INSTYTUT BIOLOGII DOŚWIADCZALNEJ
IM. M. NENCKIEGO POLSKIEJ AKADEMII NAUK

THE NENCKI INSTITUTE OF EXPERIMENTAL
BIOLOGY POLISH ACADEMY OF SCIENCES

POLSKIE ARCHIWUM HYDROBIOLOGII

POLISH ARCHIVES OF HYDROBIOLOGY

VOL. XVII (XXX)

No. 3

Founded by
A. LITYŃSKI, M. BOGUCKI

Editor
R. Z. KLEKOWSKI

PWN • WARSZAWA 1970

POLSKIE ARCHIWUM HYDROBIOLOGII
jest kontynuacją Archiwum Hydrobiologii i Rybactwa

POLISH ARCHIVES OF HYDROBIOLOGY
formerly Archives d'Hydrobiologie et d'Ichthyologie

Polskie Archiwum Hydrobiologii existing as such since 1953, is a continuation of *Archiwum Hydrobiologii i Rybactwa* founded in 1926 under the editorship of A. Lityński; during the period 1926 to 1939 and in 1947, thirteen volumes of *Archiwum Hydrobiologii i Rybactwa* have appeared, volume XII, 3, 4 published in September 1939, being almost entirely destroyed due to war action.

The journal publishes original works reporting experimental results, descriptive works and theoretical investigations in every sphere of hydrobiology. The article must contain original research not already published and which is not being considered for publication elsewhere. Papers will be published in the official Congress languages of Societas Internationalis Limnologiae (at present: English, French, Italian and German).

NOTICE TO AUTHORS

About manuscripts preparation principles will be printed in the last number of 1970, together with the yearly contents.

POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	329–335	1970

A. SZCZEPAŃSKI

METHODS OF MORPHOMETRICAL AND MECHANICAL CHARACTERISTICS OF *PHRAGMITES COMMUNIS* TRIN.

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ABSTRACT

Morphometrical characteristics of reed were compared with their mechanical characteristics. Estimation criteria used in reed investigations were chosen.

CONTENTS

1. INTRODUCTION

Investigations of the productivity of macrophytes are usually carried out by estimating the maximum biomass (WESTLAKE 1965). This measurement does not use up all the possibilities within this group of methods known together as "methods of growth analysis" (KVET 1966). Biometrical measurements taken at determined moments of development are the elements of the method of growth analysis.

In the instance of reed, the biometrical measurements may be also used to determine the connections between the biological production and the environment, and also between the biological production and the use value. However, the objective criteria of such estimation are lacking. Though the biometrical characteristics are the result of both anatomical-morphological and biochemical features, the anatomical analysis itself does not determine its use value, but only explains it.

The existing standard PN-57/B-20 109 under the title "Building Reed" discusses only the technical requirements essential for building industry. They are incomplete, and as we read in the preface, a supplement is indispensable. In literature discussing the estimation of usable reed much attention is paid to the volume and amount of fibre — essential feature for cellulose industry — while none to the morphometrical characteristics (TOBLER 1943, RUDESCU et al. 1965).

Therefore in order to begin the complex comparative investigations of reed we had to prepare estimation criteria of usable reed. Thus we obtained, still incomplete, representation of connections between respective features and the variation range of discussed features. At the same time visible dependences between the investigated features and biological conditions, in which the development of investigated reed took place, were found.

While describing the estimation criteria, both the features used in anatomical-morphological investigations and also those used in production-ecological investigations, and industrial criteria (Björk 1967, Rudescu et al. 1965), were taken into consideration to the same extent.

2. PARAMETERS OF MORPHOLOGICAL CHARACTERISTICS

Shoot

A. Length.
  I. Length of the shoot:
    a. total (from the soil surface),
      α to the top of panicle,
      β to the place, where the upper leaf is attached,
      γ to the place, where the lower green leaf is attached,
    b. emerged part,
    c. submerged part.
  II. Length of the stalk:
    a. total (to the base of panicle),
    b. industrial (emerged length to the base of panicle).
  III. Length of the internode:
    a. real length of the internode (measured value),
    b. average length for the given stalk (value calculated from the measurements of all internodes of the same stalk),
    c. the average of this order in a sample (e.g. the average of the IV internode in the given reed-belt).

B. Thickness of the shoot:
    a. at the bottom,
    b. at the water level,
    c. top (at the base of the panicle),
    d. on the level of the leaf sheaths of the lower green leaf,
    e. the diameter of the inside hole,
    f. thickness of the stalk wall.

C. Convergence:

$\frac{\varnothing d - \varnothing g}{l}$ in mm/m provides information about the slenderness of stalk,

$\varnothing\, d$ = diameter of the under-internode in mm,

$\varnothing\, g$ = diameter of the top internode in mm,

l = total length of the stalk in m.

Leaf

A. Length;
B. Maximum breadth;
C. Mean breadth;
D. Breadth indicator B/A;
E. Area:
  a. real (the determined value for definite leaf),
  b. the average for the stalk,
  c. total for the shoot,

d. total per surface unit LAI (Leaf Area Index: in plant ecophysiology — proportion between the total area of assimilating leaves and the soil surface, on which these plants grow).

Panicle

A. Length.

Biomass

A. Of one shoot:
   a. total,
   b. of green leaves,
   c. of panicle,
   d. of dry leaves,
   e. of side shoots,
   f. of adventitious root.
B. Of subterranean parts;
C. Per surface unit of the bottom (each item of A and B);
D. Proportion of subterranean parts to overground parts;
E. Proportion of leaf area to the plant's biomass (LAR).

The presented morphometrical features do not cover the entire problem and the list of these features may be expanded if necessary.

The majority of mentioned biometrical characteristics creates initial material to estimate the productivity using the methods of growth analysis. This method does not require complicated devices, and may be commonly applied, where macrophytes are concerned.

3. PARAMETERS OF MECHANICAL CHARACTERISTICS

The mechanical strength of reed is also connected with the morphometrical characteristics, which on one hand determine the usefullness of reed in industry, and on the other — illustrate the living conditions of reed.

Especially interesting are the flexibility and brittleness of the stalk. The tensile strength is of lesser significance.

The measurements of two first characteristics are relatively simple to make, but the measurement of tensile strength despite its seeming simpleness, meets some methodical difficulties, which limit the possibilities of using it.

Both the flexibility and brittleness of stalk are the effect of the same elements of stalk structure and differ only as to the measurements technique.

If the morphometric measurements do not require lengthy explanations and immediately give the right information about the condition of reed, then the mechanical properties, which are the function of many components, require a visualization of connections between the measured effect and morphometrical characteristics on one hand and conditions of the measurement on the other hand. Only standardization of the measurements allows to draw conclusions about the biological dependences.

The flexibility of reed stalk is measured by loading the propped stalk in two constant points with a weight and determining the deflection condition (Fig. 1).

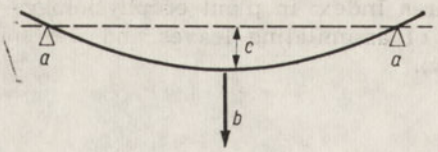

Fig. 1. The diagram of the deflection measurement of reed stalk under loading. a — propping points; b — place of loading; c — deflection condition

The deflection condition depends on the spacing of props and the loading quantity according to the principles of mechanics and the arrow is directly proportional to loading (Fig. 2). In the investigations of reed we accepted as normal measurement the deflection as a result of loading with 500 g, at 500 mm spacing of props.

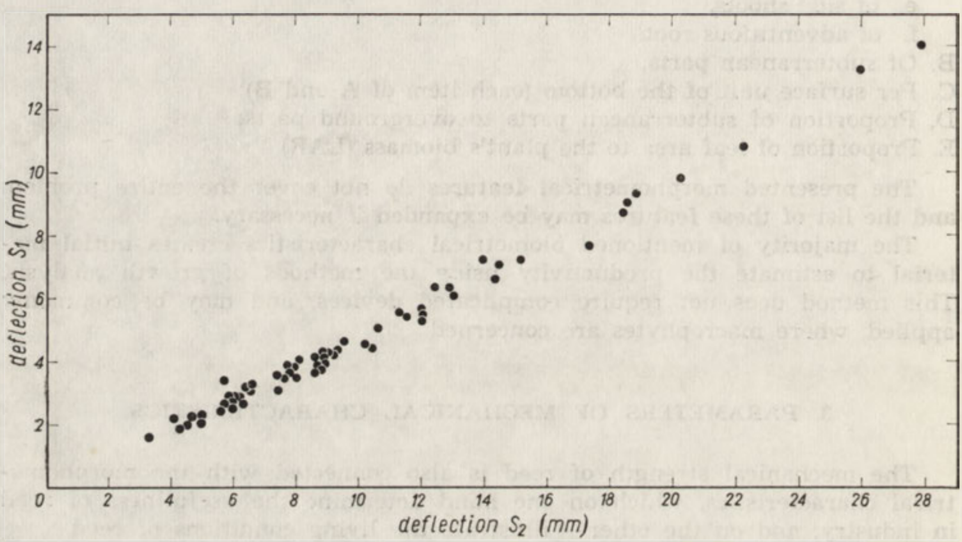

Fig. 2. Deflection condition of reed under different loadings. S_1 — deflection condition under the loading 250 g at spacing 500 mm; S_2 — deflection condition of the same reed under the loading 500 g and spacing 500 mm (reed from Mikołajskie Lake)

The deflection condition depends on the degree of reed humidity. The drier is the reed the stiffer it is and at the same the dispersion of measurements in series is smaller. For example: the reed collected in winter — directly after — 11 ± 1 mm; the same reed air-dry — 10.4 ± 0.8 mm; and the reed dried at 105°C — 9.9 ± 0.5 mm. But reed soaked in water and then dried at 105°C becomes more flexible. This dependence is presented in Fig. 3. Gradually, while remaining in water, the deflection condition increased from 11.4 mm to 26.3 mm, regularly increasing the deflection about 0.8 mm per 1 month of soaking.

The deflection condition as a result of loading also depends on the stalk diameter. It is inversely proportional to r^4 (radius raised to the fourth power) (Fig. 4), and it should be pointed out that the scatter is quite big as apart from the diameter the thickness of the walls and the length of internodes

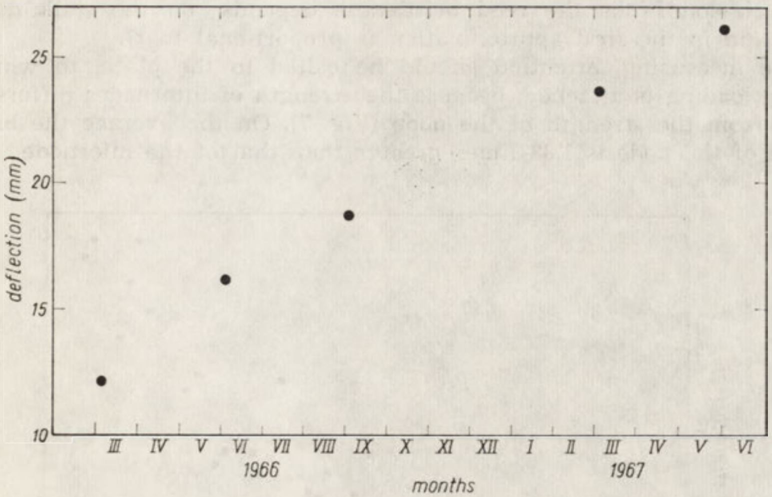

Fig. 3. The dependence of reed deflection from the time, during which it stays in water (reed collected from Mikołajskie Lake in March 1966)

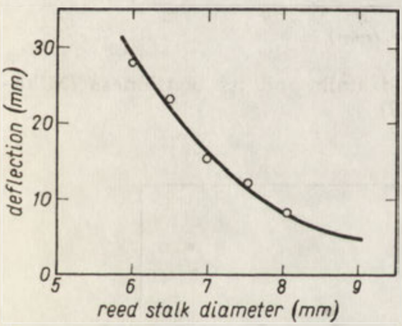

Fig. 4. Dependence of reed deflection from its diameter (reed from Mikołajskie Lake, 1966); loading 500 g, spacing 500 mm. Each point represents the average from 10–20 measurements

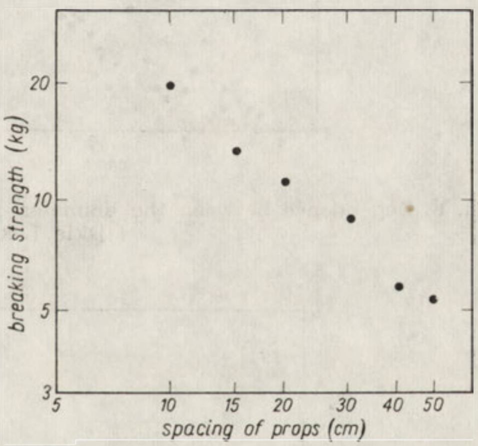

Fig. 5. Dependence of the breaking strength of reed on the spacing of props (reed from Mikołajskie Lake, 1966. Double log scale)

is also important. These elements represent to some extent the habitat, and the deflection measurement may be used to estimate the reed from various stations.

Brittleness of reed (loading the reed stalk propped in two points till it breaks) depends on the prop spacing, and Fig. 5 illustrates this dependence. It is inversely proportional to spacing. The spacing of 100 mm has been accepted as standard.

In such conditions the reed brittleness depends on the stalk diameter (Fig. 6) and in the first approximation is proportional to r^2.

While measuring, attention should be called to the place, to which the breaking loading is attached, because the strength of internodes differs considerably from the strength of the node (Fig. 7). On the average the breaking strength of the node is 1.83 times greater than that of the internode.

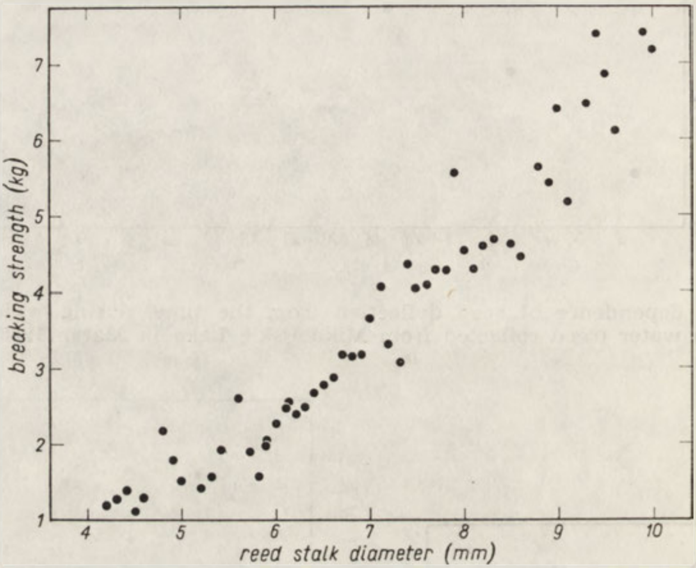

Fig. 6. Dependence between the diameter of reed stalk and its brittleness (Mikołajskie Lake 1967)

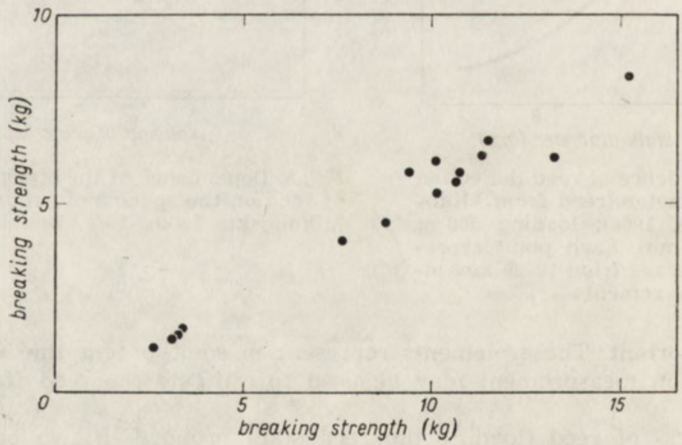

Fig. 7. Brittleness of nodes and internodes. X-axis — breaking strength attached to the node; Y-axis — breaking strength attached to the adjoining internode. Each point represents the average from 10 stalks (Mikołajskie Lake 1967)

Comparison of biometrical characteristics, which are the grounds for growth analysis, with mechanical properties of reed allows to find connections between the biological productivity and the industrial value of reed.

4. SUMMARY

Reed morphometric elements used in a growth analysis were discussed as well as the reed resistance character determining the usefulness of reed for industrial purposes.

5. STRESZCZENIE

Omówione zostały elementy morfometryczne trzciny używane w analizie wzrostowej oraz charakterystyki wytrzymałościowe trzciny określające jej przydatność dla celów przemysłowych.

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Comparison of biometrical characteristics, [illegible] the [illegible] growth analysis, with mechanical properties [illegible] tions between the biological product [illegible]

[illegible]

Reed morphometric methods used [illegible] as the reed resistance of [illegible] purposes.

7 STRESZ[illegible]

Omówione zostały metody morfometr[illegible] lowej oraz charakterystyk [illegible] dla celów przemysłowych.

8 REFEREN[illegible]

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POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	337–356	1970

M. PLANTER

PHYSICO-CHEMICAL PROPERTIES OF THE WATER OF REED-BELTS IN MIKOŁAJSKIE, TAŁTOWISKO AND ŚNIARDWY LAKES

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ABSTRACT

The chemical composition of water in reed-belt profiles of eutrophic, mezotrophic and polymictic lakes of Mazurian Lakeland was studied. It was found that the chemical mechanism of the waters of open reed-belt having a contact with the mid-lake water undergoes similar seasonal changes as the chemism of epilimnion.

CONTENTS

1. INTRODUCTION

Littoral is a separate zone in the lake. The production of this zone depends on several factors such as e.g. configuration of the coastal sandbank, wave motion, chemical and mechanical composition of bottom sediments and the abundance of mineral salts. Therefore within the same lake, several types of littoral may be distinguished, e.g. in Lake Śniardwy distinguished were: 1. psammolittoral, 2. psammolittoral with great lake helophytes, 3. phytolittoral of great lakes (BERNATOWICZ and ZACHWIEJA 1966). The water in bays of lakes differs as to the amount of phytoplankton from the waters of mid-lake (SZCZEPAŃSKA 1967). The separateness of littoral, the isolation of some its types from pelagic waters (RYBAK et al. 1964) and the differentiation from the point of vegetation (BERNATOWICZ and ZACHWIEJA 1966) undoubtedly affect the chemical properties of water in this part of the lake. Investigations of ZACHWIEJA (1965) show a spatial differentiation of physico-chemical properties of water in the littoral of Lake Mamry. As the distance from the shore increases the alkalinity decreases, pH increases and also oxygenation of water. The amount of oxygen in water increases successively with the distance from the shore, while the amount of organic matter decreases (GIEYsztor 1961). The author suggests a variability of chemical composition of water depending on morphological conditions and the existence of differentiation of littoral water and "open waters" of the lake from the point of the content of chemical components.

Investigations carried out in the Volga Delta (Ivlev 1950) showed a differentiation of chemical properties of water within the same reed-belt. The water of the reed-belts had a lower pH, lower oxygen content and higher BOD than the water in the river. Intensive decomposition of *Phragmites communis* took place even in anaerobic conditions causing the passage of mineral components and easily soluble organic compounds into water.

Therefore it seemed useful to: 1. examine the chemical properties of the water of reed-belts in several lakes, the possible differentiation within the same reed-belt and comparison of the chemical properties of water of the reed-belt with the chemism of littoral water beyond the reed-belt, 2. examine the seasonal changes of the physico-chemical properties, of the basic mineral components and some biogenes of the water of reed-belts.

2. TERRAIN DESCRIPTION AND METHODS

Investigations were carried out in three lakes of the Mazurian Lakeland: in eutrophic Mikołajskie Lake, in mezotrophic Lake Tałtowisko and polymictic Lake Śniardwy (Olszewski and Paschalski 1959). In each of these lakes within the reed-belt a profile perpendicular to the shore line of the lake was delimited. The profiles in Mikołajskie Lake and Lake Tałtowisko included the whole breadth of the reed-belt.

The profile in Mikołajskie Lake included 6 stations (Fig. 1A). The stations from 1 to 5 were in the reed-belt, station 5 on the line of reed-belt and water (the margin of the reeds), station 6 — the control one — beyond the reed-belt. The reed-belt was about 20 m broad. The investigations were carried out from January 1967 to March 1968. Samples of water were taken on the average every 2 weeks.

The profile in Lake Tałtowisko included 5 stations (Fig. 1B). Station 4 was on the margin of the reed-belt, while the control station 5 was beyond the reed-belt. The reed-belt was 42 m broad. Investigations were carried out from January 1967 to March 1968. Samples of water were taken on the average every 2 weeks.

The profile in Lake Śniardwy included only the part of reed-belt because of the difficulties in sampling water from the inshore part of the reed-belt. Station 1 was about 60 m distant from the shore (Fig. 1C) in front of the heap of dead reed accumulated by the water, which limited the contact of this part of reed-belt with the water of the mid-lake (isolated reed-belt). Stations 2, 3 and 4 were delimited in the part of reed-belt having a contact with the water of mid-lake (open reed-belt), and the control station 5 was beyond the reeds. The reed-belt from the shore to the margin was 200 m broad. The water from the profile of reeds in Lake Śniardwy was sampled in monthly intervals from May 1967 to March 1968.

Samples of water in particular stations were taken from above the bottom using Ruttner apparatus. Before the colorimetric determinations were made the samples of water were filtered through soft filter paper to separate the suspensions. The chemical composition of water was investigated using the classic methods (Just and Hermanowicz 1955, Standard Methods 1960). Calcium, sodium and potassium were determined after previously being con-

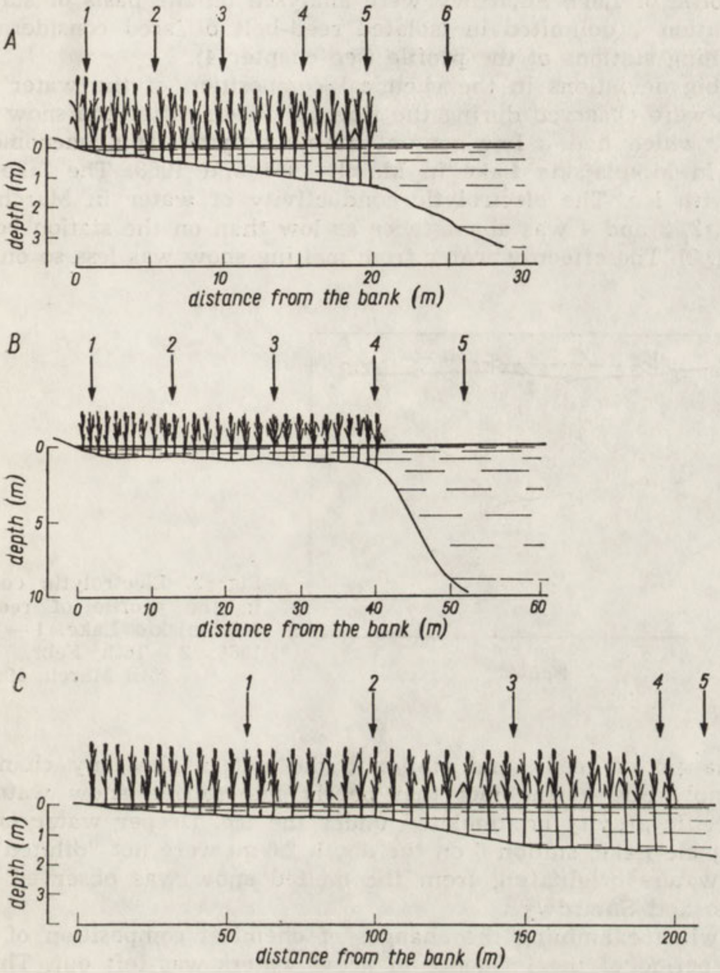


Fig. 1. Distribution of stations in the profiles of reed-belts. 1–6 — station numbers. A — Mikołajskie Lake; B — Tałtowisko Lake; C — Śniardwy Lake

verted into chlorides on a flame photometer. The total concentration of dissociated compounds was indirectly controlled by measurements of the electrolytic conductivity.

3. CHANGES IN TIME OF PHYSICO-CHEMICAL PROPERTIES

The physico-chemical properties and basic chemical components displayed within the profile of open reed-belts a slight gradation (see chapter 4). The changes in time of these elements were considered for the reed-belts in Mikołajskie Lake and Lake Tałtowisko cn the basis of station 3 and the control one beyond the reeds. Changes in time of the chemical properties of water in the profile of Lake Śniardwy were analysed on the basis of stations 1, 3 and 5. Station 1 delimited in isolated reed-belt differed considerably from the remaining stations of the profile (see chapter 4).

Quite big deviations in the chemical composition of the water from the reed-belts were observed during the flow of waters, after the snow had melted away, which had a low content of electrolytes. This phenomenon was observed in Mikołajskie Lake in March 1967 and 1968. The lake was yet covered with ice. The electrolytic conductivity of water in March 1967 on stations 1, 2, 3 and 4 was about twice as low than on the station beyond the reeds (Fig. 2). The effect of water from melting snow was less so on station 5

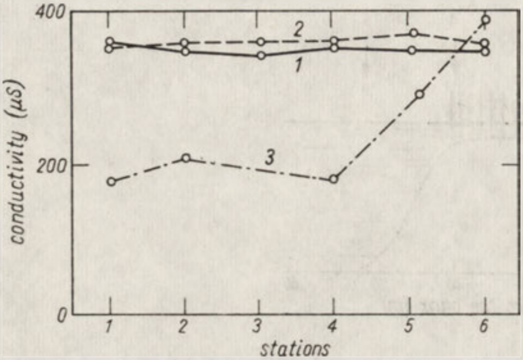


Fig. 2. Electrolytic conductivity in the profile of reed-belt of Mikołajskie Lake. 1 — 26th Jan., 1968; 2 — 16th Febr., 1968; 3 — 26th March, 1968

on the margin of reeds, and station 6 did not display any changes. This was probably due to the fact that poorly mineralized snow water having a low specific gravity accumulated under the ice. Deeper water layers (e.g. in Mikołajskie Lake, station 6 on the depth 2.6 m) were not "diluted". Similar effect of waters originating from the melted snow was observed in Lakes Tałtowisko and Śniardwy.

Thus, when examining the changes of chemical composition of water in time, the period of the influence of snow waters was left out. This phenomenon stands apart frcm all the processes taking place in the lake reed-belts.

Electrolytic conductivity — $\varkappa_{20}$

Mikołajskie Lake (Fig. 3A). The highest values were observed fom January to May; a decrease since the end of May; an increase since November till the winter [1] maximum (December, January, February). The electrolytic conductivity on stations 3 and 6 (leaving out the period of spring flow of snow waters) ranged from 290 to 360 µS.

Lake Tałtowisko (Fig. 3B). Maximum values from December to May (360 to 404 µS), a decrease since May, minimum values in summer (334 to 373 µS), in autumn since October — an increase.

Lake Śniardwy (Fig. 3C). Very slight changes in time of the electrolytic conductivity on stations 3 and 5 (in autumn and winter about

[1] "Seasons" were used according to yearly seasons, not lake ones.

310 μS, in summer from 280 to 300 μS). An increase since May on station 1. The maximum values — October and February. In November and December — lack of water on the station.

pH

Mikołajskie Lake (Fig. 4A). Its level was close to 8 (leaving out the spring flow of snow waters to littoral) from December to February. It increased since April; maximum values from May to August — about 8.5; a decrease since September.

Tałtowisko Lake (Fig. 4B). The lowest pH in winter months: 7.7 to 8.0, the highest pH from May to mid-September: 8.3–8.8.

Lake Śniardwy (Fig. 4C). In the open reed-belts (i.e. having a contact with mid-lake water) the pH underwent very slight changes and ranged within the limits 7.9 to 8.4. In summer (July, August, beginning of September) it was slightly higher than in winter and autumn. But on station 1 the water reaction was from 7.4 to 7.9.

Concentration of HCO_3^-

Mikołajskie Lake (Fig. 5A). The maximum concentration of HCO_3^- is in winter: 2.70–2.89 mval/l and minimum in summer: 2.45–2.72 mval/l, in spring and autumn it was lower than in winter and higher than in summer. The amplitude of the fluctuations of the HCO_3^- concentration from January 1967 to March 1968 (leaving out the spring flow of snow waters for March) was for the stations 3 and 6 — 0.45 mval/l.

Lake Tałtowisko (Fig. 5B). The highest values were observed in winter and spring: 2.72–3.10 mval/l, the lowest — in August, September and October: 2.61–2.85 mval/l. Since October — an increase to the winter maximum. The amplitude of fluctuations in the investigated period was 0.55 mval/l (not taking into consideration the minimum in March).

Lake Śniardwy (Fig. 5C). Slight changes in water of the "open" part of reed-belt with a tendency to decrease from winter to summer. The amplitudes of fluctuations were: for station 3 — 0.25 mval HCO_3^-/l, for station 5 — 0.30 mval/l. The HCO_3^- concentration on station 1 was much higher than in the water of open reed-belt. The maximum values were observed in August and during autumn.

Calcium

Mikołajskie Lake (Fig. 6A). Maximum concentrations in May, June, September and the beginning of October (42–50 mg/l); minimum ones from July to mid-September (36–41 mg/l). In winter Ca concentrations were from 39 to 45 mg/l.

Lake Tałtowisko (Fig. 6B). During winter and spring from 42 to 55 mg/l (leaving out the period of spring flow of snow waters); a decrease since June, minimum in summer (July, August, beginning of September). In autumn the Ca concentration was higher than in summer and slightly lower than in winter.

Lake Śniardwy (Fig. 6C). During winter, spring and autumn on stations 2 and 5 — 32–40 mg/l; in summer from June to September — 29–30 mg Ca/l. On station 1 where the contact with mid-lake water was somehow limited there was more of calcium, even up to 105 mg/l in August 1967.

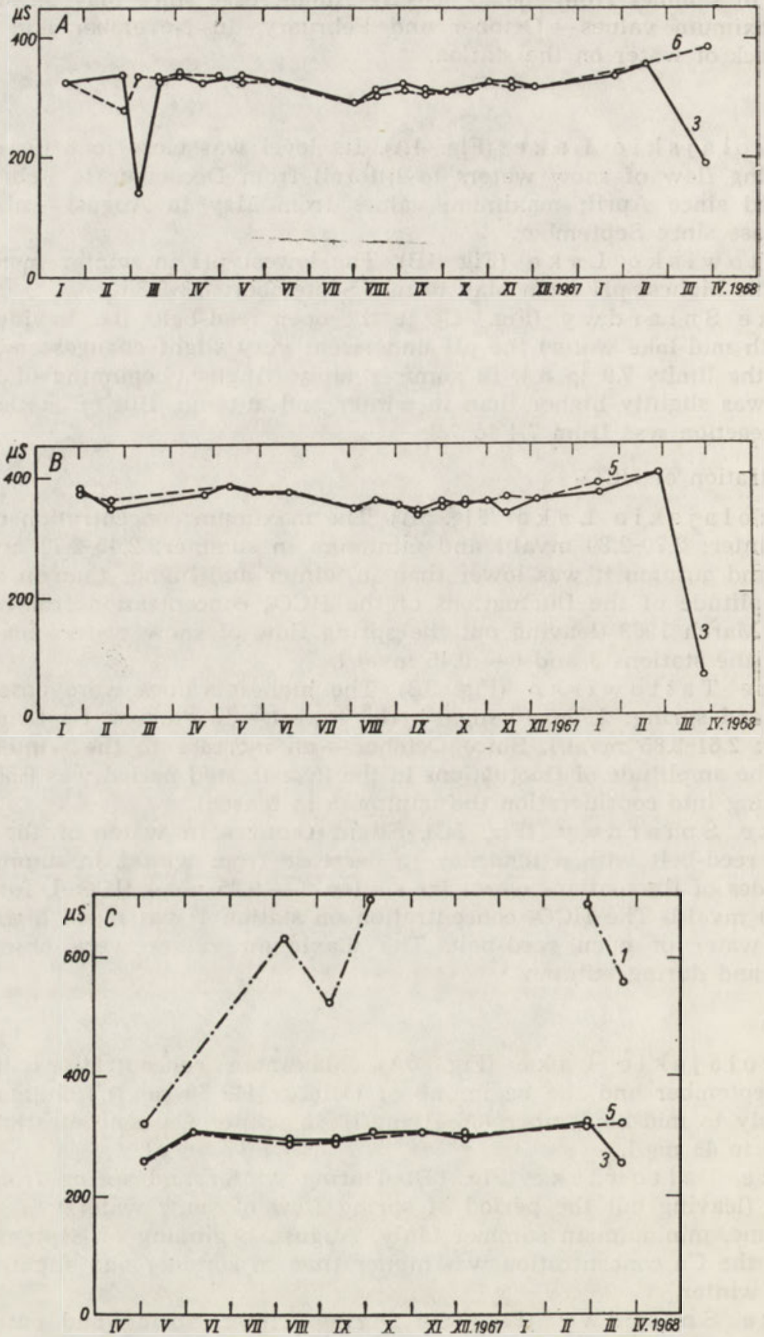


Fig. 3. Time changes of the conductivity of the reed-belts water. A — Mikołajskie Lake; B — Tałtowisko Lake; C — Śniardwy Lake. (1, 3, 5, 6 — numbers of stations)

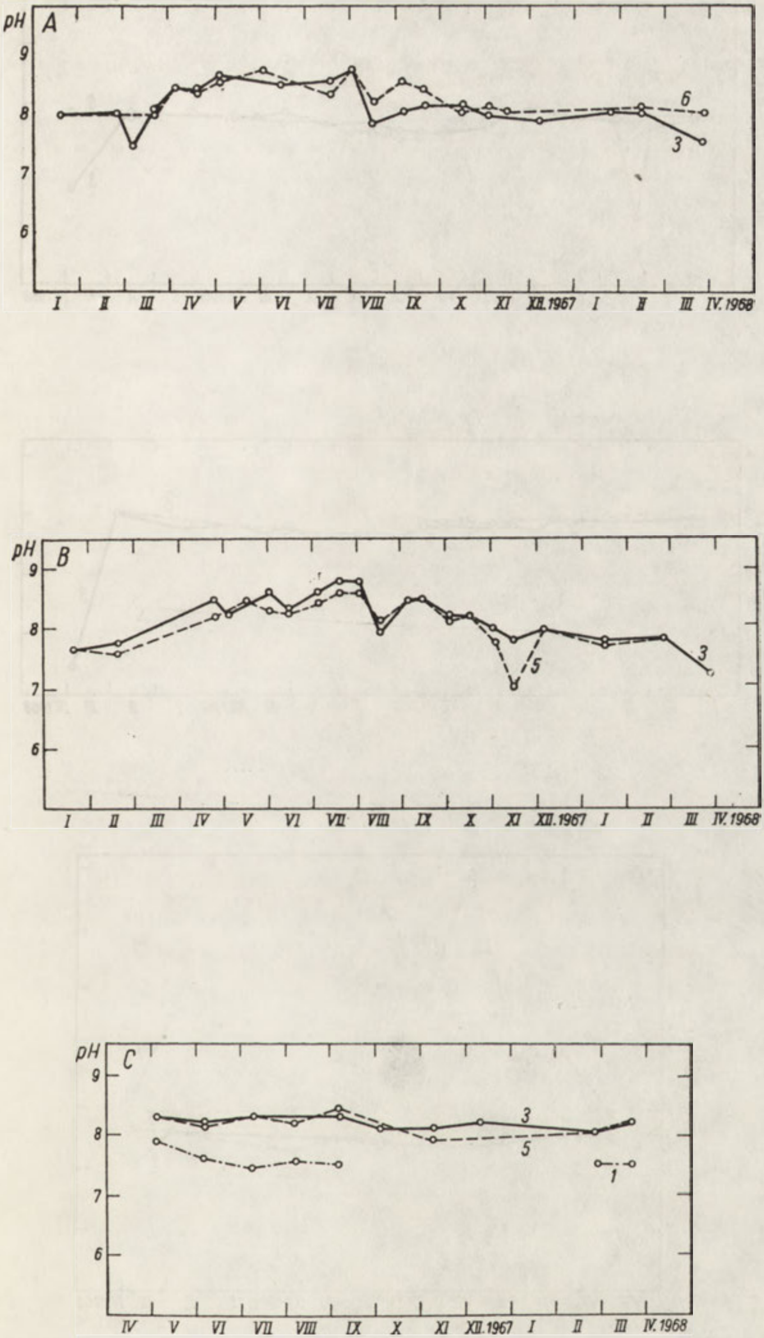


Fig. 4. Time changes of the pH of the reed-belts water. A — Mikołajskie Lake; B — Tołtowisko Lake; C — Śniardwy Lake. (1, 3, 5, 6 — numbers of stations)

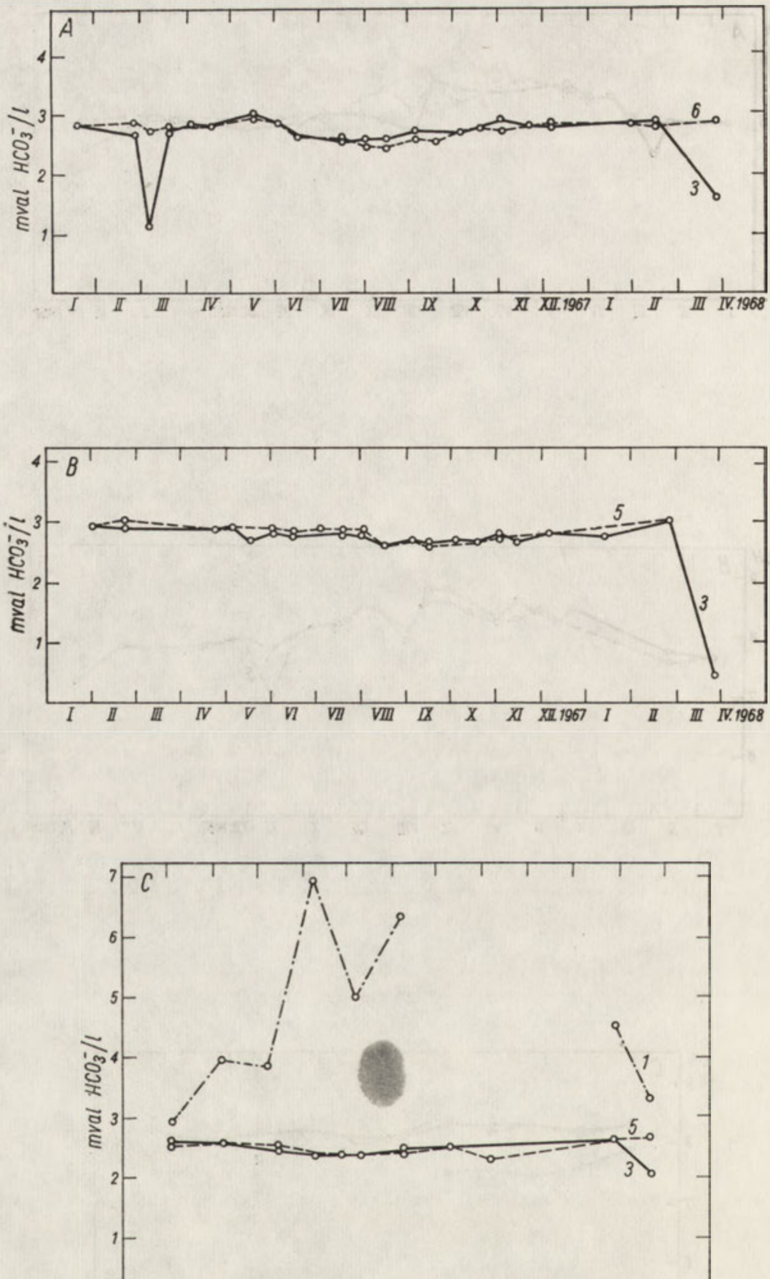


Fig. 5. Time changes of HCO_3^- concentration in the reed-belts water. A — Mikołajskie Lake; B — Tałtowisko Lake; C — Śniardwy Lake. (1, 3, 5, 6 — numbers of stations)

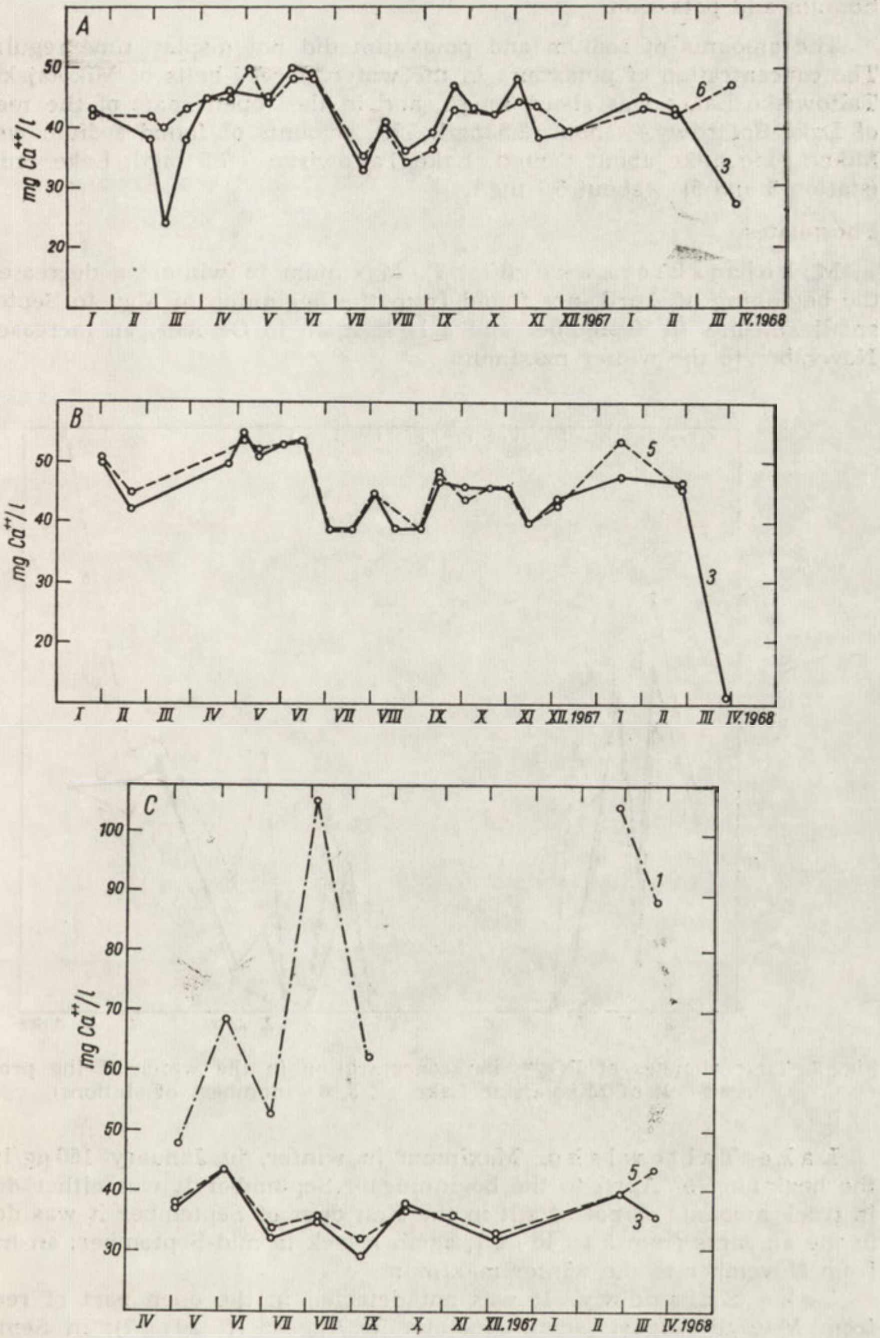


Fig. 6. Time changes of Ca concentration in the reed-belts water. A — Mikołajskie Lake; B — Tałtowisko Lake; C — Śniardwy Lake. (1, 3, 5, 6 — numbers of stations)

Sodium and potassium

The amounts of sodium and potassium did not display time regularities. The concentration of potassium in the water of reed-belts of Mikołajskie and Tałtowisko Lakes was about 3 mg/l, and in the "open" part of the reed-belt of Lake Śniardwy — about 2.5 mg/l. The amounts of found sodium were: in Mikołajskie Lake about 6 mg/l, Lake Tałtowisko — 7.5 mg/l, Lake Śniardwy (station 3 and 5) — about 5.7 mg/l.

Phosphates

Mikołajskie Lake (Fig. 7). Maximum in winter; a decrease since the beginning of April, not found from the beginning of May to September; small amounts in September and a lack again in October; an increase since November to the winter maximum.

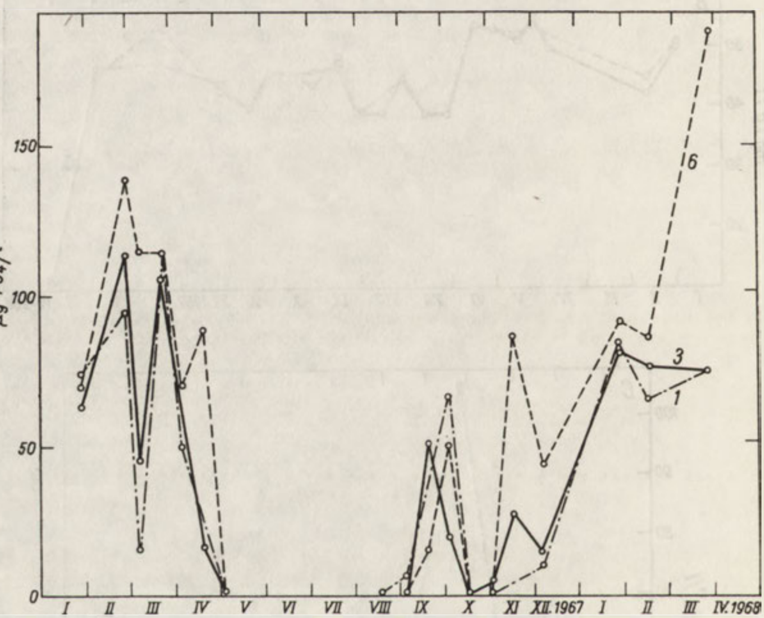


Fig. 7. Time changes of PO_4^{---} ion concentration in the water of the profile of reed-belt of Mikołajskie Lake. (1, 3, 6 — numbers of stations)

Lake Tałtowisko. Maximum in winter, in January 150 μg/l; from the beginning of April to the beginning of September it was either detected in track amounts or not at all; in the first days of September it was detected in the amounts from 5 to 40 μg/l; again a lack in mid-September; an increase from November to the winter maximum.

Lake Śniardwy. It was not detected in the open part of reed-belt from May to August; small amounts in August (10–20 μg/l); in September either track amounts were detected or none at all; reappearance in November; maximum in winter (25–55 μg/l). It was not detected in May and June in the isolated part; from July to March 1968 the concentration of phosphates was from 25 μg/l to 3.3 mg/l; the maximum in September. There was a lack of phosphates on station 1, when the water level was relatively high (about 40 cm) and the electrolytic conductivity not much higher than in the open part (see Fig. 3C).

Ammonia nitrogen

Mikołajskie Lake. Higher concentrations from September to January, on the average 0.19 mg/l; in the remaining period of time it was more or less even, on the average 0.13 mg/l.

Lake Tałtowisko. No visible changes in time, and the concentration was on the average 0.20 mg/l.

Lake Śniardwy. In the open part of the reed-belts the level was even, on the average 0.11 mg/l. In the isolated reed-belts the concentration of ammonia nitrogen was considerably higher, on the average 0.44 mg/l.

Dissolved total iron

Mikołajskie Lake (Fig. 8). Maximum concentrations in May, June and July, minimum ones in the first days of September.

Lake Tałtowisko. It is present during the entire period of investigations in an average amount 85 μg/l, and similarly in the open reed-belt of Lake Śniardwy — about 75 μg/l.

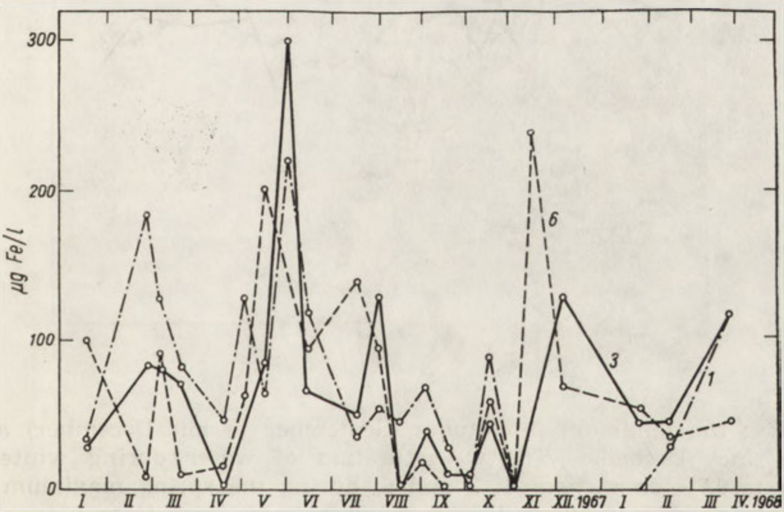
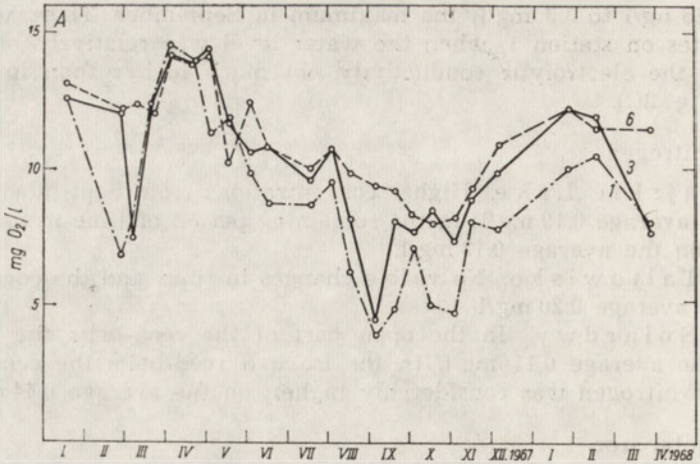
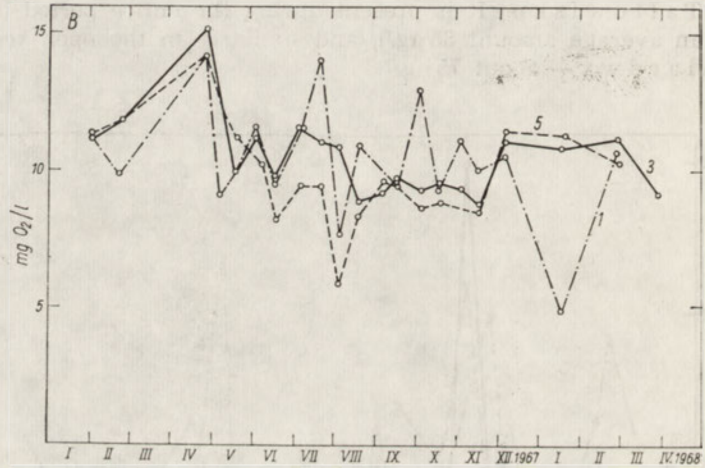


Fig. 8. Time changes of Fe concentration in the water of the profile of reed-belt of Mikołajskie Lake. (1, 3, 6 — numbers of stations)

Dissolved oxygen

Mikołajskie Lake (Fig. 9A). During the flow of snow waters to the littoral (March 1967 and 1968) a lower oxygen level was observed on stations 1 and 3 than on the station beyond the reed-belt. The maximum in April and at the beginning of May after the ice had broken up; a decrease





since May; the minimum in autumn (September to mid-December) and an increase since December. The O_2 saturation of water during winter was from 48 to 92% on stations 1, 3 and 6; during the spring maximum about 115%, in summer from 47 to 125%, and in autumn from 41 to 81%.

Lake Tałtowisko (Fig. 9B). In winter, when the lake was frozen the oxygenation of water was from 35 to 82%. After the ice had broken up (the second half of April) the maximum of oxygen concentration was from 102 to 129%. In spring (apart from the April maximum) the saturation was within the range from 88 to 107%, in summer from 70 to 162%, and in autumn from 74 to 134%.

Lake Śniardwy (Fig. 9C). Maximum oxygen concentration in the open part of reed-belt in March — about 15 mg/l. The concentrations were higher in winter than in summer and autumn. The oxygenation of water on

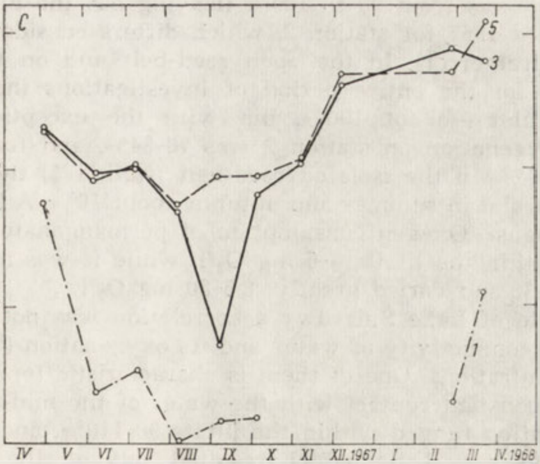


Fig. 9. Time changes of oxygen concentration in the reed-belts water. A — Mikołajskie Lake; B — Tołtowisko Lake; C — Śniardwy Lake. (1, 3, 5, 6 — numbers of stations)

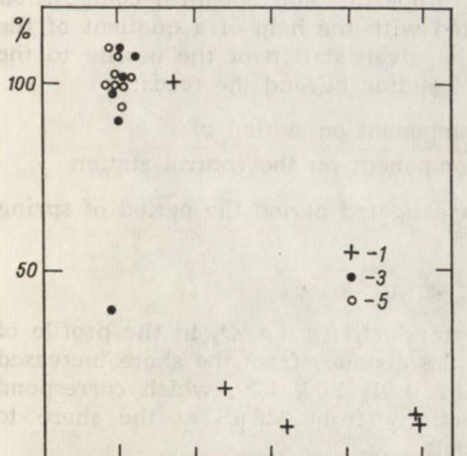


Fig. 10. Correlation between the electrolytic conductivity of water and the per cent of its oxygenation. Śniardwy Lake. (1, 3, 5 — numbers of stations)

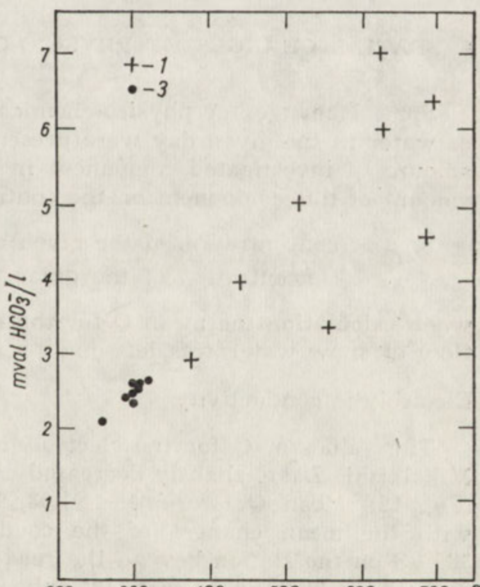


Fig. 11. Correlation between the electrolytic conductivity of water and the concentration of HCO_3^- ions. Śniardwy Lake. (1, 3 — numbers of stations)

stations 3 and 5 was from 90 to 109% (leaving out the measurement on the 6th of September 1967 for station 2, which differs considerably and is probably an analytical errcr). In the open reed-belt and on the station beyond the reed-belt — for the entire period of investigations the oxygenation was in general regular — about 100%, but with the exception of autumn. In autumn the oxygenation on station 2 was 78–84%, and for stations 3, 4 and 5 from 90 to 99%. In the isolated reed-belt (station 1) the oxygenation was frcm 0 to 100%, and in summer and autumn about 10%. A lack of oxygen was observed in August. Oxygen consumption of permanganate in the cpen reed--belt ranged within the limits 4–6 mg O_2/l, while it was much higher in the isolated reed-belt and varied greatly: 8.5–30 mg O_2/l.

In the profile of Lake Śniardwy a correlation was not observed between the electrolytic conductivity of water and its oxygenation (Fig. 10). The points form two concentrations. One of them is characteristic for the water of reed--belt having a constant contact with the water of the mid-lake (station 3 and 5). The oxygenation ranged within the limits 90–110%, and the scatter of the conductivity was very little, which resulted out of the seasonal changes (see Fig. 3C). But in the isolated reed-belts the low water oxygenation (0-19%) was usually accompanied by high conductivity (from 440 to 695 μS).

A positive correlation was observed between the concentration of bicarbonate ions and the conductivity. Generally for the obtained range of concentrations the water with a higher HCO_3^- concentration had higher conductivity (Fig. 11). Similar correlation was obtained by Szczepański (1968) for the lakes of the Krutynia River basin.

4. SPATIAL CHANGES OF PHYSICO-CHEMICAL PROPERTIES IN PROFILES

Spatial changes of physico-chemical properties and chemical composition of water in the given day were presented with the help of a quotient of the amount of investigated component in the given staticn of the profile to the amount of this component on the control station beyond the reeds:

$$Q = \frac{\text{concentration of the given component on station } x}{\text{concentration of the given component on the control station}}$$

when calculating the mean Q for the investigated period the period of spring flow of snow water was left out.

Electrolytic conductivity

The values of Q for the electrolytic ccnductivity, i.e. $Q_{\varkappa}$ in the profile of Mikołajskie Lake, slightly decreased as the distance from the shore increased (Fig. 12). Mean $Q_{\varkappa}$ were: 1.04, 1.03, 1.01, 1.01, 1.00, 1.00, which correspond with the mean changes of the conductivity from 338 μS at the shore to 325 μS on the station beyond the reed-belt.

In Lake Tałtowisko (Fig. 12) only station 1 was slightly richer in mineral salts, while on the others $Q_{\varkappa}$ were equal 1.00. The water in the isolated reed--belt — Śniardwy, station 1 — had often twice as high conductivity than the water in the control station. Mean $Q_{\varkappa}$ was 1.74 (Fig. 12). In the open reed--belt only station 2 had 5% higher conductivity than station 5.

Concentration of HCO_3^-

HCO_3^- concentration slightly changed in open reed-belts (Fig. 13). The mean amplitudes of fluctuations in the profiles of Mikołajskie Lake and Lake Tałtowisko were 0.06 mval/l. On station 1 of the Śniardwy profile the concentrations of HCO_3^- were almost two times higher than on the other stations. Mean $Q_{HCO_3^-} = 1.81$ (Fig. 13).

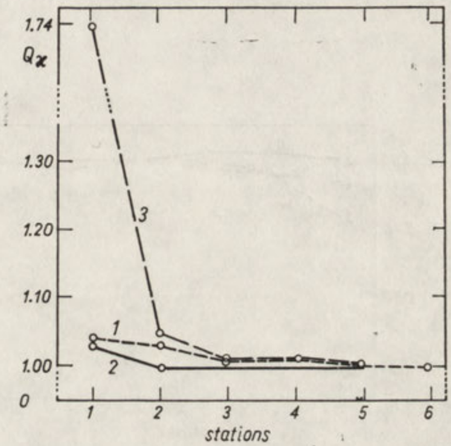


Fig. 12. Spatial changes of the electrolytic conductivity in reed-belts — mean $Q_{\varkappa}$. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3— Śniardwy Lake

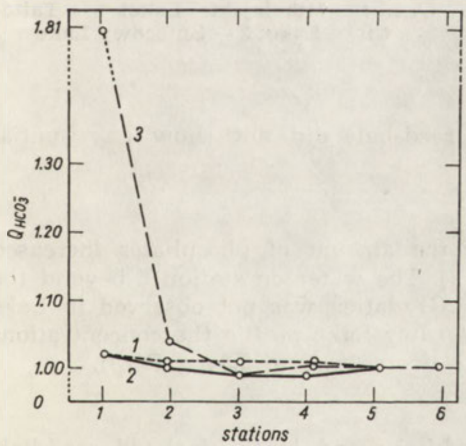


Fig. 13. Spatial changes of HCO_3^- concentration in reed-belts — nean $Q_{HCO_3^-}$. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3 — Śniardwy Lake

pH

pH of water increased from the shore to the margin (Fig. 14). These were slight changes as compared with open reed-belt e.g. Mikołajskie Lake. The pH was practically constant in the profile of Lake Tałtowisko, and on station 1 of the Śniardwy profile it was on the average some 8% lower than on station 5.

Calcium

Ca concentration decreased from the shore to the margin of Mikołajskie Lake reed-belt (Fig. 15) — on the average 44–42 mg/l; it was practically constant in the Tałtowisko Lake reed-belt — on the average about 46 mg/l. For station 1 of the Śniardwy Lake profile $Q_{Ca} = 1.89$. In the open part of the profile the concentrations were even.

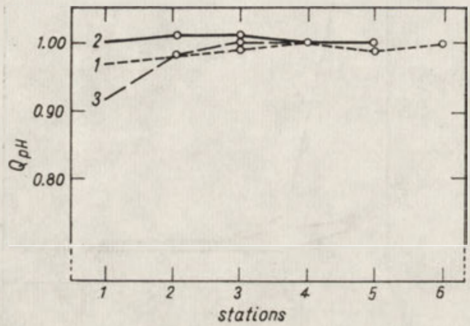


Fig. 14. Spatial changes of water reaction in reed-belts — mean Q_{pH}. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3 — Śniardwy Lake

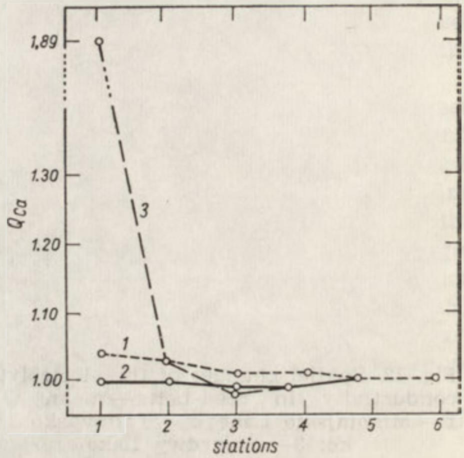


Fig. 15. Spatial changes of Ca concentration in the reed-belts water — mean Q_{Ca}. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3 — Śniardwy Lake

K

Potassium concentrations in open reed-belt did not show any spatial changes.

Phosphates

In the profile of Mikołajskie Lake the amount of phosphates increased from the shore to the margin (see Fig. 7). The water on station 6 beyond the reed-belt was the richest one in PO_4^{---}. Gradation was not observed in Lake Tałtowisko, and in the open part of Śniardwy Lake profile the concentrations were even. Station 1 was much richer — from 25 µg to 3.3 mg PO_4/l.

$N\text{-}NH_4^+$

In the inshore stations of open reed-belts and in the isolated reed-belt the concentrations of $N\text{-}NH_4^+$ were higher than in the further parts of profiles (Fig. 16), where a distinct spatial differentiation was not observed.

Fe

The gradation of iron concentration was not observed in Mikołajskie Lake and Lake Tałtowisko (see Fig. 8). In the isolated reed-belt of Lake Śniardwy the concentrations were higher — on the average 133 µg, while in the open reed-belt — 75 µg.

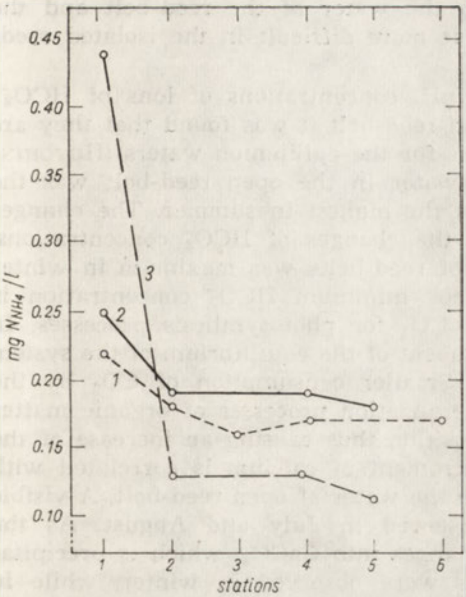


Fig. 16. Spatial changes of N-NH_4^+ concentration in the reed-belts water — mean concentration of N-NH_4^+. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3 — Śniardwy Lake

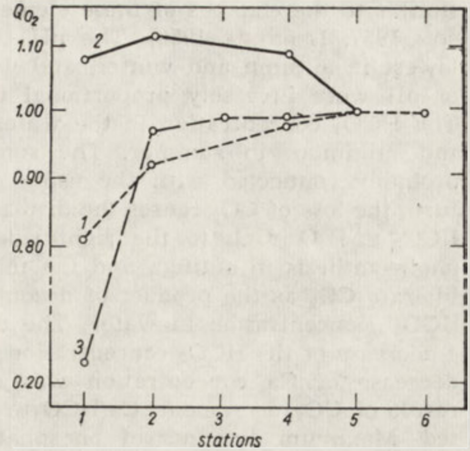


Fig. 17. Spatial changes of O_2 concentration in the reed-belts water — mean Q_{O_2}. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake; 3 — Śniardwy Lake

O_2

The amount of oxygen in the reed-belt of Mikołajskie Lake increased from the shore to the margin (Fig. 17). The mean concentrations (leaving out the period of the flow of snow waters to littoral) were from the shore: 9.0 to 11.1 mg O_2/l on the control station. The gradation in Tałtowisko Lake reed-belt was not significant (Fig. 17). On the control station 5 the oxygen concentrations were lower as it was in the middle of thermocline, on the depth about 9 m. On station 1 of Śniardwy Lake the concentrations of oxygen were generally low (see Fig. 9C and Fig. 17) — on the average 2.5 mg/l and even an oxygen deficit. On other stations — on the average 10.5–10.8 mg O_2/l.

5. DISCUSSION

The analyses of chemical properties of water of the reed-belt in lakes: Mikołajskie, Tałtowisko, Śniardwy proved the existence of two zones considerably differing as to the physico-chemical properties, basic mineral components and biogenes. The first zone — the open reeds of the lake (the reed-belt of Mikołajskie and Tałtowisko Lakes and part of the reed-belt in Lake Śniardwy — stations 2–5), the second one — isolated reeds (part of the reeds in Lake Śniardwy — station 1). Due to the movements of water and diffusion processes in the open reed-belt there is an exchange of chemical compounds and gases dissolved in water between the water of the reed-belt and the water of the mid-lake. This exchange is more difficult in the isolated reed--belts.

Observing the seasonal changes of pH, concentrations of ions of HCO_3^-, Ca^{++} and PO_4^{---} in the water of open reed-belt it was found that they are similar to the changes of these elements for the epilimnion waters (Hutchinson 1957, Lepneva 1950). The pH of water in the open reed-belt was the lowest in autumn and winter, and was the highest in summer. The changes of pH were inversely proportional to the changes of HCO_3^- concentrations. The HCO_3^- concentration in the water of reed-belts was maximum in winter and minimum in summer. The summer minimum HCO_3^- concentration is probably connected with the using of CO_2 for photosynthesis processes. In turn, the loss of CO_2 causes the displacement of the equillibrium of the system $HCO_3^- \rightleftarrows H_2O + CO_2$ to the right side. Smaller consumption of CO_2 by the photosynthesis in autumn and the mineralization processes of organic matter liberate CO_2 as the product of decomposition thus causing an increase of the HCO_3^- concentration in water. The decrement of calcium is correlated with a decrease of the HCO_3^- concentration in the water of open reed-belt. A visible decrease of Ca concentration was observed in July and August. As the result of CO_2 decrement, $Ca(HCO_3)_2$ changes into $CaCO_3$, which is precipitated. Maximum amounts of phosphates were observed in winter, while in spring and summer they were not detected or found in track amounts, which is connected with the mass blooms of algae (Hutchinson 1957). The appearance of phosphates in the water of reed-belts at the beginning of autumn is due to the mineralization processes of organic matter. The repeated disappearance of PO_4^{---} in autumn is connected with the growth of periphyton. In September 1964, the amount of chlorophyll in periphyton was 6.6 $\mu g/cm^2$, and in October 1964 — about 30 $\mu g/cm^2$ of the surface of reed stem (Szczepańska 1970). The ammonia nitrogen did not display any considerable changes in time, and only in the profile of Mikcłajskie Lake higher concentrations were observed during autumn and winter. Oxygen deficits were not observed in the water of the open reed-belts. The oxygenation of water was lower in winter and autumn than in spring and summer.

Isolated reed-belt having a limited contact with the water of the mid-lake (the reed-belt in Śniardwy Lake, station 1) have a separate chemical properties of water. Intense decomposition processes of organic matter liberate the mineral components and biogenes thus enriching the water of the reed-belt. As the contact of this part of reed-belt with the water of open reed-belt and the water of the mid-lake is insufficient therefore the exchange of ions and dissolved organic compounds is more difficult. That is why the isolated reed--belt have almost twice as big salt content (almost two times higher conductivity of water, higher concentrations of Ca^{++} and HCO_3^- and higher concentration of such biogenes as phosphates, ammonia nitrogen and iron). In the isolated reed-belt the oxygenation was low and was on the average about 10%, frequently dropping down to 0. The oxygen was used in mineralization processes of organic matter, the intensity of which is proved by the permanganate oxygen consumption of water of this part of reed-belt.

The investigated reed-belts in Mikołajskie Lake and Lake Tałtowisko may be included to the type of small lake littoral (acc. to the classification of Bernatowicz and Zachwieja). Whereas the reed-belt in Lake Śniardwy is a variety of great lake phytolittoral. The heap of plant remains accumulated by the water protects the isolated part from the wave motion.

Mean values of the investigated chemical components of the water of reed-belts for particular stations of the profiles displayed some spatial differentiation. As the distance from the shore increases the pH increases, and the electrolytic conductivity, concentrations of bicarbonate and calcium ions decrease. The ammonia nitrogen concentration of the water in the inshore part of reed-belt was higher than in the middle or on the margin. In the reed-belt of Mikołajskie Lake the amount of phosphates increased as the distance from the shore increased. Spatial gradation of PO_4^{---} was not observed in Lake Tałtowisko and in the open reed-belt of Lake Śniardwy. Dissolved total iron was usually found throughout the year and it had no visible spatial differentiation within the profiles. Spatial differentiation of physico-chemical properties was most distinct in the profile of the narrowest investigated reed-belt in Mikołajskie Lake. In the reed-belt of Lake Tałtowisko and in the part of open reed-belt of Lake Śniardwy the spatial differentiation was very slight. Gradaticn of the physico-chemical properties of water from the shore to the margin of reed-belts was in general during the entire period of investigations and was distinct in Mikołajskie Lake, while slight in the others and suggested the existence of a constant inflow of mineral components to pelagic waters, which originated from the decomposition of organic matter or erosion of the lake shores. Whereas the lower oxygen concentrations in the inshore part pointed to some more intensive decomposition processes of organic matter.

6. SUMMARY

The chemical composition of water was investigated in the profiles of reed--belt of eutrophic Mikołajskie Lake, mezotrophic Lake Tałtowisko and polymictic Lake Śniardwy. The seasonal changes of physico-chemical properties were analysed as well as the spatial differentiation of the chemical properties of water within the reed-belts. Every two weeks or every month determined were: pH, electrolytic conductivity, HCO_3^-, Ca^{++}, Na^+, K^+, Fe, PO_4^{---}, $N\text{-}NH_4^+$, O_2, permanganate oxygen consumption.

The chemical properties of water of the open reed-belt having a contact with the water of mid-lake undergoes similar seasonal changes as the chemism of epilimnion. Maximum pH values were observed in summer and the minimum ones in winter. The conductivity, HCO_3^- and Ca^{++} concentrations decreased from winter to summer and increased from summer to winter. Maximum concentrations of PO_4^{---} were observed in winter, while none were found from May to September. The iron was found in general throughout the year. The water of open reed-belt had no oxygen deficits. The water of isolated reeds (not having a contact with the mid-lake water) was much richer in mineral salts (the conductivity is almost twice as high, higher Ca^{++} and HCO_3^- concentrations and greater amount of biogenes) than the water of open reed-belts. In open reed-belts the mean values of the conductivity, concentrations of HCO_3^-, Ca^{++}, $N\text{-}NH_4^+$ showed a tendency to decrease from the shore to the margin of reed-belt. The water reaction and oxygen concentration increased together with the distance from the shore. Only the phosphates in the reed-belt of Mikołajskie Lake displayed a spatial gradation (an increase from the shore towards the margin).

7. STRESZCZENIE

Badano chemiczny skład wody w profilach trzcinowisk jezior: eutroficznym Mikołajskim, mezotroficznym Tałtowisku i polimiktycznym Śniardwy. Analizowano sezonowe zmiany własności fizykochemicznych oraz przestrzenne zróżnicowanie chemizmu wody w obrębie trzcinowisk. Co dwa tygodnie lub co miesiąc oznaczano: pH, przewodnictwo elektrolityczne, stężenie HCO_3^-, Ca^{++}, Na^+, K^+, Fe, PO_4^{---}, N-NH_4^+, O_2, utlenialność nadmanganianową.

Chemizm wody trzcinowisk otwartych posiadających kontakt z wodą śródjezierza, ulegał podobnym zmianom sezonowym, jak chemizm epilimnionu. Maksymalne wartości pH zaobserwowano latem, minimalne zimą. Przewodnictwo elektrolityczne, stężenie HCO_3^- i Ca^{++} zmniejszały się od zimy do lata, wzrastały od lata do zimy. Maksymalne stężenie PO_4^{---}stwierdzono w zimie, od maja do września jonu tego nie wykrywano. Żelazo występowało na ogół przez cały rok. Woda trzcinowisk otwartych nie wykazywała deficytów tlenowych. Woda trzcinowiska izolowanego (nie posiadającego kontaktu z wodą śródjezierza) była znacznie bogatsza w sole mineralne (prawie dwukrotnie wyższe elektroprzewodnictwo, większe stężenie Ca^{++}, HCO_3^- oraz wyższa ilość biogenów) niż woda trzcinowisk otwartych. W trzcinowiskach otwartych średnie wartości przewodnictwa elektrolitycznego, stężenia HCO_3^-, Ca^{++}, N-NH_4^+ wykazały pewne tendencje spadkowe od brzegu do skraju trzcinowiska. Odczyn wody i stężenie O_2 rosły w miarę oddalania się od brzegu. Fosforany, jedynie w trzcinowisku jeziora Mikołajskiego, wykazały gradację przestrzenną (wzrost od brzegu do skraju).

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POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	357-362	1970

M. PLANTER

ELUTION OF MINERAL COMPONENTS OUT OF DEAD REED *PHRAGMITES COMMUNIS* TRIN.

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ABSTRACT

The elution of mineral components out of ripe, dead reed into water was studied. The elution rates of Na^{+}, K^{+}, Ca^{++}, N-NH_4^{+} and PO_4^{---} were different.

CONTENTS

1. INTRODUCTION

80% of biomass of emergent vegetation in Lake Śniardwy is reed (BERNATOWICZ et al. 1968). During the maximum of biomass the reed production there was 4.3 t of dry weight out of 1 ha of surface covered with vegetation. In Lake Charzykowo, about 4.5 t of dry weight of reed (SOLSKI 1962) falls per 1 ha of littoral zone covered with vegetation. In Lake Dobsko, in some parts of littoral the reed production was even 16 t/ha (BERNATOWICZ and RADZIEJ 1960).

The reed takes mineral salts from substrate. The withered reed stems fall to the bottom of reservoirs. There the mechanical and chemical decomposition processes take place, due to which the aquatic habitat is enriched with biogenes.

This paper attempted to point out the rate and amount of mineral components "passing" from reed into water and thereby the participation of reed in the circulation of these components in the water body.

2. MATERIAL AND METHODS

The reed used in experiments was mowed in January 1966 and air dried. The stems together with leaves were cut in small pieces (about 0.5 cm long). Portions of reed according to the conditions of experiment were flooded with distilled water, lake water, carbonated water or saturated with N_2, in an amount 1 l per 10 g of dry reed weight. Then the samples remained during a determined period of time in room temperature. The jars with the mixture of reed and distilled or lake water were not tightly sealed, which allowed for free gas exchange. The reed with carbonated water remained in the atmosphere of this gas, while the reed with water saturated with N_2 — in the atmosphere of N_2. The carbonated water had the following concentrations of O_2: 6 and 12 hr elution — 1.7 mg/l; 72, 96 and 120 hr elution — 0.5 mg O_2/l. Oxygen concentration in water saturated with N_2 was on the average 2.2 mg/l. Chaffed reed was separated out of water by filtering through filter paper. In three parallel filtrates pH, electrolytic conductivity and concentrations of Ca^{++}, K^+, Na^+, N-NH_4^+, PO_4^{---}, were determined. Ca^{++}, Na^+ and K^+ were determined on flame photometer, N-NH_4^+ — by Nessler method and PO_4^{---} — according to the molybdate blue method.

3. RESULTS

A. ELUTION OF MINERAL COMPONENTS OUT OF REED INTO DISTILLED WATER

The elution rate of some of the components are presented in Fig. 1A, B, C. Total concentration of eluted components increases together with the time of extraction. The electrolytic conductivity increases from 5 μS in distilled water to 103 μS after 10.5 days of the experiment.

The sodium was most quickly eluted. Already after 35 min its concentration in filtrates was established (on the average 3.2 mg Na/l). The potassium concentration after 2 hr remained about 5 mg/l. But the phosphates (ortho form) obtained the maximum concentration — 3.4 mg PO_4/l after 4 hr. The elution of calcium was even slower, and its concentration in filtrates increased successively up to 30 days. To the moment of the establishment of concentration (after 5.5 days) the elution of ammonium ions was similar to that of calcium.

The elution was accompanied by the decaying process, which is proved by the decrease of pH from 6.1 to 4.4.

The comparison of the chemical composition of eluate, after 6 months of elution, with the elution rate presented in Fig. 1A, B, C allows to conclude that ripe, mowed reed gives away the maximum amount of mineral components into water. The elution rate of particular components was different (Fig. 1A, B, C).

Heterogeneity of material, ion adsorption on reed (especially sorption of PO_4^{---}) and co-precipitation with other ions probably resulted in the fluctuation cf the concentrations of particular investigated components in filtrates.

B. ELUTION OF MINERAL COMPONENTS OUT OF REED INTO LAKE WATER

In this experiment, portions of reed were flooded with lake water of a known chemical composition (Table I — time 0). The amounts of investigated mineral components, eluted of reed into lake water, and also the concentration increments of these components in relation to initial concentrations are presented in Table I. The increments of concentrations of respective components in filtrates and the changes in the pH value and electrolytic con-

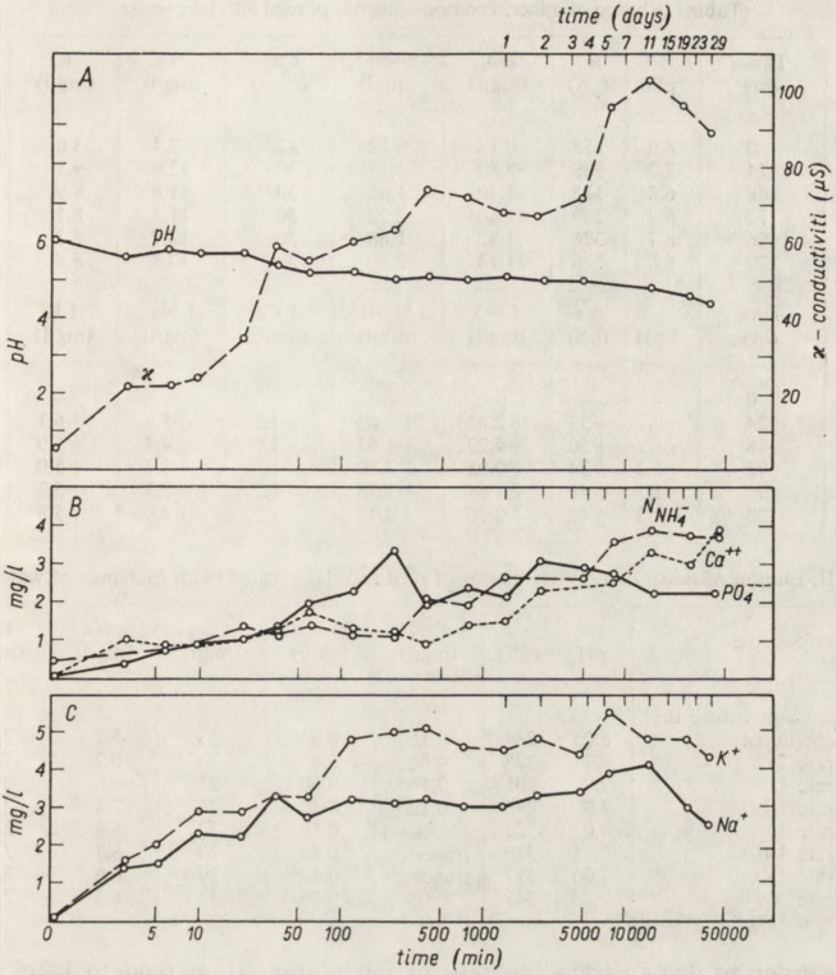

Fig. 1. Elution of mineral components out of reed into distilled water (10 g d. wt. of reed/1 l of water). A — pH and electrolytic conductivity of filtrates; B — concentrations of Ca^{+}, N-NH_4^+ and PO_4^{---} in filtrates; C — Na^+ and K^+ concentrations in filtrates

ductivity point to the fact that usually the elution of mineral components from reed to lake water stops after 24 hr. Comparing the data in Table I with the Fig. 1A, B, C, it can be said that there are not any basic differences in the elution of phosphates, ammonia nitrogen, sodium and potassium from reed to distilled water and lake water. A decrease of the phosphates increment in the successive extracts might have been caused by the sorption of these ions on reed. The increment of the electrolytic conductivity value in lake water were lower than those in distilled water in corresponding time intervals (this is probably the result of a decrease of Ca concentration in filtrates). The decrease of concentration of Ca ions was characteristic and incomprehensible. Lake water contained 42 mg Ca/l, but in the filtrate after 24 hr elution there was 30 mg/l.

Table I. Elution of mineral components out of reed into lake water

Time (hr)	pH	ϰ (μS)	PO_4 (mg/l)	N-NH_4 (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)
0	8.0	335	0.18	0.12	42	7.4	3.0
24	7.3	368	2.80	2.17	30	12.8	9.1
48	6.8	385	4.40	1.65	30	11.8	8.9
72	6.8	369	1.16	2.22	30	11.1	8.1
96	6.7	376	1.82	1.68	30	12.7	8.3
120	6.8	376	1.14	2.50	30	12.3	8.8
Time (hr)	**Δ pH**	**Δ ϰ (μS)**	**Δ PO_4 (mg/l)**	**Δ N-NH_4 (mg/l)**	**Δ Ca (mg/l)**	**Δ Na (mg/l)**	**Δ K (mg/l)**
0	—	—	—	—	—	—	—
24	−0.7	+33	+2.62	+2.05	−12	+5.4	+6.1
48	−1.2	+50	+4.22	+1.53	−12	+4.4	+5.9
72	−1.2	+34	+0.98	+2.10	−12	+3.7	+5.0
96	−1.3	+41	+1.64	+1.56	−12	+5.3	+5.3
120	−1.2	+41	+0.96	+2.38	−12	+4.9	+5.8

Table II. Elution of mineral components out of reed into lake water (with exchange of water)

Sample	pH	ϰ (μS)	PO_4 (mg/l)	N-NH_4 (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)
Lake water before the experiment	8.05	284	0.15	0.33	33	5.7	2.4
Filtrate I	7.2	338	0.68	3.8	25	9.7	7.4
Filtrate II	7.7	301	0.16	0.60	23	6.6	2.6
Filtrate III	7.9	294	0.12	0.40	22	7.4	2.5
Filtrate V	8.0	328	traces	0.66	27	6.8	2.8
Filtrate VII	7.95	319	traces	0.49	28	6.7	2.8
Filtrate IX	7.90	317	traces	0.42	29	6.6	2.8
Filtrate XV	7.80	348	0.01	0.36	33	8.3	2.5

In order to demonstrate the rate of ion elution from reed to lake water the following experiment was made. A portion of reed was flooded with lake water. After 24 hr the reed was separated from the eluate, the chemical composition of the filtrate (filtrate I — Table II) was determined and the reed was once again flooded with lake water in the amount of 1 l per one reed portion. This was repeated after 2, 3, 5, 7, 9 and 15 days.

Data (Table II) show that the first elution results in a passage of investigated mineral components from reed to lake water. Filtrates of the further successive extractions of the same portion of reed did not show any considerable deviations from the lake water used in the experiment. Elution of calcium was concealed by its concentration decrease in the filtrates.

C. ELUTION OF MINERAL COMPONENTS OUT OF REED INTO DISTILLED WATER AT DECREASED OXYGEN CONCENTRATION

Comparing the elution of mineral components from reed to distilled water (Fig. 1A, B, C) and to water saturated with gases (Tables III, IV) it was found to be not inhibited at a decreased oxygen concentration. Only the elution of phosphorus was weaker but a repetition of the experiment showed that in corresponding time intervals it was on a level similar as the elution into distilled water. The elution of calcium into carbonated water was quicker and more intensive than that with a normal oxygen content.

Table III. Elution of mineral components out of reed into carbonated water

Time (hr)	ϰ (μS)	pH	PO_4 (mg/l)	N-NH_4 (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)
0	42	4.4	0.01	0.10	—	—	—
6	115	4.9	1.40	1.60	6.6	3.3	6.2
12	125	5.0	1.60	2.0	7.4	3.1	4.9
24	106	4.7	1.78	2.14	9.2	3.7	4.8
48	116	4.8	1.68	2.97	8.7	4.4	6.4
72	143	4.9	2.28	2.22	8.5	3.7	4.6
96	134	4.9	2.97	2.14	8.6	4.0	4.8
120	119	4.7	2.08	3.60	11.3	4.4	4.9

Table IV. Elution of mineral components out of reed into water saturated with N_2

Time (hr)	ϰ (μS)	pH	PO_4 (mg/l)	N-NH_4 (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)
0	5	5.8	—	0.10	—	—	—
6	75	6.2	1.0	1.13	4.0	3.8	4.4
12	79	6.2	1.5	1.98	3.8	3.2	5.0
24	71	5.7	1.0	1.31	5.0	3.8	4.3
48	81	5.8	1.78	2.48	4.9	3.5	4.9
72	88	5.8	1.58	2.08	3.6	3.5	4.1
96	87	5.8	2.87	2.61	3.8	3.3	4.8
120	88	5.3	2.19	3.52	4.7	5.4	4.9

This was confirmed by repetitions of the experiments. However, differences were observed in the amounts of eluted substances and in rate of eluting but these did not introduce any essential changes to the presented picture of the elution of investigated components from reed into water.

4. CONCLUSIONS

From the carried out analyses it results that after a several minutes lasting contact with 10 g of dry reed weight about 3 mg of Na passes into water, what calculated per 1 ha of lake surface overgrown with vegetation is from 1.3 to 4.8 kg Na (reed biomass on 1 ha according to data: Bernatowicz et al. 1968, Solski 1962, Bernatowicz and Radziej 1960). But the amount of potassium leached out of reed during few hours ranges from 2.2 to 8.2 kg/ha, and the amount of phosphates — from 1.5 to 5.4 kg PO_4/ha. The amount of ammonia nitrogen passing during few days from reed into water is from 1.7 to 6.2 kg/ha, and of calcium — 1.7 to 6.4 kg/ha of surface overgrown with vegetation. After 9 days 5 to 15% of total silicon content of reed is found in water. Out of the reed stem 25 mm long 20 to 200 μg Si (Jörgensen 1957) passes into water.

Thus the mowed or withered in a natural way reed remaining in the reservoir considerably enriches the water in mineral components.

5. SUMMARY

Ripe, decayed reed submerged in distilled water supplies the water with mineral components. Sodium passes the quickest from reed into water. Its concentration in water is already determined after 35 minutes. The elution of potassium and phosphates lasts several hours, and of ammonium nitrate several days. Calcium was eluted much slower and its concentration in water increased successively up to 30 days.

Elution of Na^+, K^+, N-NH_4^+ and PO_4^{---} out of reed into lake water is similar as the elution of these ions into distilled water and is finished as a rule after 24 hr of contact of reed and water.

The elution of mineral components from reed into water saturated with CO_2 and N_2 had a similar course as in distilled water. Only Ca^{++} passed much quicker and more intensely from reed into carbonated water than into distilled water, lake water or water saturated with N_2.

6. STRESZCZENIE

Stwierdzono, że dojrzała martwa trzcina zanurzona w wodzie destylowanej oddaje do niej składniki mineralne. Najszybciej przechodzi z trzciny do wody sód. Już po 35 min stężenie jego w wodzie ustala się. Wymywanie potasu i fosforanów trwa kilka godzin, a azotu amonowego kilka dni. Znacznie wolniej wymywał się wapń, stężenie jego w wodzie wzrastało sukcesywnie aż do 30 dni.

Wymywanie Na^+, K^+, N-NH_4^+ i PO_4^{---} z trzciny do wody przebiega podobnie jak wymywanie tych jonów do wody destylowanej i ustaje w zasadzie po 1 dobie kontaktu trzciny z wodą.

Wymywanie składników mineralnych z trzciny do wody nasyconej CO_2 oraz N_2 przebiegało podobnie jak do wody destylowanej. Jedynie Ca^{++} znacznie szybciej i intensywniej przechodził z trzciny do wody nasyconej CO_2 niż do wody destylowanej, jeziorowej lub nasyconej N_2.

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POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	363–371	1970

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THE RELATIONS BETWEEN THE REED STANDING-CROP AND FISHERY EFFECT

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ABSTRACT

The dependence between the reed standing-crop, size of littoral and the catches of some fish species was analysed. The investigations included 53 lakes of the Mazurian Lakeland. The reed production had no significant effect on fishing production. However, a significant dependence was observed between the percentage participation of littoral in the total lake surface and the catches of tench and pike (positive dependence) and bream (negative dependence).

CONTENTS

1. INTRODUCTION

Littoral is a very important lake zone for fishing production. The spawning of the majority of fish species takes place there, and also their very young forms develop. In this zone, among the vascular plants, many crustaceans, mollusca and larvae of insects live, which are the basic food of some fish species (PLISZKA and DZIEKOŃSKA 1953).

However, the vascular plants do not form only the food base, but influence also the reproduction and development conditions of fish connected with littoral. Phytophylous fish lay the spawn on submerged plants, where it has suitable development conditions (KOCÓŁ 1953). The vegetation is not only a good hiding-place for the fry, but also creates good feeding conditions as considerable amounts of invertebrates live on these plants and are the basic food for the young fish (KOCÓŁ 1953). The emergent plants stop the erosion processes and protect the warmed eulittoral shallows (ČERFAS 1934, KOCÓŁ 1953) against the wave motion, but indirectly they may cause some serious losses in fishing production. Especially dangerous is their excessive development, which results in making the water bodies more shallow and fencing off the access for fish to the richest feeding grounds (KOCÓŁ 1952), which in turn negatively affects the fish growth rate (IVLEV 1950). This is confirmed by the observations of NIKOLSKIJ on roach (*Rutilus rutilus caspicus*) from Aral Sea.

Nikolskij says that "the 'reed' form of this fish develops much worse than the 'sea' one" (Nikolskij 1940). Experimental removal of hard vegetation out of littoral of a small lake (14.44 ha) improved the living conditions of some fish species and especially of bream (*Abramis brama* L.) and bleak (*Alburnus alburnus* L.) (Bernatowicz 1965).

Ivlev (1950) investigated the effect of reed-belts in Volga delta on the biology and chemical properties of water. He found that the daily fluctuations of oxygen content in water from the reed-belts, at a simultaneous decrease of its total content, cause mass death of fish. Also the laboratory investigations carried out by him showed greater death rate of spawn and fry in the water from reed-belts. This phenomenon is explained by Ivlev by the presence of toxic substances in reed water, formed in the decomposition process of reed (*Phragmites communis*).

Negative estimation of emergent vegetation is very common among the pond fishermen. Starmach (1965), Stegman (1965) and Isaev (1951), express this belief and recommend the application of treatments limiting the occurrence of emergent vegetation.

The discussed authors did not determine the numerical estimation of the influence of helophytes on fish population.

Therefore, the estimation of emergent vegetation on the basis of material characterizing reed and fishing production, seems to be interesting. At present, we are in possession of data on the exploitation of some lake reed-belts of the Mazurian Lakeland and fishing exploitation of these lakes. This allowed to make an attempt to find the numerical dependence between the reed standing-crop and catches of fish.

2. MATERIAL AND METHODS

Data on fishing production were obtained from the books of National Fishing Farms in Giżycko, Mikołajki, Mrągowo and Ruciane. The surface of the lakes and their littoral were determined on the basis of bathymetric plans made by the Institute of Inland Fishery in Olsztyn. Data on the reed standing-crop from particular lakes were found in the "Comparison of plans and reed standing-crop in years 1962–1965" by the Mazurian Factories of Reed Prefabricated Elements in Mikołajki.

53 lakes belonging to the National Fishing Farms in Giżycko, Mikołajki, Mrągowo and Ruciane were investigated. Some of the lakes were not taken into account as no data were available on their fishing exploitation, reed standing-crop or littoral surface. The surface limited by bathymetrical contours 0.0 and 2.5 m was assumed as littoral.

Factors independent of man (temperature, atmospheric falls, direction and wind strength and the like) affect the yield of both fishing and reed productions. This results in fluctuations of the yield of reed standing-crop and fish catches in respective years. In order to eliminate partly the effect of the above mentioned factors the arithmetic averages were calculated both for the fish catches and reed standing-crop in the years 1963–1965.

In order to have a common comparative basis both the means of fish catches (in kg) and the means of reed standing-crop (in standard wisps) were calculated into lake surface units (1 ha). The standard wisp consists of shoots of an identical length and placed with their bases together. The minimum length of a shoot in a wisp should be 120 ± 5 cm and the diameter at the thicker end should not have less than 5.5 mm. The circumference of the wisp measured at the bottom binding (30 cm from the base) should measure ± 3 cm (Polish Standard). In order to connect the littoral with reed production the yield of reed out of 1 ha of this zone was calculated. The obtained value is called density further on in the paper.

Fish species living in various zones of the lake were investigated (Table I), which allowed to grasp the differences in the reaction of particular species to the size and density of reed-belts.

Table I. Life zones of the discussed fish species

Fish species	Place of occurrence	Spawning places
Tinca tinca (L.)	littoral zone	shallows, underwater meadows
Esox lucius (L.)	littoral zone	shallows, underwater meadows
Rutilus rutilus (L.)	littoral zone	shallows, underwater meadows
Coregonus albula (L.)	open lake zone	hard bottom on the depth 3-20 m
Perca fluviatilis (L.)	littoral zone, open lake zone and profundal zone	underwater plants and objects of littoral zone
Abramis brama (L.)	littoral and bottom zones	shallows, underwater meadows
Anguilla anguilla (L.)	littoral and bottom zones	apart from the place of occurrence (Sargass Sea)

The investigations up to now suggested (Bernatowicz 1965) that the dependence between the size of reed-belts and the yield of fish catches is simple — inversely proportional, i.e. together with the increase of reed amount the number of fish decreases to a smaller or greater extent. Therefore only the correlation coefficient was used in the analysis of the compiled material.

$$r_{xy} = \frac{nS_{xy}}{\sqrt{nS_x^2 \cdot nS_y^2}}$$

where $nS_{xy} = \sum (x-\bar{x}) \cdot (y-\bar{y})$; $nS_x^2 = \sum (x-\bar{x})^2$; $nS_y^2 = \sum (y-\bar{y})^2$;

and: x — amount of reed in units of standard wisps; y — number of caught fish in kg.

This dependence was considered as an essential one, when the value $t^0 = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$ was greater than the value $t_{0.05}$ found in the table of the distribution of the variable t (Oktaba 1963). The obtained correlation coefficients are presented in Figures 1, 2, 3.

The lower limit of the significance of correlation coefficient was calculated with the probability $p = 0.95$ and $p = 0.99$, basing on the formula $t^0 = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$ and inserting successively the values $t_{0.05}$ and $t_{0.01}$ found in the table of the distribution of the variable t at $v = n - 2$ degrees of freedom.

The regression line presented in Figures 4–8 was calculated using the formula

$$\bar{y}_x - \bar{y} = r\sqrt{\frac{nS_y^2}{nS_x^2}}(x-\bar{x})$$

where $\bar{x}$ — mean amount of reed (in wisps) or mean participation of littoral in the total lake surface (in %); $\bar{y}$ — mean fish catches (in kg/ha); $\bar{y}_x$ — weighted mean y towards x.

On the regression line the mean value of fish catches and reed standing-crop or the size of littoral are marked.

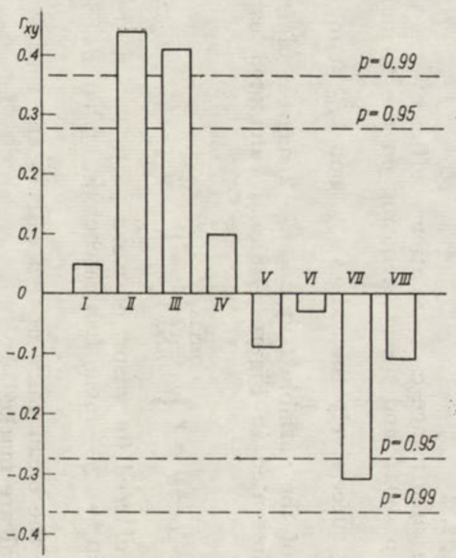

Fig. 1. Coefficients of correlations between the participation of littoral in the total lake surface, and fish catches. r_{xy} — values of correlation coefficients; p — significance level of correlation coefficients. I — fish total; II — *Tinca tinca*; III — *Esox lucius*; IV — *Rutilus rutilus*; V — *Coregonus albula*; VI — *Perca fluviatilis*; VII — *Abramis brama*; VIII — *Anguilla anguilla*

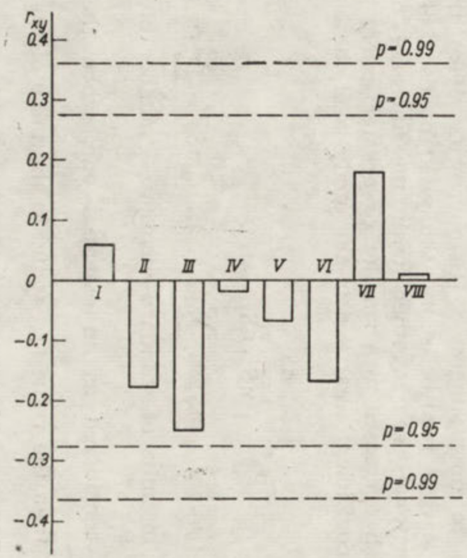

Fig. 2. Coefficients of correlation between density of reeds and fish catches. r_{xy} — values of correlation coefficients; p — significance level of correlation coefficients. I — fish total; II — *Tinca tinca*; III — *Esox lucius*; IV — *Rutilus rutilus*; V — *Coregonus albula*; VI — *Perca fluviatilis*; VII — *Abramis brama*; VIII — *Anguilla anguilla*

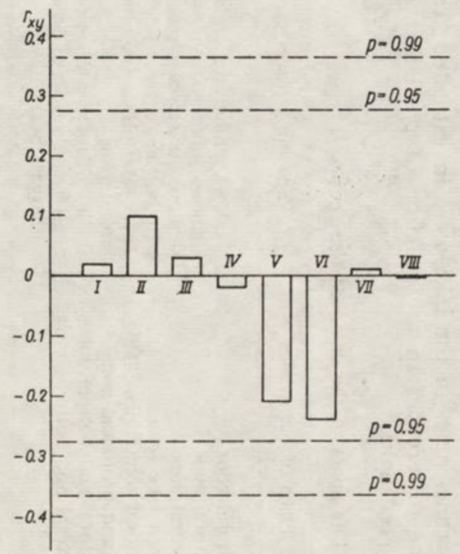

Fig. 3. Coefficients of correlation between reed standing-crop and fish catches. r_{xy} — values of correlation coefficients; p — significance level of correlation coefficients. I — fish total; II — *Tinca tinca*; III — *Esox lucius*; IV — *Ritilus rutilus*; V — *Coregonus albula*; VI — *Perca fluviatilis*; VII — *Abramis brama*; VIII — *Anguilla anguilla*

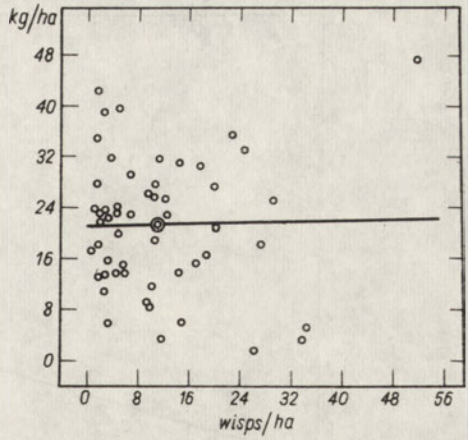

Fig. 4. Dependences between reed standing-crop and total fish catches

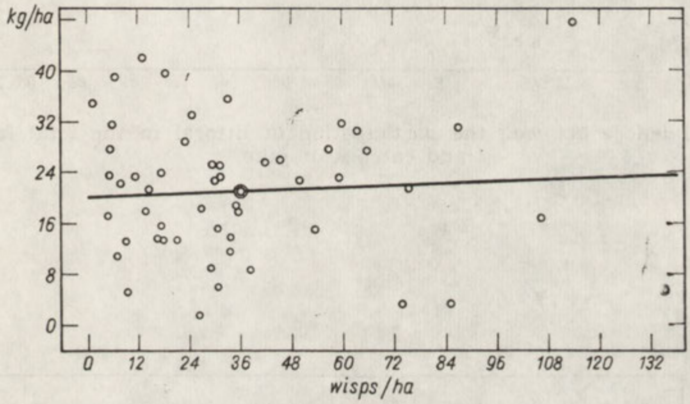

Fig. 5. Dependences between reed density and total fish catches

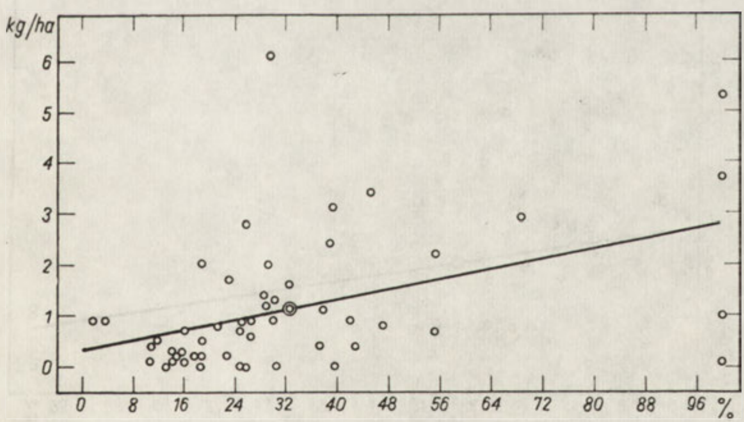

Fig. 6. Dependences between the participation of littoral in the total lake surface and catches of tench

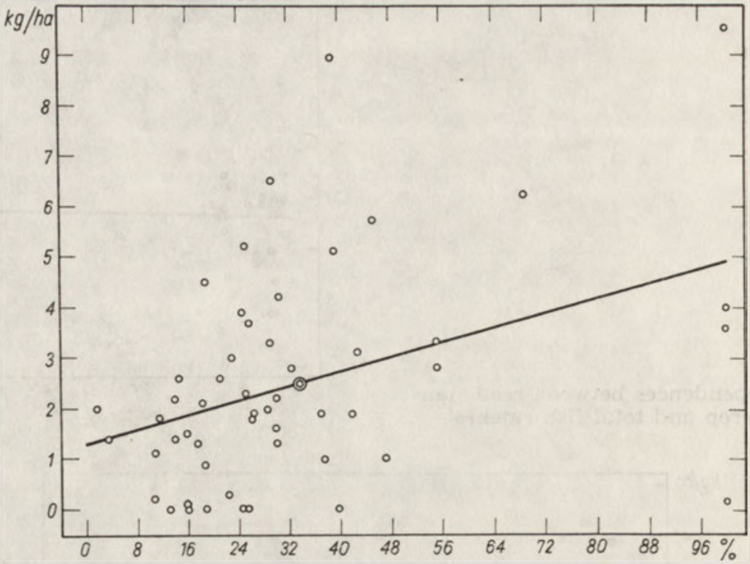

Fig. 7. Dependences between the participation of littoral in the total lake surface and catches of pike

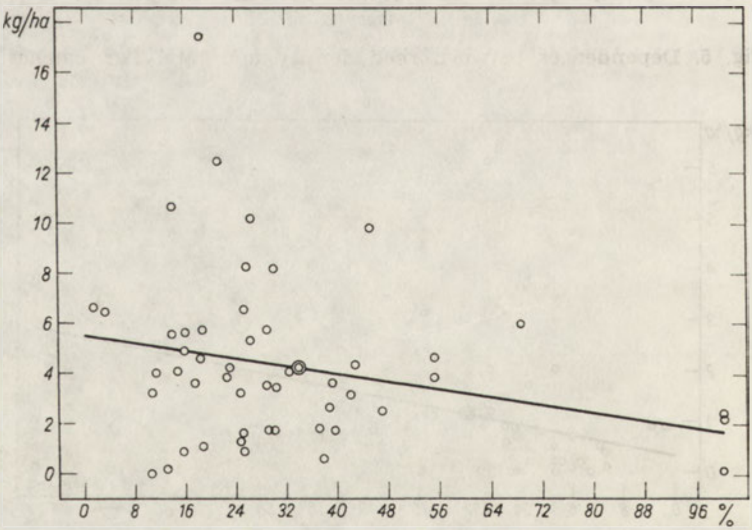

Fig. 8. Dependences between the participation of littoral in the total lake surface and catches of bream

3. RESULTS

The coefficients of correlation between the reed standing-crop out of 1 ha of the lake and the total fish catches were calculated as well as the one between the reed standing-crop and economically more important fish species. Also, the coefficients of correlation between the littoral surface in per cents of water area and fish production were calculated as well as the one between the reed-belts density and fish catches. The dependences between the reed standing-crop and total fish catches are presented in Fig. 4, while those between the density cf reed-belts and total fish catches — in Fig. 5.

Correlation between the reed standing-crop and fish catches calculated out of 53 pairs is approximate to 0, which points to a lack of essential connections between the fishing production and reed standing-crop.

The coefficient of correlation between the total fish catches and the percentage littoral participation in the global surfaces of particular lakes is positive, which points to the fact that the dependence between these variables is positive, therefore together with an increase of littoral the number of caught fish would increase. However, an estimation of the correlation coefficient points to a lack of essential mathematical dependence between the above mentioned values (Fig. 1). An attempt to determine the dependence between the density of reed-belts and the fishing production was not successful as in the previous instance. Negative correlation coefficient proves about the negative effect of dense reed-belts on fish, but the significance of this effect is very small (Fig. 2).

4. DISCUSSION

Preliminary analysis of the correlation coefficients points to an existence of two groups of fish, which react individually to the size of littoral. These groups are the same as the biological properties of analysed species (Table I). Group I consists of fish strongly related to littoral and so: tench, pike and roach; group II is less connected with that zone and consists of: bleak, perch, bream and eel.

Group I

Tench and pike display a definitely positive reaction to the size of littoral (Fig. 1, 6, 7). These species are strongly related to this zone of the lake. Their spawning takes place there, and also the young and adult forms live there. The tench feeds almost exclusively on organisms occurring in the inshore parts of the lake (Pliszka and Dziekońska 1953). The relation of predatory pike with littoral can be explained by its specific way of obtaining food. Strong relationship of tench and pike with littoral is pointed out by the positive, although very weak, reaction to the presence of reed. Negative ccrrelation was observed between the density of reed-belts and the catches of both species (Fig. 2). The roach is the third species belonging to this group. Its relationship with littoral is a positive one similarly as in the instance of tench and pike, but much weaker $r = +0.10$. The reed affects the roach negatively, therefore the roach is less connected with the inshore zone of the lake (Fig. 3).

Observations of Pliszka and Dziekońska confirm these assumptions. They found that the roach from Lake Tajty feeds not only with the organisms of the inshore zone, but may also search for food in the deep water of the open lake (Pliszka and Dziekońska 1953). A minimum negative relationship was observed between the density of reeds and the yield of roach catches (correlation coefficient — 0.02).

Group II

The bleak reacts negatively both to the size of littoral and reed. This species feeds mainly on crustacean plankton and its shoals remain in the open waters of oligotrophic, mezotrophic and even eutrophic lakes (Bernatowicz 1953). The relatively weak negative effect of the density of reeds on bleak confirms the supposition that a third factor — fertility of littoral acts on both these variables, increasing both the density of reed-belts and the population of bleak. However, the positive effect of the fertility of littoral is weaker in this instance than the negative action of reed and this is probably why the reaction of this fish to the density of reed-belts is negative.

The reaction of perch to all the investigated factors is negative. An estimation of the substantiality of correlation coefficients points to a lack of dependence between the perch catches and reed standing-crop and size of littoral.

The bream and eel have been also classified to the group of fish connected to a lesser extent with littoral. Similarly as bleak and perch both these species react negatively to the size of littoral (Table I). The correlation coefficient between the catches of bream and participation of littoral in the global lake surface points to an existence of an essential negative relationship (Fig. 1, 8). This is probably connected with the biological properties of this species. The spawning grounds of bream are the shallows, but it feeds in deeper parts of the lake (Table I). Positive reaction of eel and bream to the density of reed-belts confirms the previous suggestions as to the parallel effect of littoral fertility on reed and fish.

As the analysis did not show any essential negative effect of reed production on fishing production, therefore it should be assumed that the negative effect of emergent vegetation discussed at the beginning is compensated by their positive effects, or is so small compared to other factors that it is invisible.

5. SUMMARY

An analysis of the dependences between the reed standing-crop and size of littoral and catches of some fish species, in lakes of a greater surface than 40 ha, is presented. 53 lakes of the Mazurian Lakeland belonging to the National Fishing Farms in Giżycko, Mikołajki, Mrągowo and Ruciane were studied. The mean fish catches in particular lakes in the years 1963–1965 were calculated from the "Lake Books". Similarly on the basis of the "Comparison of plans and reed standing-crop in the years 1962–1965" the reed standing-crop was calculated. The surface limited by bathymetrical contours 0.0 and 2.5 was assumed as littoral.

The analysis did not show any essential negative effect of reed production on fishing production, but it was found that there is an essential mathematical dependence between the percentage participation of littoral in the total lake surface and the catches of tench and pike (positive) and bream (negative).

6. STRESZCZENIE

Przedstawiono analizę zależności między pozyskiem trzciny i wielkością litoralu a odłowami niektórych gatunków ryb z jezior o powierzchni ponad 40 ha. Badaniami objęto 53 jeziora Pojezierza Mazurskiego, administrowane przez PGRyb. w Giżycku, Mikołajkach, Mrągowie i Rucianem. Na podstawie „Ksiąg jeziorowych" wyliczono średnie odłowy ryb z poszczególnych jezior z lat 1963–1965. W podobny sposób na podstawie „Zestawienia planów i wykonania pozysku trzciny za lata 1962–1965", obliczono pozysk trzciny. Za litoral przyjęto powierzchnię jeziora zawartą między izobatami 0,0 a 2,5 metra.

Analiza nie wykazała istotnego negatywnego wpływu produkcji trzcinowej na produkcję rybacką, stwierdzono natomiast, że istnieje istotna matematyczna zależność pomiędzy procentowym udziałem litoralu w ogólnej powierzchni jeziora a odłowami lina i szczupaka (dodatnia) oraz odłowami leszcza (ujemna).

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POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	373-396	1970

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CHANGES IN THE REED (*PHRAGMITES COMMUNIS* TRIN.) CONDITION CAUSED BY DISEASES OF FUNGAL AND ANIMAL ORIGIN

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ABSTRACT

The change of condition of reed — *Phragmites communis* Trin. under the influence of parasites and pests, which attack mainly the stem, was investigated. The following species were taken into consideration: parasitic fungi — *Ustilago grandis, Deightoniella arundinacea*, animal pests — *Lipara lucens, L. rufitarsis, Archanara dissoluta, Steneotarsonemus phragmitidis*. The change of the length of stem, and also length, diameter and resistance to breaking of reed internodes as a result of disease were investigated. The reed is most frequently attacked by *Archanara dissoluta* and *Lipara lucens*. Both these species lower the reed condition considerably and are of great significance for reed industry.

CONTENTS

1. INTRODUCTION

Similarly as other plant species the reed has many parasites and pests, which to a smaller or greater extent reduce its production.

Donacia clavipes F. larvae are found feeding in the rhizomes. Frequently on leaf sheaths and leaves, parasitic fungi develop such as: *Puccinia phragmitis* (Schum.) Koern., *Puccinia magnusiana* Körn., *Scirrhia rimosa* (Alb. et Schw.), and also numerous insects are feeding on, among which the aphids dominate. Mycelium of *Ustilago grandis* Fr. and *Deightoniella arundinacea* (Corda) Hughes may be found in all parts of the plant. *Giraudiella inclusa* Frfld. (Diptera, Cecidomydae) and *Archanara dissoluta* larvae feed in the inside of the stem. The top of the shoot is damaged by Diptera larvae: *Lipara lucens* Meigen and *Lipara rufitarsis* Loew. The mite — *Steneotarsonemus phragmitidis* (Schldl.) destroys the reed panicles. Almost in all inflorescences the sclerotia of the fungus *Claviceps purpurea* (Fr.) Tul. may be found, which develop instead of the seeds.

The aim of this research was to estimate the economical significance of these parasites and pests, the action of which lowers the condition of stem — the element of reed most valuable for industrial purposes.

Table I. List of lakes examined during the season of 1967, with consideration to the occurrence of respective species of parasites and pests

No.	Lake (x = samples of reed for biometrical analysis)	*Ustilago grandis* Basidiomycetes	*Deightoniella arundinacea* Fungi Imperfecti	*Lipara lucens* Diptera	*Lipara rufitarsis* Diptera	*Archanara dissoluta* Lepidoptera	*Steneotarsonemus phragmitidis* Acarina
1	x Brożane		+		++		
2	x Serwy		++			+	
3	Widno						
4	x Zdrężno		++			+	
5	x Łaśmiady			++			
6	Sawinda M.		+				
7	x Garbaś				++		
8	x Bielskie		++	++	++	+	
9	x Ublik W.		++			++	+
10	x Ublik M.			+	++		
11	x Buwełno		+			++	
12	x Wąż		++	++			
13	x Szymoneckie	++					
14	x Szymonki			++	++	+	
15	x Kotek		++	+	++	+	
16	x Tałtowisko		++	+	+	++	++
17	x Tałty				++		
18	x Mikołajskie	++	+	+	+	+	
19	x Łuknajno					++	
20	x Śniardwy-Przeczka	++		+		+	
21	x Juksty		+		++	++	
22	Czos		+				
23	Głębokie						
24	Zyndaki		+				
25	Warpuńskie			+			
26	Pustnik		+	+			
27	Gielądzkie	+				+	
28	x Lampackie					++	
29	x Dłużec					+	++
30	x Kujno		++				
31	x Piłakno		++				++
32	x Jełmuń			+			++
33	x Kraksy			++			
34	Dadaj		+	+			
35	x Dobrąg			+		++	
36	x Wadąg				++	++	
37	Marąg		+	+			+
38	x Długie				++		
39	Gil						
40	Bartężek			+			
41	x Ruda Woda					++	
42	x Jaśkowskie				++	+	
43	Jeziorak						
44	Rucewo W.						
45	x Rucewo M.			+		++	
46	x Bądze			++			
47	x Dzierzgoń	++	+				
48	Orkusz				+		
49	Spierewnik						
50	x Jeleń	++				+	++
51	Śmiadowo						

continued

No.	Lake (x = samples of reed for biometrical analysis)	*Ustilago grandis* Basidiomycetes	*Deightoniella arundinacea* Fungi Imperfecti	*Lipara lucens* Diptera	*Lipara rufitarsis* Diptera	*Archanara dissoluta* Lepidoptera	*Steneotarsonemus phragmitidis* Acarina
52	x Pile			++		+	
53	x Lubicko W.				++	++	
54	Drawsko						
55	Krosino						
56	x Żabice			+		++	
57	Przytoń						
58	Węgorzyno						
59	Woświn			+			
60	x Dąbie	++		++		++	
	Number of stations = 38	7	20	23	15	24	8

\+ — occurs rarely in the reed-belts — less than 20%.
++ — occurs frequent in the reed-belts — more than 20%.

2. MATERIAL AND METHODS

The material was collected in autumn, 1967, from 60 lakes of Suwałki, Mazurian and Pomeranian Lake Districts (Table I, Fig. 1).

The generally assumed in plant pathology methods of measuring the density of affecting the plants and the extent of plant damage, used in agriculture, which require taking a great amount of samples from one area (Węgorek 1966), unfortunately, can not be applied always in natural plant communities such as reed-belts. The biological balance between the host plant and the parasite is preserved here to a greater extent than in artificial communities. Usually the disease has a scattered character — only single plants or their small groups are attacked. Epidemic is a rare instance. Therefore taking great many samples from one area is often difficult. The main attitude was to sample a great amount of samples from different lakes, limiting simultaneously the number of samples from one station. It is better, because it allows to examine the effect of different habitats on the development of given disease. Samples were taken only then, when the given species occurred in the reed-belt at least in 20%.

60 samples were used in the biometrical analysis. Each sample contained the same number of healthy and diseased reed stems (from 5 to 30 on different stations). On the whole 830 diseased plants were examined and compared with the same amount of healthy ones. For each reed-belt the number of shoots per 1 m² was estimated, and also the type of bottom and depth of water.

The difficulties in compiling the material were chiefly connected with the occurrence of 2 forms — big and small reed on the same area. In the instance, in which it was impossible to determine, which form had been attacked, because of great changes caused by the disease, the choice of stems for the comparison could not be always the right one. Apart from that the diseased plants were often broken, and therefore, it was not always possible

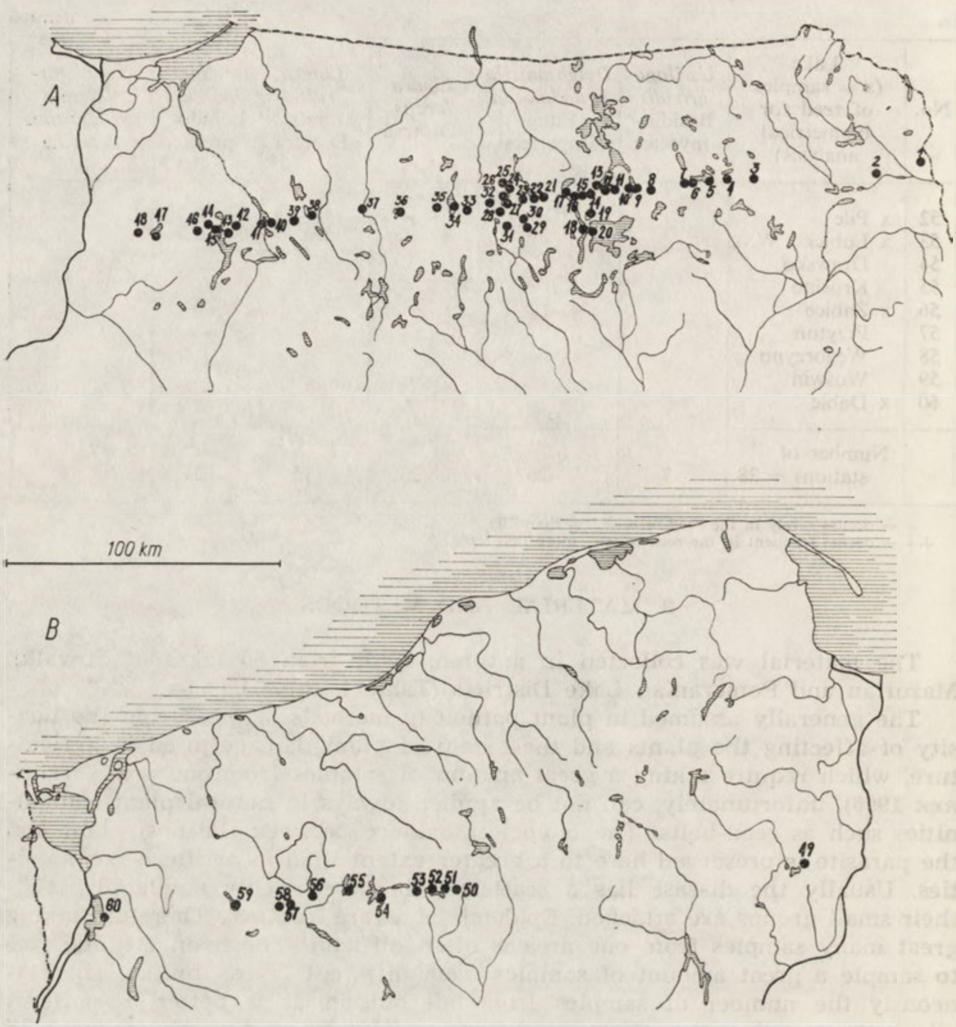


Fig. 1. Geographical distribution of examined lakes. A — Suwałki and Mazurian Lake District; B — Pomeranian Lake District. (Numbers on the map correspond with the numbers in Table I)

to find out the real differences between the condition of diseased and healthy reed.

The following elements were used in the biometrical analysis:

1. the stem length from the stem base to the base of panicle;
2. the length of the I, IV and IX internode above the water level;
3. diameter of the I, IV and IX internode above the water level;
4. resistance to breaking of the I, IV and IX internode above the water level.

In the case of *Archanara dissoluta* the I, III and IV internode were measured above the water level.

The resistance to breaking was measured on a tensile testing machine (Veb Thuringer Industriewerk Rauenstein Type FMGw 250 at spacing of props 100 mm), after previous drying in a forced draught oven at 105°C for 3 hr. Additionally for respective diseases the characteristic elements were measured such as: the size of galls (*Lipara lucens*), the number of lateral branches (*Archanara dissoluta*), number and length of all internodes above water, taking into consideration the place where sori (the mass of the spores) appear — *Ustilago grandis*.

In order to check, whether there are different races of smut *Ustilago grandis* in the compiled material, the spores — chlamydospores were measured (100 from each sample), and also their germination rate in a hanging drop was observed using Bauch's method (1925). The values concerning the condition of diseased reed are given in per cents from the values concerning the condition of healthy one.

According to Szczepański's investigations (1970) the reed's resistance to breaking depends on the stem diameter and is proportional to the second power of radius. The measurements made in this research confirmed this correlation (Fig. 2) and allowed to calculate the value of coefficient k, which characterizes the other factors apart from the diameter, determinative the stem strength. The value of this coefficient may be expressed by the formula:

$$K = \frac{y}{r^2}$$

where y — stem resistance to breaking measured in the middle of internode; r — stem radius in the middle of internode.

DISEASE SYMPTOMS AND CHANGES IN THE CONDITION OF REED CAUSED BY THE DISCUSSED SPECIES

Ustilago grandis Fr. (Basidiomycetes, Ustilaginales) — smut

This species is ranked among the group of facultative saprophytes (Kochman 1967), and however is basically a parasite — can be cultured on artificial food material. The young buds or shoots of growing reed are in spring infected (Kochman 1936).

At first the mycelium, developing in intercellular spaces of parenchymal tissue, does not display external disease symptoms. The stems are thin and short, and the inflorescences are not produced. In July, the reed internodes become strongly swollen and the parasite's sori appear under the epidermis filled with black mass of chlamydospores. In late autumn the epidermis bursts and the chlamydospores overwinter in the ground, or possibly in water, where they germinate and give promycelia, on which sporidia — the source of new infection — develope (according to the observations made during the season of 1967, on Mikołajskie Lake).

At the reed's cosmopolitism this smut is considered by many authors (Bauch 1925, Kochman 1936) as a rare species. Fitting (1922) recorded this species only in northern Europe (Scandinavia, Finnland, England, Belgium and Germany) with south limit in Northern Alps. Ruttkay et al. (1964) mention Danube as the space limit of this species. Also Roman and Roman (1964), mention several records from Danube Delta.

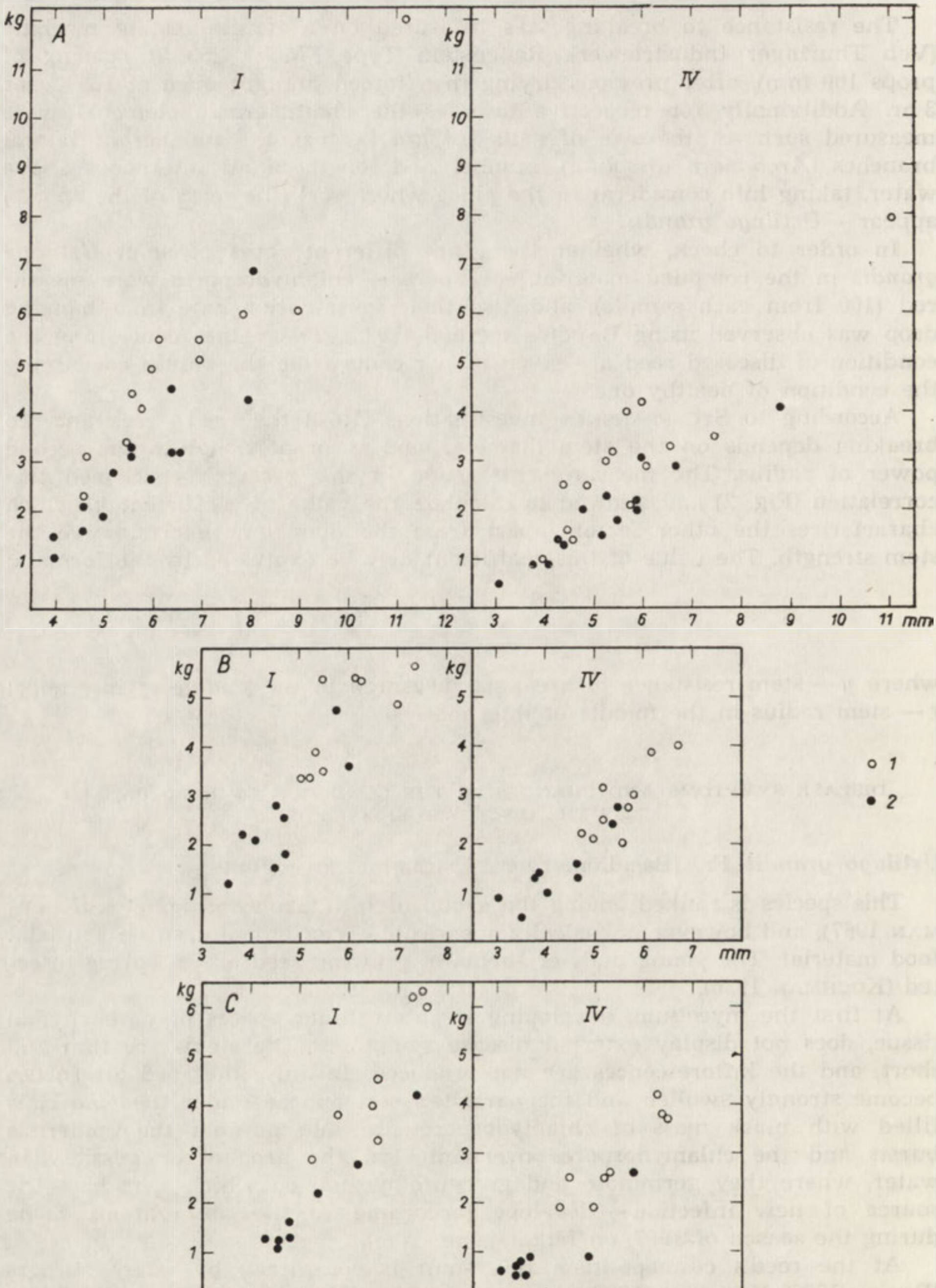
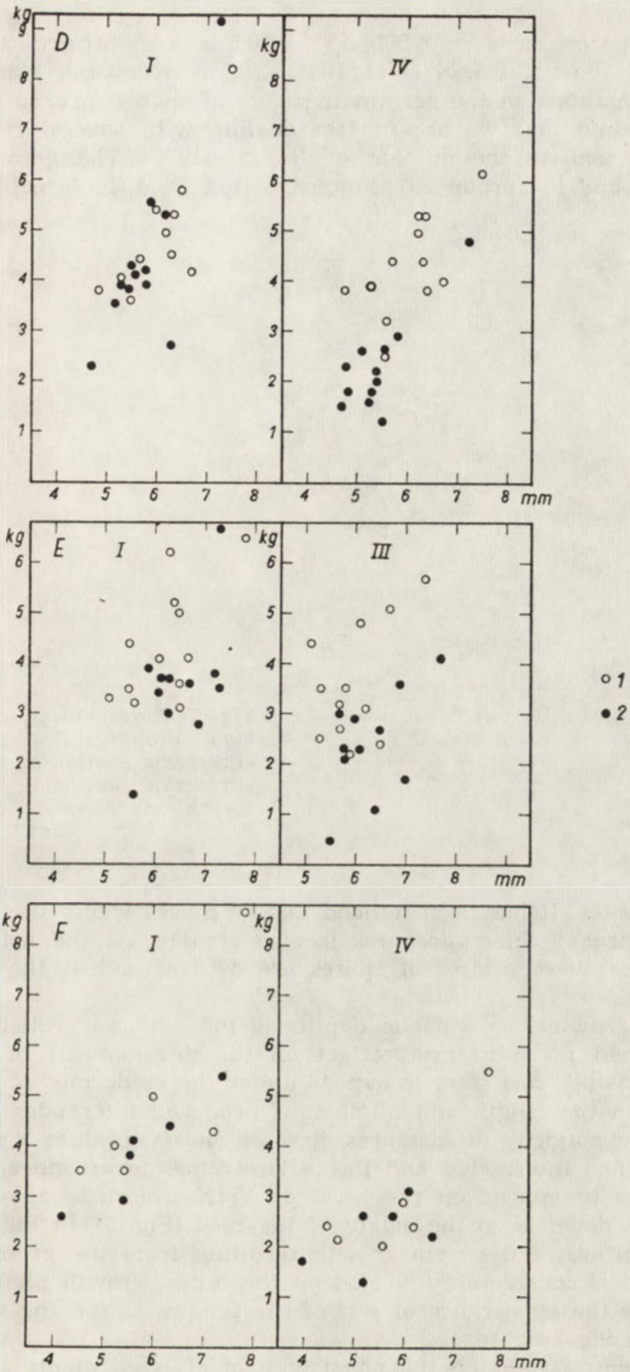


Fig. 2. Dependence between the stem diameter and its resistance to breaking (on the level of I and IV internode above water level) in healthy — 1, and infected



reed — 2. A — *Ustilago grandis* Fr.; B — *Deightoniella arundinacea*; C — *Lipara lucens*; D — *Lipara rufitarsis*; E — *Archanara dissoluta*; F — *Steneotarsonemus phragmitidis*

Chlamydospores measure 6.5–14.5×6.5–10.5 μ (Ainsworth and Sampson 1950: 10–12×7–10 μ; Ruttkay et al. 1964: 6–9.5 μ; Kcchman 1936: 8–11 μ).

The investigations on the germination rate of spcres in drop cultures may allow to presume that we are in fact dealing with several races of smut, which would confirm the opinion of Bauch (1925). The germination rate, size of spores and the produced promycelia (Fig. 3) differ greatly in samples

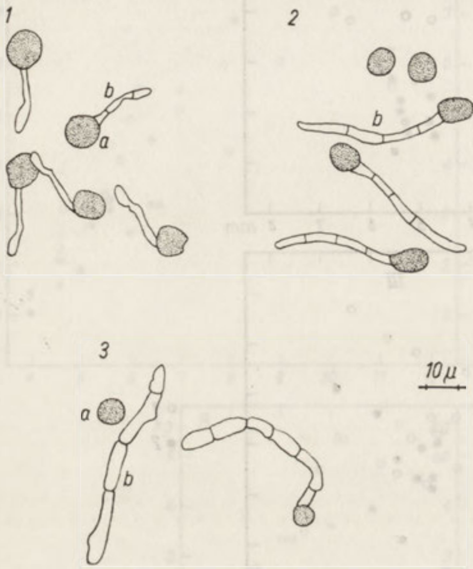


Fig. 3. Germinating spores of *Ustilago grandis* Fr. 1 — Śniardwy-Przeczka, Station a; 2 — Śniardwy-Przeczka, Station b; 3 — Dzierzgoń. a — chlamydospore; b — promycelium

from various sites. It has been noticed that in places where the reed is high, the average size of chlamydospores is also greater. At the heights of reed 195–243 cm the average sizes of spores are 8×8 μ, and at the heights 325–330 cm — 9.5×8 μ.

The reed growing on various depths (0–100 cm) was collected and the water level had no substantial effect on the development of the disease. When the parasite's sori start to appear under the epidermis of stems, strong disturbances in the length and number of produced internodes are observed (Fig. 4). In the majority of instances diseased shocts produce a greater number of very short internodes, and the inflorescence never appears. The parasite's sori usually appear on the level of V–IX internode above the water level, and this depends on the height of the reed (Fig. 5). In Figure 6 we see that the inhibition cf the stem growth resulting from the presence of smut is irregular; it is considerably weaker in the initial growth phase and is the strongest after the appearance of sori of the fungus, i.e. on the segment from the VII internode upwards.

Several investigations on the physiology of diseased plants allow to state that the infection with parasitic fungi leads to increased metabolic activity of the plant. The greatest protein and carbohydrates consumption by fungus is observed during its sporulation (Livne 1964), which is probably at the cost of the growth of host plant. That is why the growth is strongly inhibited in the discussed case.

Samples for a biometrical analysis were taken from 13 stations (Table II).

Table II. Habitat and the condition of healthy reed in the place, where *Ustilago grandis* is found

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m²	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
13 a	Szymoneckie	sand	40	60	228	1.6
13 b	Szymoneckie	sand	40	60	196	1.0
13 c	Szymoneckie	sand	50	60	223	1.4
13 d	Szymoneckie	sand	60	60	267	2.1
18 a	Mikołajskie	sand	30	70	298	3.5
18 b	Mikołajskie	sand	20	70	208	3.2
20 a	Śniardwy-Przeczka	mud	0	80	195	4.2
20 b	Śniardwy-Przeczka	mud	0	100	325	7.9
47 a	Dzierzgoń	sand	0	40	200	4.0
47 b	Dzierzgoń	sand	40	40	221	2.4
47 c	Dzierzgoń	sand	0	40	162	2.5
50	Jeleń	mud	30	100	243	3.0
60	Dąbie	gravel	100	56	330	2.9
	$\overline{X}$			72	238	3.0

The greatest differences in the length of the stem are observed on Śniardwy Lake (No. 20b) and on Lake Jeleń (No. 50) (Table III). These are the only stations having swampy ground. The density of shoots there is very big (100 per 1 m²) (Table II). Perhaps, such conditions decrease the resistance of reed to the parasite, which may develop better. The resistance to breaking for these samples is about 50% of the resistance of healthy reed. Great scatter

Table III. Changes in the reed condition under the influence of *Ustilago grandis* (control — 100%)

No. of station	Stem length	Length of internodes			Diameter of internodes			Strength of internodes		
		I	IV	IX	I	IV	IX	I	IV	IX
13 a	73.0	96.0	92.5	70.1	114.2	133.3	146.8	136.3	193.7	180.0
13 b	70.9	90.7	75.3	59.1	86.9	77.4	92.5	47.8	50.0	100.0
13 c	65.4	85.5	70.7	45.0	90.9	95.6	106.2	55.8	92.8	150.0
13 d	71.5	92.1	79.6	59.6	92.8	101.7	127.5	62.7	95.2	183.3
18 a	76.0	93.2	82.0	66.1	82.3	86.3	100.7	57.7	68.6	83.3
18 b	76.6	89.0	85.7	73.4	91.8	98.1	113.0	58.1	71.8	133.3
20 a	63.5	158.1	100.6	65.0	91.8	86.6	97.7	60.0	35.7	63.6
20 b	43.1	98.4	77.4	—	72.3	79.2	—	57.5	51.8	—
47 a	71.6	110.3	103.1	72.5	86.6	84.2	86.0	57.1	50.0	61.5
47 b	78.3	103.7	93.0	69.6	79.3	83.6	80.5	39.0	36.0	71.4
47 c	68.7	103.2	86.3	67.0	85.9	86.3	81.8	48.3	36.0	25.0
50	56.7	74.5	58.0	54.0	82.1	81.1	100.0	47.7	46.6	83.3
60	70.0	90.3	85.1	62.5	91.4	96.7	113.0	58.1	75.8	121.4
$\overline{X}$	68.1	98.8	83.7	63.8	83.3	91.5	103.5	60.4	69.5	100.7

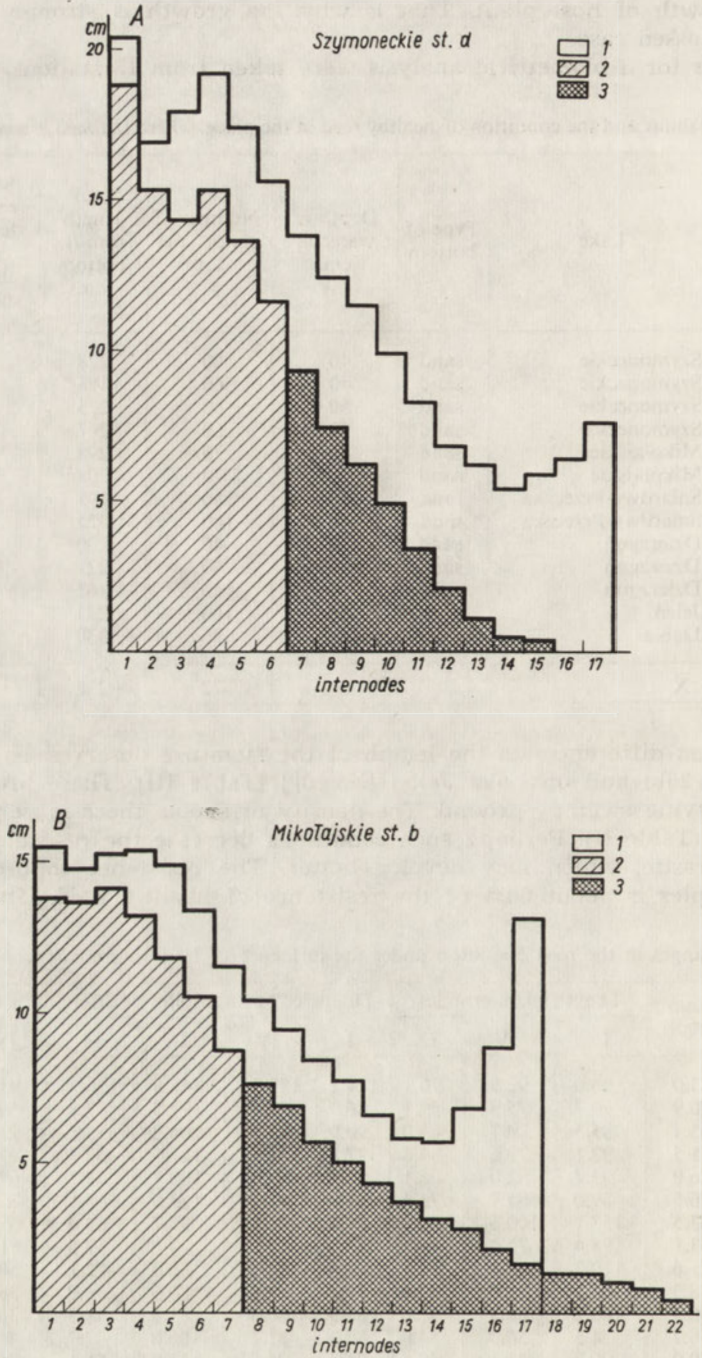
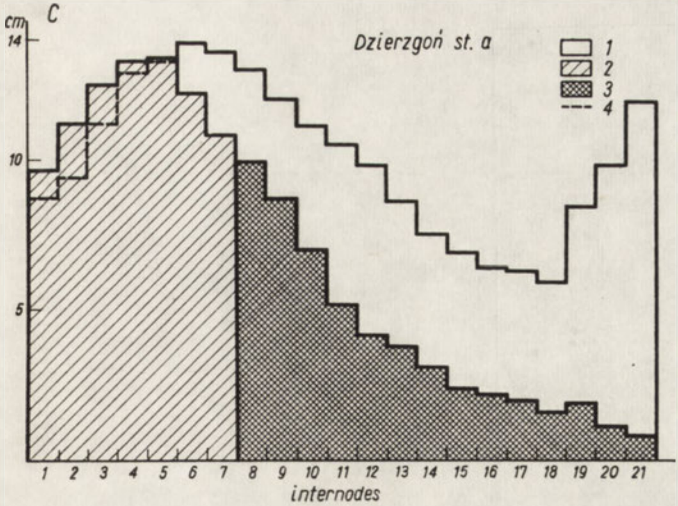
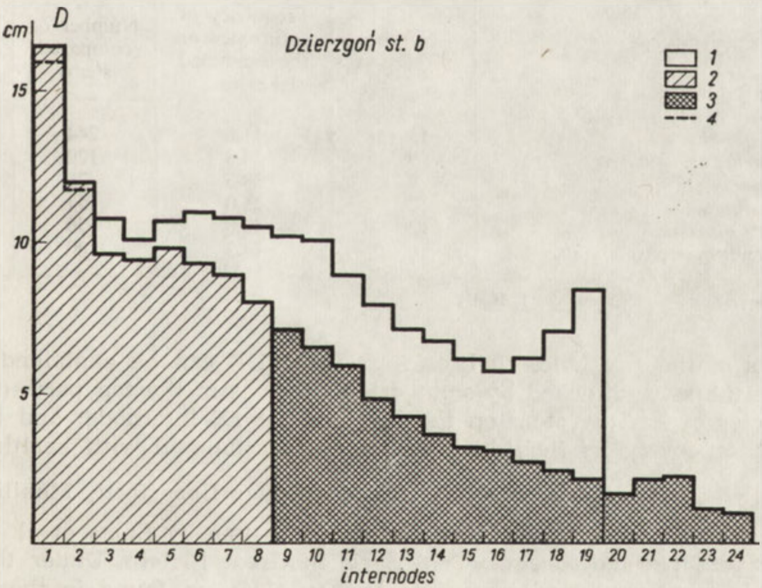


Fig. 4. Changes in the length of successive internodes of reed stem under the influence of *Ustilago grandis* Fr. 1 — healthy reed; 2 — infected reed — internodes





with invisible infection; 3 — infected reed — internodes with visible infection; 4 — healthy reed — shorter internodes than in the infected reed

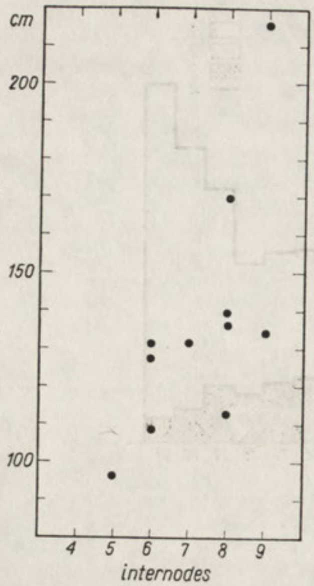


Fig. 5. Dependence between the place of appearance of *Ustilago grandis* Fr. sori and the length of reed

Table IV. Changes in the reed condition caused by

Species	Number of station	Frequency of occurrence on the examined lakes in %	Number of compared stems	Stem length
Ustilago grandis	13	11.6	244	68.1
Deightoniella arundinacea	9	33.3	120	75.2
Lipara lucens	8	38.3	76	57.1
Lipara rufitarsis	12	25.0	154	74.3
*Archanara dissoluta**	12	40.0	156	64.5
Steneotarsonemus phragmitidis	6	13.3	80	79.2

* Measurements for the internodes I, II, III.

of values of the resistance to breaking (Table III) can be explained by the fact that the stem attacked by smut often thickens in the top parts (to 147% of diameter of healthy stem on the level of the IX internode) and hardens, and simultaneously its flexibility decreases as compared with healthy stem.

Deightoniella arundinacea (Corda) Hughes (Fungi Imperfecti, Moniliales)

This species has been described for the first time by Ellis et al. in 1951, as *Napicladium arundinaceum* (Cda) Sacc. in Great Britain. Under the same name it is mentioned by Roman and Roman (1964) as found in the Danube Delta, and also by Siemaszko (1923) and Dominik (1936) — in Poland. Hughes (1952) describing it under the present name, mentions reed as the only host

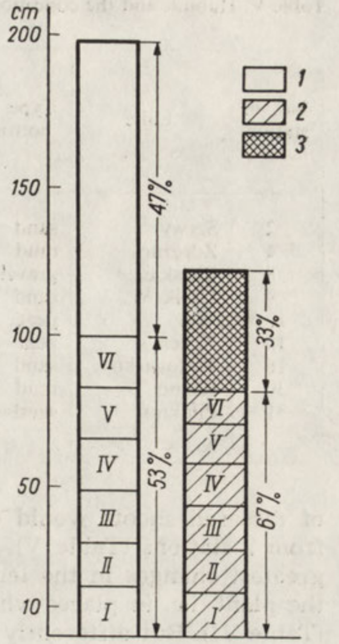


Fig. 6. Differences in length of healthy reeds and those infected by *Ustilago grandis* Fr. 1 — healthy reed. 53% — growth achieved on the segment I–VI internodes; 47% — growth attained on the segment from the VI internode to the panicle base; 2 — infected reed. Internodes with invisible infection; 67% — growth attained on the segment I–VI internodes; 3 — infected reed. Internodes with visible infection; 33% — growth attained on the segment from the VI internode to the end of the stem, which does not produce the panicle. I–VI — successive internodes

respective parasite and pest species (control — 100%)

Length of internodes			Diameter of internodes			Strength of internodes		
I	IV	IX	I	IV	IX	I	IV	IX
98.8	83.7	63.8	83.3	91.5	103.5	60.4	69.5	100.7
103.7	73.5	73.5	78.1	77.2	72.9	55.8	52.9	39.5
111.2	87.6	—	75.6	72.0	—	42.0	32.7	—
103.2	102.0	80.2	94.7	93.5	95.5	86.0	67.7	50.4
92.0	98.1	98.3	99.4	106.4	105.3	82.6	—	68.7
88.9	93.3	98.8	95.6	95.8	96.9	83.8	80.3	68.8

of this parasite. The mycelium of fungus is found in roots, rhizomes, stems and leaves of a plant. Conidiophores grow out of the subepidermal cells, and the leaf sheaths and leaves are already in June covered with dark grey, almost black coating of spores. The growth of reed is inhibited, the stem does not thicken, and if the panicles happen to develop they are very small and the seeds in them never ripen. According to our researches the measurements of conidial spores are: 17.5–49.5×9.5–21.0 μ (according to Lindau 1922: 40–50×15–18 μ).

However this parasite is frequently found in reed-belts (Table IV) it rarely causes some greater damages. Usually, only single individuals or a small shoot cluster are attacked. A systemic infection i.e. such, where the number

Table V. Habitat and the condition of healthy reed in the place of occurrence of *Deightoniella arundinacea*

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m^2	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
2	Serwy	sand	50	48	225	2.7
4	Zdrężno	mud	30	36	211	2.1
8	Bielskie	gravel	0	44	203	3.8
9	Ublik W.	sand	0	32	180	2.2
12	Wąż	peat	0	44	169	2.5
15	Kotek	peat	0	56	186	3.0
16	Tałtowisko	sand	0	44	180	2.0
30	Kujno	mud	30	60	235	4.0
31	Piłakno	sand	30	92	227	3.8
	$\overline{X}$			50	201	2.9

of diseased shoots would exceed 50% was not noticed. Samples were taken from 9 stations (Table V). Similarly as in case of reed attacked by smut, the greatest changes in the length of internodes are observed in the top parts of the plant, i.e. in places where production of spores by the fungus takes place (Table VI). But differently as in the previous instance the stem does not loose its flexibility but becomes easier broken (Table IV). The weakest is the reed from Lake Serwy (No. 2), where the strength of the IX internode attains hardly 14.3% of the strength of healthy reed. The best condition is that of the reed on Lake Piłakno (No. 31), where the stem length remains almost unaltered (93.8%), and the weakness is only in the stem strength in the top part (64%) (Table VI).

Table VI. Changes in the reed condition under the influence of *Deightoniella arundinacea* (control — 100%)

No. of station	Stem length	Length of internodes			Diameter of internodes			Strength of internodes		
		I	IV	IX	I	IV	IX	I	IV	IX
2	67.5	91.5	50.4	53.6	63.4	63.2	46.3	34.9	18.5	14.3
4	77.7	98.5	70.6	68.4	86.8	94.0	85.3	84.8	76.2	50.0
8	60.6	116.7	65.9	57.9	70.9	73.1	69.0	40.7	58.1	25.0
9	67.2	84.3	62.5	68.6	70.6	66.7	68.6	36.4	40.9	60.0
12	74.6	114.9	85.8	67.8	75.9	78.8	67.5	53.8	40.0	16.7
15	70.9	79.4	66.7	80.8	74.6	67.2	68.3	49.1	46.7	33.3
16	85.3	123.2	83.3	80.2	85.5	83.9	82.5	51.4	65.0	46.0
30	79.5	102.8	78.1	82.5	82.4	80.8	81.6	64.3	67.5	46.7
31	93.8	122.5	98.8	101.9	93.6	87.1	87.2	87.0	63.2	64.0
$\overline{X}$	75.2	103.7	73.5	73.5	78.1	77.2	72.9	55.8	52.9	39.5

Lipara lucens Meigen (Insecta, Diptera, Chloropidae)

Diptera, which developes on reed cause the production of cigar-shaped galls on the top of the plant. This species has been found in Germany, Holland and England (Ruppolt 1957), in Hungary (Ruttkay et al. 1964), and in Romania (Rudescu et al. 1965).

According to our measurements the size of a gall is 3–11.5 cm, on the average 7 cm (acc. to Ruppolt 10–22 cm; acc. to Rudescu et al. 5–6 cm) and probably depends on the habitat, in which the pest occurs (Table VII).

Table VII. Measurements of *Lipara lucens* galls

No. of station	Length in cm			Diameter in mm			Number of internodes
	min.	max.	$\bar{X}$	min.	max.	$\bar{X}$	
5	3	8.5	5.4	4.8	6.2	5.2	6
8	5.2	8.7	6.8	5.8	8.0	6.4	6
12	5.0	8.5	6.6	5.7	8.5	7.1	9
14	4.8	10.4	7.4	5.0	7.5	6.4	10
33	4.1	6.6	5.6	5.0	7.8	6.6	9
46	4.7	7.6	5.7	4.9	7.7	6.6	9
52	5.5	7.5	5.6	5.0	7.7	6.3	8
60	7.6	11.5	9.5	6.3	9.2	7.9	10

In accordance with Ruppolt's observations (1957) this species is most frequently found in thin reed-belts on land or only periodically flooded, usually on swampy areas with alder and birch. Table VIII presents a characteristic of stations, on which in our investigations *Lipara lucens* were found. Samples were taken from 8 lakes. The most intensely attacked reed-belts

Table VIII. Habitat and the condition of healthy reed in the place, where *Lipara lucens* is found

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m²	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
5	Łaśmiady	mud	0	28	181	3.7
8	Bielskie	gravel	0	44	209	3.7
12	Wąż	peat	0	44	169	2.5
14	Szymonki	peat	0	92	163	2.5
33	Kraksy	mud	0	84	176	2.6
46	Bądze	mud	0	36	202	1.9
52	Pile	gravel	0	48	148	1.9
60	Dąbie	mud	0	56	227	5.1
	$\bar{X}$			54	184	2.9

was found round Lake Wąż (No. 12) (Table IX). It is a peat bog, where the lake became completely overgrown. Lipara larvae from this area are bigger than on other stations: 9–14×3–4 mm. The smallest changes of reed condition were observed on Lake Łaśmiady (No. 5).

The length of the I internode, and sometimes of the IV one is greater in the instance of attacked shoots than of the healthy ones almost on all stations (Table IX). It was found that the larva attacks the growing-point when the reed has already formed 6–10 internodes. Therefore it may be assumed that the pest lays the eggs usually on the higher shoots.

Table IX. Changes in the reed condition under the influence of *Lipara lucens* (control — 100%)

No. of station	Stem length	Length of internodes		Diameter of internodes		Strength of internodes	
		I	IV	I	IV	I	IV
5	69.0	98.0	87.6	96.9	89.2	70.0	70.2
8	45.4	118.1	82.4	58.4	56.2	20.6	13.1
12	44.9	108.9	79.0	65.4	65.3	27.5	20.0
14	60.7	109.7	94.1	75.0	68.8	31.5	24.0
33	50.5	104.7	78.3	80.3	69.8	48.8	34.6
46	60.8	99.0	76.5	67.8	70.0	48.4	42.1
52	70.9	129.0	106.7	78.5	79.0	44.8	36.8
60	56.5	122.2	96.3	82.5	77.7	45.1	21.4
$\bar{X}$	57.0	111.2	87.6	75.6	72.0	42.0	32.7

Lipara rufitarsis Loew (Insecta, Diptera, Chloropidae)

The development of this species is identical as that of the previous one (Ruppolt 1957). The only difference is that it does not produce lignified galls with pupal chamber inside. The reed as in the previous instance also does not blossom. On the top of shoot a swelling of rolled leaves is formed, inside of which there is the larva. Larvae are smaller than the previous ones: 8–11×1–2.5 mm (acc. to Ruppolt 6–8×1 mm) and ventrally flattened.

This species, however sometimes occurs in great numbers does not damage the reed as much as the previous one. It can be found not only in reed-belts periodically flooded but also on greater depths (Table X, stations: 1, 10, 21, 36). Similarly as in the previous case high shoots are attacked (Table XI stations 1, 8, 17, 21, 38). The changes in the strength of stems are observed on their whole length. It is especially visible on Lake Tałty (No. 17) and on

Table X. Habitat and the condition of healthy reed in the place, where *Lipara rufitarsis* is found

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m²	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
1	Brożane	sand	10	28	242	6.1
7	Garbaś	mud	0	40	160	2.5
8	Bielskie	gravel	0	44	209	3.8
10	Ublik M.	mud	20	36	207	3.2
14	Szymonki	peat	0	92	163	2.5
15	Kotek	peat	0	56	189	3.0
17	Tałty	sand	0	48	203	4.3
21	Juksty	mud	40	44	231	3.0
36	Wadąg	mud	10	48	214	2.4
38	Długie	mud	0	28	211	4.1
42	Jaśkowskie	sand	0	64	196	2.4
53	Lubicko W.	mud	0	36	208	3.4
$\bar{X}$				47	202	3.4

Table XI. Changes in the reed condition under the influence of *Lipara rufitarsis* (control — 100%)

No. of station	Stem length	Length of internodes			Diameter of internodes			Strength of internodes		
		I	IV	IX	I	IV	IX	I	IV	IX
1	86.4	106.6	107.2	96.9	97.3	97.3	96.4	110.9	78.6	80.9
7	70.6	88.0	99.3	55.5	85.4	83.9	100.0	63.8	60.0	50.0
8	68.4	112.1	105.8	98.4	90.7	90.6	104.2	87.3	76.3	64.2
10	82.1	102.3	100.5	78.7	93.3	96.4	85.3	75.9	68.7	37.5
14	87.7	92.2	90.2	—	92.0	84.4	—	73.5	60.0	—
15	61.2	94.3	101.2	94.8	100.0	100.0	95.2	100.0	86.6	54.5
17	65.5	114.8	108.9	—	93.5	89.8	—	85.7	41.8	—
21	81.8	101.2	109.0	100.0	108.3	84.4	94.2	92.1	92.0	44.4
36	64.9	95.9	99.4	77.2	87.3	82.8	82.3	95.5	39.0	—
38	72.0	134.4	104.1	33.3	94.0	84.6	104.3	65.8	50.0	34.7
42	68.8	102.3	103.6	87.5	92.9	98.0	91.1	86.6	76.4	45.4
53	82.2	94.3	94.8	80.5	101.8	108.0	102.5	95.0	83.3	42.8
$\bar{X}$	74.3	103.2	102.0	80.2	94.7	93.5	95.5	86.0	67.7	50.4

Lake Wądąg (No. 36), where the condition of diseased reed is the lowest (to 65% of the length of healthy stem and to 40% of its strength on the level of the IV internode) — Table XI. In both instances the condition of healthy reed is good as compared with other stations (Table X).

Archanara dissoluta (Insecta, Lepidoptera, Noctuidae)

The size of mature butterfly is 12–14 mm. In July–August the females lay eggs on the leaves of reed. The larvae overwinter within the stems, out of which they come in May and attack young reed shoots (Ruttkay et al. 1964). Each larva bores a hole in the stem in order to get inside. It eats the entire parenchyma of the internode moving towards the germs of new leaves. Then it bores out a hole in the next segment, avoiding the node and so on. The damaged stems are filled with the faeces of larvae and have cha-

Table XII. Changes in the reed condition under the influence of *Archanara dissoluta* (control — 100%)

No. of station	Stem length	Length of internodes			Diameter of internodes			Strength of internodes		Number of lateral branches
		I	II	III	I	II	III	I	III	
9	59.8	84.1	97.5	94.7	95.3	98.4	98.3	74.0	60.4	2
11	59.9	94.6	103.4	108.9	106.1	109.3	103.2	77.7	35.4	3
16	70.0	70.7	74.5	77.7	114.5	110.5	114.0	85.7	100.0	2
21	61.4	97.3	97.8	97.1	92.3	94.8	93.2	58.4	53.7	2
28	71.1	103.4	114.0	113.0	86.1	90.3	93.2	45.1	22.7	2
35	72.0	98.9	95.3	99.7	108.9	109.0	109.4	106.2	92.0	2
36	52.6	71.6	—	92.8	108.9	—	107.6	85.3	70.8	3
41	65.6	—	—	—	—	—	—	82.9	68.7	2
45	58.2	88.3	95.0	93.0	107.2	103.7	105.6	88.6	85.7	2
53	53.5	101.3	97.4	92.6	98.4	98.3	100.0	71.1	60.0	1
56	84.2	106.8	106.3	108.2	131.3	136.7	119.6	109.0	95.8	0
60	66.6	95.1	100.0	103.5	115.8	113.4	114.9	108.0	80.3	4
$\bar{X}$	64.5	92.0	98.1	98.3	99.4	106.4	105.3	82.6	68.8	

racteristic round holes at the base of each node. The top parts of plants at first become yellow, then wither and break. Such reed never blossoms. The lateral growing points in bottom nodes are put into action, out of which lateral branches grow out. Pupation takes place at the beginning of summer.

Table XIII. Habitat and the condition of healthy reed in the place, where *Archanara dissoluta* is found

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m²	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
9	Ublik W.	sand	10	32	209	5.0
11	Buwełno	sand	30	30	202	3.2
16	Tałtowisko	sand	0	44	180	2.7
21	Juksty	mud	10	44	241	6.7
28	Lampackie	mud	40	56	194	2.2
35	Dobrąg	sand	0	56	206	2.5
36	Wadąg	mud	10	48	214	2.4
41	Ruda Woda	sand	50	56	270	3.2
45	Rucewo M.	mud	0	64	208	3.5
53	Lubicko W.	mud	30	36	278	3.5
56	Żabice	mud	0	40	165	2.4
60	Dąbie	mud	0	56	227	5.1
X				47	216	3.5

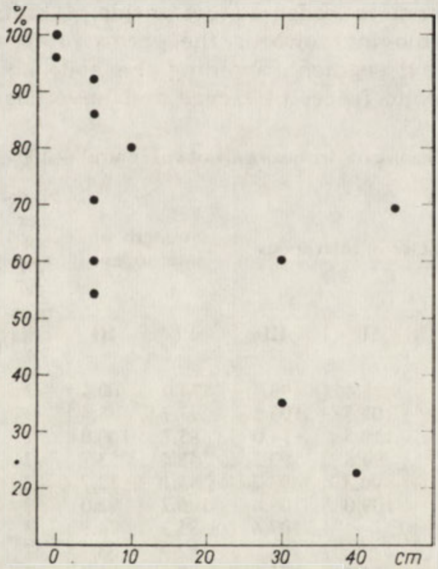


Fig. 7. Weakening of stems from various depths, and damaged by *Archanara dissoluta* (control — 100%)

This insect belongs to the most often reed pests and causes great damages, disqualifying this plant for industrial purposes. It can be found on reed growing on various depths. This pest causes first of all losses in the height of reed (up to 47%, Table XII) which as a result of stem squeezing breaks. It has no influence on the length of respective internodes, which at the moment of attack already attained their normal size (Table XII). The greatest damages were done on Lake Wadąg (No. 36) and on Lake Lampackie (No. 28). Strong differentiation of results is observed in respective lakes, which is probably connected with the variety of habitat (Table XIII). It was found that on greater depths the strength of diseased stem is more reduced than in dry reed-belts (Fig. 7). The larva attacks the delicate tissue, and when comes across lignified tissue moves upwards in order to find a better place for feeding. In this case the losses caused are smaller than when the reed is attacked from the base.

Steneotarsonemus phragmitidis (Schldl.)[1] (Acarina, Acaridoidea, Tarsonemidae)

This mite causes the appearance of warts at the base and inside of inflorescences. The leaves surrounding the panicle are sticked together and strongly curled in characteristic knots. The inflorescence covered with dark brown cancer tissue — does not ripen. The mites are very small, only visible under the microscope. Eggs 112×76 μ, larvae with three pairs of legs 160××76 μ and mature forms with 4 pairs of legs 240×100 μ (Fig. 8) are found

Fig. 8. *Steneotarsonemus phragmitidis* Schldl. — mature form

in the warts. This pest displays high vitality. In the material collected during winter at a temperature −20°C moving larvae were found. The reed-belts on Lake Łukajno was infected with this species in 88% and investigated during 3 seasons, and every year the same intensity of pests was noticed.

The mite is a pest of reed rarely found. The damages it causes are of no special importance from the economical point of view. Usually the inflorescence is damaged, but it is known that reed production is mainly vegetative. The mite most frequently attacks the dense, high reed-belts (up to 100 shoots per 1 m², Table XIV). It is possible that great density of shoots

[1] I am very grateful to the scientific workers from the Institute of Plant Protection in Poznań for determining the species.

Table XIV. Habitat and the condition of healthy reed in place, where *Steneotarsonemus phragmitidis* is found

No. of station	Lake	Type of bottom	Depth of water in cm	Number of shoots per 1 m²	Stem length from the bottom (cm)	Strength of reed on the level of IV internode above water surface (kG)
16	Tałtowisko	sand	0	44	180	2.7
19	Łuknajno	mud	0	100	241	2.4
29	Dłużec	mud	0	72	198	3.4
31	Piłakno	sand	20	92	230	5.5
32	Jełmuń	sand	0	56	192	2.4
50	Jeleń	mud	10	100	201	2.1
$\bar{X}$				77	207	3.0

Table XV. Changes in the reed condition under the influence of *Steneotarsonemus phragmitidis* (control — 100%)

No. of station	Stem length	Length of internodes			Diameter of internodes			Strength of internodes		
		I	IV	IX	I	IV	IX	I	IV	IX
16	93.3	102.4	102.2	107.2	103.6	103.5	100.0	117.1	130.0	80.0
19	80.9	106.8	100.4	97.9	102.7	106.4	105.6	112.5	91.6	78.5
29	89.3	86.0	94.4	97.8	91.8	86.6	97.7	76.0	76.4	88.8
31	80.4	60.2	75.2	122.3	81.0	79.2	83.6	50.5	56.3	64.2
32	67.7	88.7	92.5	89.2	91.3	88.8	85.3	74.2	70.8	60.0
50	67.6	89.7	95.1	78.7	103.7	110.6	109.7	72.5	57.1	41.6
$\bar{X}$	79.2	88.9	93.3	98.8	95.6	95.8	96.9	83.8	80.3	68.8

makes it easier for the pest to get on to other stems and helps the spreading of infection. Table XV shows that the mite lowers the height of infected reed to a small extent and slightly more the resistance to breaking of top internodes. The greatest changes were observed on Lake Jeleń (No. 50), where diseased stems attained 67.6% of the height of healthy stems and 41.6% of its strength on the level of the IX internode.

3. DISCUSSION

While analysing the habitats, in which the discussed pests and parasites of reed are most frequently found, it can be said that:

Lipara lucens is most frequently found in sites periodically flooded, often overgrown with alder and birch, usually on peat soils. On such areas the reed-belt is characterized by small density (54 shoots per 1 m²) and small stem length (on the average 184 cm, Table VIII). *Lipara rufitarsis* is found in similar sites.

Smut and mite attack dense (above 70 shoots per 1 m²), high (above 200 cm) reed-belts on different soils (Table II and XIV).

The remaining species are found in different habitat conditions.

Lowering of the stem length is within the range 43–94%. *Archanara dis-*

soluta and *Lipara lucens* are the most frequent species and cause the greatest damages. They cause the greatest losses in the length of reed stem (Table IV).

The strength cf diseased stem cn the water level is from 20 to 136%, on the level of the IV internode above water from 13 to 193%. The stem is weakened the most by *Lipara lucens* and *Deightoniella arundinacea* (Table IV).

The smut, however belongs to the most rarely found reed parasites in the country, causes considerable losses in the infected reed-belts. Usually its frequency of occurrence exceeds 50%, and the infection increases in each following year. With time the reed from such area is of no use for industrial purposes.

The norms treating about the usefulness of reed for industrial purposes are as following (see PRCTOKOL...):

1. unsorted reed: the length of stems up to 200 cm. Apart from that a break on the length to 40 cm; bursting on the length to 60 cm; squeezing on the length to 50 cm; existence of holes after-insects in the number of 125 per 250 stems disqualifies the reed;

2. sorted reed: the length of stems up to 200 cm. Apart from that a break on the length to 10 cm; bursting on the length to 20 cm; squeezing on the length to 15 cm; existence of holes after insects in the number of 45 per 250 stems disqualifies the reed.

Analysing these norms, it can be said, that only damages caused by *Lipara rufitarsis* and *Steneotarsonemus phragmitidis* do not disqualify the reed. The other species make the reed useless for industrial purposes.

As it has been already said, there is a correlation between the stem diameter of reed and its resistance to breaking. These dependences are not identical for bottom and top internodes. We also observe differences between diseased and healthy stems. Analysing Fig. 2 it can be said that the points characterizing diseased reed are usually below the points characterizing healthy reed (in Fig. 2A, B, C, E), which proves that there is a simultaneous decrease of stem diameter and its strength, but the strength decreases to a greater extent than the diameter, which is clearly seen in Fig. 2E. These changes are more distinct for the IV than for the I internode. In Figure 2D, F such division of points is not observed. This allows to state that *Lipara rufitarsis* and *Steneotarsonemus phragmitidis* changes the reed condition to a smaller degree than the other diseases.

Table XVI shows that the coefficient value characterizing other factors conditioning the stem resistance to breaking apart from the diameter, is

Table XVI. Values of coefficient K for healthy and diseased reed

No. of internode	Coefficient	*Ustilago grandis*	*Deightoniella arundinacea*	*Lipara lucens*	*Lipara rufitarsis*	*Archanara dissoluta*	*Steneotarsonemus phragmitidis*
I	K_h	0.473	0.505	0.586	0.544	0.447	0.526
I	K_d	0.369	0.472	0.430	0.529	0.331	0.451
I	K_d/K_h	0.780	0.934	0.733	0.972	0.740	0.857
IV	K_h	0.356	0.370	0.397	0.404	0.402	0.357
IV	K_d	0.281	0.303	0.236	0.301	0.231	0.291
IV	K_d/K_h	0.789	0.818	0.594	0.745	0.574	0.815

always lower for the IV internode than for the I one, and it is both for the healthy and diseased reed. The coefficient value of the diseased reed on the level of the same internode is lower than for the healthy one. It can be also noticed that these differences are the strongest in the instance of *Lipara lucens* and *Archanara dissoluta*, i.e. at the greatest damages. These differences considerably increase in the top part of the stem.

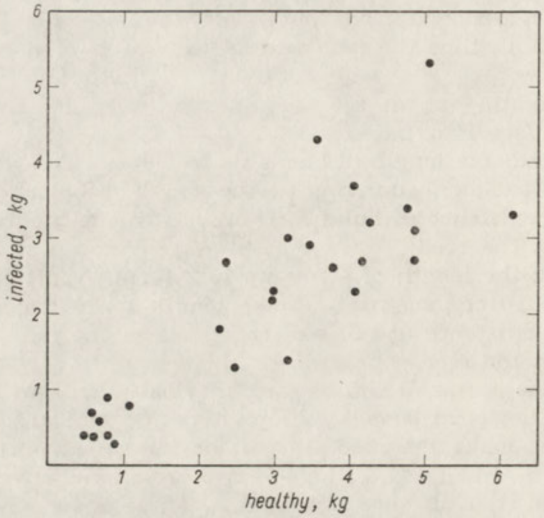


Fig. 9. Lowering the strength of reed stem under the influence of disease

Comparing the healthy and diseased stems having the same diameter (from similar material) it has been found that the strength of diseased ones is smaller almost in all instances (Fig. 9).

4. SUMMARY

Investigations were carried out on the change of reed — *Phragmites communis* Trin. condition under the influence of parasites and pests, chiefly attacking the stem. The investigations included the following species: parasitic fungi — *Ustilago grandis, Deightoniella arundinacea*, animal pests — *Lipara lucens, Lipara rufitarsis, Archanara dissoluta, Steneotarsonemus phragmitidis*.

The material was obtained from 60 lakes of Suwalskie, Mazurian and Pomeranian Lake Districts, in autumn, 1967.

The reed is most frequently attacked by *Archanara dissoluta* and *Lipara lucens* (40 and 38% of examined lakes). The damages caused by these species are of considerable significance for reed industry, because they seriously reduce the condition of reed. The stems damaged by them attain on the average 64 and 57% of length and 69 and 33% of the strength of healthy stems. The smut — *Ustilago grandis* and mite — *Steneotarsonemus phragmitidis* belong to species most rarely found on reed (12 and 13% of the examined lakes). The mite causes the smallest changes in the condition of reed (Table XV).

Reduction of the length of diseased reed stem in comparison with the healthy one is within the range from 43 to 94%. The resistance to breaking of diseased stem

on the water level is from 21 to 136%, on the level of the IV internode above water from 13 to 193%.

A correlation was found between the diameter and the stem's strength. At the same diameters the strength of diseased stems is smaller than that of healthy ones.

5. STRESZCZENIE

Prowadzono badania nad zmianą kondycji trzciny — *Phragmites communis* Trin. pod wpływem pasożytów i szkodników, atakujących głównie łodygę. Badania objęły następujące gatunki: grzyby pasożytnicze — *Ustilago grandis, Deightoniella arundinacea*; szkodniki zwierzęce — *Lipara lucens, Lipara rufitarsis, Archanara dissoluta, Steneotarsonemus phragmitidis.*

Materiał zebrano z 60 jezior Pojezierza Suwalskiego, Mazurskiego i Pomorskiego jesienią 1967 roku.

Trzcina najczęściej atakowana jest przez *Archanara dissoluta* i *Lipara lucens* (40 i 38% badanych jezior). Szkody wywołane przez te gatunki mają poważne znaczenie dla gospodarki, gdyż obniżają one poważnie kondycję trzciny. Zniszczone przez nie łodygi osiągają średnio 64 i 57% wysokości oraz 69 i 33% wytrzymałości łodyg zdrowych. Do najrzadziej na trzcinie spotykanych gatunków należy głownia — *Ustilago grandis* i roztocz — *Steneotarsonemus phragmitidis* (12 i 13% badanych jezior). Najmniejsze zmiany w kondycji trzciny powoduje roztocz (Tabela XV).

Zmniejszenie wysokości chorego źdźbła trzciny w stosunku do zdrowego kształtuje się w granicach od 43 do 94%. Wytrzymałość na złamanie chorej trzciny na poziomie wody wynosi od 21 do 136%, na wysokości czwartego międzywęźla nad wodą od 13 do 193%.

Stwierdzono korelację między średnicą a wytrzymałością łodygi. Przy tych samych średnicach wytrzymałość chorych łodyg jest mniejsza niż zdrowych.

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POLSKIE ARCHIWUM HYDROBIOLOGII (Pol. Arch. Hydrobiol.)	17 (30)	3	397-418	1970

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PERIPHYTON OF SEVERAL LAKES OF THE MAZURIAN LAKELAND

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ABSTRACT

Investigations of the dynamics of quantitative changes of reed periphyton were carried out on 6 lakes of the Mazurian Lakeland. The periphyton was analysed on this year's and last year's reed-shoots and on slides. The amount of dry weight of organic matter, organic nitrogen and chlorophyll content were determined. The content of chlorophyll in the same lake was approximate in different years, but greater differences were observed in lakes of varied trophy. Thus, it seems that chiefly algae decide about the processes taking place in the periphytic biocenosis.

CONTENTS

1. INTRODUCTION

Since the paper by Seligo (1905) periphyton is the subject of investigations of many research workers. Both the algologists and zoologists are interested in the subject. Several papers appear dealing with several aspects of life of this biocenosis. Such investigations are also carried out in Poland (Bohr 1962, 1964, Kowalczewski 1965, Pieczyńska 1964, Pieczyńska and Spodniewska 1963, Pieczyńska and Szczepańska 1966, Wolnomiejski and Dunajska 1966, Wysocka-Bujalska 1952, 1958a, 1958b, 1961).

Lately, the scientists became more interested with productivity problems. Castenholz (1961), while analysing the periphyton production in various types of water bodies points out that this production is of great significance in economics, and especially that of small and shallow water bodies. The primary periphyton production in greater reservoirs is also a considerable part of the primary production of littoral. According to Assman (1953) this production reaches 40% as compared with the total production of macrophytes. Pieczyńska and Szczepańska (1966) estimate the primary periphyton production in Mikołajskie Lake as 23% as compared with the primary production of littoral overgrown with emergent vegetation. In an extreme instance this production may be several times higher than the production of macrophytes (Wetzel 1964).

One of the elements of the studies of primary production are the changes of the chlorophyll content in periphyton (Waters 1961, Pieczyńska and Szczepańska 1966, Szczepański and Szczepańska 1966). Another production indicator are the changes of nitrogen content of periphyton (Straškraba 1963). Also the changes of the amount of dry weight and organic matter are frequently investigated (Kowalczewski 1965, Maciolek and Kennedy 1964, Szczepański 1968a). Pieczyńska and Szczepańska (1966) introduced into investigations on primary production of water bodies, varying from the typological point of view, two elements parallely applied — changes of biomass, the indicator of which was the chlorophyll amount, and production of O_2. Szczepański (1968a) working on a similar problem introduces several additional elements such as analysis of dry weight, calorific value, organic matter, ash content, amount of chlorophyll and Ca content of periphyton incrustation.

Studies on the productivity of reed-belts were included within the investigations of the Institute of Ecology, Polish Academy of Sciences, on the productivity of water bodies. This paper discusses the production of periphyton developing on reeds. The investigations were carried out in reed-belts of lakes of a varied trophy.

2. METHODS AND MATERIAL

Periphyton is composed of animals, plants and organic and inorganic detritus. As it is a heterogenous substance it requires the application of indicators characterizing various parameters of its production.

Its dry weight, ash and organic matter content were estimated. The calorific value of periphyton, its organic nitrogen and chlorophyll content were determined as well as the amount of Ca in ash, the main mass of Ca having the character of incrustation. The obtained results were calculated into periphyton weight units and into surface units of the substratum covered by periphyton.

The investigations included periphyton developing on this year's and last year's shoots of reed and the slides introduced into the reeds and exposed for 3 or 4 weeks. These slides were placed on wooden stands on the depth of 0.5 m. Slides measuring 70×10 mm were used to determine the chlorophyll amount and were placed in a tube containing extraction fluid after the exposure without scraping off the periphyton.

Periphyton was scraped off the reed stems measuring simultaneously the diameter and stalk length in order to determine the area out of which the sample was obtained. Depending on the amount of periphyton one sample consisted of the material from 5–10 stalks. The periphyton was scraped off into an evaporating dish and dried. Dry weight was obtained by drying to the constant weight at a temperature 105°C. The ash content was determined by burning in an electric furnace at a temperature 600°C. The amount of organic matter was calculated as a weight-loss on burning. The calorific value was determined by combustion of 1 g of dry periphyton in an adiabatic calorimeter K.L.3. Organic nitrogen was determined by Kjeldahl method. The amount of Ca in ash was estimated using the flame photometer after converting Ca into $CaCl_2$. Sections 5 cm long were cut out of the stalk in order to determine the chlorophyll in periphyton developing on reed. 5 such sections, each one from a different reed formed one sample. Periphyton scraped off them was extracted. The chlorophyll content was determined in alcoholic extract (a mixture of ethanol and methanol). The solvent was boiled (few minutes) together with the periphyton to destroy the chlorophyllase. Three-fold extraction was applied, each one lasting 24 hr. The extraction fluid was kept in darkness, at a temperature about 0°C. The successive extractions were decanted together. In order to remove the suspension the extraction was centrifugated (6000 r.p.m. in 15 min). The solution was filled up to 25 ml with pure extraction fluid. The extinction was measured on Pulfrich photometer in micro-tubes, 20 cm long. The measurements were made with the filter 66 (665 mμ). The photometer was calibrated with standard solution chlorophyll "a" Sandoz.

The material was from 6 lakes of Mazurian Lakeland differing from the typological point of view.

In 1963, only the chlorophyll changes on the slides were analysed. The material was from Lake Tałtowisko — 46 series.

In 1964, the material was sampled from the following lakes: Lisunie, Mikołajskie and Tałtowisko. The investigations included slide periphyton — 68 series, periphyton from last year's reed — 86 series and periphyton from this year's reed — 74 series. The dry weight, ash content, organic nitrogen and chlorophyll were analysed.

In 1966 the following lakes were examined: Kotek, Mikołajskie, Skonał, Śniardwy, Tałtowisko. The total of 81 series of periphyton from this year's reed was sampled. The dry weight, organic matter, calorific value, Ca content and amount of chlorophyll were analysed.

In 1964 samples were taken every 3 weeks. In 1966 — each month. Depending on the programme the number of stations on each lake was from 1 to 6. The samples were taken from reeds growing on the depth from 0.5 to 1 m, more or less cn the same distance from the border line of reed-belt and open water.

3. TERRAIN DESCRIPTION

The investigations were carried out on several lakes of the Mazurian Lakeland (north-eastern Poland). They all are among the moraines of the last glaciation. And so:

Lake Kotek — polimictic, eutrophic. Area: 42.2 ha, maximum depth: 2.5 m. The vegetation covers almost completely the bottom of the reservoir. The reed-belts cover a large area.

Lake Lisunie — holomictic, eutrophic, with a strong tendency towards dystrophy, with a clinograde oxygen curve. Area: 14.8 ha, maximum depth: 8.5 m. "A lake with a decreased carbonate hardness but with an average pH" — Olszewski and Paschalski (1959). Only very small sections of littoral are overgrown with reed. The submerged plants cover about 1.63 ha (Pieczyńska — unpublished data).

Mikołajskie Lake — holomictic, eutrophic with a clinograde oxygen curve. Area: 460 ha, maximum depth: 27.5 m (Szczepański 1958). The littoral zone covers 10% of total surface (Synowiec 1961). *Phragmites communis* Trin. covers the area of 32.3 ha, which is 7.01% of the total lake surface (Kowalczewski and Wasilewski 1966). This species strongly dominates among emergent plants. The lake shores are in their greater part high. The western shore is almost completely wooded.

Lake Skonał — holomictic, eutrophic with a tendency towards dystrophy and a clinograde oxygen curve (Szczepański 1968b). Area: 20 ha, maximum depth: 5.5 m (Olszewski and Paschalski 1959). Almost entire littoral of the main basin is overgrown by a reed-belt, 4–40 m broad. The reeds cover 15.82% of the total surface (Kosicka 1958). The lake drainage area is all covered with coniferous and mixed forests.

Lake Śniardwy — polimictic, eutrophic. Area: 10 588.44 ha (without Sekst and Warnołt Lakes), maximum depth: 25 m. Such great surface allows for big waves. The reed-belt can be even 200 m broad (Szczepańska — unpublished data).

Lake Tałtowisko — holomictic, mezotrophic with a minus heterograde oxygen curve (Szczepański 1968b). Area: 326.9 ha, maximum depth: 39.5 m. 35.1 ha of littoral is covered by emergent vegetation. The main component of emergent plants is reed (Bernatowicz and Pieczyńska 1965) and covers 10.8% of total lake surface. The north-eastern shore is low and wet and covered with forest, the south-eastern and south-western shores are low and not wooded.

4. RESULTS

A. DEPENDENCE OF PERIPHYTON AMOUNT ON SUBSTRATUM

The investigations on the dependence of periphyton on substratum were carried out many times. Pieczyńska and Spodniewska (1963) found that "when different substrata are located in one place of the reservoir then the occurrence of periphyton organisms is similar (species composition, dominance structure, abundance). The existing differences, even considerable ones, do not distinguish a certain substratum or a group of substrata (e.g. live, dead or experimentally introduced into the reservoir) and are of the same order as the differentiations in time and space observed on one kind of substratum. But considerable differences of periphyton were observed on the same substrata from different lakes or even places within one lake". Rehbronn (1937) found the existence of obvious dependence of periphyton on the kind of substratum, especially in the first stages of colonization.

The above conclusions do not include the differentiations in time, and often the investigated material contains periphyton of a various time of development. Szczepański and Szczepańska (1966) found that the 14 days of colonization are followed by some period of stabilization in the periphyton development, which lasts about 4 weeks. This allows to compare the samples of periphyton from artificial substrata having an exposure time 2–6 weeks. The problem of comparability of this type of material with those collected from this year's or last year's reed remains open. Glass, live reed and last year's reed (dead) are undoubtedly different substrata, but it seems that in this situation more important is the age of periphyton, which in the instance of slides was 3–4 weeks.

In the instance of live reed, the shoots of which appear in May, during the vegetation period, this periphyton is from 0 to 8 months old. But in the instance of last year's reed — from 12 to 20 months.

The amount of periphyton on last year's reed is greater during almost the entire vegetation period than on live reed, and only at the end of vegetation period the amounts of periphyton may be levelled on both kinds of reed, they may be even greater on this year's reed (Fig. 1, 2).

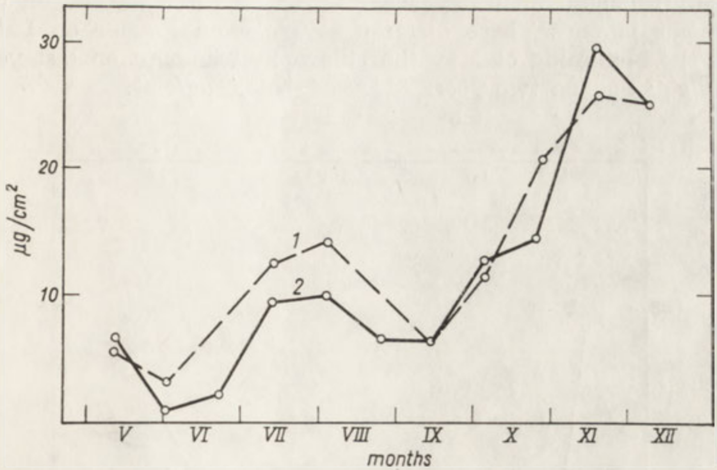

Fig. 1. Seasonal changes of the amount of periphyton chlorophyll on last and this year's reed (the means out of 3 stations). 1 — of last year's reed; 2 — of this year's reed. Mikołajskie Lake, 1964

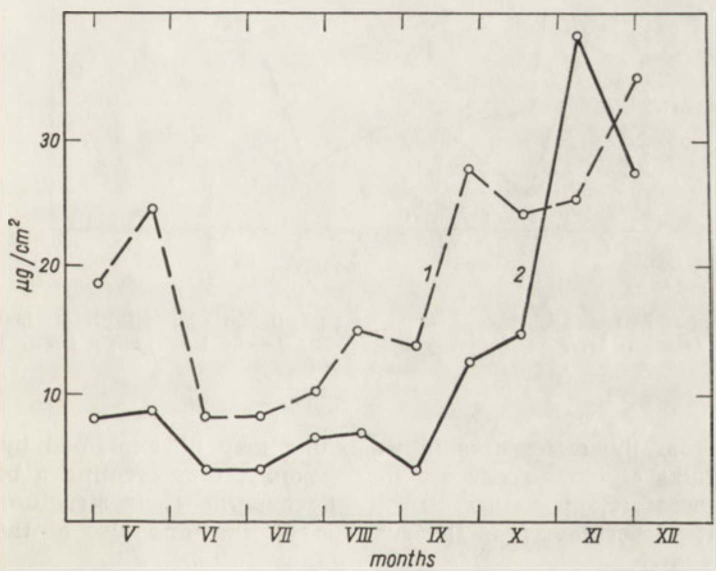

Fig. 2. Seasonal changes of the amount of periphyton chlorophyll on last and this year's reed (the means out of stations I, II). 1 — of last year's reed; 2 — of this year's reed. Tałtowisko Lake, 1964

On some stations of Lake Lisunie and of Lake Tałtowisko the periphyton amounts are during the entire vegetation period greater on last year's reed (Fig. 3). Even greater differences in the amount of periphyton are observed between the last year's reed and that two years old (data only from the period of early spring). In the middle of March, on Mikołajskie Lake the chlorophyll amount on last year's reed was 3.6 μg/cm², and on two years old reed — 16.5 μg/cm². These differences are even greater on Lake Tałtowisko — at the beginning of May the chlorophyll amount on last year's reed was 18.7 μg/cm² and on two years old reed — 45.0 μg/cm².

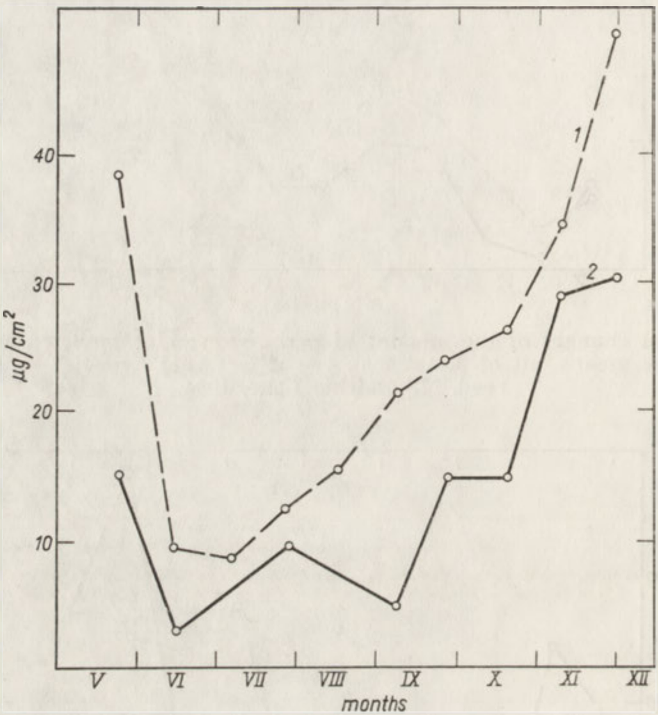

Fig. 3. Seasonal changes of the amount of periphyton chlorophyll on last and this year's reed (station I). 1 — of last year's reed; 2 — of this year's reed. Tałtowisko Lake, 1964

Apart from the differences in time, this may be explained by the fact that the stalks of older reeds are more spongy, thus creating a better substratum. Therefore, on natural substrata, changing their structure in time, the amount of periphyton is the function of time and also of the changes of substratum.

Mean annual values of chlorophyll amount on this year's reed are slightly lower than on last year's reed, but the respective stations are not identical in that respect. On Mikołajskie Lake the amount of periphyton on this year's reeds is 9, 12 and 23% smaller than on last year's reed from the same stations. The analogous differences on Lake Tałtowisko are 10 and 40% for two stations. Mean chlorophyll amounts in the periphyton of last year's and this year's reed periphyton are presented in Table I.

The differences between stations I, II and III on Mikołajskie Lake and stations I and II on Lake Tałtowisko are of the same order as the differences

Table I. Mean chlorophyll amounts on last year's and this year's reed (May-November 1964)

Lake	Age of reed	Chlorophyll amount (μg/cm²) Station I	II	III
Mikołajskie	last year's	12.31	11.75	14.62
	this year's	11.17	10.38	11.27
Tałtowisko	last year's	22.75	14.31	—
	this year's	13.63	12.87	—

between last year's and this year's reed on the given lake. It should be pointed out that on this year's reed the periphyton constantly contains smaller amounts of chlorophyll. Especially great differences were noticed on Lake Lisunie. The chlorophyll amounts in the periphyton of this lake in last year's reed are nearly three times greater than on this year's reeds. They are 10.7 μg/cm² on last year's reed and 3.11 μg/cm² on this year's reed (monthly means — June to November).

B. DIFFERENTIATION OF THE PERIPHYTON AMOUNT WITHIN THE LAKE

Periphyton in the lake is a heterogenous community, which displays great spatial differentiation (Fig. 4). In July, on Mikołajskie Lake the differences between stations on this year's reed were about 15 times as large, which

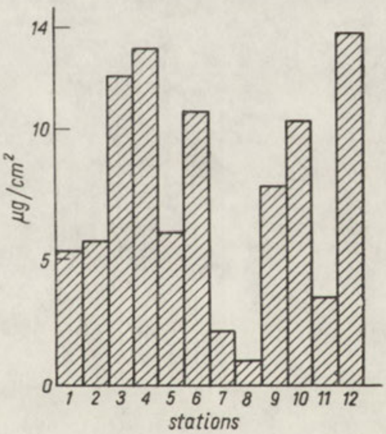

Fig. 4. Chlorophyll content in the periphyton of this year's reeds on various stations of Mikołajskie Lake. July the 21th, 1964

makes it necessary to be more careful while generalizing the observations for entire water bodies. So great differences between stations may be caused by the fact that on some stations the period of mass development of algae had not begun yet and the chlorophyll amounts are yet low. These differences are not so striking on the slides (Fig. 5) as the amount of periphyton was 2.2 times greater on the richest station than on the poorest one for the period of low production, and 2.5 times greater for the autumn maximum of peri-

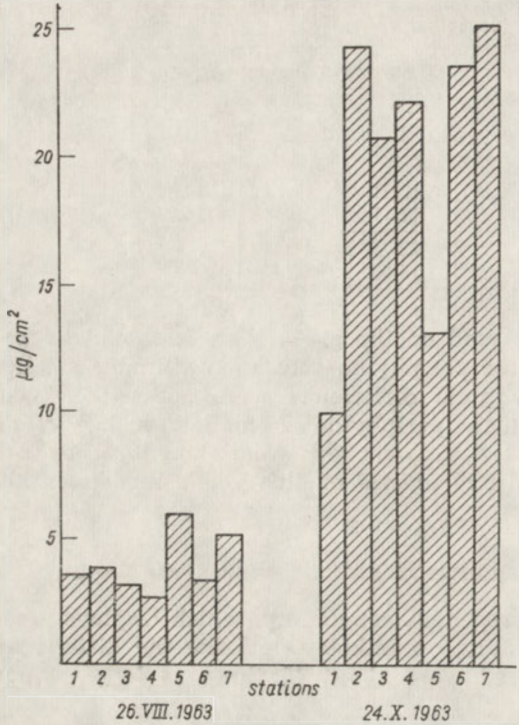

Fig. 5. Chlorophyll of slide periphyton from various stations of Lake Tałtowisko in August and October 1963. 1 — bay I, deep into the bay; 2 — bay I, promontory; 3 — littoral on the southern bank; 4 — littoral on northern bank; 5 — bay II, deep into the bay; 6 — bay II, promontory; 7 — littoral exposed to the wave

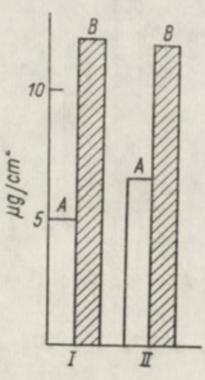

Fig. 6. Chlorophyll of slide periphyton from quiet places. A — deep into the bay and those exposed to the wave; B — promontories. I — bay I; II — bay II. Tałtowisko Lake, October the 24th, 1963

phyton development. In the autumn material there are visible differences between the stations exposed to wave motion and those quiet ones. The exposed stations contain greater periphyton amounts on slides in that period (Fig. 6). The course of seasonal changes on stations similarly exposed to wave motion are of the same character (Fig. 7). The late-spring and early-autumn minimum separated by not big summer maximum and the late-autumn increase on three stations of a similar exposure are approximate.

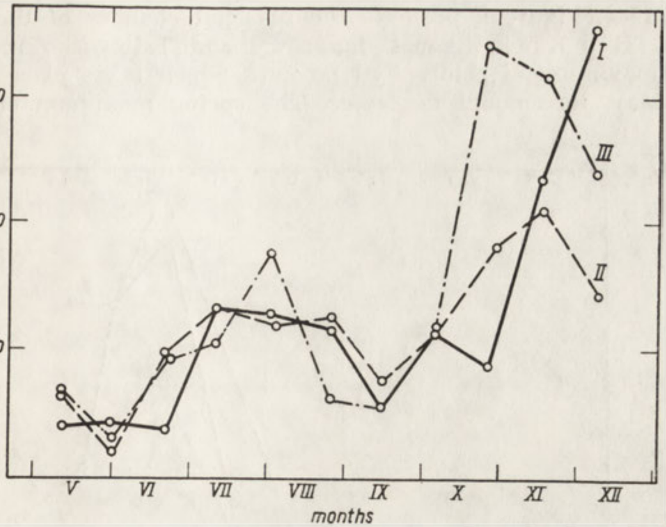

Fig. 7. Seasonal changes of chlorophyll in periphyton of last year's reed on three stations. I, II, III — stations. Mikołajskie Lake, 1964

C. SEASONAL CHANGES OF THE PERIPHYTON AMOUNT

Changes in chlorophyll amount

The periphyton material collected during several years allows to state some regularities of seasonal changes. Figure 8 presents the seasonal changes of the chlorophyll amount on Mikołajskie Lake, Lake Tałtowisko and

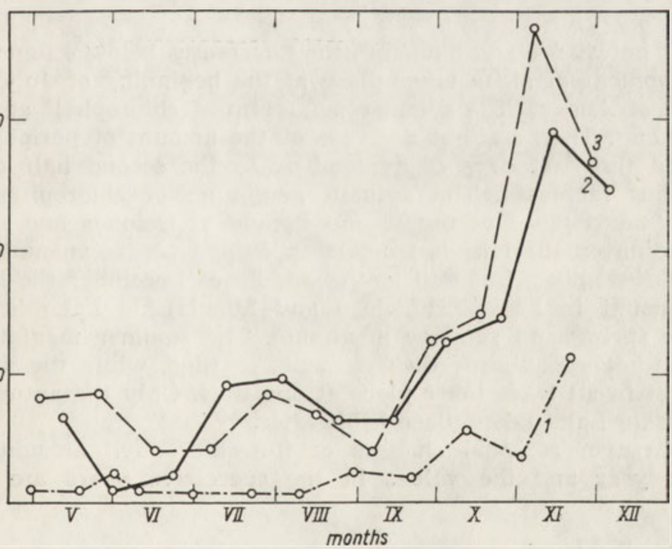

Fig. 8. Seasonal changes of the chlorophyll amount in periphyton of this year's reeds in 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

Lisunie in 1964. Figure 9 presents the seasonal changes of the chlorophyll amount on lakes Kotek, Skonał, Śniardwy and Tałtowisko in 1966. After the spring maximum of chlorophyll amount, which takes place in the third decade of May, its amount decreases. The spring maximum of chlorophyll

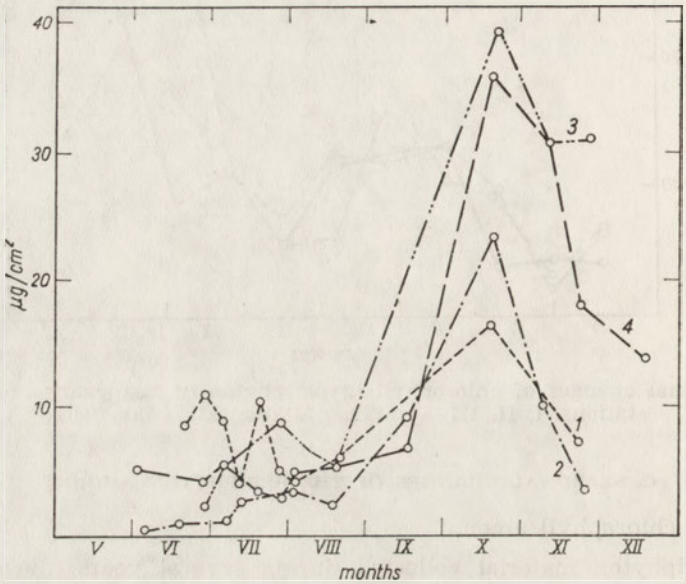

Fig. 9. Seasonal changes of the chlorophyll amount in periphyton of this year's reeds in 1966. 1 — Kotek Lake; 2 — Skonał Lake; 3 — Śniardwy Lake; 4 — Tałtowisko Lake

amount [1] is between 6 and 8 μg/cm², then decreases below 4 μg/cm². The summer development of algae takes place at the beginning of July and lasts to the middle of August. The summer maximum of chlorophyll amount is from 7 to 10 μg/cm². Then a slight decrease of the amount of periphyton algae is observed in the first days of September. In the second half of September their amount increases. The autumn maximum of chlorophyll amount in periphyton takes place in the second decade of October and in November, and depending on the lake is from 12 to 40 μg/cm². Its amount decreases at the end of November. But still in the middle of December the level of chlorophyll amount in Lake Tałtowisko and Mikołajskie Lake is higher than during the spring and summer maximum. The summer maximum in particular lakes undergoes some displacements in time, while the autumn maximum almost in all lakes takes place at one time. Only the autumn maximum in Mikołajskie Lake takes place a bit later.

The course of seasonal changes of the chlorophyll amount is repeated year after year and the values in the successive years are approximate (Table II).

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[1] The numbers represent the chlorophyll amounts on this year's reed (1964) sampled from Lakes Tałtowisko and Mikołajskie.

In 1964 the autumn maxima on both lakes were slightly higher than in 1966. On Lake Tałtowisko, in both years they are higher than on Mikołajskie Lake. It should be pointed out that the differences in typology for this period are more visible than the differences between respective years.

Table II. Autumn maxima of chlorophyll amount on this year's reed on Mikołajskie and Tałtowisko Lakes

Lake	Chlorophyll amount (μg/cm²)	
	1964	1966
Mikołajskie	29.4	28.0
Tałtowisko	38.4	36.0

Jörgensen (1957) obtained a similar picture of seasonal changes of periphyton diatoma for Lake Fure, Denmark. The difference between the material of Jörgensen and our is that the spring maxima in Jörgensen material are definitely higher than the autumn ones, and this may be the result that Jörgensen based on the number of diatom cells, while we — on chlorophyll content.

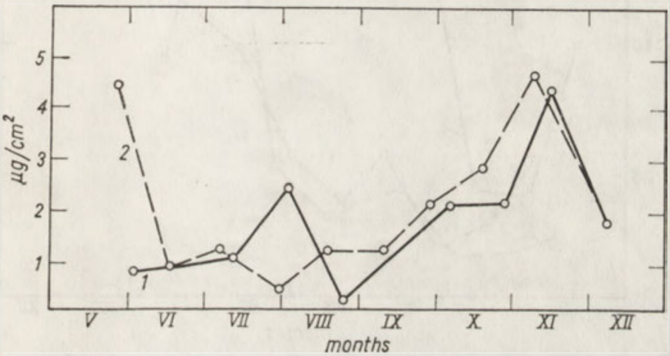

Fig. 10. Seasonal changes of the chlorophyll amount in slide periphyton in 1964. 1 — Mikołajskie Lake; 2 — Tałtowisko Lake

The development intensity on young substrata is similar. Figure 10 presents the course of the changes of the intensity of colonization on slides exposed for three weeks on Lakes Tałtowisko and Mikołajskie in 1964. The colonization intensity is lower in the first part of vegetation period. Since the end of August the colonization intensity increases regularly, attaining the maximum in November, and again decreases.

In 1965 a similar picture of seasonal changes in chlorophyll amount in slide periphyton was obtained on Mikołajskie Lake (Szczepańska 1968).

In lakes of a small chlorophyll content — Lake Lisunie — the observed rhythm of seasonal changes is not the same, however in this instance also an autumn increase of the number of algae takes place.

Seasonal changes of other periphyton elements

Seasonal changes of dry weight, organic matter, Ca amount and calorific value are to some extent an illustration of seasonal changes in chlorophyll amount.

D r y w e i g h t. Seasonal changes of periphyton dry weight on 5 lakes investigated in 1966 show a maximum in October, and also a slight increase of the amount of dry weight, which cannot be assumed as a visible maximum, because of the considerable fluctuations of value. In November the amount of dry weight decreases to the winter level.

O r g a n i c m a t t e r. The organic matter in 1966 displayed a similar character of seasonal changes. And so, great maximum in October (on Mikołajskie Lake in November), and whatmore a slight increase in July on Lakes Skonał and Śniardwy. Figure 11 presents the seasonal changes of organic

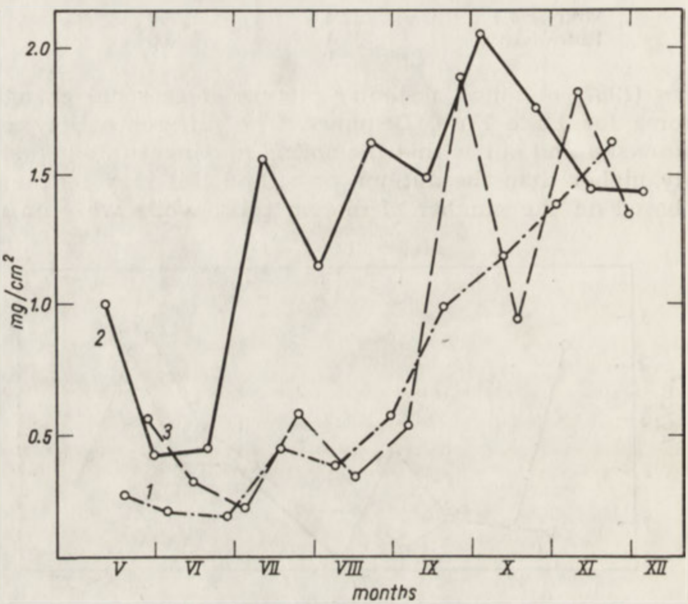

Fig. 11. Seasonal changes of organic matter in periphyton of this year's reeds in 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

matter on three lakes in 1964. Intensive cumulation of periphyton biomass on Mikołajskie Lake already begins in July, and on Lakes Tałtowisko and Lisunie — at the end of October.

A m o u n t o f c a l o r i e s. The amount of calories per unit of surface occupied by periphyton (Fig. 12) increases during the vegetation season, attaining its maximum in October–November, and the intensity of this increase varies in different lakes. In late autumn the amount of calories is reduced to the winter level. The calorific value of periphyton (amount of calories per 1 g of dry weight shows differences in the course of seasonal changes.

During the entire vegetation period the calorific value of the periphyton of Lake Śniardwy remains on the level 1400 cal/g dry weight.

Lake Skonał has a lower calorific value and is characterized by two distinct minima — in July and October (below 1000 cal/g d.wt.).

Lakes Tałtowisko and Kotek have the highest calorific value in spring — above 2000 cal/g d.wt. These values decrease in summer. The minimum is

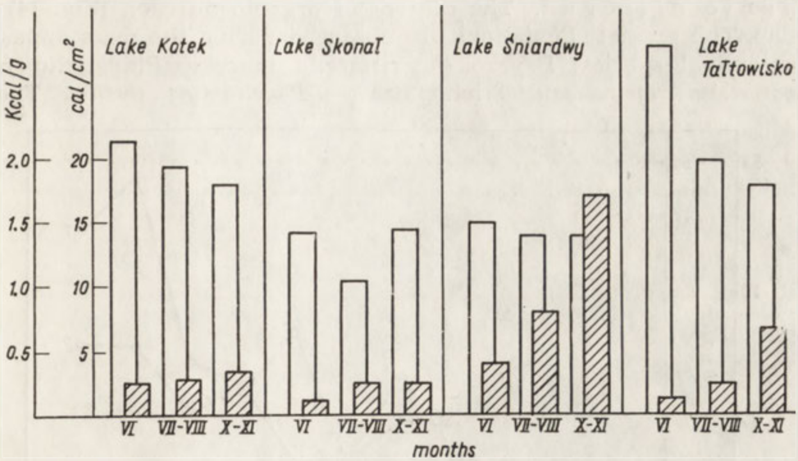

Fig. 12. Seasonal changes of the amount of calories per cm² and of the calorific value of periphyton in 1966. White columns — kcal/g of dry wt.; marked columns — cal/cm²

at the end of summer. During that minimum the calorific value is 1400 cal/g d.wt. In autumn there is a short-lasting increase of calorific value up to 2000 cal/g d.wt. (The mean for that period on both these lakes is 1800 cal/g d.wt). Figure 12 presents mean calorific values for spring, summer and autumn. These mean values decrease from spring to autumn. However, despite this decrease of calorific value, the amount of calories per surface unit either increases slightly (Lake Kotek) or the increase is very big (Lake Śniardwy), which points to an especially big increase of biomass on this lake and in that period as compared with the increase on other lakes.

Quantity of calcium. The quantity of calcium (Fig. 13) does not show greater seasonal variations. The most frequently found quantity is

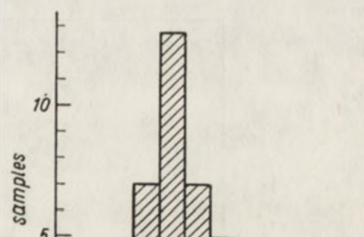

Fig. 13. Percentage variation of Ca content in dry weight of the periphyton of this year's reeds. Material from the entire vegetation season from 5 lakes, 1966

within the limits 11–13% of dry weight. The calcium content in spring samples is slightly lower, while in autumn samples — slightly higher. In autumn the Ca content in dry weight is about 3% higher.

O r g a n i c n i t r o g e n. The content of organic nitrogen (Fig. 14) is not so regular. The greatest deviations are observed during the mass appearances of some animal species: Bryozoa — *Cristatella mucedo, Plumatella fungosa* and *Plumatella repens* and Trichoptera — *Psychomyia pusilla*. Then are

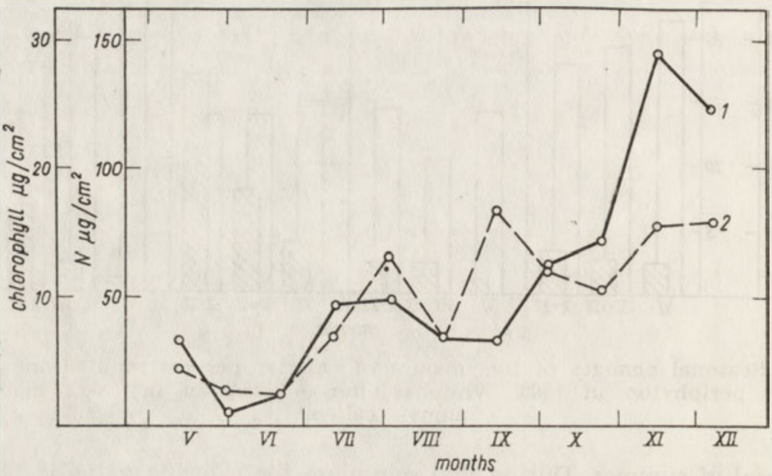

Fig. 14. Seasonal changes of chlorophyll and organic nitrogen in periphyton of this year's reeds. 1 — chlorophyll; 2 — organic nitrogen. Mikołajskie Lake, 1964

observed the deviations of seasonal changes of organic nitrogen from the other components. STRAŠKRABA (1963) observed similar irregularities of seasonal changes of organic nitrogen in periphyton. The diagrams presented by him show that on each of the investigated stations the course of seasonal changes of organic nitrogen in periphyton has a different character. However, in our investigations on the whole the quantity of nitrogen in periphyton increases from spring to autumn attaining the maximum in autumn (Fig. 15).

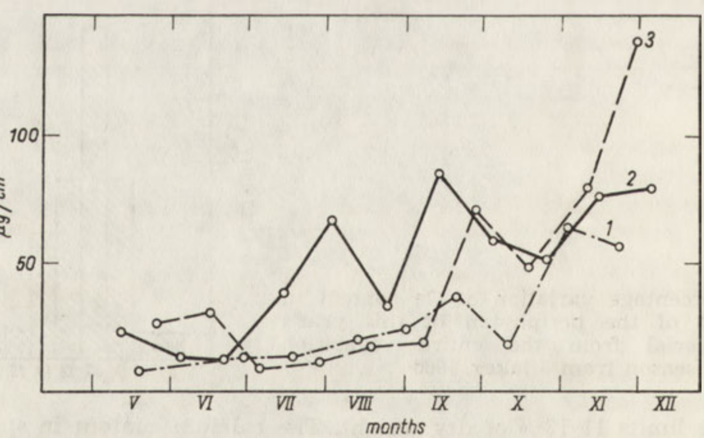

Fig. 15. Seasonal changes of organic nitrogen in periphyton of this year's reeds, 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

On Mikołajskie Lake the mean quantity of organic nitrogen from the vegetation period is 48.8 μg/cm² of substratum ranging from 12.6 to 84.3 μg/cm². On Lake Tałtowisko the mean quantity of organic nitrogen is almost the same — 44.9 μg/cm², but the range of variation is considerably greater 8.3–135.7 μg/cm². On Lake Lisunie the quantity of nitrogen is definitely smaller and is 27.8 μg/cm², the range of variations 6.9–63.5 μg/cm².

5. DISCUSSION AND CONCLUSIONS

A. THE RELATION BETWEEN THE RESPECTIVE PERIPHYTON ELEMENTS

The previous chapter discussed the seasonal changes of respective periphyton elements. These elements are strongly related one to another. Observation of these connections during the vegetation season allows to obtain more information about periphyton.

Mass appearance of animals or algae influences the value of the relation of "chlorophyll to nitrogen", "chlorophyll to organic matter" and "nitrogen to organic matter". The minima and maxima of these relations during the vegetation season as well as their mean values for the entire vegetation period are different for various lakes (Fig. 16) and point to the dissimilarity of the processes taking place there.

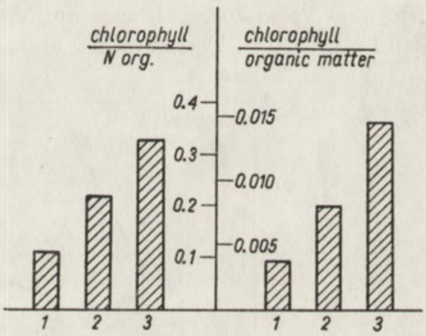

Fig. 16. Means (from the vegetation season) of the relation chlorophyll/nitrogen and chlorophyll/organic matter in periphyton of this year's reeds, 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

The quantitative relation of chlorophyll to nitrogen has the greatest value on Lake Tałtowisko, which would prove about the great participation of algae in the periphyton of that lake. The value of this relation is lower on Mikołajskie Lake, and even lower on Lake Lisunie (Fig. 16, 17). The summer maximum of the relation chlorophyll/nitrogen is slightly higher on Lake Tałtowisko than the autumn one, which would point to the fact that the quantities of nitrogen in the periphyton of this lake are greater in autumn than in summer. Figures 8 and 15 present the course of seasonal changes of the respective elements of this relation. The summer maximum on Mikołajskie Lake is visibly lower than the autumn one. On Lake Lisunie the summer maximum of chlorophyll amount is not observed as well as the increase in that period of the relation chlorophyll/nitrogen. This relation on this lake shows an increase from spring to autumn and a decrease at the beginning of November (Fig. 17).

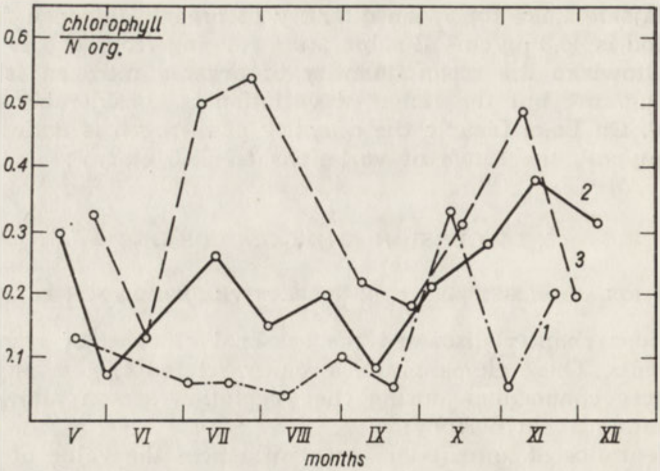

Fig. 17. Means (from the vegetation season) of the relation chlorophyll/nitrogen in periphyton of this year's reeds, 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

Mass appearance of animals in periphyton affects also the changes of the quantitative relation chlorophyll/organic matter. This relation is the highest on Lake Tałtowisko, lower on Mikołajskie Lake and the lowest on Lake Lisunie (Fig. 18). The summer maximum of this indicator on Lake Tałtowisko

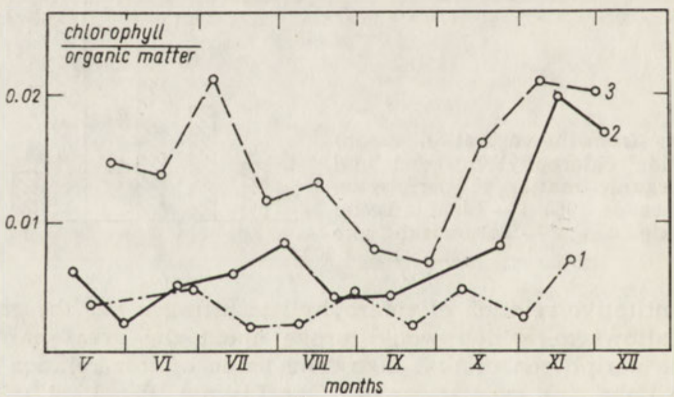

Fig. 18. Means (from the vegetation season) of the relation chlorophyll/organic matter in periphyton of this year's reeds, 1964. 1 — Lisunie Lake; 2 — Mikołajskie Lake; 3 — Tałtowisko Lake

is almost the same as the autumn one, despite the fact that the chlorophyll amounts are in autumn considerably greater, which would point to small quantities of organic matter on this lake in summer (Fig. 11).

Summer maximum of this relation on Mikołajskie Lake takes place later than on Lake Tałtowisko (summer maximum of the chlorophyll amount takes place later) and is much lower than the autumn one. Summer maximum of this relation on Mikołajskie Lake is much lower than on Lake Tałtowisko, despite the slightly greater amounts of chlorophyll on Mikołajskie Lake during the summer maximum. This points to a much greater quantitative participation of chlorophyll in organic matter in the periphyton of this lake in summer. The autumn maximum of this relation on Lake Tałtowisko and Mikołajskie Lake is almost identical.

On Lake Lisunie this relation increases from spring to autumn attaining its maximum in the end of November.

The relation of organic nitrogen to organic matter is different on various lakes. A great participation of organic nitrogen in organic matter is observed on Lake Tałtowisko in spring and in autumn. On Mikołajskie Lake only a slight increase of this relation is observed from spring to autumn, and on Lake Lisunie a slight decrease in that same time.

When comparing the discussed relations it can be seen that the main factor forming the picture of periphyton is the development of algae. Their mass appearances subordinate the entire processes in that biocenosis.

B. DEPENDENCE OF PERIPHYTON ON THE LIMNOLOGICAL TYPE OF LAKE

The dependences of periphyton on the limnological type of lakes are very little known. Only recently, papers on that subject were published. Pieczyńska and Szczepańska (1966) analyse the dependence of primary periphyton production in limnologically various types of lakes. Szczepański (1968a) connects the amount of periphyton with the type of lake. The material included in this paper allows to connect various parameters of periphyton with the limnological type of lake. As we are observing some displacements in time, in the dynamics of periphyton development during summer, in order to make a comparison we shall be using either the material from the autumn maximum of periphyton development or the means for the vegetation period (all there where it is possible to calculate the mean). Table III presents the means out of 3 autumn series for 5 lakes.

The Table has been divided into two parts: "A" and "B". Part "A" contains data on the respective elements calculated per surface unit. Part "B" contains data calculated per weight unit and they determine the periphyton value. Therefore part "B" represents "the value", part "A" — the quantity.

In part "A" the eutrophic-polimictic Lake Śniardwy contains the highest amounts of dry weight and the remaining elements. The values of these elements in this lake, in part "B", are low, when compared with other lakes. The calorific value and amount of dry periphyton weight is the lowest here, the per cent of organic matter is the one before last. From the point of chlorophyll content this lake is on the third place following the eutrophic Mikołajskie Lake and b-mezotrophic Lake Tałtowisko. Lake Skonał — eutrophic with a tendency towards dystrophy has the lowest values of biomass and of the indicators of periphyton value apart from Ca. Mikołajskie Lake and Lake Tałtowisko are the most similar lakes from the point of biomass and periphyton value. It should be added that the biomass and its value of the periphyton of Lake Tałtowisko is greater than those of Mikołajskie Lake. The eutrophic-pond Lake Kotek has a not very big biomass but its calorific value of organic matter is the greatest.

As it can be seen it is difficult to arrange these lakes in an order on the

Table III. Characteristic of autumn periphyton

Lake	A — Periphyton biomass		B		
	Dry wt. (mg/cm²)	Organic matter (mg/cm²)	Chlorophyll (μg/cm²)	Ca (mg/cm²)	cal/cm²
Kotek	2.9	1.5	13.6	0.49	4.3
Mikołajskie	3.0	1.6	21.2	0.35	5.0
Skonał	1.9	0.9	6.5	0.40	2.4
Śniardwy	6.3	3.1	34.0	0.83	8.5
Tałtowisko	3.8	2.1	28.9	0.52	6.8

basis of various elements not reduced to a common denominator. In order to arrange them in a more univocal way the percentage values for particular columns were calculated on the basis of data in Table III. 100% was assumed as the highest value for each column, e.g. in the first column Lake Śniardwy has the greatest amounts of dry weight in mg/cm² (6.3 mg/cm²) and this value has been assumed as 100%. Having this value the percentage values were calculated for other lakes. Similarly were calculated the percentage values for the second column. Then for part "A" the mean was calculated out of the percentage values for each lake. This mean was 100% for Lake Śniardwy, 71.5% — for Lake Tałtowisko and so on (Table IV, column "A"). The "value" of periphyton (Table IV, column "B") similarly calculated out of the values in part "B" of Table III.

Table IV. Estimation of autumn reed periphyton (1966, the means out of 3 series)

Lake	Biomass increase amount A	Quality (value) B	Geometric mean ($C = \sqrt{AB}$)
Kotek	48.8	88.6	65.9
Mikołajskie	57.8	93.3	73.5
Skonał	30.9	75.5	48.3
Śniardwy	100.0	85.1	92.5
Tałtowisko	71.5	98.3	83.8

Therefore according to the value of autumn biomass the lakes are arranged as following: 1 — Śniardwy, 2 — Tałtowisko, 3 — Mikołajskie, 4 — Kotek, 5 — Skonał.

Arranging the lakes according to the periphyton "value" the order would be different: 1 — Tałtowisko, 2 — Mikołajskie, 3 — Kotek, 4 — Śniardwy, 5 — Skonał.

In both arrangements Lake Skonał is the last one in order, while Lake Śniardwy, which is the first one according to the biomass value is the fourth one where periphyton is concerned.

Finally the geometrical mean obtained out of biomass and its "value" allows for uniform arrangement of the lakes. This value is given in the third on this year's reed (1966, means from 3 series)

B — Chemical and energetical characteristics					
% organic matter in dry wt.	% Ca in dry wt.	calorific value		% chlorophyll	
		dry wt. (cal/g)	organic matter (cal/g)	in dry wt.	in organic matter
53.9	16.4	1680	3410	0.53	0.97
54.6	11.4	1630	3100	0.72	1.31
45.0	20.6	1440	2850	0.36	0.72
49.0	13.0	1370	2980	0.55	1.13
55.7	13.4	1800	3200	0.72	1.30

column of Table IV. Then the order of lakes is as following: 1 — Śniardwy, 2 — Tałtowisko, 3 — Mikołajskie, 4 — Kotek, 5 — Skonał.

This of course is an approximate arrangement as it is based only on few characteristics and does not contain the entire variety of periphyton properties. However, this allows to reduce many numbers characterizing the particular reservoir to one number sufficiently determining this reservoir.

Figure 19 presents the geometrical means of periphyton estimation and the amount of calories on cm² in periphyton. Thus it can be seen that the

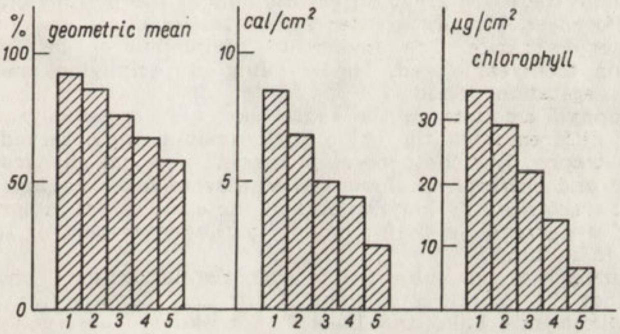

Fig. 19. Comparison of lakes on the basis of geometrical mean of periphyton estimation (cal/cm²) and chlorophyll amount, 1966. 1 — Śniardwy Lake; 2 — Tałtowisko Lake; 3 — Mikołajskie Lake; 4 — Kotek Lake; 5 — Skonał Lake

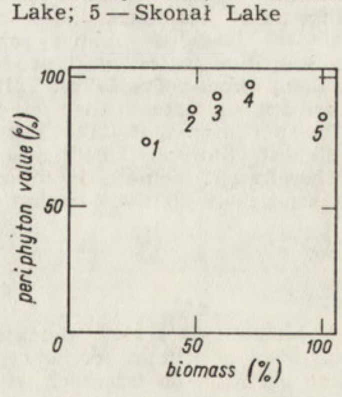

Fig. 20. Dependence between the amount of biomass and the "periphyton value", 1966. 1 — Skonał Lake; 2 — Kotek Lake; 3 — Mikołajskie Lake; 4 — Tałtowisko Lake; 5 — Śniardwy Lake

main production indicator, i.e. the amount of calories per cm^2, corresponds with the geometrical mean (Table IV).

Figure 20 graphically presents the relation between the amount of periphyton biomass (Table IV, column "A") and the periphyton value (Table IV, column "B"). It shows that Lake Śniardwy differs from other lakes because of its very big biomass. Also Lake Skonał should be considered separately both from the point of its low biomass and its small "value". The other three lakes form an approximate group. The periphyton of these lakes does not display any greater differences.

As the order (Fig. 19) of lakes arranged according to their chlorophyll amount is the same as that according to the periphyton "value" the opinion that the algae have a decisive influence on the dynamics of processes in that biocenosis is confirmed.

6. SUMMARY

In 1964 and 1966 from May to December, investigations were carried out on the dynamics of the changes of the amount of reed periphyton on 6 lakes of Mazurian Lakeland. The periphyton was analysed on this year's reed, last year's reed and on slides. The amounts of dry weight, organic matter, organic nitrogen and chlorophyll were determined. Apart from that in 1966 the amount of Ca and the calorific value were determined with the exception of nitrogen, which was not determined.

Within one lake there are great differentiations of the periphyton amount caused by habitat differences. Usually greater periphyton amounts are found on stations with free water exchange. The amount of periphyton on last year's reed was greater than on this year's reed. The levelling of periphyton amount took place at the end of vegetation period.

The chlorophyll amounts on the same lake, in successive years are approximate. Greater differences in the chlorophyll amount are observed between lakes with different trophy. But the general picture of seasonal changes of dry weight, organic matter and chlorophyll amount is similar in lakes having an approximate trophy. It is characterized by low contents of these indicators in spring, by summer maximum and a decrease in their amount in the latter part of the summer and by maximum in autumn.

Organic nitrogen is not subjected to such regular seasonal changes. However, it is noticed that the quantities of organic nitrogen increase from spring towards autumn. On Mikołajskie Lake and Lake Tałtowisko are observed two maxima of the relation of amount of chlorophyll to organic matter, and amount of chlorophyll to organic nitrogen — one in the middle of summer, the other in the latter part of autumn. On Lake Lisunie the relation of the amounts of these elements undergoes frequent variations, displaying a slight increase in autumn.

On the basis of summary analysis of autumn periphyton it was found that Lake Śniardwy is the most productive lake. The poorest periphyton development is in Lake Skonał. The lakes: Tałtowisko, Mikołajskie and Kotek are in the middle and are approximate to themselves from the point of periphyton amount.

The periphyton of Lake Tałtowisko has the highest calorific value as well as the highest chlorophyll content in dry weight and organic matter.

Therefore it seems right to say that the algae decide mainly about the processes taking place in the periphytic biocenosis.

7. STRESZCZENIE

W latach 1964 i 1966 od maja do grudnia prowadzono badania nad dynamiką zmian ilości perifitonu trzcinowego na 6 jeziorach Pojezierza Mazurskiego. Analizowano perifiton na trzcinach tegorocznych, zeszłorocznych i szkiełkach. Określano

ilości suchej masy, materii organicznej, azotu organicznego i ilości chlorofilu. W 1966 określono ponadto ilość Ca i kaloryczność, a nie określano ilości azotu.

W obrębie jednego jeziora występują duże zróżnicowania ilości perifitonu spowodowane różnicami środowiskowymi. Zazwyczaj na stanowiskach o swobodnej wymianie wody występują większe ilości perifitonu. Stwierdzono większą jego ilość na trzcinie zeszłorocznej niż na tegorocznej. Wyrównanie ilości perifitonu następowało dopiero pod koniec okresu wegetacyjnego.

Ilości chlorofilu w obrębie tego samego jeziora w kolejnych latach są zbliżone. Większe różnice w ilości chlorofilu obserwuje się między jeziorami o różnej trofii. Jednak ogólny obraz zmian sezonowych suchej masy i materii organicznej oraz ilości chlorofilu jest podobny w jeziorach o zbliżonej trofii — charakteryzuje się on niskimi ilościami tych wskaźników wiosną, maksimum letnim, spadkiem w końcu lata i maksimum w jesieni.

Azot organiczny nie podlega tak regularnym zmianom sezonowym. Zauważa się jednak, że ilości azotu organicznego wzrastają od wiosny ku jesieni. Na jeziorach Mikołajskim i Tałtowisko obserwuje się dwa maksima w stosunku ilości chlorofilu do materii organicznej oraz ilości chlorofilu do N-organicznego — jedno w środku lata, drugie w końcu jesieni. Na jeziorze Lisunie stosunek ilości tych samych elementów ulega bardzo częstym wahaniom wykazując w jesieni lekki wzrost.

Na podstawie zbiorczej analizy perifitonu jesiennego, stwierdzono, że najproduktywniejszym jeziorem są Śniardwy. W jeziorze Skonał perifiton rozwija się najsłabiej. Jeziora Tałtowisko, Mikołajskie i Kotek zajmują stanowisko pośrednie i są zbliżone do siebie pod względem ilości perifitonu. Perifiton jeziora Tałtowisko odznacza się najwyższą kalorycznością i najwyższą zawartością chlorofilu w suchej masie i materii organicznej.

Wydaje się więc słuszne twierdzenie, że o procesach zachodzących w perifitonowej biocenozie decydują głównie glony.

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PERSONAL NOTICE

The Editorial staff of Polish Archives of Hydrobiology announces the departure of Henryk I. Adler B. A., who has terminated his long standing services as the Secretary of our Board.

Mr. Adler joined the staff in 1966 and his work has been extremely valuable especially with regard to our efforts while establishing the new look of our journal.

We hereby convey our gratitude and wish him all the success in his new work.

The Editorial Board of Polish Archives of Hydrobiology

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