigated by Raciborski (1888) and Gutwiński (1884, 1890, 1893, 1897, 1898, 1901). The necessity therefore arose of undertaking a more detailed investigation of the flora of algae in a river in which the intended building-up and regulation of the bed might cause complete changes among the communities of organisms.

The present work, as a supplement to the first part (Chudyba 1965), attempts to distinguish and describe *Cladophora glomerata* communities in a typical Carpathian river. It also contains a short description of the investigated terrain and presents the general characteristics of the environment in which the investigation was carried out.

C. glomerata is among the most characteristic fluvial algae. Around it and in its thalli many other species of algae appear, especially diatoms. A community with *C. glomerata* as a characteristic species is undoubtedly the most representative for the algal flora of the Skawa.

C. glomerata itself, in spite of the interest which it has provoked in botanists, such as Brand (1899, 1902, 1909 a, b), Borovicov (1914),

Bliding (1936), Cholnoky (1930), Colmant (1931), Hoek (1963), Kann (1940), Lundh (1951), Morozova (1959), Schoser (1956), Symoens (1957), Waern (1939, 1952), Zacharova (1923) and others, has not been till now the subject of more detailed investigation with regard to its appearance and ecology in particular rivers.

The *C. glomerata* association has already been described (Naumann 1926, Sauer 1937, Margalef 1949, Symoens 1951, 1954, Bohr 1962) but is nevertheless not yet sufficiently known.

The present work was carried out under the direction of Professor Karol Starmach, to whom I wish to express my profound gratitude for entrusting me with this subject, and for his care and valuable indications during its execution. I should also like to thank Docent Jadwiga Siemińska for her help in preparing the paper for print, as well as Professor T. Młynek for his kind interest in my work and for facilitating the laboratory investigation.

Geographical and hydrological characteristics of the river Skawa and of its basin

The basin of the Skawa is situated within the compass of the Carpathian Mountains and partly in the submontane area. Its upper part is in the Beskid range, which is cleft and divided by the valley of the Skawa. The High Beskid, that of the Babia Góra, lies to the south-west. To the east of the river Skawa in its southern part are the Gorce range, with the Insular Beskid in the north.

The Carpathian Highlands extend to the north of the Beskids and are divided by the river Skawa into the Wadowice (to the west of the river) and Lanckorona Highlands (to the east).

Further north from Carpathian Highlands is the submontane region. In its western part, the Oświęcim Cirque, the Skawa falls into the Vistula.

Streams flowing from the north-eastern slopes of the Łysa Góra Mt. (alt. 806 m) form the river Skawa in the High Beskid at an altitude of 780 m. It has an average decline of 5.62‰ and, flowing mostly in a north-westerly direction, it falls into the Vistula in the locality of Podolsze (alt. 217.9 m). Its length amounts to L = 100.7 km, of wich 81.7 km belong to its upper course and 19.0 km to its lower one. The entire decline is 562 m.

The area of the whole basin of the Skawa amounts to F = 1188 km^2, 873 km^2 in its upper part and 315 km^2 in the lower one.

The density of the river network in the upper part of the Skawa basin is 0.98 km/km^2, and 0.85 km/km^2 in the lower part 0.948 km/km^2 on the average, with a total length of flows in the whole drainage basin amounting to 1098 km.

The course of the river Skawa can be divided into:

a) The submontane course (with the exception of the part of the sources about 3 km long) from the locality of Spytkowice Podhalańskie to the mouth of the Bystra stream.

b) The montane course, from the locality Bystra to the mouth of the Choczenka stream.

c) The lower course (in the plain) from the mouth of the Choczenka to the issue into the Vistula.

The sector of the sources, relatively short (approx. 3—4 km) and with a very sharp gradient, has the character of a stream and ends in the locality of Spytkowice Podhalańskie. From there onwards, the dominating feature of this part of the Skawa up to the mouth of the Bystra is a very inconsiderable gradient of the river valley, which is responsible for its nearly lowland character. The Skawa flows here through meadows and arable fields and its bed, very winding, is narrow (1—4 m broad) and cuts deeply into the rocky substratum (up to 7 m). The depth of the water varies from 5 to 50 cm. The relation of the lotic to the lenitic zone is 1 : 4 over 1 km. The river bottom is mostly sandy and slimy or only slimy.

From the mouth of the stream Bystra to the issue of the stream Choczenka the gradient increases (fig.1) and a series of distinctly montane affluents (Skawica, Stryszawka, Paleczka) fall into the Skawa, which only then exhibits all the features of a montane river. The bed of the Skawa becomes broader (fig. 2) and shallows up to 1 m. The bottom is covered with considerable masses of rock debris transported by numerous torrents which form considerable raised cones where they fall into the Skawa. The course of the river is rapid and there are numerous cascades. The mean depth of the water is 60 cm. Though deeper places and shallower ones with a strong current appear from time to time. The relation of the lotic zone to the lenitic one changes abruptly and amounts on the average to 4 : 1 over 1 km.

In the neighbourhood of Wadowice the river Skawa enters into its last lowland sector. The mean gradient is 1.6‰, and in places even 1.2‰. The river bed, with a nearly rectilinear breadth and gentle curves, is 50—200 m wide. The bottom is covered with fine gravel and has visible sandy shoals. The Skawa flows very slowly here, forming only a few riffles with a more rapid current. The relation of the lotic to the lenitic zone over 1 km amounts on the average to 1 : 9.

The general characteristics of the more important affluents of the Skawa, from its sources to its mouth, are presented in Table I.

Dividing the Western Carpathian Mountains into geobotanical units (Kornaś 1955, Szafer 1959, Pawłowski 1959), the greater part of the terrain of the basin in question belongs, from the floristic point of view, to the Subdistrict of Silesia and Babia Góra, while the

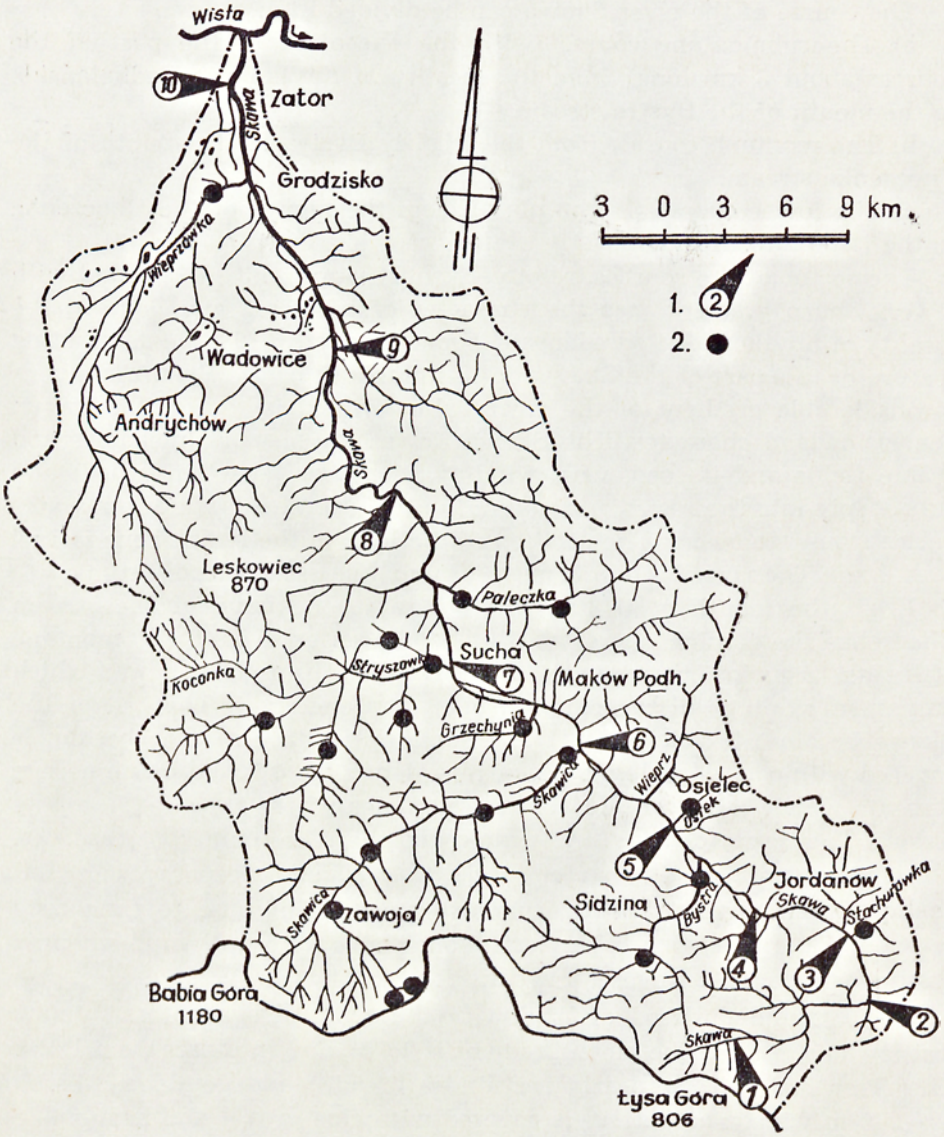


Fig. 1. Basin of the river Skawa. 1 — sampling places; 2 — places in which the presence of *Cladophora glomerata* was observed

short sector of the Skawa near its mouth belongs to the District of the Oświęcim Cirque.

The basin of the Skawa is situated in the area of the Flish Carpathian Mountains of the External Flish and of the formations of the Carpathian submontane region (Książkiewicz 1939, 1948, 1951, 1958, Świderski 1953, Michalik 1962).

Fig. 2. Gradient of the river Skawa

In the terrain of the drainage basin sandstone, sandy and loamy and marly soils appear. Loesses are present in a fairly large complex in the northern part of the basin.

The soils lie on an impermeable substratum so that marshes and peat bogs can be found fairly frequently in the valleys of the Skawa and its affluents.

Table I. General characteristics of the more important tributaries of the river Skawa

No	Stream	Affluent	Springs at altitude in m	Length from springs to mouth in km	Place near the river mouth	Mean decline in ‰	Surface of river basin in km^2
1	Podżaga	left bank	600	6.2	Spytkowice Podhalańskie	14	19.6
2	Naprawka	right bank	575	7.0	Jordanów	19	17.6
3	Bystra	left bank	705	14.3	Bystra	19.9	81.3
4	Wieprzec	right bank	670	7.4	Juszczyn	37.3	18.7
5	Skawica	left bank	1460	22.7	Juszczyn	27.9	145.9
6	Żarnówka	right bank	600	5.2	Maków Podhalański	45.5	11.7
7	Grzechynia	left bank	638	7.5	Maków Podhalański	38.8	13.9
8	Stryszawka	left bank	840	26.0	Sucha	31	140.7
9	Paleczka	right bank	495	14.4	Zembrzyce	13.8	81.8
10	Tarnawa	left bank	650	10.3	Skawce	32.7	22.3
11	Ponikiewka	left bank	680	7.6	Zbyczakówka	55.0	17.2
12	Choczenka	left bank	521	12.4	Wadowice	20.9	25.2
13	Kleczanka	right bank	347	41.5	near Wadowice	6.1	63.5
14	Wieprzówka	left bank	800-600	115.5	Grodzisko	9.0	158.3

Table II. Mean air temperatures in the basin of the river Skawa for the years 1959-1963

Place	Spring			Summer			Autumn			Winter			Year
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
Babia Góra	-1.9	3.2	6.6	10.1	11.9	12.2	8.6	5.3	1.7	-4.3	-6.6	-5.9	3.4
Zawoja	0.9	6.7	9.7	13.4	14.8	15.2	11.4	7.9	4.2	-2.2	-4.2	-4.0	6.1
Maków Podhalański	2.2	8.3	11.6	15.4	16.7	16.7	11.5	8.6	4.0	0.0	-4.3	-3.8	7.2
Leskowiec	2.0	6.5	9.1	13.0	14.4	15.0	11.2	7.6	3.6	-3.0	-5.0	-4.0	5.8
Wadowice	2.7	9.0	12.2	14.7	17.2	17.5	13.2	8.8	5.0	-1.9	-3.5	-3.0	7.6

From a list of mean air temperature values during several years (Table II) it appears that the lowest mean annual temperature as well as the mean air temperature values for particular months correspond to those of mountain areas. The mean annual temperatures fall with a rise in altitude and this is also the case for monthly temperatures. The lowest monthly temperatures appear in January and February and the highest in July and August.

The first slight frosts usually in the valleys occur at the end of October and the last ones in the middle of May.

The highest water temperature in the Skawa (Table III) is attained in the summer months, but in this period the minimum does not fall below 6.8°C, while the maxima often reach 22.6°C. In December, January, and February and often in the first decade of March the water of the Skawa is coldest and retains its minimum of 0.0°C; rarely occurring

Table III. Mean monthly water temperatures in the river Skawa for the years 1959-1963 in Wadowice

Year	Spring			Summer			Autumn			Winter			Mean
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
1959	4.4	7.9	12.9	14.5	17.5	17.1	12.2	7.2	5.7	2.0	0.6	0.2	8.5
1960	3.4	7.3	12.0	15.6	14.1	16.2	13.4	10.0	3.7	1.6	0.8	0.3	8.2
1961	4.6	10.1	12.0	16.1	16.8	16.4	14.6	10.7	6.5	3.1	0.4	0.9	9.3
1962	0.8	6.5	9.7	12.8	15.1	17.1	12.5	9.0	5.0	1.8	0.6	0.3	7.6
1963	1.0	6.7	11.7	16.2	18.6	17.6	15.2	9.2	5.1	0.4	0.1	0.3	8.5
1959-1963	2.8	7.7	11.6	15.0	16.4	17.0	13.6	9.2	5.2	1.8	0.5	0.4	8.4

Table IV. Some ecological factors in the river Skawa (1963)

Locality No	1	2	3	4	5	6	7	8	9	10
Date	Sept. 20	Sept. 20	Sept. 19	Sept. 19	Sept. 19	Sept. 18	Sept. 18	Sept. 24	Sept. 25	Sept. 26
Air temperature °C	20	21	20	20	21	20	29	10	11	12
Water temperature °C	14	15	15	17	17	18	21	11	11	11
Depth in cm in places where samples were collected	10	10	15	20	30	35	30	45	70	70
Rapidity of current in cm/sec	10	12	16	30	50	80	65	90	90	90
pH of water	7.8	7.9	7.8	7.8	7.8	7.2	8.8	7.6	8.0	7.2
Hardness of water in German degrees	15.0	12.0	10.5	8.8	8.2	6.3	6.2	6.2	6.4	6.0
Alkalinity of water in mv	5.2	4.8	5.0	3.4	5.2	1.8	2.2	2.0	1.8	2.0

Table V. Mean precipitation in the years 1959-1963 in the Skawa basin in mm

Place	Spring			Summer			Autumn			Winter			Year
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
Babia Góra	87	112	157	201	232	119	85	64	92	112	87	76	1426
Zawoja	51	83	158	168	201	99	66	60	76	95	51	40	1148
Sidzina	42	65	94	132	129	69	44	37	48	49	45	34	788
Jordanów	37	50	105	109	157	62	45	31	51	42	56	36	781
Osielec	43	48	105	119	145	61	48	35	56	52	41	35	788
Maków Podhalański	48	73	111	136	179	76	63	52	64	59	52	39	952
Sucha	56	61	122	148	184	74	52	42	72	69	58	44	982
Leskowiec	66	108	125	145	217	92	77	54	71	76	53	48	1132
Wadowice	36	60	106	93	169	67	47	39	57	52	37	29	792
Andrychów	42	57	113	113	192	76	53	44	48	59	41	35	873
Grodzisko	33	50	97	86	157	61	42	33	51	46	33	26	705

maxima do not exceed 9°C. Temperatures noted during the collecting of samples are listed in Table IV (in which the depth of the water, the rapidity of the current, hardness, and alkalinity are also given).

The distribution of atmospheric precipitation (Table V) in the Skawa basin is strictly connected with the formation of the terrain and coincides, as a rule, with the calculations of W i s z n i e w s k i (1953, fig. 3).

The beginning of the snow cover usually falls in the first decade of December, the thaw taking place in the last decade of March. In the lowland area of the river basin the snow cover lasts on the average for

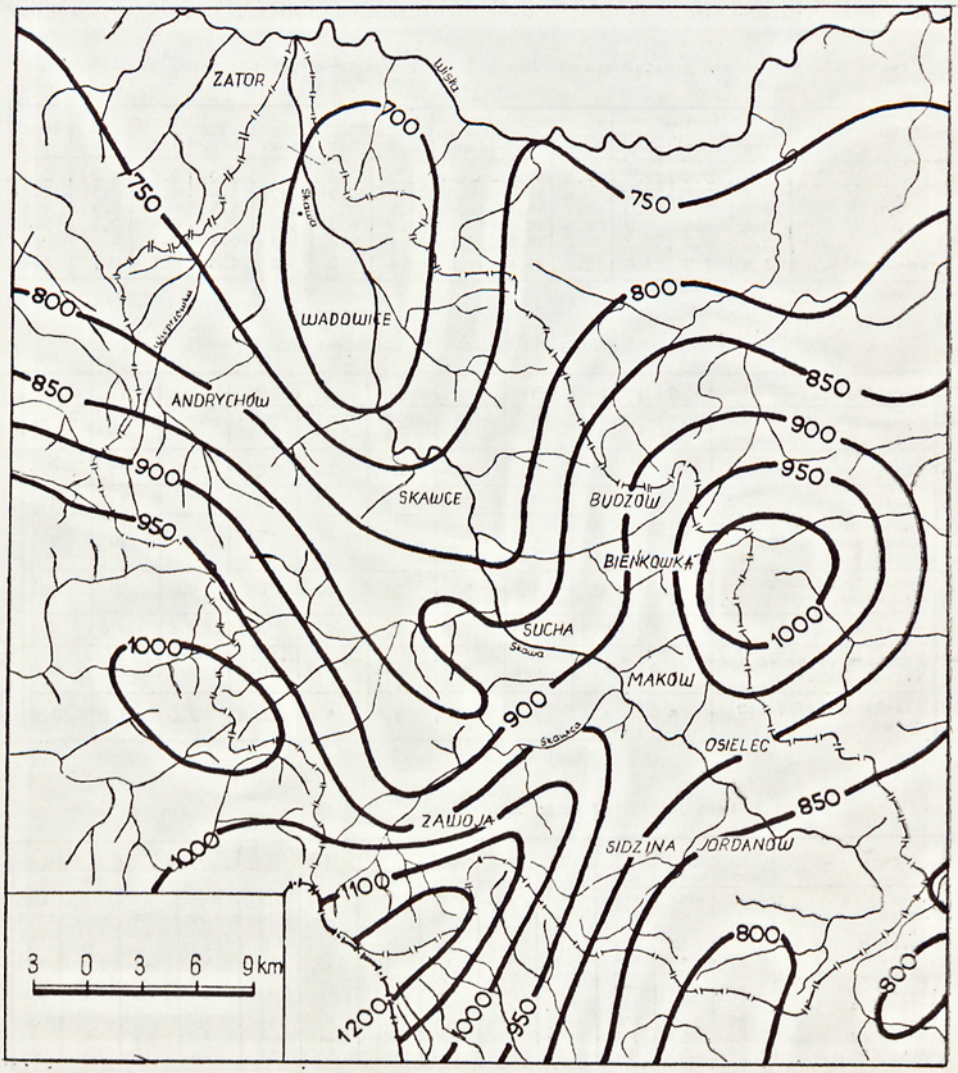


Fig. 3. Mean sums of atmospheric precipitation in 1 mm — in the basin of the Skawa in the years 1891—1930 (after Wiszniewski 1953)

80 days. At greater altitudes the snow lies longer, in the highest mountain parts exceeding 140 days in the year.

Ice appears in December on the river Skawa and lasts till March. Hoar-frost and ice appear near the banks in December while the ice

cover is maintained throughout January and February and often also the beginning of March. Its thickness is 10—50 cm. The mean number of days when the Skawa is ice-bound is 28, and 34 when other ice phenomena (hoar-frost, ice floes, ice near the banks) are present.

The highest water levels in the river Skawa (Table VI) are maintained during the spring and summer months.

Table VI. Monthly mean values of the water level in the river Skawa 1959-1963 in cm

Place	Spring			Summer			Autumn			Winter			Year
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	
Jordanów	211	205	198	202	200	191	185	186	197	191	195	201	197
Osielec	180	181	173	176	176	184	177	176	170	174	175	183	177
Sucha	158	159	154	154	151	142	135	132	133	142	150	154	147
Wadowice	203	205	197	203	196	184	174	172	176	186	198	203	191
Zator	159	158	150	154	151	131	118	118	122	135	144	145	140

The colour and transparency of the water in the river Skawa vary considerably in the course of the year and depend on the level and the amount of suspensions brought in from the upper course of the river by numerous streamlets flowing into it and by drains. The water is usually transparent and only acquires a yellowish-brown colour at higher water levels.

The water of the Skawa is pure, as a rule (Raczyński 1962, Musiał 1963). A certain pollution visible in the region of Wadowice and near the mouth of the Wieprzówka is caused by industrial waste waters from Wadowice and Andrychów. The pollution, however, is rapidly cleared (in the space of about 500 m of the river's course) and does not play any important role in the life of the river.

Method

The investigation was carried out at the following sampling places (fig. 1):

A. Places at which samples were collected for detailed laboratory investigation:

1. The stream forming the river Skawa in the village of Spytkowice Podhalańskie, about 1 km above the road leading to Jordanów through Wysoka — the spring sector; altitude about 540 m.

2. The Skawa in the locality of Skawa Górna, about 3.5 km above the railway halt of Skawa; alt. approx. 470 m.

3. The Skawa in the locality of Skawa Dolna, about 500 m before the mouth of the stream Stachurówka; alt. approx. 460 m.

4. The Skawa near the locality of Jordanów, above the mouth of the stream Toporzysko; alt. approx. 430 m.

5. The Skawa above the locality of Osielec, about 2 km before the mouth of the Bystra; alt. approx. 416 m.

6. The Skawa in the locality of Biała, above the mouth of the Skawica; alt. approx. 380 m.

7. The Skawa near the locality of Sucha, above the mouth of the Stryszawka; alt. approx. 330 m.

8. The Skawa near the locality of Skawa; alt. approx. 296 m.

9. The Skawa in Wadowice; alt. approx. 260 m.

10. The Skawa in Zator — the sector near its mouth; alt. approx. 226 m.

B. Additional sampling places in which the presence of *Cladophora glomerata* was observed (affluents of the river Skawa):

1. The stream Stachurówka, about 3 km before its issue into the Skawa.

2. The river Bystra in the locality of Sidzina and the place where it falls into the Skawa.

3. The stream Osielec in the locality of Osielec.

4. The river Skawica, about 4 km before its issue into the Skawa, in the localities of Skawica, Zawoja Górna, Zawojna Dolna, and the tributary Jaworzyna in its source sector.

5. The stream Grzechynia in the locality of Grzechynia.

6. The river Stryszawka in its mouth sector, in the vicinity of Sucha, in the localities of Stryszawa and Lachowice and in its small tributaries, the streams Zasypnica and Błądzonka.

7. The river Paleczka near Budzów and Zembrzyce.

8. The river Wieprzówka, about 6 km from its issue into the Skawa.

Material was collected in the autumn period from September 1st to 27th, 1963. The autumn period was chosen for the following reasons (C h u d y b a 1965):

a. The development of the *C. glomerata* in the system of the river Skawa is characterised by two maxima, spring and autumn, the latter maximum being the highest in the year.

b. Species of other systematic groups which constantly accompany the *C. glomerata* also attain during this period their highest maxima as to quality and quantity.

Thus for investigation of the community of *C. glomerata* in the river Skawa in its most typical form the material collected in autumn is the most valuable.

Samples for detailed laboratory investigation were collected only in the river Skawa. Data concerning the appearance of this species in some of the affluents of the Skawa were also added to the results concerning its distribution.

Within the three previously distinguished sectors of the river Skawa, a total of 10 sampling places was taken into account. Particular sampling places represent the most characteristic places of the lotic zone in particular sectors of the river. These were the places where the most abundant and intensive development of the *C. glomerata* was observed (sociability 5, according to the Braun-Blanquet scale), permitting an accurate visual selection and choice of uniform flakes for carrying out phytosociological surveys.

As these were rather extensive (50—150 m^2), 10 samples were chosen in each of them from 8—12 stones, as typical as possible and also larger (with a diameter of 10—30 cm), collected on the cross-section and longitudinal section of the river. Only occasionally were samples collected from fine gravel and other objects in the water.

Thalli of *C. glomerata* were cut off at the base with a scalpel on an area of about 1 cm^2 from the sheltered side of each stone and placed in a seperate tube.

Sometimes algae were scraped and collected from places where the *C. glomerata* had been previously cut. In some cases additional material was collected beyond the investigated lotic part of the river.

All samples were preserved on the spot in a fluid consisting of 1 part 40 per cent formalin and 3 parts 96 per cent ethyl alcohol.

It was decided, on principle, to obtain a collection of thalli from a total surface of 1 dm^2 from each.

A total of 137 samples were collected and examined. 100 samples (10 samples from each sampling place), representing uniform flakes of *C. glomerata* communities, formed a basis for later comparison of particular stations of the investigated terrain, while 37 samples were used for orientative investigation only.

The preserved material from every test tube was first studied without submitting its content to the process of maceration.

Typical *Cladophora* thalli were chosen, their length measured and the type of branching determined as well as the manner in which, algae were often distributed upon them. The degree of saturation of cellular membranes with calcium carbonate was determined at a guess, the thalli being treated with a 1/10 n solution of HCl and depending on the degree of effervescence, the following scale of degrees was applied: insignificant, moderate, great.

The species composition of the algae possible to determine was established on the basis of the 10 preparations in potassium acetate (1 : 50) usually examined.

For an accurate determination of diatoms half the collected material from one test tube was taken and macerated with a mixture of saturated solution of $K_2Cr_2O_7$ and concentrated sulphuric acid (H_2SO_4) in the proportion 1 : 3. After the washing out of impurities and the setting of

armatures of the diatoms, 3 durable preparations were made from the sediment diluted with 95 per cent alcohol in the proportion 1 : 4 confined in a pleurax.

Each preparation was accurately investigated, each band in turn, until more new forms were found.

When describing associations of algae, the method introduced by Starmach (Starmach 1961, 1962 a, b, 1964, Kawecka 1964, Chudybowa 1964, Wasylik 1965) was used. The description of associations in this case is based on the differentiation of dominating species and the determination of their role in the spatial system of the community. Details concerning the method were given in the preceding paper (Chudyba 1965).

Distribution of *Cladophora glomerata*

During the period of investigation, *C. glomerata* was found along the whole length of the river Skawa, from its sources to its mouth. They appeared in different intensity in particular sectors of the river. The montane sector (sampling places 5—8) was relatively the most overgrown; towards the sources and mouth of the river this abundance diminished.

C. glomerata appeared also in all, or nearly all affluents, not excepting the source sectors of mountain streams (e.g. the Jaworzyna stream at alt. 940 m) and other smaller seasonal tributaries. It is a settled benthonic alga and only accidentally broken off parts of its thalli could be found in the investigated terrain in the form of freely floating tufts or separate filaments. The thallus is attached to the substratum by means of branched rhizoids which grow out of the basal cell or out of several cells of the base. It forms turf-like coatings adhering tightly to the substratum, in the form of numerous filaments twisted like rope, disposed smoothly with the current. It grows on stones of different sizes and also on shells, on paling submerged in the water, on pieces of iron and a submersed tree branches.

Greater agglomerations of luxuriant and well developed thalli visible to the naked eye were only seen in those parts of the river with stronger current.

During the course of investigation the water of these parts was in general shallow (Table IV) and larger stones often projected above the water. Among thalli collected from such projecting stones (sampling places 3, 6, 5) stems of the mosses: *Brachythecium rivulare* (Bruch.) Br. eur., and *Hygroamblystegium luridum* (Hedw.) Jennings were found attached to the substratum.

In lotic places the thalli attained a maximum length (up to 120 cm, sampling place 7) and abundance of branches. The maximum length of the thalli found in the river Skawa should not be considered as exceptional;

Table VII. External appearance of Cladophora glomerata thalli. Its numerosity and sociability in particular localities of the river Skawa

Locality No	1	2	3	4	5	6	7	8	9	10
Date	Sept.20 1963	Sept.20 1963	Sept.19 1963	Sept.19 1963	Sept.19 1963	Sept.18 1963	Sept.18 1963	Sept.24 1963	Sept.25 1963	Sept.26 1963
Average length of thalli in cm	0.5-2	1-3	2-5	5-10	30-50	35-70	80-120	50-100	10-20	15-25
Colour of thalli	greyish--green, brown at the base	upper part green, remaining part brown	upper part green remaining part brownish-- black	green, in the basal parts yellow	green, brown at the base	green, yellow at the base	bright-green, brown at the base	bright-green, yellow at the base	green, brownish--black at the base	green, brown at the base
Abundance of ramification	small	small	moderate	moderate	numerous	numerous	numerous	numerous	moderate	moderate
Numerosity after the Braun-Blanquette scale	5	5	5	5	5	5	5	5	5	5
Distribution of epiphytes	entire thalli covered with epiphytes	in the basal and central parts of the thalli	in the basal and central parts of the thalli	in the basal and central parts of the thalli	in the basal and central parts of the thalli	in the basal parts of the thalli	in the basal and central parts of the thalli	in the basal parts of the thalli	in the basal and central parts of the thalli	in the basal and central parts of the thalli
Sociability after the Braun-Blanquette scale	the species forms greater or smaller tufts 3		the species forms moderately large concentrations 4			the species forms large concentrations - "masses" 5			the species forms moderately large concentrations 4	

the thalli of this alga can attain, according to Kann (1940) and Thomas (1960), a length of several metres.

The length of the thalli in lotic parts of the river Skawa was enormously differentiated; it reached its maxima (50—120 cm) in the central, montane sector of the river (sampling places 5—8). Towards the sources and the mouth the length of the thalli diminished to 0.5—15 cm (sampling places 1, 2, 3, 9, 10) (Table VII and fig. 6).

Some parts of the bottom in slowly flowing water had no thalli or were sparsely overgrown with small ones (0.5—2 cm, occasionally 4 cm long).

In contradistinction to the thalli from lotic places, which were only covered with epiphytes at their base, the thalli from lenitic places were almost entirely covered with epiphytes and with a greyish-brown inorganic deposit.

In intensity of appearance, *C. glomerata* shows a tendency to settle in more illuminated parts of the bottom of the river Skawa. This probably explains why its most numerous and abundant development was noted at an inconsiderable depth, from 20—40 cm. *C. glomerata* was not found in places with a depth of 2 m or more in the river Skawa. Its absence perhaps being caused by the small intensity of light at that depth (Den Hartog 1958).

C. glomerata develops most numerously and abundantly in places with a current in which the water is better aerated and new stores of nutritious salts are continuously brought by the current. The most abundant development of the thalli was observed in the faster flowing parts of the river, when the pH of the water was 8.8 (sampling place 7). At lower pH of the water in the Skawa (e.g. at sampling places 1, 2, 3, 10), the length of the thalli and intensity of the appearance of this algae were considerably reduced (Tables IV and VII).

Van den Hoek (1963) maintains that this plant develops more slowly and irregularly when the pH is lower than 7.5, and Hornung (1959) states that it does not tolerate a pH lower than 7.1. In some of the Skone lakes (southern Sweden) where the water has a lower pH, *C. glomerata* does not appear (Lundh 1951). Also Brand (Heering 1921) states that it cannot be found in swamps and peat-bogs. The vegetative reproduction of *C. glomerata* ceases and sporulation sets in when the pH is lower than 7.2—7.4 (Zernov 1949).

Zernov and Uspenski (1927) consider that an immediate cause of a better development of *C. glomerata* in alkaline waters is the noxious accumulation of ferric ions in acid waters.

C. glomerata also develops in some polluted sectors of the river Skawa (e.g. in the neighbourhood of Wadowice); it does not grow, however, in strongly polluted places, such as small areas of the river in the immediate vicinity of the outlets of channels conveying waste waters. These

observations are confirmed by data given by Meschkat (1937), Kann (1940, 1959), and Thomas (1960) who observed the sensitivity of this alga to a high degree of pollution. Kolkwitz (1950) and Liebmann (1951) consider *C. glomerata* to be an oligosaprobic plant, and Zernov regards it as a β-mesosaprobic one.

C. glomerata demonstrates a considerable tolerance with regard to water temperature, which fluctuated in the river Skawa 11—21°C during the period of investigation. The maximum temperature it can endure without harm is, according to Thurman (1952), 24°C. At higher temperatures its development is inhibited and the thalli are necrosed. Lower water temperatures (+2°C, Chudyba 1965) did not provoke any disturbances in the development of its thalli in the river Skawa. Zcharova (1923) states that the alga, when taken out of the water can endure „frost during one night".

In summing up the results of investigation and observation of the distribution of this species in the autumn period in the river Skawa, the following must be stated:

1. It appears along the whole length of the river Skawa, from its sources to its mouth and in all its tributaries, within an altitude range of 218—940 m.

2. A lack of selection is observed in relation to the substratum, but it avoids every living substratum, such as the shoots of aquatic plants, eac.

3. A complex of factors influence the maximum development of the thalli in the river Skawa, of which the most important are: a) a permanent substratum (stones, etc.); b) well illuminated places in the river, with a current velocity of 60—80 cm/sec., a depth of 60—80 cm and pure, well oxygenated water; c) a water temperature of 15—20°C, pH 8.8, alkalinity of 1.8—2.2, and hardness of 6.2.

4. The most favourable conditions for a luxuriant and copious development of the thalli are provided by the central, montane sector of the river Skawa.

Variability of the thalli

Two groups clearly differing from each other can be distinguished in the collected thalli of *C. glomerata*: the thalli from places with a current (*Cladophora glomerata rheobenthicum*) and those from the places with no current (*Cladophora glomerata limnobenthicum*).

In places with a current the thalli had a typical tuft-like form. They were usually strongly branched and terminated in the upper parts with very numerous, oblong, brush-like systems of offshoots.

The morphology of the thalli is very varied, sometimes even difficult to determine. Mostly they had the form of branched clusters with

a strongly developed main axis and many lateral branches — or many forms of cymose branchings. The thallus was frequently composed of several main axes, branched pseudo-dychotomically. The branchings were fairly frequently disposed on one side of the axis.

The thalli were sometimes slightly or fairly well saturated with calcium carbonate, but only in the basal parts. The length of the thalli was usually 20—100 cm.

In the montane sector of the Skawa (sampling places 5—8) *C. glomerata* fo. *longissima* Rabenh. (*C. longissima* Kütz), with strongly elongated thalli (80—120 cm long) and numerous lateral branches terminated in a brush-like manner, prevailed.

Fo. *genuina* (Kirch.) Brand and fo. *callicoma* Rabenh. (*C. callicoma* Kütz., *C. Thurettii* Bréb.) with short thalli (10—30 cm long) and branches of a more fimbriated character, of cymose type were also fairly frequently found.

In the submontane (sampling places 1—4) and the lowland (9, 10) courses of the river Skawa, the dominating type of thalli were fo. *genuina*, fo. *callicoma*, fo. *fasciculata* and fo. *rivularis*.

Besides the forms of thalli already mentioned, which always appeared in superior numbers, thalli connected with some phases of development, above all those of a form belonging to *status juvenilis, status frondescens, status ramosus*, and *status stagnalis* (Heering 1921), were found among them in greater or smaller numbers.

Thalli from lenitic places were short (from 0.5 to 4 cm) and grew only rarely on stones. They had very few or no branches. The membranes of cells were greatly thickened (up to 25 μ), distinctly stratified, and strongly saturated with calcium carbonate. Sometimes the incrustation with calcium was so great that the thalli became brittle.

The shape of the thalli resembled the typical forms of development: *status hiemalis, status incrustans, status detersus, status refrondescens*, and sometimes even *status stagnalis*.

The colour of the thalli was yellow or brown, caused by abundantly developing diatoms or by deposited slimy parts.

Accompanying algae

Before beginning a description of habitats, numerous comparative investigations, covering samples collected at the same sampling places and those collected at different ones, with or without current, were carried out.

The thalli of *C. glomerata* were usually accompanied in great numbers by many species of algae belonging to different systematic groups (Table VIII).

Table VIII. Floristic spectrum

Locality	Date	Schizomycetes			Cyanophyta			Bacillariophyceae			Chlorophyta			Charophyta			Rhodophyta			Fungi			Total		
		number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p	number of taxons	number of genera	p
1	Sept.20	1	1	1	31	14	1171	84	25	8153	32	19	981	-	-	-	1	1	122	1	1	32	150	61	10460
2	Sept.20	1	1	10	32	14	1429	135	28	9040	42	18	2670	1	1	50	-	-	-	1	1	31	212	63	13230
3	Sept.19	1	1	12	27	13	1884	138	27	10978	41	19	4129	-	-	-	1	1	31	1	1	31	209	62	17065
4	Sept.19	1	1	30	24	14	714	149	26	16451	38	19	1741	-	-	-	1	1	31	-	-	-	213	61	18967
5	Sept.19	1	1	10	30	15	1603	159	27	17858	47	24	1444	-	-	-	-	-	-	1	1	90	238	68	21005
6	Sept.18	1	1	2	32	15	1264	211	30	22184	39	19	3699	1	1	100	1	1	2	1	1	2	286	68	27253
7	Sept.18	1	1	30	37	13	1824	200	29	23584	48	25	1989	-	-	-	1	1	2	-	-	-	287	69	27429
8	Sept.24	1	1	40	27	11	1226	184	29	14222	37	23	980	1	1	100	-	-	-	-	-	-	250	65	16568
9	Sept.25	1	1	60	26	10	2399	155	28	12423	30	20	2095	1	1	50	-	-	-	-	-	-	213	60	17027
10	Sept.26	1	1	51	32	13	2201	139	28	8109	27	16	2624	-	-	-	-	-	-	1	1	2	200	59	12987
Total from all localities		1	1	246	43	16	15715	249	34	143002	62	29	22352	1	1	300	2	2	188	1	1	188	359	84	181991
Percentage of systematic units		0.3			12.0			69.0			17.5			0.3			0.6			0.3			100		

On thalli living in the lotic parts of the river the same species of accompanying algae were found as in lenitic places, though in individual samples from places with a slow current floristic list were usually less plentiful. In thalli living in a strong current, particular species were usually represented by a larger number of specimens. However, these differences do not form a basis for distinguishing separate communities of algae accompanying *C. glomerata* in dependence on the rapidity of the current. Hence samples from lenitic places, usually containing a smaller amount of algae and a greater admixture of slime and sand, were not taken into consideration for a further characterisation of the community.

Samples originating from lotic places with a current of varying rapidity (Table IV) demonstrate a considerable similarity both in their composition and in the number of algae. It would result therefore that in the distinguished habitats of the river Skawa the rapidity of the current (up to 90 cm/sec.) did not play any significant role in the formation of the community of accompanying algae.

No significant difference was perceived in the qualitative and numerical composition of the algae accompanying *C. glomerata,* which originated from stones differing in size or mineralogical composition.

In samples collected at different depths (Table IV) no significant divergences were observed in the qualitative composition and number of accompanying algae. This is true also of samples from different parts of the same sampling place on a transversal and longitudinal section of the river.

A comparison of the material scraped off from places where the thalli of *Cladophora* had previously been cut off with *Cladophora* thalli cut off from the places showed much less diversity and a smaller number of species in the scraped off material. Species of algae which did not exist among the thalli that had been cut off were not found in the material.

For the reasons mentioned above, samples of material from places where the thalli of *C. glomerata* had been collected were omitted from further elaboration.

Slight changes in the temperature and chemism of the water (Table IV) at particular sampling places of the river Skawa had no influence on the composition of species nor on their abundance. In this connection the character of the totality of ecological factors in the river Skawa or in its particular sectors during the period of investigation may be considered as uniform.

A very significant dependence of the accompanying algae on the length and abundance of the thalli was observed. The longer and better branched the thalli, the greater was the diversity of species and the greater the number of specimens (Table VII, fig. 6). The number of dominants and subdominants also increased as the thalli of the *Cladophora* became longer and more plentifully branched.

It can therefore be assumed, on the grounds of the data presented here that in the description of a community, it would be most appropriate to take as basis material collected in places with a current. The application of a uniform method in characterising particular associations allows then to be compared without committing any great error.

The term accompanying algae has been given in this work to all plant organisms which grow on *C. glomerata* (as e.g. the epiphytic algae of the genus *Chamaesiphon, Meridion, Diatoma, Cocconeis, Navicula, Amphora, Eunotia, Cymbella, Gomphonema, Rhoicosphenia, Epithemia, Synedra*) or to those that develop in the compact net of its tangled filaments. As stated by Thurman (1952), the number of individuals on 1 cm of the length of the thalli of *C. glomerata* varied between 750 and 73 200, on the average 19 013 individuals.

In 100 samples with *C. glomerata* from the Skawa, a total of 358 systematic units of algae were determined representing 84 genera, 4 species of mosses, 1 species of fungus and 2 species of higher plants (fragments of shoots of *Myriophyllum spicatum* L., and *Potamogeton crispus* L.) entangled in the filaments of the algae. The numerical and percentage participation of particular systematic groups from the distinguished sampling places is presented in Table VIII.

At each separate sampling place as at all the sampling places together, diatoms appear in the greatest number, followed by green algae, blue-green algae and then by a few representatives of other groups.

The greatest total coefficient of coverage, 143 002, is attained by diatoms, while green algae reach 22 352 only, and blue-green algae 15 715; other groups of plants have a relatively low coefficient of coverage.

The percentage participation of particular systematic groups of algae accompanying the *C. glomerata* in the river Skawa is as follows, compared with the complex of *C. glomerata* described by Sauer (1937):

	Sauer	Chudyba
Bacillariophyceae	66%	69%
Chlorophyta	16%	17%
Cyanophyta	9%	12%
Phaeophyta	3%	—
Rhodophyta	—	0.6%

The total number of species of algae accompanying the *C. glomerata* at particular sampling places is presented in fig. 4. The percentage participation of species from particular systematic groups as well as their coefficients is illustrated in fig. 5.

The total amount of all taxons of algae from particular systematic groups and their total coefficients of coverage at separate sampling places increase gradually at the length and abundance of *Cladophora* thalli

become greater. The interpendence of these values is expressed graphically in fig. 6 and Tables VIII and XII .

Sampling places 6, 7, and 8 in the montane sector of the Skawa (fig. 4) were found to possess the greatest number of species and of their specimens, represented in the total degree of coverage. Towards the sources and the mouth of the Skawa, the number of species of accom-

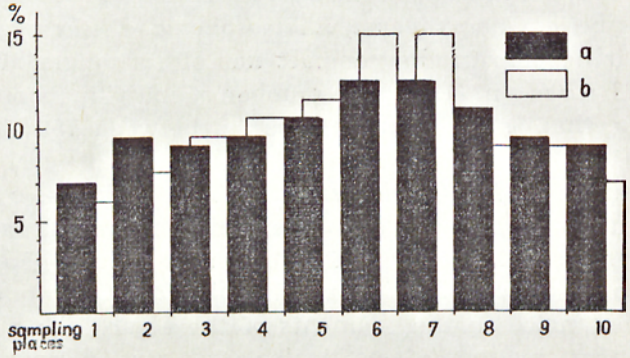


Fig. 4. Total amount of algae accompanying *C. glomerata* at particular sampling places of the river Skawa. a — total number of species; b — total coefficient of coverage for the total number of species

panying algae and the value of their total coefficients of coverage decreased; the length of *Cladophora* thalli and the abundance of their branches also diminished.

Species of the *Pennatae* class prevailed among the diatoms. Only 5 species belonged to the *Centricae* class (Table XII). The genera

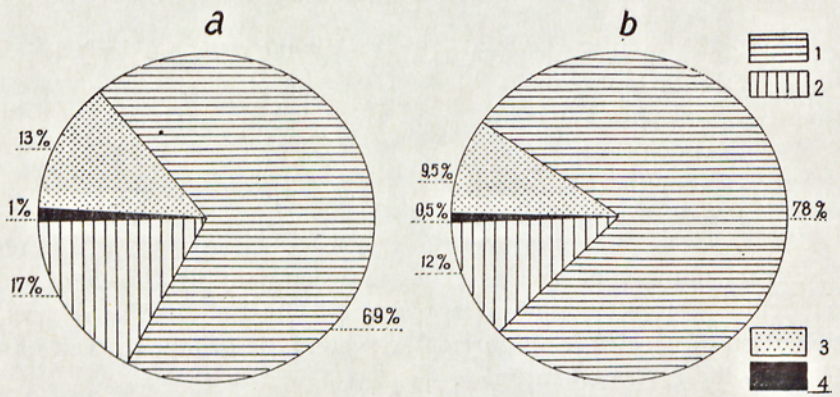


Fig. 5. Percentage participation of accompanying species from particular systematic groups. a — total number of species; b — total coefficient of coverage; 1 — *Bacillariophyceae*; 2 — *Chlorophyta*; 3 — *Cyanophyta*; 4 — remaining species

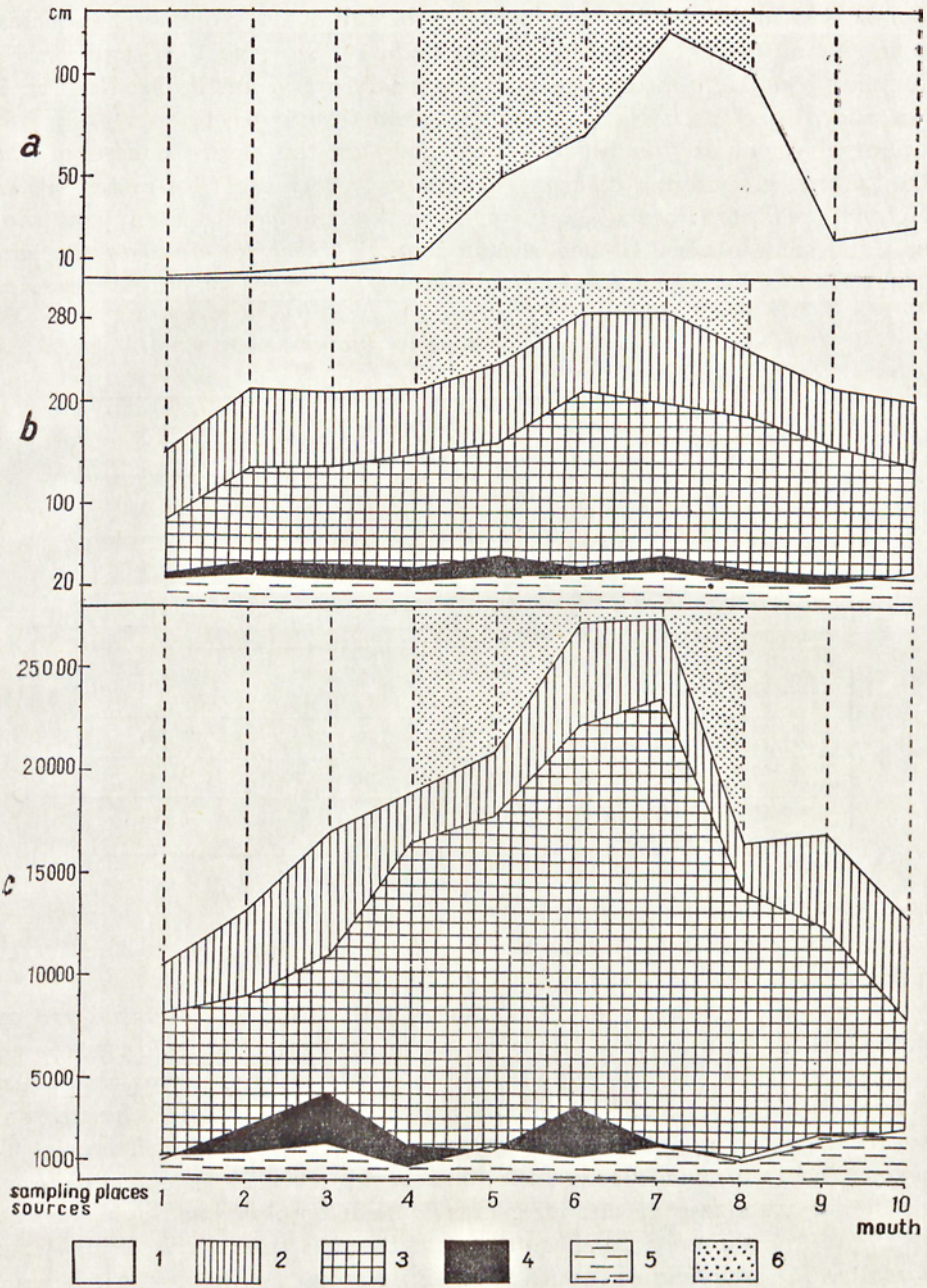


Fig. 6. Participation of algal species accompanying *C. glomerata*. a — average length of *Cladophora thalli*; b — number of species of accompanying algae; c — total coefficients of coverage; 1 — length of *Cladophora* thalli; 2 — total; 3 — *Bacillariophyceae*; 4 — *Chlorophyta*; 5 — *Cyanophyta*; 6 — sampling places at which the longest *Cladophora* thalli, the greatest number of accompanying algae and their highest total coefficient of coverage were observed

represented in the greatest numbers are the following: *Navicula* 33 species, varieties and forms, *Nitzschia* 30, *Cymbella* 18, *Synedra* 18, *Fragilaria* 16, *Gomphonema* 15, etc; of blue-green algae *Phormidium* 6, *Oscillatoria* 4, etc., and of green algae *Closterium* 9, *Scenedesmus* 6, etc.

Some accompanying algae appear only in the upper course of the Skawa, as e. g. *Chamaesiphon incrustans* var. *elongatus, Closterium venus, Diploneis oculata, Navicula mutica, Nitzschia hungarica, Pinnularia molaris* and some others. However, *Homoeothrix fusca* fo. *elongata, Actinastrum Hantzschii, Cosmarium quadrum* var. *minus, Cymatopleura solea*

Table IX. Biological spectrum of algae accompanying Cladophora glomerata in the river Skawa

Shape of thallus	Amount of taxons in particular biological groups	Total coefficient of coverage (P) in particular biological groups
Filamentous and bushy algae attached together with Cladophora glomerata to the substratum	11	5 850
Flat and crustaceous algae attached with Cladophora glomerata to the substratum	6	804
Filamentous and bushy algae unattached to the substratum, distributed loosely among Cladophora glomerata thalli	29	12 719
Algae with single cells joined in bands, zigzags, small fans etc., loosely distributed among Cladophora glomerata thalli	45	37 259
Epiphytes attached to Cladophora glomerata thalli by means of stylets	22	17 503
Epiphytes attached directly (sitting ones) to Cladophora glomerata thalli	64	53 398
Single cells and small colonies loosely maintaining themselves among the tangled thalli of Cladophora glomerata	182	54 458

var. *clavata, Cymbella tumida, Gomphonema gracile, Stephanodiscus Hantzschii, Tabellaria fenestrata* are found exclusively in the lower course of the river.

Among the diatoms found, 32 species and varieties are considered as characteristic for montane waters: *Caloneis alpestris, C. silicula* var. *alpina Diatoma anceps, D. hiemale, Neidium affine* var. *amphirhynchus, Achnanthes linearis, A. lanceolata* and var. *elliptica, A. minutissima, Eucocconeis flexella, Ceratoneis arcus, Cymbella aequalis, C. laevis, C. perpusilla, Denticula elegans, Eunotia arcus, Fragilaria capucina* var. *mesolepta, F. virescens* and var. *mesolepta, Gomphonema longiceps, G. gracile, Navicula mutica, N. rotaeana, Nitzschia sublinearis, Pinnularia borealis, P. microstauron* with var. *Brebissonii, P. molaris* and var. *lapponica, P. subsolaris, P. viridis* var. *sudetica,* and *Tabellaria flocculosa.*

The remaining 326 forms of diatoms are widespread in flowing and stagnant waters of various types and can be found in all kinds of localities.

A considerable part of the algae found were typical epiphytes, the remainder being free-living plankton and benthos algae. 86 forms of

epiphytic algae were determined. They demonstrated the greatest degree of stability and the greatest numbers at particular sampling places and in general (Table IX).

Description of the community

The species composition of accompanying algae was not quite identical in different localities, but it was always approximate. A specially great resemblance cann be seen between sampling places in the middle sector of the river (sampling places 4 to 8). The limits between particular

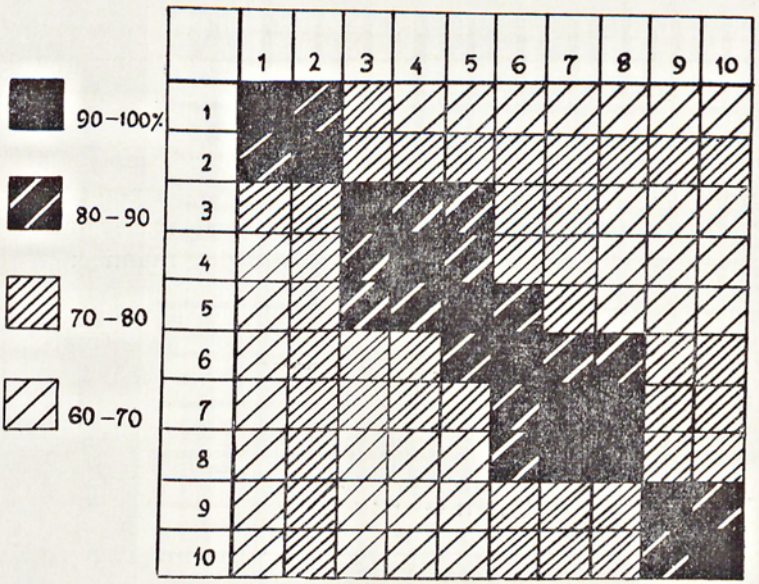


Fig. 7. Table of coefficients of similitude for 10 sampling places at which communities of C. *glomerata* were found in the river Skawa, aranged according to the method of J. Czekanowski (Kulczyński 1928, 1940)

sampling places were never sharply defined. Even at sampling places of the source parts (sampling places 1, 2) and those of the mouth of the river (9, 10) a certain constant combination of species characteristic for all the localities was maintained.

As can be seen from the fig. 7 presenting the distribution of coefficients of resemblance for 10 investigated sampling places all samples from the river Skawa have high coefficients of resemblance, attaining 60—100 per cent, and belong therefore to a single group. This group is not entirely homogeneous (fig. 7).

The sampling places of the source parts (1, 2) and from the sector of the mouth of the river Skawa (9, 10), when compared with those of the central part of the river's course (4, 8), have a lower coefficient of resemblance. Lower coefficients of resemblance can also be found between sampling places distant from each other (as e. g. sampling places 2 and 10, 5 and 9, etc.). Sampling places situated close to each other are very similar (sampling places 3, 4, 5; 5, 6, 7, 8; etc.).

It was concluded therefore, in connection with the data obtained and the great similitude of ecological factors existing in the selected localities of the river Skawa, that the groups of algae accompanying *C. glomerata* at all the sampling places of the river form one type of community and a single phytocenose with a similar floristic composition and a similar structure.

The community is composed of many species, of which one, the *C. glomerata,* dominates, forming the principal structural trunk of the whole community, around which the remaining species accompanying its thalli are „entwined".

A considerable number of accompanying algae appear at all the sampling places of the river Skawa, or at least at 80 per cent of them, demonstrating only smaller or greater numerical variations. Of these species 130 were found, distributed in the following manner:

	% of sampling places		
	80—90	100	Total
Schizomycetes	—	1	1
Cyanophyta	9	9	18
Bacillariophyceae	43	43	86
Chlorophyta	15	10	25
Total:	63	67	130

Species present at at least 80 per cent of the investigated sampling places should be further divided into two groups:

1. Especially characteristic species or dominants, with classes of constancy V and IV (Table X).

2. Accompanying species (subdominants) having the IIIrd and IInd class of constancy, and accidental or accessory species (adominants) with the I class of constancy.

Of the dominating species in particular localities only a small number are common to all sampling places and these seam to be characteristic for the community. The remaining dominants from some of the sampling places should rather form a basis for determining the facies or subfacies.

Species dominating at all sampling places, or at least at 80 per cent of them, are listed in Table XI, according to the decreasing mean total of the coefficients of coverage (P). Only the five first species, *Diatoma vulgare* var. *productum, Cocconeis placentula* var. *euglypta, Chamaesi-*

phon incrustans, Diatoma elongatum var. *tenue,* and *Gomphonema olivaceum,* should be considered as specially distinguishing the *C. glomerata* complex. These are species having a total coefficient of coverage above 2700.

Table X. Degree of constancy of dominating species in particular localities of the river Skawa

No	Locality	1	2	3	4	5	6	7	8	9	10	Total P
1	Calothrix kossinskajae	–	–	–	–	IV	–	–	–	IV	–	632
2	Chamaesiphon incrustans	V	V	V	V	V	V	V	V	V	V	3902
3	Homeothrix varians	–	–	–	–	–	IV	IV	–	IV	–	692
4	Phormidium subfuscum	IV	IV	–	–	–	IV	IV	IV	–	–	1031
5	Achnanthes affinis	–	–	–	–	IV	–	–	–	–	–	405
6	– lanceolata	–	IV	–	IV	IV	IV	IV	–	–	–	621
7	– – var. rostrata	–	–	–	IV	V	–	IV	–	–	–	709
8	– minutissima	IV	V	IV	V	V	IV	IV	IV	–	–	1330
9	Cocconeis pediculus	–	IV	IV	V	IV	V	IV	–	–	–	1321
10	– placentula	V	V	V	V	V	IV	V	IV	V	–	2579
11	– – var. euglypta	V	V	V	V	V	V	V	V	V	V	4240
12	Cyclotella meneghiniana	–	–	–	–	IV	–	IV	–	–	–	617
13	Cymatopleura solea	–	–	–	IV	–	IV	IV	–	–	–	2258
14	– – var. apiculata	–	–	IV	IV	–	–	IV	–	–	–	2202
15	Cymbella affinis	–	–	IV	–	–	–	IV	IV	V	V	1792
16	– helvetica var. balatonis	–	–	–	–	–	–	IV	–	–	–	2388
17	– var. curta	–	–	–	–	IV	IV	IV	IV	–	–	2262
18	– prostrata	V	–	–	–	IV	–	IV	–	–	–	2618
19	– sinuata	–	–	–	–	–	–	IV	–	–	–	302
20	– ventricosa	IV	V	V	V	V	V	V	V	–	–	2490
21	Denticula tenuis var.crassula	–	–	–	–	IV	–	–	–	–	–	322
22	Diatoma elongatum var. tenue	IV	IV	V	IV	IV	V	V	V	V	V	3003
23	– vulgare	–	–	–	–	IV	IV	–	–	–	–	1812
24	– – var. capitulatum	–	–	–	–	–	V	–	–	V	–	927
25	– – var. ehrenbergii	–	V	–	–	–	IV	V	IV	–	–	2828
26	– – var. lineare	–	–	–	–	–	IV	–	–	–	–	1481
27	– – var. ovale	–	–	–	–	–	IV	–	–	–	–	460
28	– – var. productum	IV	V	IV	V	V	V	V	V	V	V	7608
29	Eunotia arcus	–	–	–	–	–	–	IV	–	–	–	51
30	Fragilaria capucina	–	–	–	–	–	IV	V	IV	V	V	3150
31	– – var. mesolepta	–	–	–	–	–	–	IV	–	V	V	1993
32	– intermedia	–	–	–	–	–	–	IV	–	–	–	234
33	– – var. dubia	–	–	–	–	–	–	IV	–	–	–	550
34	– pinnata	–	–	–	–	–	–	IV	–	–	–	170
35	– virescens var. mesolepta	–	–	–	–	IV	–	IV	–	–	–	2406
36	Gomphonema acuminatum	–	–	–	–	–	–	IV	–	–	–	149
37	– angustatum	–	–	–	–	–	–	IV	IV	–	–	412
38	– gracile	–	–	–	–	–	–	IV	–	–	–	180
39	– intricatum var. pumilum	–	–	–	–	–	–	IV	IV	–	–	272
40	– longiceps	–	–	–	–	–	–	V	IV	–	–	881
41	– – var. subclavatum	–	–	–	–	–	–	IV	–	IV	–	1808
42	– olivaceum	V	V	V	V	V	V	V	V	V	V	2765
43	– – var. calcareum	–	–	–	V	V	IV	IV	–	IV	–	1058
44	– parvulum	–	–	–	–	–	–	IV	IV	IV	–	701
45	Melosira varians	V	–	–	IV	–	–	–	–	–	–	3249
46	Navicula anglica	–	V	–	IV	IV	–	IV	–	–	–	676
47	– bacillum	–	–	–	–	–	IV	IV	–	–	–	561
48	– cryptocephala	–	–	–	IV	IV	–	–	–	–	–	720
49	– cryptocephala var. exilis	–	–	–	–	–	–	IV	–	–	–	326
50	– gracilis	IV	–	IV	–	–	–	IV	–	–	–	2080
51	– pupula	–	–	–	–	–	–	IV	–	–	–	489
52	– tuscula	–	IV	–	–	IV	–	IV	–	–	–	747
53	– viridula	–	–	–	–	IV	IV	–	–	–	–	788
54	Nitzschia dissipata	–	–	IV	–	–	IV	V	–	IV	V	1283
55	– sigmoidea	IV	–	IV	–	–	–	–	–	–	–	4280
56	– sinuata var. tabellaria	–	–	–	–	V	V	V	–	–	–	1375
57	Rhoicosphenia curvata	V	–	–	–	–	–	–	–	–	–	662
58	Surirella ovata	–	–	IV	IV	IV	–	IV	–	–	–	584
59	Synedra acus	–	–	–	–	V	–	–	–	–	–	1940
60	– rumpens	–	–	–	–	–	–	IV	–	–	–	776
61	– – var. fragilarioides	–	–	–	–	–	–	IV	IV	IV	–	1425
62	– ulna	–	–	–	IV	V	IV	V	IV	V	IV	7090
63	– – var. amphirhynchus	–	–	–	–	IV	–	IV	IV	IV	–	1890
64	– vaucheriae	–	–	–	–	IV	IV	IV	–	IV	–	1071
65	Scenedesmus quadricauda	–	–	IV	–	–	–	IV	–	–	–	794
66	Ulothrix zonata	–	–	–	–	IV	IV	–	–	–	–	1361
	Total	14	14	16	19	31	28	52	20	20	10	

77 species constantly appearing at all sampling places of the river Skawa were found. They never attained the Vth and IVth degree of constancy and are reckoned among the groups of dominants and sub-

dominants. Of these, 1 species belong to the *Schizomycetes*, 14 to *Cyanophyta*, 39 to *Bacillariophyceae*, and 23 to the *Chlorophyta*.

None of the subdominants, although they accompany the *C. glomerata* thalli at all sampling places, play any imortant role in the community, owing to their low class of constancy.

229 species, present at less than 80 per cent of the sampling places in the river Skawa were found — 1 species of *Fungus*, 25 *Cyanophyta*, 163 *Bacillariophyceae*, 37 *Chlorophyta* and 2 *Rhodophyta* species.

Table XI. Coefficient of coverage of dominating species accompanying Cladophora glomerata thalli in the river Skawa

No	Species	P
1.	Diatoma vulgare var. productum	7 608
2.	Cocconeis placentula var. euglypta	4 240
3.	Chamaesiphon incrustans	3 902
4.	Diatoma elongatum var. tenue	3 003
5.	Gomphonema olivaceum	2 765
6.	Cocconeis placentula	2 579
7.	Cymbella ventricosa	2 490
8.	Achnanthes minutissima	1 330

No definite opinion can be formed as to the role of these species in the differentiation of the community nor as to the possibility of their development. They appear as single specimens or in slightly greater numbers as subdominants. Among them only *Diatoma vulgare* var. *Ehrenbergii* was a dominant in four localities and *Gomphonema angustatum*, *b. intricatum* var. *pumilum*, and *G. longiceps* were dominants in two sampling places.

Species of diatoms like the following: *Achnanthes affinis*, *Cymbella helvetica* var. *balatonis*, *C. sinuata*, *Eunotia arcus*, *Fragilaria intermedia* var.*dubia*, *F. pinnata*, *Gomphonema acuminatum*, *G. gracile* and *Synedra rumpens* were each dominants in only one sampling place. In this group of algae the presence of dead cells was frequently noted. This might signify that these species were probably transported by the current from other parts of the river Skawa or of its tributaries.

A group of 130 species constantly accompanying *C. glomerata* at all the sampling places of the river Skawa or at 80 per cent of them at least, was considered as being specially connected with the community. In this group only dominants with an extensive range of appearance, thus those which were constantly and numerously found at all sampling places (Table XI), were regarded as characteristic (leading) species.

Among the characteristic species thus distinguished many ubiquitous ones can be found, whose distribution is very extensive. However, as the majority of algae are ubiquitous or even cosmopolitan a description of the

community based on dominating species seems to be sufficient at present. Dominating species also have a basic importance in the transmission of energy from one trophic level to another (S t a r m a c h 1962 a).

The coefficients of coverage of some of the more important dominants at successive sampling places of the river Skawa are graphically re-

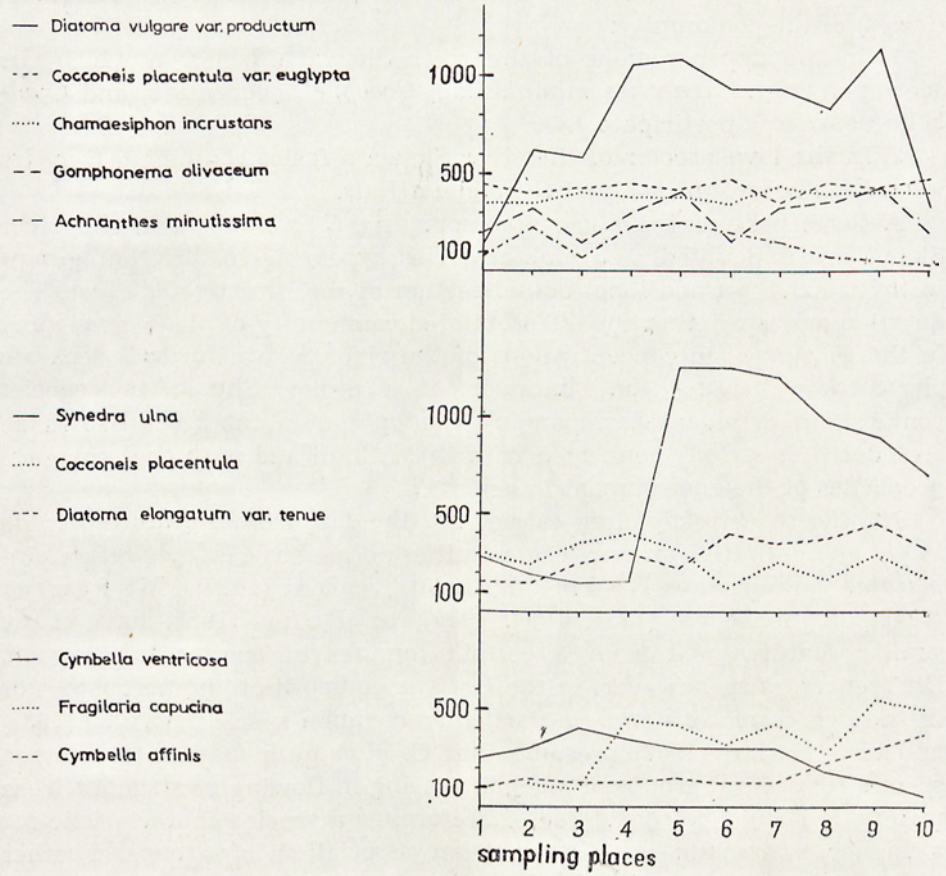


Fig. 8. Coefficients of coverage (P) of several more important dominants of the *C. glomerata* community at particular sampling places of the river Skawa

presented in fig. 8. They are typical epiphytes and, for this reason, the investigated *C. glomerata* community in the river Skawa has been differentiated under the name of *Cladophoretum glomeratae-epiphytosum rheobenthicum*. Leading species, appearing everywhere and in a large number of specimens, are the following: *Diatoma vulgare* var. *productum*, *Cocconeis placentula* var. *euglypta*, *Chamaesiphon incrustans*, *Diatoma elongatum* var. *tenue* and *Gomphonema olivaceum*. These species also accompanied the *C. glomerata* in the river Skawa as dominants during all seasons of the year (C h u d y b a 1965). The differentiated

community appears in its most typical form in the middle sector of the river Skawa at sampling places 5—8.

Communities at the sampling places 1—4 and 9 and 10, demonstrating a small but constant deviation in their quantitative composition and list of dominants when compared with the typical community present in the middle course of the river Skawa, were distinguished as separate variants (facies) of the community:

1. in the upper regions of the river Skawa a facies in which the accompanying *Achnanthes minutissima, Cocconeis placentula,* and *Cymbella ventricosa* participate.

2. In the lower sector of the river Skawa a facies containing *Synedra ulna, Fragilaria capucina,* and *Cymbella affinis.*

A large part of the algae accompanying *C. glomerata* in the river Skawa are undoubtedly eutrophic species appearing in different groups in the transversal and longitudinal section of the investigated river. The question arises whether the differentiated community of algae developing in the *C. glomerata* concentrations of the river Skawa forms a separate phytocenose bearing the character of a group. Should the species composition of algae accompanying *Cladophora* in the river Skawa be considered as strictly connected with these thalli and with the ecological properties of the environment in general?

Neither the investigations carried nor the data from literature provide as yet any definitive answer. Communities defined as *Cladophoretum glomeratae* groups by Nauman (1926), Sauer (1937), Margalef (1949), Symoens (1951, 1954, 1957), or Bohr (1962) have many similar features and even a certain number of species in common. Differences exist, however, in the floristic composition, numerousness or in the degree of constancy in particular common species. Sauer (1937) and also Bohr (1962) presume that *C. glomerata* may be a common species for several groups of algae appearing in flowing or stagnant fresh waters. It should be considered, therefore, as a species characteristic for a higher systematic unit, as e. g. an association of groups. Further investigation in different water environments would still be necessary.

Many fundamental difficulties arise, mostly of a methodological nature, in finding common criteria when comparing the results of the present work with those obtained by the authors mentioned above. Ecological data concerning species forming the investigated community are also not very well known.

Notes concerning some species

Asterothrix rhaphidioides (Reinsch spec.) Printz (*Tetracladium marchalianum* De Wild.) (fig. 10). An aquatic fungus of the group *Fungi imperfecti, Hyphales* order. Colour of thalli light-green. Walls of

cells often indistinct. Main axis 30—40 μ long, 2—5 μ broad. Length of processes 40—50 μ, breadth 2—4 μ. Conidiae 3—6 μ, broad, 5—16 μ in length. Single specimens, especially in the upper sector of the Skawa. Ingold, Ranzoni and Nilsson (Dudka 1962) consider this species as the most widespread of all species of aquatic fungi. Common in stagnant and flowing waters up to an altitude of 2000 m (Huber-Pestalozzi 1925, 1938). I infer, on the basis of the accessible literature, that this species is a new one for Poland.

Achnanthes lanceolata (Bréb.) Grun. var. *elliptica* C. (fig. 15). Length of valves 11—16μ, breadth 5—5.5 μ, 12—13 striae on the epitheca in 10 μ. Rather common, mostly in the upper course of the Skawa. Siemińska (1964) considers this variety as a typical north-alpine one, found in Poland in upper montane localities.

Caloneis silicula (Ehr.) Cl. var. *alpina* Cl. (fig. 26). Valves 20—27 μ long, 5—6 μbroad, 20 striae in 10 μ. Found very seldom, only in the middle course of the Skawa. A typically alpine variety. Recorded in Poland only in Biała Pszemsza and in the neighbourhood of Kraków (Siemińska 1964).

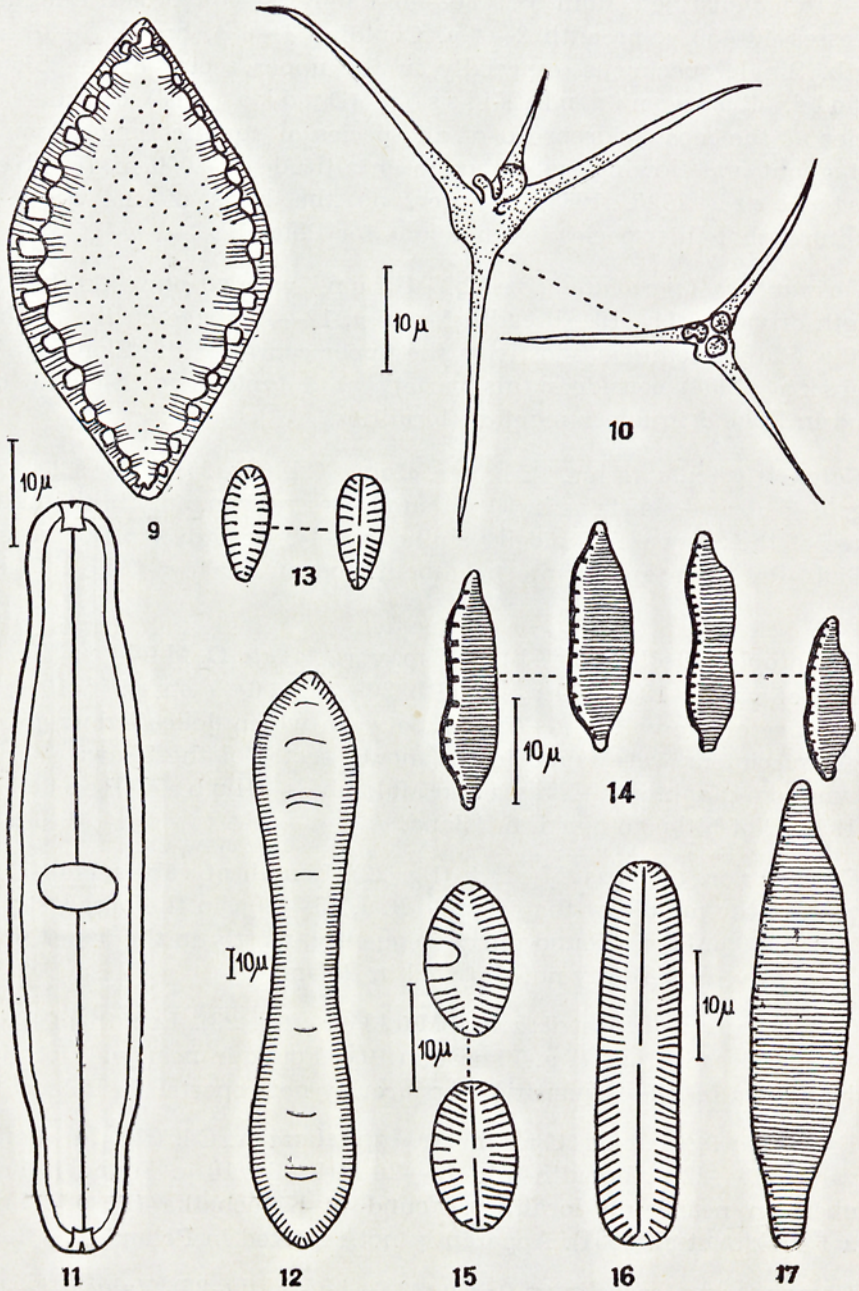
Cymatopleura solea (Bréb) W. Sm. var. *clavata* O. Müller (fig. 12). Length of valves 180—230 μ, breadth 20—35 μ, 6—7 striae in 10 μ. On the surface of the valves 5—7 folds, between which delicate dots appear. Single specimens were found in the mouth sector of the Skawa. Variety known from plankton of Nyassa and Malombase (Huber-Pestalozzi 1942). Not hitherto noted in Poland.

C. solea var. *vulgaris* Meist. (fig. 22). Length of valves 140—150 μ, breadth in the middle of the cell 18—20 μ, 25—30 μ in the broadest part, 7 striae in 10 μ. It was found fairly frequently, mostly in the upper sector of the Skawa. Apperently not reported in Poland.

C. solea var. *subconstricta* O. Müller (fig. 23). Length of valves 120—140 μ breadth 23—27 μ, 7 striae in 10 μ. Found in nearly all localities of the Skawa in small quantities. Apparently not reported in Poland.

Fragilaria intermedia Grun. var. *capitellata* A. Cl. (fig. 24). Length of valves 15—22 μ, breadth 5 μ, 18—20 striae in 10 μ. Found in small numbers in nearly all localities. Found in Kamchatka (Proškina-Lavrenko et al. 1951). Apparently not reported in Poland.

Gomphonema tergestinum (Grun.) Fricke (fig. 25). Valves 18—22 μ long, 5—6 μ broad, 12 striae in 10 μ; characteristic central area unilaterally developed, reaching the border of the valve with one dot situated in its centre. Found in small quantities at different sampling places. Specimens found had typical features in accordance with the diagnosis given by



Figs 9—17. 9 — *Surirella turgida*; 10 — *Asterothrix rhaphidioides*; 11 — *Neidium affine* var. *minus*; 12 — *Cymatopleura solea* var. *clavata*; 13 — *Rhoicosphenia Vanheurckii*; 14 — *Nitzschia pseudoamphioxys*; 15 — *Achnanthes lanceolata var. elliptica*; 16 — *Pinnularia molaris* var. *lapponica*; 17 — *Nitzschia angustata* var. *curta*

Hustedt (1930), Proškina-Lavrenko et al. (1951), Siemińska (1964), and also by Bílý and Hanuška (1952). A specimen very similar in appearance is described by Cleve-Euler (1953) as *Gomphonema intricatum* Kütz. var. *dichotomum* (Kütz.) Grun. fo. *semipura* (Vol. IV; 18, fig. 1283 t). The shape of the specimens found also resemble the very variable species *Gomphonema angustatum* (Kütz.) Rabh. (Cleve-Euler, Vol. IV; 179, fig. 1270). *G. tergestinum* is considered as a very rare species. It has been reported in Poland in the neighbourhood of Kraków and Podole (Siemińska 1964).

Navicula graciloides A. Mayer (fig. 27). Valves 35—40 μ long, 7—8 μ broad, 13 striae in 10 μ. Found very seldom as single specimens. Hustedt (1930) maintains that this species should be included in the range of variability of *Navicula cari* Ehr. Reported in Poland among other places in the vicinity of Gdańsk (Siemińska 1964).

Neidium affine (Ehr.) Cl. var. *minus* Cl. (fig. 11) Single specimens were found only at sampling places 2 and 6. The variety is rather seldom found; it has been reported from the lakes Baikal and Onega (Proškina-Lavrenko et al. 1951). Not hitherto reported in Poland.

Nitzschia angustata (W. Sm.) Grun. fo. *antiqua* (Schum.) A. Cl. (fig. 20). Length of valves 35—39 μ, breadth 5—6 μ, about 21 striae in 10 μ. 12 strongly defined dots in 10 μ. In the investigated material it appears fairly often at nearly all sampling places. Not hitherto reported in Poland.

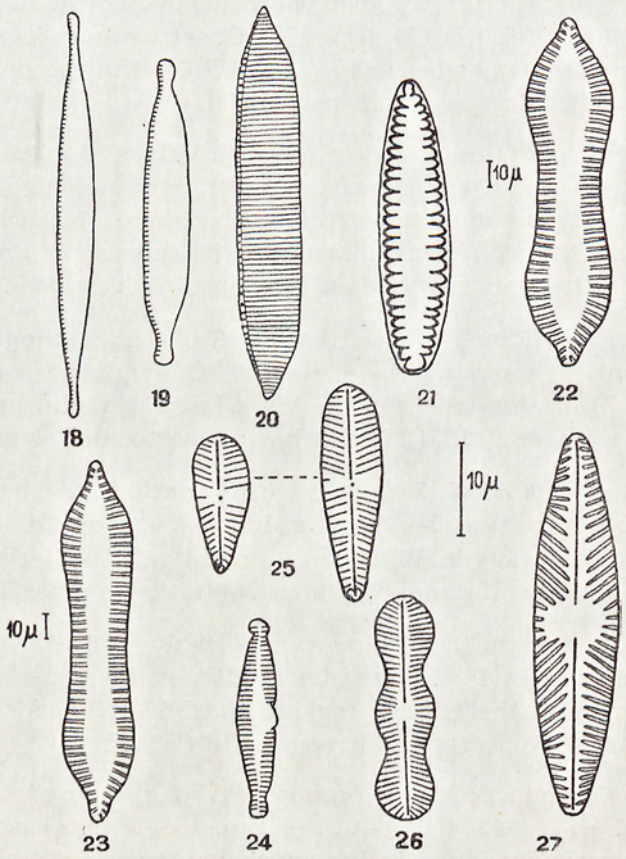
N. angustata var. *curta* Grun. (fig. 17). Valves 38—45 μ long. 5—6 μ broad, 14—16 striae in 10 μ. Found fairly often in the upper sector of the Skawa. Reported in the eastern regions of USSR (Proškina-Lavrenko et. 1951). Apparently not reported in Poland.

N. gracilis Hantzsch. var. *capitata* Wils. et Poretzky (fig. 18). Length of valves 39—42 μ, breadth 3—3.5 μ, 13—15 dots on the crista in 10 μ. Single specimens found in the upper and lower sectors of the river Skawa. Reported by Proškina-Lavrenko et al. from the river Usolka (Solikamsk). Apparently not reported in Poland.

N. palea (Kütz.) W. Sm. var. *capitata* Wils. et Poretzky (fig. 19). Valves 25—35 u long, 2—5 u broad, 14 dots on the crista in 10 μ. It differs from *N. palea* in its extremities which terminate cephalically. Found in small numbers different sampling places. Proškina-Lavrenko et al. (1951) has reported it in the plankton of the river Nevka. In Poland reported only in the Rogoźnik (Kawecka 1964).

N. pseudoamphioxys Hust. (fig. 14). Length of cases 20—23 μ, breadth 4—5 μ, 7—8 dots on the crista in 10 μ, about 24 delicate transversal striae in 10 μ. Found very seldom, mostly in the lower course of the Skawa.

This species has, according to Huber-Pestalozzi (1942), a tendency to form asymmetric forms, very similar to *Hantzschia amphioxys* (Ehr.) Grun. which, as Siemińska (1964) maintains, is a very variable species and forms numerous varieties appearing mostly in sources and streams.



Figs 18—27. 18 — *Nitzschia gracilis* var. *capitata*; 19 — *N. palea* var. *capitata*; 20 — *N. angustata* fo. *antiqua*; 21 — *Surirella angustata* var. *elongata*; 22 — *Cymatopleura solea* var. *vulgaris*; 23 — *C. solea* var. *subconstricta*; 24 — *Fragilaria intermedia* var. *capitellata*; 25 — *Gomphonema tergestinum*; 26 — *Caloneis silicula* var. *alpina*; 27 — *Navicula graciloides*

Pinnularia molaris Grun. var. *lapponica* Mölder (fig. 16). Length of valves 30—35 μ, breadth 6—8 μ, 9—10 striae in 10 μ. Very few specimens found in the upper sector of the Skawa. A rare variety, found in the waters of Finland (Proškina-Lavrenko et al. 1951). Not hitherto reported in Poland.

Rhoicosphenia Vanheurckii Grun. (fig. 13). Valves 8—9 μ long, 3—5 μ broad, 14 striae in 10 μ. Found as single specimens at various sampling

places in the Skawa. Acording to Hustedt (1932—1966), it is doubtful species, probably one of the irregularly developed *Gomphonema* species, difficult to determine owing to its great variability. The species has been reported from France, Belgium, and the USSR (Proškina-Lavrenko et al. 1951, Siemińska 1964).

Surirella angustata Kütz. var. *elongata* Skv. (fig. 21). Length of valves 25—29 μ, breadth 6 μ, 7 small costae in 10 μ, about 25 delicate striae in 10 μ. Found in small numbers, mostly in the upper sector of the Skawa. Apparently not reported in Poland.

S. turgida W. Sm. (fig. 9). Valves 40—45 μ long, 25—35 μ broad, 3 tubules of alae in 10 μ; the dimensions were slightly smaller than those given by Proškina-Lavrenko et al. (1951) and Siemińska (1964). Found rarely at different sampling places. Reported as widespread in western Europe and in USSR (Proškina-Lavrenko et al. 1951).

Results

Cladophora glomerata appeared in the whole course of the river Skawa, from its sources to its mouth and in all its affluents, at an altitude from 218 to 940 m. The maximum development of the thalli depended upon a complex of factors, of which the most important were: a constant substratum (as e. g. stones of medium size etc.), well illuminated parts with a courrent in the river, water temperature of 15—20°C, pH 8.8, alkalinity of water 1.8—2.2 mv, and hardness of water 6.2.

The most suitable conditions for a luxuriant and abundant development of the thalli were created by the central montane sector of the river Skawa (sampling places 5—8).

The thalli collected in the Skawa can be divided into two groups distinctly different from each other from the morphological point of view: thalli from parts with a current determined as *Cladophora glomerata rheobenthicum* and thalli from places with no current, determined as *Cladophora glomerata limnobenthicum.*

Among accompanying algae the following were determined: macroscopic algae growing on the substratum with *C. glomerata,* epiphytic algae attaching themselves directly or by means of stylets to the *C. glomerata* cells, and unattached algae existing loosely among the others. Altogether 358 species and lower systematic units of accompanying algae were determined. *C. glomerata* thalli were also found entangled with mosses and flowering aquatic plants (Table XII).

In concentrations of *Cladophora* thalli in shallower parts with a current the following mosses were found, sometimes appearing fairly abundantly: *Hygrohypnum luridum* (Hedw.) Jennings, *Hygroamblystegium flu-*

Table XIX. Species collected in 1963 together with Cladophora glomerata thalli in the river Skawa, with regard to their constancy and coefficient of coverage (P) (10 samples from each locality were investigated)

Locality	1		2		3		4		5		6		7		8		9		10		P
Date	Sept.20		Sept.20		Sept.19		Sept.19		Sept.19		Sept.18		Sept.18		Sept.24		Sept.25		Sept.26		Total
Name of species	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	
S C H I Z O M Y C E T E S																					
Sphaerotilus natans Kütz.	I	1	I	10	II	12	II	30	I	10	I	2	II	30	II	40	II	60	II	51	246
C Y A N O P H Y T A																					
Anabaena sp. Bory	I	60	II	90	-	-	-	-	I	2	I	2	-	-	-	-	II	32	II	62	248
Aphanothece clathrata W. et G.S. West	I	21	I	30	II	60	II	32	I	11	II	3	II	50	II	22	-	-	-	-	229
Calothrix kossinskajae Poljansky	I	22	II	12	III	60	III	41	IV	121	III	51	III	32	III	33	IV	110	III	150	632
Chamaesiphon carpaticus Starm.	-	-	-	-	I	2	-	-	-	-	I	2	II	3	-	-	-	-	-	-	7
- incrustans Grun.	V	361	V	361	V	400	V	390	V	390	V	350	V	420	V	410	V	410	V	410	3902
- - var. elongatus Starm.	-	-	-	-	II	90	I	2	I	2	-	-	-	-	-	-	-	-	-	-	94
- polonicus Hansg.	I	20	I	11	II	40	I	2	I	11	II	21	I	1	-	-	-	-	-	-	106
Chroococcus turgidus (Kütz.) Näg.	II	13	I	22	III	100	I	11	I	11	II	21	II	12	II	12	-	-	II	3	205
Gloeocapsa kützingiana Näg.	II	40	I	11	-	-	I	2	II	21	I	2	I	1	-	-	-	-	-	-	77
- turgida Hollerb. f. maxima Hollerb.	II	33	I	121	II	91	II	12	II	120	II	3	-	-	-	-	-	-	I	2	382
Gomphosphaeria sp. Kütz.	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	-	-	I	1	5
Homeothrix sp. (Thur.) Kirch.	-	-	-	-	I	2	-	-	I	1	II	21	I	2	I	1	I	20	I	2	49
- crustacea Woronichin	-	-	-	-	-	-	I	1	-	-	-	-	I	11	II	22	II	60	I	11	105
- fusca Starm. f. elongata Starm.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	II	3	II	150	II	32	186
- janthina (Born. et Flah.) Starm.	II	31	II	32	I	1	I	1	III	80	III	71	II	80	II	31	III	140	II	61	528
- varians Geitler	I	2	I	40	II	31	II	12	III	100	IV	44	IV	141	III	42	IV	150	III	130	692
Lyngbya circumcreta G.S. West	I	1	-	-	-	-	-	-	I	2	-	-	I	2	-	-	-	-	-	-	5
- kryloviana Popova et Degter.	I	1	I	20	I	11	-	-	I	11	II	12	II	3	I	2	-	-	-	-	60
- kützingii Schmidle	I	2	I	21	III	70	I	11	I	30	II	3	II	51	III	42	III	80	III	130	440
Merismopedia elegans A. Br.	III	71	II	50	II	41	I	2	I	30	II	22	III	81	III	14	III	60	II	21	392
- glauca (Ehr.) Näg.	I	11	II	50	II	31	I	10	III	42	II	21	II	70	II	13	-	-	II	3	251
- punctata Meyen.	I	11	I	30	-	-	I	11	-	-	III	62	II	70	II	41	-	-	-	-	225
- tenuissima Lemm.	II	4	II	12	-	-	-	-	I	1	I	2	II	31	-	-	-	-	II	21	71
Microcystis sp. (Kütz.) Elenk.	I	2	I	11	-	-	II	12	I	1	II	21	I	2	I	1	I	11	-	-	62
- holsatica Lemm.	-	-	-	-	-	-	I	2	-	-	-	-	I	2	-	-	-	-	-	-	4
Oncobyrsa rivularis (Kütz.) Menegh.	-	-	-	-	II	21	I	11	-	-	I	1	I	2	-	-	-	-	-	-	35
Oscillatoria sp. Vauch.	I	11	I	1	-	-	-	-	-	-	I	1	II	3	I	2	I	11	I	1	30
- geminata Menegh.	II	30	I	11	I	2	-	-	I	2	I	2	I	2	II	3	II	40	II	21	113
- formosa Bory	-	-	-	-	-	-	I	21	-	-	II	21	II	3	III	61	II	50	II	50	206
- limosa Ag.	II	3	II	61	I	2	-	-	-	-	-	-	II	3	II	91	III	210	III	34	404
- tenuis Ag.	I	30	-	-	-	-	-	-	-	-	I	2	II	61	II	3	II	90	II	120	306
Phormidium sp. Kütz.	I	11	I	1	I	11	-	-	-	-	I	10	II	3	I	2	II	21	I	2	61
- ambiguum Gomot.	I	2	I	90	II	180	II	32	III	182	III	211	II	180	III	92	II	210	III	300	1479
- autumnale (Ag.) Gomot.	I	1	II	120	I	61	-	-	III	152	II	121	III	92	II	3	II	90	II	150	790
- favosum (Bory) Gomot.	III	211	III	92	III	361	II	32	II	31	II	3	III	181	III	93	II	120	III	271	1395
- subfuscum Kütz.	IV	122	IV	54	III	140	II	50	II	80	IV	63	IV	111	IV	151	III	120	III	140	1031
- uncinatum (Ag.) Gomot.	-	-	I	1	I	31	-	-	II	150	II	91	II	61	II	33	II	150	I	2	519
Pleurocapsa minor Hansg. em. Geitler	I	2	I	1	-	-	I	2	I	1	I	2	-	-	-	-	-	-	I	1	9
Spirulina sp. Turp.	-	-	I	1	-	-	-	-	I	11	-	-	I	2	-	-	-	-	II	12	26

Spirulina maior Kütz.	I	11	I	20	I	11	II	12	II	3	-	-	II	31	-	-	I	11	I	2	101
- minima A. Wurtz.	-	-	I	20	II	22	-	-	I	2	-	-	II	21	II	3	II	30	II	21	119
- okensis (C. Meyer) Geitler	I	11	I	1	II	12	-	-	-	-	-	-	I	2	-	-	I	2	III	5	32
- platensis (Nordst.) Geitler	I	20	II	31	-	-	-	-	-	-	-	-	-	-	-	-	II	21	II	30	102
B A C I L L A R I O P H Y C E A E																							
Achnanthes affinis Grun.	-	-	I	10	II	22	III	110	IV	130	III	90	II	31	II	12	-	-	-	-	405
- amphicephala Hust.	-	-	-	-	I	1	-	-	II	31	II	31	I	11	I	2	-	-	-	-	76
- lanceolata (Bréb.) Grun.	III	32	IV	111	III	14	IV	62	IV	82	IV	132	IV	104	III	51	II	31	I	2	621
- - var. capitata O. Müll.	-	-	-	-	II	31	III	80	III	110	II	70	II	90	II	12	I	1	-	-	394
- - var. elliptica Cl.	I	2	I	11	I	2	II	31	III	120	II	50	II	61	I	11	I	2	I	2	292
- - var. rostrata (Ostr.) Hust.	-	-	II	21	II	21	IV	101	V	250	III	120	IV	122	III	61	I	11	I	2	709
- - f. ventricosa Hust.	-	-	I	11	I	2	II	21	-	-	-	-	I	2	-	-	II	12	II	12	60
- linearis (W. Sm.) Grun.	-	-	-	-	I	2	III	61	III	100	III	91	III	102	II	41	I	2	II	21	420
- minutissima Kütz.	IV	82	V	220	IV	81	V	220	V	241	IV	200	IV	152	IV	73	II	50	I	11	1330
- - var. cryptocephala Grun.	-	-	II	12	I	11	I	11	III	90	III	102	II	121	II	100	I	11	-	-	458
Amphora ovalis Kütz.	-	-	I	2	I	2	I	2	II	120	II	240	III	302	II	32	I	31	II	61	792
- - var. gracilis Ehr.	-	-	-	-	I	11	I	20	II	40	II	50	II	60	II	31	I	1	-	-	213
- - var. pediculus Kütz.	I	2	I	11	II	31	I	1	-	-	III	71	II	51	III	62	II	31	I	11	271
- venata Kütz.	-	-	I	1	I	2	-	-	II	50	II	50	I	30	I	11	-	-	-	-	144
Amphipleura pellucida Kütz.	III	330	III	150	II	180	-	-	II	32	-	-	-	-	-	-	I	1	I	2	695
Asterionella gracillima (Hantzsch.) Heib.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	31	I	2	33
Caloneis alpestris (Grun.) Cl.	-	-	-	-	I	1	II	61	II	62	II	62	-	-	-	-	-	-	-	-	186
- amphisbaena (Bory) Cl.	-	-	-	-	II	61	II	90	-	-	-	-	-	-	-	-	-	-	I	2	153
- bacillum (Grun.) Mer.	-	-	-	-	-	-	II	12	III	80	II	60	III	54	II	12	-	-	-	-	218
- schroederi Hust.	-	-	I	1	-	-	I	11	I	2	-	-	-	-	-	-	-	-	-	-	14
- schumanniana (Grun.) Cl.	I	2	-	-	I	2	II	60	III	42	II	22	II	31	II	12	-	-	-	-	171
- - var. biconstricta Grun.	-	-	-	-	I	1	I	31	-	-	-	-	-	-	-	-	-	-	-	-	32
- silicula (Ehr.) Cl.	-	-	I	20	I	11	III	70	III	42	II	50	III	63	II	12	I	2	I	1	271
- - var. alpina Cl.	-	-	I	11	I	2	II	21	II	21	II	12	-	-	-	-	-	-	-	-	67
- - var. truncatula Grun.	-	-	-	-	I	31	III	241	II	91	II	92	II	91	I	2	I	2	-	-	550
- - var. ventricosa (Ehr.) Donk.	-	-	-	-	-	-	-	-	-	-	II	2	II	12	II	3	-	-	-	-	17
Campylodiscus sp. Ehr.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	I	1	-	-	-	-	2
Ceratoneis arcus (Ehr.) Kütz.	-	-	-	-	-	-	-	-	II	21	II	31	III	15	II	3	-	-	I	2	72
- - var. amphioxys (Rabenh.) Brun.	I	1	I	11	-	-	I	2	II	51	III	22	II	31	II	31	I	11	I	1	161
- - var. linearis Holmboe	-	-	II	3	-	-	-	-	-	-	I	31	II	92	I	2	I	2	I	2	132
Cocconeis disculus (Schum.) Cl. var. diminuta (Pant.) Sheskukova	I	20	I	20	I	11	-	-	I	2	II	32	-	-	-	-	-	-	-	-	85
- pediculus Ehr.	III	90	IV	170	IV	102	V	172	IV	160	V	281	IV	95	III	61	II	50	III	140	1321
- placentula Ehr.	V	290	V	261	V	380	V	401	V	320	IV	122	V	253	IV	161	V	300	III	91	2579
- - var.euglypta (Ehr.) Cl.	V	440	V	410	V	420	V	440	V	430	V	450	V	330	V	440	V	430	V	450	4240
- - var. intermedia (Herib.) Cl.	II	61	I	31	I	31	II	61	II	32	II	91	II	33	-	-	1	31	II	32	403
- - var. rouxii (Brun. et Herib.) Cl.	-	-	I	2	I	2	-	-	I	11	II	21	II	13	-	-	-	-	-	-	49
Cyclotella kützingiana Thwait	-	-	-	-	-	-	-	-	-	-	I	2	I	2	I	1	-	-	-	-	5
- meneghiniana Kütz.	-	-	II	30	III	70	II	21	IV	130	III	110	IV	142	III	71	II	12	II	31	617
- stelligera Cl. et. Grun.	-	-	-	-	-	-	I	1	I	11	I	2	II	3	I	2	-	-	I	11	30
Cymatopleura elliptica (Bréb.) W. Sm.	-	-	-	-	-	-	-	-	-	-	I	1	I	2	I	1	-	-	-	-	4
- solea (Bréb.) W. Sm.	I	71	I	71	II	141	IV	770	III	212	IV	423	IV	284	III	213	I	71	I	2	2258
- - var. apiculata (W.Sm.) Ralfs.	-	-	III	241	IV	420	IV	540	III	270	III	152	IV	184	III	152	III	212	I	31	2202
- - var. clavata O. Müll.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	111	113
- - var. regula (Ehr.) Grun.	I	2	I	31	I	2	III	181	II	120	-	-	-	-	-	-	-	-	-	-	336
- - var. subconstricta O. Müll.	I	71	I	140	I	1	I	71	-	-	I	71	-	-	-	-	I	71	I	2	427
- - var. vulgaris Meist.	-	-	-	-	-	-	-	-	II	72	II	210	II	351	III	143	-	-	-	-	776
Cymbella aequalis W. Sm.	-	-	-	-	-	-	I	2	-	-	II	12	II	21	I	2	-	-	-	-	37
- affinis Kütz.	II	91	III	150	IV	131	III	130	III	140	III	130	IV	123	IV	220	V	300	V	380	1795
- aspera (Ehr.) Cl.	-	-	I	31	-	-	-	-	I	31	II	120	II	61	II	91	II	3	I	60	357
- cistula (Hemp.) Grun.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	31	-	-	33
- helvetica Kütz.	I	2	I	60	II	32	I	2	III	270	II	32	II	90	II	121	III	210	II	61	880

Locality	1		2		3		4		5		6		7		8		9		10		P
Date	Sept.20		Sept.20		Sept.19		Sept.19		Sept.19		Sept.18		Sept.18		Sept.24		Sept.25		Sept.26		
Name of species	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	Total
Cymbella helvetica var. balatonis (Grun.) Cl	-	-	-	-	-	-	-	-	II	72	III	630	IV	633	III	701	II	350	I	2	2388
- - var. curta Cl.	I	31	III	240	III	92	I	60	IV	451	IV	451	IV	303	IV	273	III	181	III	180	2262
- laevis Näg.	-	-	-	-	-	-	I	11	-	-	III	61	III	81	III	33	I	2	-	-	188
- lanceolata (Ehr.) V. H.	-	-	II	72	-	-	-	-	I	2	II	280	II	351	II	211	I	2	-	-	918
- naviculiformis Auersw.	-	-	-	-	-	-	-	-	-	-	II	11	I	2	I	2	I	2	-	-	17
- parva (W.Sm.) Cl.	-	-	I	11	-	-	-	-	-	-	II	40	I	11	I	11	-	-	I	11	84
- perpusilla A. Cl.	-	-	-	-	-	-	I	20	-	-	II	22	II	12	I	2	-	-	-	-	56
- prostrata (Berk.) Cl.	V	631	III	240	II	62	III	420	IV	270	III	360	IV	420	III	122	II	61	II	32	2618
- sinuata Greg.	I	2	I	11	-	-	-	-	-	-	III	81	IV	161	III	23	II	4	I	20	302
- - f. ovata Hust.	-	-	-	-	-	-	-	-	-	-	II	21	II	12	II	3	-	-	I	1	37
- tumida (Bréb.) V. H.	-	-	-	-	-	-	-	-	-	-	I	2	II	3	I	1	II	31	II	21	58
- turgidula Grun.	-	-	-	-	-	-	-	-	-	-	I	1	I	2	-	-	I	2	I	2	7
- ventricosa Kütz.	IV	240	V	291	V	390	V	351	V	291	V	291	V	291	V	163	III	121	III	61	2490
Denticula elegans Kütz.	-	-	I	11	-	-	-	-	II	12	I	2	II	12	I	2	I	2	I	2	43
- tenuis (Kütz.) Hust.	-	-	-	-	-	-	-	-	I	2	I	1	-	-	-	-	-	-	-	-	3
- - var. crasulla (Näg.) Hust.	-	-	II	40	I	2	II	60	IV	120	III	62	II	12	II	12	II	12	I	2	322
Diatoma anceps (Ehr.) Kirchn.	-	-	-	-	-	-	I	2	I	1	II	22	-	-	I	1	I	10	-	-	36
- elongatum (Lyngb.) Ag. v.tenue (Ag.) V.H.	IV	151	IV	160	V	242	IV	310	IV	210	V	410	V	360	V	370	V	460	V	330	3003
- hiemale (Lyngb.) Heib.	-	-	-	-	-	-	I	1	II	3	II	32	-	-	-	-	-	-	-	-	36
- vulgare Bory	I	1	III	92	I	31	III	300	IV	123	IV	601	II	210	III	182	III	211	II	61	1812
- - var. breve Grun.	-	-	I	20	I	11	II	21	II	31	III	91	II	70	II	51	II	50	I	11	356
- - var. capitulatum Grun.	I	1	I	20	I	11	III	70	II	21	V	331	II	100	III	91	V	162	III	120	927
- - var. ehrenbergii (Kütz.) Grun.	-	-	V	211	-	-	-	-	III	125	IV	540	V	872	IV	630	III	330	II	120	2828
- - var. lineare Grun.	-	-	I	31	I	2	II	91	I	2	IV	511	II	240	III	213	III	241	II	150	1481
- - var. ovale (Fricke) Hust.	-	-	II	21	I	1	-	-	III	14	IV	142	II	150	II	70	II	60	I	2	460
- - var. productum Grun.	IV	125	V	631	IV	570	V	1050	V	1080	V	930	V	932	V	840	V	1110	V	340	7608
Diploneis oculata (Bréb.) Cl.	I	2	I	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
- elliptica (Kütz.) Cl.	-	-	I	1	II	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
Epithemia argus Kütz.	-	-	-	-	-	-	-	-	-	-	II	151	II	91	II	32	-	-	-	-	274
- turgida (Ehr.) Kütz.	-	-	-	-	-	-	-	-	-	-	II	92	II	121	II	62	-	-	-	-	275
- zebra (Ehr.) Kütz.	-	-	I	60	I	2	II	180	III	330	II	241	II	271	II	91	I	31	I	2	1208
- - var. saxonica (Kütz.) Grun.	-	-	-	-	-	-	-	-	II	120	II	32	II	32	I	2	-	-	-	-	186
Eucocconeis flexella Kütz.	-	-	-	-	I	1	-	-	-	-	I	2	II	12	II	12	-	-	-	-	27
Eunotia arcus Ehr.	-	-	-	-	-	-	-	-	III	23	-	-	IV	25	II	3	-	-	-	-	51
- lunaris (Ehr.) Grun. var. subarcuata (Nag.) Grun.	-	-	-	-	-	-	-	-	-	-	I	2	II	12	I	2	-	-	-	-	16
Fragilaria bidens Heib.	-	-	II	30	I	11	I	20	-	-	I	2	II	12	II	3	I	2	-	-	80
- brevistriata Grun.	I	11	II	12	-	-	I	2	-	-	II	21	II	71	II	51	II	50	I	11	229
- capucina Desm.	-	-	II	120	I	90	III	440	III	420	IV	332	V	422	IV	273	V	541	V	512	3150
- - var. mesolepta Rabenh.	-	-	I	31	-	-	II	91	III	331	III	182	IV	243	III	183	V	480	V	452	1993
- construens (Ehr.) Grun.	-	-	-	-	-	-	-	-	-	-	II	12	I	2	I	2	I	2	-	-	18
- - var. binodis (Ehr.) Grun.	-	-	-	-	-	-	-	-	-	-	I	1	I	2	I	1	-	-	I	2	6
- - var. venter (Ehr.) Grun.	-	-	-	-	-	-	-	-	-	-	I	2	II	12	I	2	I	2	I	2	20
- crotonensis Kitt.	-	-	II	61	I	2	I	2	-	-	-	-	II	3	II	12	I	31	II	90	201
- intermedia Grun.	I	11	I	2	II	21	II	12	-	-	II	31	IV	84	III	52	II	21	-	-	234
- - var. capitellata A. Cl.	I	1	-	-	II	30	II	60	II	31	III	73	II	81	II	51	II	60	II	50	437
- - var. dubia	-	-	I	1	-	-	-	-	-	-	II	91	IV	243	III	152	II	62	I	1	550

Fragilaria leptostauron (Ehr.) Hust.	-	-	I	2	-	-	I	2	-	-	I	1	II	3	I	2	-	-	-	-	10
- pinnata Ehr.	-	-	-	-	I	11	-	-	-	-	I	2	IV	72	III	52	II	22	I	11	170
- - var. lancettula (Schum.) Hust.	-	-	-	-	I	2	-	-	-	-	II	12	II	61	II	5	I	11	I	11	102
- virescens Ralfs.	-	-	I	31	-	-	I	2	III	300	II	33	II	32	I	31	II	32	II	61	522
- - var. mesolepta Schönf.	II	151	I	30	III	240	III	450	IV	540	II	180	IV	303	III	182	II	150	II	180	2406
Frustulia vulgaris Thw.	II	181	III	271	III	181	II	150	I	31	II	3	II	32	I	2	I	31	I	60	942
Gomphonema acuminatum Ehr.	I	11	-	-	-	-	-	-	-	-	II	12	IV	73	III	51	-	-	I	2	149
- - var. coronatum (Ehr.) W. Sm.	I	31	I	2	-	-	-	-	II	32	-	-	II	32	I	2	I	2	-	-	101
- angustatum (Kütz.) Rabenh.	-	-	-	-	-	-	I	31	II	13	III	80	IV	114	IV	102	III	42	II	30	412
- constrictum Ehr.	I	2	I	2	I	11	-	-	I	2	II	22	II	80	II	31	II	12	II	12	174
- gracile Ehr.	-	-	-	-	-	-	-	-	-	-	II	12	IV	103	III	62	II	3	-	-	180
- intricatum Kütz.	-	-	-	-	-	-	-	-	-	-	II	13	II	41	II	12	I	2	-	-	68
- - var. pumillum Grun.	I	2	-	-	-	-	-	-	-	-	II	22	IV	131	IV	54	III	51	II	12	272
- longiceps Ehr.	-	-	II	61	-	-	I	1	-	-	II	91	V	422	IV	243	II	61	I	2	881
- - var. subclavatum Grun.	I	31	I	31	I	1	I	1	II	61	II	120	IV	421	III	450	IV	510	III	182	1808
- - - - f. gracile Hust.	-	-	-	-	I	2	II	41	III	61	II	41	II	40	II	31	II	31	I	2	249
- olivaceum (Lyngb.) Kütz.	V	201	V	320	IV	150	V	290	V	390	V	141	V	321	V	341	V	420	V	191	2765
- - var. calcareum Cl.	I	20	I	2	III	60	V	172	V	161	IV	63	IV	200	III	160	IV	110	III	110	1058
- parvulum (Kütz.) Grun.	II	12	II	21	II	12	III	70	III	130	II	50	IV	92	IV	92	IV	151	III	71	701
- - var. micropus (Kütz.) Cl.	-	-	-	-	-	-	-	-	I	11	II	12	II	32	II	12	I	2	-	-	69
- tergestinum (Grun.) Fricke (?)	-	-	-	-	I	11	II	41	-	-	I	2	III	23	II	12	I	1	-	-	90
Gyrosigma acuminatum (Kütz.) Rabenh.	-	-	II	210	III	771	III	630	III	911	II	420	III	561	II	72	I	2	I	2	3579
- attenuatum (Kütz.) Rabenh	-	-	II	72	III	491	III	911	III	491	III	702	II	351	I	2	I	2	I	71	3093
- kützingii (Grun.) Cl.	I	71	I	2	I	2	II	210	-	-	-	-	-	-	-	-	-	-	-	-	285
- scalproides (Rabenh.) Cl.	I	31	I	31	II	150	III	301	II	61	II	121	II	61	I	2	I	31	I	2	791
Hantzschia amphioxys (Ehr.) Grun.	-	-	-	-	I	2	I	2	-	-	-	-	II	3	I	2	-	-	-	-	9
- - f. capitata O. Müll.	I	2	-	-	I	31	I	31	-	-	I	2	I	31	II	3	-	-	-	-	100
Melosira varians Ag.	V	1230	III	300	III	63	IV	451	II	151	III	300	III	331	III	122	II	61	III	240	3249
Meridion circulare Ag.	II	21	I	11	-	-	I	2	I	11	III	32	III	33	I	2	II	21	II	3	136
Navicula anglica Ralfs.	II	21	V	172	III	90	IV	102	IV	102	III	71	IV	63	III	42	II	11	I	2	676
- bacilliformis Grun.	-	-	-	-	I	2	I	2	-	-	I	11	-	-	-	-	I	1	-	-	16
- bacillum Ehr.	-	-	III	110	II	12	III	100	III	71	IV	64	IV	111	III	42	II	50	I	1	561
- bicapitellata Hust.	I	1	I	1	-	-	-	-	-	-	II	3	II	21	I	2	I	2	I	2	32
- binodis Ehr.	-	-	-	-	I	1	I	20	I	11	II	21	II	3	-	-	-	-	I	1	57
- cryptocephala Kütz.	III	120	III	81	II	12	IV	131	IV	101	III	61	III	82	III	52	II	40	II	40	720
- - var. exilis (Kütz.) Grun.	I	2	II	41	I	2	III	80	II	21	III	43	IV	110	II	13	II	12	I	2	326
- - var. intermedia Grun.	I	11	I	20	I	11	III	91	II	21	III	81	III	82	II	13	I	2	I	2	334
- - var. veneta (Kütz.) Grun.	I	20	II	50	II	12	III	91	III	101	III	91	III	112	III	52	I	2	I	1	532
- cuspidata Kütz.	-	-	I	1	-	-	-	-	I	3	II	72	II	72	I	2	-	-	I	1	151
- - var. ambiqua (Ehr.) Grun.	-	-	-	-	-	-	-	-	II	61	I	60	II	61	-	-	I	31	-	-	213
- dicephala (Ehr.) W. Sm.	I	11	-	-	I	11	II	3	III	100	III	42	III	62	II	3	II	31	I	2	265
- exigua (Grég.) O. Müll.	-	-	-	-	-	-	-	-	-	-	I	11	I	2	I	2	I	2	I	2	19
- - var. elliptica Hust.	-	-	-	-	-	-	-	-	-	-	II	40	II	51	I	2	-		-	-	93
- gracilis Ehr.	IV	391	II	150	IV	272	II	180	III	301	II	151	IV	332	III	181	II	61	II	61	2080
- graciloides A. Mayer	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	1	I	11		-	14
- hungarica Grun. var. capitata Cl.	-	-	I	11		-	II	50	II	12	II	21	II	50	II	12	I	11	II	30	197
- laterostrata Hust.	-	-	-	-	-	-	II	21	II	12	-	-	-	-	-	-	-	-	-	-	33
- minima Grun.	-	-	-	-	-	-	I	2	-	-	II	12	-	-	I	2	-	-	-	-	16
- minuscula Grun.	-	-	I	11	-	-	-	-	II	50	II	60	II	70	I	11	I	11	-	-	213
- mutica Kütz.	I	2	I	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
- pupula Kütz.	I	20	II	40	I	11	III	71	III	42	III	81	IV	111	III	61	II	50	I	2	489
- - var. capitata Hust.	I	2	II	40	II	22	II	50	III	71	II	41	II	21	I	11	I	20	I	2	280
- - var. mutata (Krasske) Hust.	-	-	-	-	-	-	-	-	II	31	II	51	III	15	II	12	-	-	-	-	109
- - var. rostrata Hust.	-	-	-	-	-	-	-	-	-	-	II	40	III	62	-	-	-	-	-	-	102
- pygmaea Kütz.	-	-	-	-	I	2	II	21	-	-	-	-	-	-	-	-	-	-	-	-	23
- radiosa Kütz.	I	31	II	32	I	31	-	-	I	31	II	210	II	150	II	91	I	31	I	60	667
- - var. tenella (Bréb.) Grun.	-	-	-	-	I	11	-	-	I	20	II	41	II	40	II	12	I	11	-	-	134

Locality	1		2		3		4		5		6		7		8		9		10		P
D a t e	Sept.20		Sept.20		Sept.19		Sept.19		Sept.19		Sept.18		Sept.18		Sept.24		Sept.25		Sept.26		
Name of species	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	cons-tancy	P	Total
Navicula reinhardtii (Grun.) Cl.	-	-	-	-	-	-	-	-	I	2	II	61	II	12	I	2	-	-	-		77
- rhynchocephala Kütz.	-	-	-	-	-	-	-	-	-	-	I	2	II	3	-	-	I	1	-		6
- rotaeana (Rabenh.) Grun.	-	-	I	2	-	-	II	21	I	1	II	21	III	15	II	3	-	-	-	-	64
- tuscula (Ehr.) Grun.	I	2	IV	131	III	80	II	30	IV	160	III	140	IV	110	III	61	II	12	II	21	747
- viridula Kütz.	III	61	III	90	III	90	III	120	IV	112	IV	111	III	82	III	51	II	21	II	50	788
Neidium affine (Ehr.) Cl.v.amphirhynchus (Ehr. Cl.)	-	-	-	-	-	-	-	-	I	2	II	90	-	-	-	-	-	-	-	-	92
- var. minus Cl.	-	-	I	2	-	-	-	-	-	-	II	61	-	-	-	-	-	-	-	-	63
- dubium (Ehr.) Cl.	-	-	-	-	I	1	II	33	I	1	II	32	-	-	-	-	I	1	I	2	70
- iridis (Ehr.) Cl. v.amphigomphus (Ehr.) V.H.	-	-	-	-	I	30	II	61	II	32	II	32	-	-	-	-	I	31	I	2	188
- -(Ehr.) Cl. var. ampliatum (Ehr.) Cl.	-	-	I	2	I	2	I	2	-	-	II	61	-	-	-	-	-	-	-	-	67
- - var. diminutum (Pant.) Wils. et Kolbe	I	11	I	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2	14
- productum (W.Sm.) Cl.	-	-	-	-	I	3	I	2	I	2	II	32	-	-	-	-	-	-	-	-	39
Nitzschia acicularis W.Sm.	-	-	-	-	-	-	II	33	-	-	I	1	III	5	-	-	I	31	II	91	161
- acuta Hantzsch.	I	1	I	140	III	560	II	141	-	-	-	-	-	-	-	-	I	2	I	2	846
- angustata (W.Sm.) Grun.	-	-	II	12	II	41	III	91	III	61	-	-	II	12	I	2	-	-	I	2	221
- - f. antiqua (Schum.) A.Cleve	-	-	II	40	III	72	III	71	II	51	II	12	II	31	I	11	I	11	-	-	299
- - var. acuta Grun.	-	-	I	31	II	121	II	61	I	2	-	-	-	-	-	-	-	-	-	-	215
- - var. curta Grun.	-	-	I	1	II	12	III	71	II	40	II	12	III	42	II	3	-	-	-	-	181
- denticula Grun.	-	-	-	-	I	2	-	-	II	31	I	2	II	3	-	-	-	-	-	-	38
- dissipata (Kütz.) Grun.	III	110	II	40	IV	150	II	41	II	41	IV	140	V	300	III	71	IV	120	V	270	1283
- - f. media (Htz.) Grun.	I	20	II	12	II	32	I	21	II	31	II	40	III	62	II	31	I	11	I	11	271
- dubia W.S.	-	-	I	1	I	1	I	2	-	-	-	-	III	5	II	3	-	-	-	-	12
- fonticola Grun.	-	-	-	-	-	-	-	-	I	11	II	3	-	-	I	1	I	2	I	2	19
- gracilis Hantzsch.	I	60	-	-	I	31	I	31	-	-	-	-	II	3	-	-	-	-	-	-	125
- var. capitata Wils. et Poretzky	-	-	-	-	-	-	I	11	-	-	I	2	I	2	I	2	I	1	I	1	19
- heufleriana Grun.	I	71	I	2	I	71	II	71	-	-	-	-	-	-	-	-	-	-	-	-	215
- - var. elongata Pant.	I	140	-	-	II	142	III	352	II	212	II	357	III	353	II	72	I	2	-	-	1630
- hungarica Grun.	I	2	I	31	II	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	153
- kützingiana Hilse	-	-	I	20	II	32	III	80	III	61	III	61	III	33	II	3	I	1	I	2	293
- linearis W.Sm.	-	-	-	-	I	30	-	-	I	90	II	62	III	64	II	32	-	-	I	1	279
- - var. tenuis (W.Sm.) Grun.	I	60	-	-	III	211	II	31	III	181	II	121	II	91	II	3	I	2	-	-	700
- palea (Kütz.) W.Sm.	I	2	I	31	I	90	II	120	I	31	II	150	II	121	II	3	-	-	-	-	548
- - var. capitata Wils. et Poretzky	-	-	-	-	I	2	-	-	-	-	II	22	II	12	II	3	-	-	-	-	39
- paleacea Grun.	-	-	I	2	-	-	-	-	-	-	II	50	II	50	II	3	-	-	I	2	107
- pseudoamphioxys Hust.	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	2	I	20	II	21	45
- recta Hantzsch.	-	-	-	-	I	90	II	180	I	60	II	3	II	32	I	2	-	-	-	-	367
- sigmoidea (Ehr.) W.Sm.	IV	1050	II	350	IV	771	II	351	III	631	II	420	III	283	III	282	I	71	I	71	4280
- sinuata (W.Sm.) Grun.v.tabellaria Grun.	-	-	II	70	II	31	III	100	V	301	V	410	V	330	III	72	II	50	I	11	1375
- stagnorum Rabenh.	-	-	-	-	I	31	I	31	II	61	II	121	II	181	-	-	-	-	-	-	425
- sublinearis Hust.	-	-	-	-	-	-	I	2	-	-	II	61	II	91	II	3	-	-	-	-	157
- thermalis Kütz.	-	-	I	1	II	151	I	60	I	31	II	3	I	31	-	-	I	1	-	-	277
- vermicularis (Kütz.) Grun.	I	140	II	280	III	631	III	561	II	142	II	141	II	351	II	211	I	2	I	2	2461
Pinnularia borealis Ehr.	I	2	I	2	-	-	II	12	II	2	II	3	-	-	-	-	-	-	I	1	22
- gibba Ehr.var. mesogongyla (Ehr.) Hust.	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	-	-	I	1	5
- - - - f. interrupta Cl.	-	-	I	60	I	2	II	61	-	-	-	-	-	-	-	-	-	-	I	2	125
- globiceps Greg.	-	-	-	-	-	-	II	21	II	3	-	-	-	-	-	-	-	-	I	1	25

Pinnularia maior (Kütz.) Cl.	-	-	-	-	-	-	-	-	-	-	II	141	I	2	-	-	-	-	I	2	145
- mesolepta (Ehr.) W. Sm.	-	-	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	-	-	4
- microstauron (Ehr.) Cl.	-	-	I	2	I	31	-	-	II	61	III	63	-	-	-	-	-	-	-	-	157
- - var. brebissonii (Kütz.) Hust.	-	-	-	-	-	-	-	-	I	1	II	12	-	-	-	-	-	-	-	-	13
- molaris Grun.	-	-	-	-	-	-	I	1	II	12	I	2	-	-	-	-	-	-	-	-	15
- - var. lapponica Mölder.	-	-	-	-	-	-	-	-	I	1	II	30	I	2	-	-	-	-	-	-	33
- subsolaris (Grun.) Cl.	I	2	-	-	-	-	-	-	-	-	-	-	I	2	-	-	I	1	-	-	5
- viridis (Nitzsch.) Ehr.	-	-	-	-	-	-	-	-	I	2	II	142	I	2	-	-	I	2	-	-	148
- - var. sudetica (Hilse) Hust.	-	-	I	2	-	-	I	2	II	61	III	34	II	33	-	-	-	-	-	-	132
Rhoicosphenia curvata (Kütz.) Grun.	V	370	I	2	II	21	II	21	II	30	II	51	III	34	II	12	II	30	III	91	662
- vanheurckii Grun (?)	-	-	-	-	I	1	I	1	-	-	I	2	I	2	I	2	I	2	-	-	10
Stauroneis anceps Ehr.	-	-	I	31	II	61	I	2	-	-	-	-	-	-	I	2	-	-	I	2	98
- phoenicenteron Ehr.	-	-	I	2	-	-	-	-	-	-	II	120	II	32	I	2	-	-	I	2	158
- smithii Grun.	I	11	-	-	I	2	II	21	I	2	II	40	-	-	-	-	-	-	-	-	76
Stephanodiscus hantzschii Grun.	-	-	-	-	-	-	-	-	-	-	I	2	II	3	I	2	I	2	I	11	20
Surirella angustata Kütz.	I	2	I	20	II	31	III	71	III	50	II	50	II	51	II	12	-	-	-	-	287
- - var. constricta Hust. f. ovata Skv.	-	-	-	-	-	-	II	50	II	31	I	11	II	12	I	11	-	-	I	1	116
- - var. elongata Skv.	-	-	-	-	I	11	II	12	II	40	II	21	II	60	II	12	-	-	-	-	156
- biseriata Bréb.	-	-	-	-	-	-	-	-	I	1	II	210	-	-	-	-	I	2	-	-	213
- didyma Kütz.	-	-	-	-	-	-	-	-	I	2	II	3	I	2	-	-	-	-	-	-	7
- gracilis (W.Sm.) Grun.	I	60	-	-	II	61	-	-	II	61	II	32	II	91	II	32	I	2	-	-	339
- linearis W.Sm. v.helvetica (Brun.) Meist.	-	-	-	-	-	-	I	2	I	1	-	-	-	-	I	2	I	31	I	2	38
- ovata Kütz.	II	31	II	21	IV	121	IV	92	IV	151	II	31	IV	63	III	14	I	20	II	40	584
- - var. pinnata (W.Sm.) Hust.	-	-	I	11	II	12	II	21	III	71	II	13	III	63	II	32	II	21	I	11	255
- - var. salina (W.Sm.) Hust.	-	-	I	11	II	51	III	72	II	40	II	31	II	31	II	12	-	-	I	1	249
- robusta Ehr. var. splendida Ehr.	I	2	-	-	-	-	-	-	-	-	II	141	I	1	-	-	I	11	-	-	155
- tenera Greg.	I	60	-	-	-	-	I	2	-	-	I	2	I	31	I	2	I	2	I	31	130
- turgida W.Sm.	-	-	-	-	I	2	II	12	II	21	I	1	-	-	-	-	-	-	-	-	36
- - var. marginata Pant.	-	-	-	-	I	31	-	-	I	1	II	61	-	-	-	-	I	31	-	-	124
Synedra acus Kütz.	I	2	II	150	I	2	III	182	V	251	II	241	III	241	III	241	II	270	III	360	1940
- - var. radians Kütz.	-	-	I	71	-	-	-	-	II	141	-	-	III	74	II	3	I	2	I	140	431
- amphicephala Kütz.	-	-	I	2	-	-	II	12	I	2	II	60	II	70	II	31	I	2	I	2	181
- - var. austriaca Grun.	-	-	-	-	-	-	I	1	-	-	I	2	II	3	I	2	I	31	-	-	39
- capitata Ehr.	-	-	-	-	-	-	-	-	-	-	I	1	II	5	-	-	-	-	-	-	6
- parasitica (W.Sm.) Hust.	-	-	-	-	-	-	-	-	II	41	II	21	III	42	III	51	I	10	I	10	175
- - var. subconstricta Grun.	-	-	I	2	I	2	-	-	-	-	-	-	I	1	-	-	-	-	-	-	5
- rumpens Kütz.	-	-	I	60	-	-	-	-	I	31	III	151	IV	392	III	51	I	60	I	31	776
- - var. familiaris (Kütz.) Grun.	-	-	-	-	I	1	-	-	I	2	II	32	II	32	II	91	I	1	I	1	160
- - var. fragilarioides Grun.	I	31	II	32	II	120	II	151	I	2	III	152	IV	302	IV	213	IV	331	II	91	1425
- - var. scotica Grun.	-	-	-	-	-	-	-	-	-	-	I	2	I	2	I	1	I	1	-	-	6
- ulna (Nitzsch.) Ehr.	III	282	III	212	II	142	IV	145	V	1261	IV	1260	V	1192	IV	982	V	912	IV	702	7090
- - var. amphirhynchus (Ehr.) Grun.	-	-	I	2	-	-	II	91	IV	242	III	211	IV	361	IV	442	IV	450	II	91	1890
- - var. contracta Ostr.	-	-	-	-	-	-	-	-	-	-	II	91	II	150	II	91	I	60	I	31	423
- - var. oxyrhynchus (Kütz.) V. H.	II	141	II	141	-	-	-	-	I	2	III	561	III	911	III	700	II	700	I	141	3297
- tabulata (Ag.) Kütz. v.parva (Kütz.) Grun.	-	-	I	2	-	-	-	-	-	-	II	31	I	11	II	12	I	30	-	-	86
- vaucheriae Kütz.	I	2	III	52	III	90	III	111	IV	151	IV	161	IV	133	III	81	IV	170	III	120	1071
- - var. capitellata Grun.	-	-	I	11	I	2	I	11	III	81	III	111	III	131	III	140	II	50	II	32	569
Tabellaria fenestrata (Lyngb.) Kütz.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	II	3	I	1	-	-	4
- flocculosa (Roth.) Kütz.	-	-	I	11	-	-	-	-	-	-	I	2	II	22	I	2	-	-	-	-	37

Locality	1		2		3		4		5		6		7		8		9		10		P
Date	Sept.20		Sept.20		Sept.19		Sept.19		Sept.19		Sept.18		Sept.18		Sept.24		Sept.25		Sept.26		
Name of species	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	constancy	P	Total
CHLOROPHYTA																					
Actinastrum hantzschii Lagerh.	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	2	II	12	-	-	16
Ankistrodesmus falcatus Ralfs.	I	2	II	21	II	31	I	2	I	2	I	2	II	21	II	12	II	13	I	11	117
- - var. mirabile W.u.G.S. West	II	32	II	32	I	31	-	-	I	2	II	3	-	-	II	61	-	-	II	91	252
- - var. mirabilis West f. dulcis Nyg.	-	-	I	2	-	-	I	11	I	11	-	-	II	21	-	-	I	1	-	-	46
- - var. spiralis West.	-	-	II	90	II	3	-	-	I	1	I	2	-	-	-	-	I	31	-	-	127
Aphanochaete repens A. Br.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	I	2	I	2	-	-	5
Bulbochaete sp. Agardh.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	I	2	I	2	-	-	5
Characium sp. A. Braun.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	I	1	-	-	-	-	2
Closterium acerosum (Schr.) Ehrenb.	I	220	II	440	III	772	II	330	I	2	III	771	II	221	I	1	-	-	-	-	2757
- cornu Ehrenb.	-	-	I	2	II	420	I	71	-	-	II	3	-	-	-	-	-	-	-	-	496
- diane Ehrenb.	-	-	-	-	-	-	I	2	-	-	I	1	II	3	-	-	-	-	-	-	6
- leibleinii Kütz.	I	2	I	140	II	420	I	140	I	71	I	2	II	141	-	-	II	141	-	-	1057
- lunula (Müll.) Nitzsch.	I	110	II	221	II	331	I	2	I	2	II	221	-	-	-	-	-	-	-	-	887
- moniliferum (Ehrenb.) Bory	I	71	II	210	II	210	I	140	I	1	II	72	II	210	-	-	-	-	-	-	914
- parvulum Naeg.	-	-	I	2	I	2	II	32	II	91	I	2	I	2	II	2	-	-	I	11	144
- strigosum Bréb.	-	2	I	2	-	-	-	-	-	-	-	-	-	-	-	-	I	71	I	2	77
- venus Kg.	-	-	I	60	II	90	I	2	-	-	-	-	-	-	-	-	-	-	-	-	152
Coelastrum microporum Naeg.	-	-	II	32	II	61	I	2	I	2	-	-	I	2	II	32	II	61	-	-	192
Cosmarium sp. Corda	-	-	I	1	I	10	-	-	I	1	II	12	I	11	I	2	I	2	-	-	39
- cucurbita Bréb.	I	2	II	21	II	30	I	2	I	11	II	22	II	21	II	3	II	21	II	31	164
- formosulum Hoff.	-	-	I	11	II	3	III	51	II	31	III	71	II	41	II	12	-	-	I	11	231
- impressulum Elfr.	-	-	-	-	I	11	II	21	II	3	III	23	I	2	-	-	-	-	-	-	60
- obtusatum Schmidle	I	2	I	60	II	90	II	61	I	31	-	-	II	3	I	2	I	1	I	1	251
- quadrum Lund. var. minus Nordst.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	II	120	120
Dictyosphaerium ehrenbergianum Naeg.	-	-	I	2	I	2	-	-	I	2	-	-	I	2	-	-	-	-	-	-	8
- pulchellum Wood.	I	2	II	21	II	21	I	2	I	20	I	11	II	40	II	3	-	-	-	-	120
Draparnaldia glomerata (Vauch.) Agardh.	I	20	I	11	II	70	II	21	III	71	II	50	II	22	II	21	I	11	II	31	328
Gloeococcus schröteri (Chodat.) Lemm.	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	-	-	-	-	4
Gongrosira trentepohliopsis Schidlee	I	2	II	32	I	31	I	2	I	2	-	-	I	2	I	2	II	120	I	2	195
Hyalotheca dissiliens Bréb.	I	60	III	210	III	181	II	61	II	61	II	91	II	120	II	62	II	180	II	121	1147
Kirchneriella contorta (Schmidle) Bohlin (?)	-	-	-	-	I	2	II	21	-	-	-	-	-	-	-	-	-	-	I	2	25
- lunaris (Kirchner) Moebius	I	2	II	12	-	-	II	3	II	12	I	2	II	21	I	2	-	-	-	-	54

Microspora amoena (Kütz.) Rabenh.	-	-	-	-	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	4
- quadrata Hanzen	I	1	-	-	-	-	-	-	I	1	-	-	I	1	-	-	-	-	-	-	3
Mougeotia sp. Ag.	I	31	-	-	-	-	-	-	-	-	I	2	I	2	II	32	II	91	II	61	219
Oedogonium sp. Link.	I	1	II	210	II	280	-	-	II	141	II	211	II	3	-	-	II	350	III	840	2036
Oocystis rupestris Kirch.	-	-	-	-	-	-	-	-	I	2	I	2	-	-	-	-	-	-	-	-	4
Pediastrum boryanum (Turp.) Menegh.	-	-	-	-	-	-	-	-	-	-	-	-	I	1	I	2	I	11	I	2	16
- duplex Meyen	-	-	-	-	-	-	-	-	I	2	-	-	-	-	-	-	-	-	-	-	2
- tetras (Ehr.) Ralf.	I	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2	4
Scenedesmus arcuatus Lemm.	-	-	-	-	I	11	-	-	I	2	-	-	II	3	II	22	II	3	I	11	52
- dimorphus (Turp.) Kütz.	I	2	III	100	III	110	II	40	II	50	III	91	III	52	III	32	-	-	III	81	558
- obliquus (Turp.) Kütz.	-	-	II	40	III	100	II	31	I	11	II	70	III	71	III	61	III	80	III	80	544
- quadricuada (Turp.) Bréb.	II	30	III	100	IV	130	III	71	II	60	III	71	IV	131	III	91	II	30	III	80	794
- - var. abundans Kirch.	I	1	II	30	II	21	II	50	II	3	II	3	I	1	II	3	I	2	I	20	134
- - var. longispina (Chod.) G.M.	I	2	I	20	I	11	I	11	I	2	II	3	II	12	II	21	-	-	-	-	82
Selenastrum gracile Reinsch.	I	11	II	21	II	12	II	3	I	11	II	21	II	51	II	12	II	3	II	21	166
- minutum (Naeg.) Col.	-	-	I	2	-	-	-	-	I	2	II	41	II	21	II	12	-	-	-	-	78
- westii (G.M.) Smith.	I	2	II	30	II	30	II	12	II	31	II	31	II	31	II	12	-	-	-	-	179
Spirogyra sp. Link.	I	210	I	280	II	210	II	72	I	2	III	840	II	280	III	351	III	560	II	210	3015
Staurastrum punctulatum Bréb.	I	2	I	11	I	2	II	12	I	11	II	12	II	12	I	2	II	21	II	210	295
Stigeoclonium flagelliferum Kütz.	I	31	II	32	II	90	I	2	I	30	I	31	II	32	-	-	II	120	III	271	639
Stigeoclonium tenue Kütz.	I	2	I	2	II	150	I	2	I	2	I	31	I	1	-	-	II	91	III	270	551
Tetraëdron trigonum (Naeg.) Hansg. var. setigerum (Archer.) Lemm.	-	-	-	-	I	2	I	2	I	1	I	2	-	-	-	-	-	-	-	-	7
Tribonema subtilissimum Pascher	-	-	-	-	II	21	I	2	I	10	-	-	I	2	II	3	-	-	-	-	38
Ulothrix oscillarina Kütz.	-	-	I	2	I	2	-	-	-	-	II	32	I	2	-	-	-	-	-	-	38
- tenerrima Kütz.	-	-	I	2	-	-	-	-	I	2	-	-	I	2	-	-	-	-	-	-	6
- tenuissima Kütz.	I	2	-	-	-	-	-	-	I	31	II	91	I	31	I	2	-	-	-	-	157
- variabilis Kütz.	I	1	I	1	II	32	I	2	I	2	-	-	I	2	I	2	I	1	-	-	43
- zonata Kütz.	I	1	I	60	II	32	III	120	IV	391	IV	540	II	181	II	3	I	2	I	31	1361
Vaucheria sp. D. C.	-	-	I	31	I	61	II	180	I	121	-	-	-	-	-	-	-	-	-	-	393
Zygnema sp. Agardh.	II	120	II	61	-	-	II	150	II	91	III	211	II	151	II	91	II	61	-	-	936
C H A R O P H Y T A																					
Chara foetida A. Braun.	-	-	I	50	-	-	-	-	-	-	I	100	-	-	I	100	I	50	-	-	300
R H O D O P H Y T A																					
Batrachospermum moniliforme Roth.	II	122	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	122
Chantransia pygmaea Kütz.	-	-	-	-	I	31	I	31	-	-	I	2	I	2	-	-	-	-	-	-	66
F U N G I																					
Asterothrix rhaphidioides (Reinsch spec.) Printz	II	32	I	31	I	31	-	-	II	90	I	2	-	-	-	-	-	-	I	2	188

viatile (H e d w.) L s k a and *Brachythecium rivulare* (B r u c h) b r. e u r. It is possible that this may be the next, higher stage (succession) of development of the *C. glomerata* community, in which the principal role would belong to mosses. However, this demands further, detailed investigation.

Some species of accompanying algae appear exclusively in the upper course of the Skawa, others only in its lower course. Among them are many species characteristic for montane waters, but the very great majority is composed of ubiquitous and common species.

In places with or without current the same species of accompanying algae appeared, but the number of specimens was smaller, on the whole, in material from places with no current; in lenitic places the admixture of particles of slime was greater.

The total number of taxons of accompanying algae found in particular systematic groups and their total coefficients of coverage increased gradually as the length and abundance of *C. glomerata* thalli increased: the longer and better branched the thalli, the greater became the diversity of acompanying algae and the more numerous their specimens (fig. 6, Tables VII and VIII).

On the basis of dominating species with a high constancy class, the community of *Cladophora glomerata-epiphytosum rheobenthicum*, typically developed in the middle course of the Skawa, was differentiated. A facies characteristic for the upper course and a second one for the lower course of the river were also distinguished.

Among the determined species of algae the author found some species new to Polish flora and several of seldom reported species.

STRESZCZENIE

Na podstawie całokształtu omówionych badań i obserwacji nad rozmieszczeniem *Cladophora glomerata* i glonów towarzyszących w rzece Skawie w okresie jesiennym można stwierdzić że:

C. glomerata występowała w całym biegu rzeki Skawy od źródeł aż po ujście oraz we wszystkich jej dopływach, od 218 do 940 m n.p.m. (ryc. 1).

Maksymalny rozwój plech w rzece Skawie uzależniony był od kompleksu czynników, z których najważniejsze to: stałe podłoże (np. średniej wielkości kamienie itp.), miejsca prądowe rzeki dobrze oświetlone, temperatura wody 15—20°C, pH 8,8, zasadowość wody 1,8—2,2 mv, twardość wody 6,2 (tabela IV i VII).

Najkorzystniejsze warunki do bujnego i obfitego rozwoju plech stwarzał środkowy, górski odcinek rzeki Skawy (stanowiska 5—8; tabela VII i ryc. 6).

Plechy gałęzatki zebrane w rzece Skawie można podzielić na dwie grupy wyraźnie różniące się między sobą pod względem morfologicznym: plechy z miejsc prądowych określane jako *Cladophora glomerata rheobenthicum* oraz plechy z miejsc bezprądowych określane jako *Cladophora glomerata limnobenthicum*.

Wśród glonów towarzyszących wyróżniono glony makroskopowe porastające podłoże wraz z plechami gałęzatki, glony epifityczne przyczepiające się bezpośrednio lub

za pomocą stylików do komórek gałęzatki oraz glony utrzymujące się luźno pomiędzy tamtymi. Ogółem oznaczono 358 gatunków i niższych jednostek systematycznych glonów towarzyszących (tabela VIII i XII); ponadto znajdowano plechy gałęzatki splątane z mchami i z kwiatowymi roślinami wodnymi.

W skupieniach plech gałęzatki w płytszych prądowych partiach rzeki Skawy znajdowano mchy: *Hygrohypnum luridum* (Hedw.) Jennings, *Hygroamblystegium fluviatile* (Hedw.) Lske i *Brachythecium rivulare* (Bruch.) Br. eur., występujące niekiedy dość obficie. Być może, że jest to następne, wyższe stadium (sukcesja) rozwojowe zbiorowiska *C. glomerata*, w którym główną rolę odgrywałyby mchy. Stwierdzenie to wymaga jednak dalszych dokładnych badań.

Niektóre gatunki glonów towarzyszących występują wyłącznie w górnym biegu Skawy, niektóre wyłącznie w dolnym biegu. Jest też między nimi sporo gatunków charakterystycznych dla wód górskich, jednak ogromna większość to gatunki ubikwistyczne, pospolite.

W miejscach prądowych i bezprądowych występowały te same gatunki glonów towarzyszących jedynie ilości okazów były na ogół nieco mniejsze w miejscach lenitycznych, w których domieszka cząstek mułu była większa.

Ogólna ilość znalezionych jednostek systematycznych glonów towarzyszących z poszczególnych grup systematycznych i ich sumaryczne współczynniki pokrycia stopniowo wzrastały wraz ze wzrostem długości i obfitości plech gałęzatki: im plechy były dłuższe i lepiej rozgałęzione tym większa była różnorodność glonów towarzyszących i większe liczby ich okazów (ryc. 6, tabela VII i VIII).

Uwzględniając gatunki dominujące o wysokiej klasie stałości, wyróżniono zbiorowisko *Cladophoretum glomeratae-epiphytosum rheobenthicum* wykształcone typowo w środkowym biegu Skawy. Ponadto wyróżniono fację charakterystyczną dla górnego biegu i drugą dla dolnego biegu rzeki.

Wśród oznaczonych gatunków glonów autor znalazł kilka gatunków nowych dla flory Polski oraz szereg gatunków rzadko podawanych.

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