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THE EFFECT OF REMAINS OF HELOPHYTES ON THE GROWTH OF *PHRAGMITES COMMUNIS* TRIN. AND *TYPHA LATIFOLIA* L.*

ABSTRACT: The growth rate and production of new shoots and biomass of *Phragmites communis* Trin. and broadleaf cattail *Typha latifolia* L. decreased proportionally to the amount of introduced helophyte remains (dead aboveground parts). The 20-day period of slower growth rate of cattail is followed by intense growth proportional to its former delay in growth. An accelerated growth following the period of suppressed growth of reed growing on remains of sweet grass *Glyceria maxima* (Hartm.) Holnb. is similar as in the case of cattail, whereas as regards the reed growing on remains of reed and cattail this has not been observed.

Contents

1. INTRODUCTION

Macrophyte rushes have a very high biological production and can be simultaneously a place of accumulation of allochthonous and autochthonous organic matter. The macrophyte remains undergoing various chemical processes of decomposition are a strong environment-forming factor. Some information about the dynamics of accumulation and transformation of macrophyte remains can be found in the paper by Pieczyńska (1972). Haslam (1971) mentions the effect of remains of *Phragmites communis* Trin. on the growth of

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following generations of this species, mainly the buds. McNaughton (1968) has observed the inhibition of leaf extracts and water squeezed out of decomposing remains of *Typha latifolia* L. on germination of seeds of this species. Kimber (1973) when analyzing the phytotoxicity of rotted straw from some grasses and legumes on the growth of wheat seedlings has pointed out that the degree of inhibition varies from one species to another and also with rotting period. He has also pointed (Kimber 1967) that proceeded rotting of straw can change pH by as much as 2.5 to 3 units by 42 days. Szczepańska (1971) when analyzing the effect of remains of various macrophyte species on seedlings of *P. communis* has observed that several of them produce an inhibitory effect.

Although the accumulation of plant remains in rushes is one of the factors forming the succession of communities, this phenomenon is not investigated much yet by ecologists.

In the Wetland Laboratory Research, Institute of Ecology, Polish Academy of Sciences studies on the effect of plant remains (coarse detritus) on the growth of *Phragmites communis* and *Typha latifolia* have been conducted.

2. MATERIAL AND METHODS

In 1973 and 1974 a breeding experiment on the effect of dead aboveground parts of some helophytes on the growth of *Phragmites communis* and *Typha latifolia* was conducted. The plants grew in plastic 5-litre pots on a substrate of lake profundal mud from the eutrophic Mikołajskie Lake and an addition of a varying amount of finely ground plants. In each pot there was 4 litres of mud. Each breeding variant contained the following amounts of dead ground plants (in grammes): 0.256, 0.80, 2.50, 8.00, 25.60, 80.00, 256.0. The breeding variant with 256.0 g plant remains did not take place in 1974. Control did not contain dead plant remains. The dried plants were thoroughly mixed with mud in the pots and 5 plant seedlings were planted in each pot.

Seeds of *Phragmites communis* and *Typha latifolia* collected in the autumn in the previous year were sown next year in spring on lake mud in plastic trays. When the plants were 1.5–4.0 cm high they were planted into pots. During the entire experiment the plants were watered with pipe non-chlorinated water.

In 1973 *Typha latifolia* was grown on mud with an addition of varying amounts of debris of *Glyceria maxima* (Hartm.) Holnb. since the beginning of July till the end of October. The height of all plants was measured, at the beginning the number of plants was counted every two weeks, later on once a month. Each variant had 4 repeats.

In 1974 *Phragmites communis* was grown on mud with an addition of remains of the following plants: *Glyceria aquatica*, *Typha latifolia* and *Phragmites communis*. The experiment lasted from mid-May till the end of September. The height of plants was measured and every three weeks the plants were counted. Each variant had 5 repeats.

At the end of the experiment the plants were cut at the soil surface, then dried to constant weight at 84°C, the dried plants were weighed. Estimated were: (a) mean height of all plants (without sprouts), (b) mean height of three tallest plants in a pot, (c) mean dry weight of aboveground parts per pot, (d) mean weight of one shoot, and (e) mean number of shoots produced by one seedling.

In 1973 soil pH in particular variants was measured at the beginning and at the end of experiment. In 1974 soil pH was measured only at the beginning of the experiment.

3. RESULTS

3.1. *Typha latifolia* L.

Decomposition accompanied by gas excretion began immediately after adding the plant remains of *Glyceria maxima* to mud. This fermentation increased the volume of soil. In variants with smaller amounts of remains the soil volume did not increase much, but in pots with 256 g of plant remains the soil considerably increased in volume already after 24 hours. After two weeks the larvae of *Erystalis* sp. appeared in these pots and the strongly smelling gas still evolved. In this breeding variant the smell persisted, although less intensely, till the end of the experiment. In 1973 the soil pH one day after adding the remains of *G. maxima* in the variant with the greatest amount of remains was 6.0, in the control 7.7. The acidity increased proportionally to the amount of added remains (Table I). At the end of experiment soil pH fluctuated in particular variants between 6.9 and 7.2.

Table I. pH of mud with varying amounts of remains of *Glyceria maxima* (Hartm.) Holnb. in 1973

Days of experiment	Amount of plant remains in g/4-litres mud							
	0	0.26	0.80	2.56	8.00	25.6	80.0	256.0
1	7.7	7.6	7.5	7.5	7.3	6.9	6.1	6.0
3 months	7.2	7.0	6.9	7.0	7.0	7.0	7.0	7.1

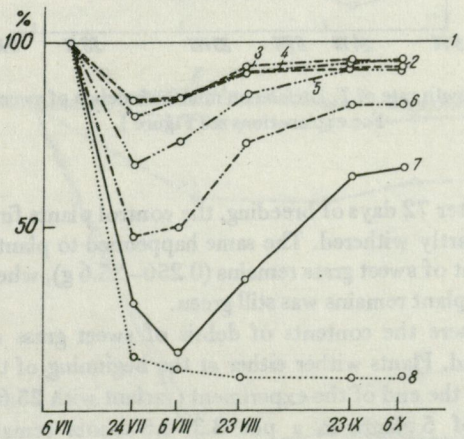

Fig. 1. Growth rate of *Typha latifolia* L. on mud with a varying amount of sweet grass debris (in % of control)

1 – mud without debris, *2* – mud with 0.26 g debris per pot, *3* – mud with 0.80 g debris per pot, *4* – mud with 2.56 g debris per pot, *5* – mud with 8.0 g debris per pot, *6* – mud with 25.6 g debris per pot, *7* – mud with 80.0 g debris per pot, *8* – mud with 256.0 g debris per pot

Addition of *G. maxima* resulted in lower growth rate of cattail at the beginning, proportionally to the amount of added plant remains. The growth was inhibited for about 20 days, and the difference in growth when compared with the control reached 85% (Fig. 1). Afterwards the depressed plants grew quicker. Only the dose of 256 g of remains disturbed so much the growth of cattail that its height did not change till the end of the experiment as the plants stopped growing. The rate of recovery was the highest among the plants with the most depressed growth; 1.2–1.3% daily as compared with the control. The less depressed plants had the rate of recovery about 0.5% daily. At the end of the vegetation season, when the plants in the control almost stopped growing the plants on plant remains also stopped growing although they did not reach the size of control plants (Fig. 2).

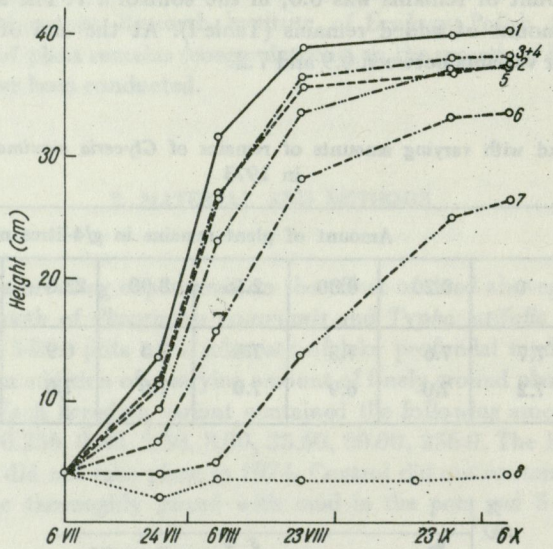

Fig. 2. Growth rate of *T. latifolia* on mud with debris of sweet grass
For explanations see Figure 1

On September 23, i.e. after 72 days of breeding, the control plants finished their growth, the leaves turned yellow and partly withered. The same happenned to plants growing on mud with an addition of small amount of sweet grass remains (0.256–25.6 g), whereas the cattail on mud with an addition of 80 g of plant remains was still green.

In breeding variants, where the contents of debris of sweet grass were 25.6–256.0 g the number of plants is reduced. Plants wither either at the beginning of the experiment (variant with 256.0 g remains) or at the end of the experiment (variant with 25.6 and 80.0 g). The plant reduction is not great – of 5 plants in a pot 3.3–4.5 shoots remain at the end of the experiment. In the control the number of cattail shoots at the end of experiment was 5 per pot.

The biomass produced by one cattail seedling is the highest in the control – 0.651 g. In the variant with 0.256 g remains of sweet grass it is 0.483 g. In variants with 0.80 and 2.56 g remains one cattail seedling produces correspondingly 0.493 and 0.539 g dry weight. In variants with 8.0, 25.6 and 80.0 g remains of sweet grass the production decreases parallel to the increase of addition of sweet grass remains to mud.

3.2. *Phragmites communis* Trin.

In 1974, similarly as in the preceding year, the substrate fermented and excreted gas immediately after adding the plant remains. The intensity depended on the amount of plant remains added to the mud.

Differences of pH between particular variants were not big. In the control pH was 6.97, in the variant with the highest addition of remains 6.79. In variants with smaller additions of remains pH stayed within these two values.

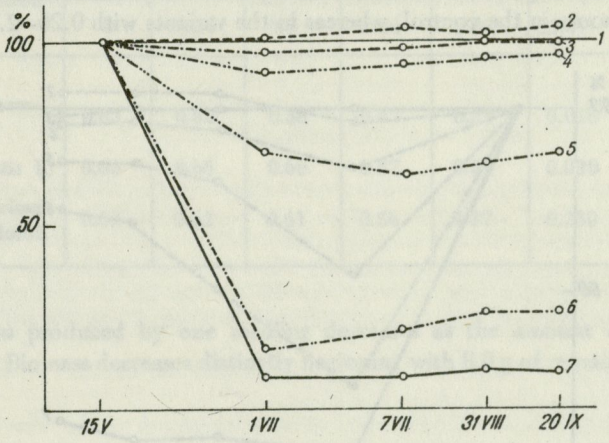

Fig. 3.Growth rate of *Phragmites communis* Trin. on mud with varying amount of debris of sweet grass (in % of control)
For explanations see Figure 1

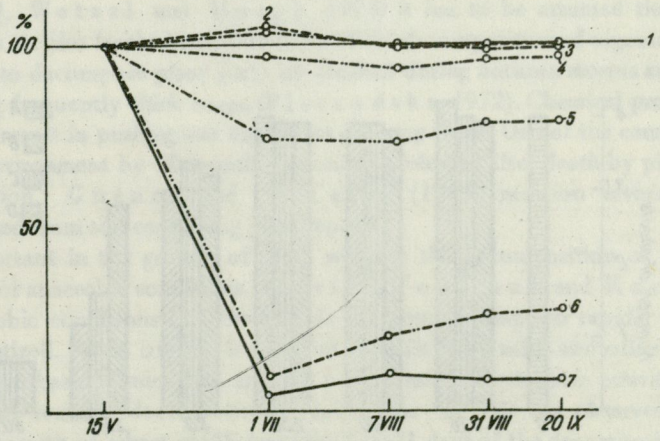

Fig. 4. Growth rate of *Ph. communis* on mud with varying amount of debris of reed (in % of control)
For explanations see Figure 1

The growth rate of reed slows down when adding plant remains proportionally to its amount, regardless the species of plant remains. The growth rate decreases more at the beginning of the experiment when adding the sweet grass. Inhibitory effect of sweet grass ends quickly and the depressed reed increases its growth rate and at the end of the vegetation season the differences in height as compared to the control are smaller than at the beginning (Fig. 3). The reed does not show marked recovery tendencies when under the influence of reed and cattail remains (Figs. 4, 5).

The reed has a great ability to produce new shoots. In this experiment its number depended on the amount of plant remains added to the mud. Small additions of remains (0.26–2.56 g) either did not affect the production of new shoots or to a very small extent. One reed seedling produced 4 new shoots in the control, whereas in the variants with 0.26–2.56 g plant remains

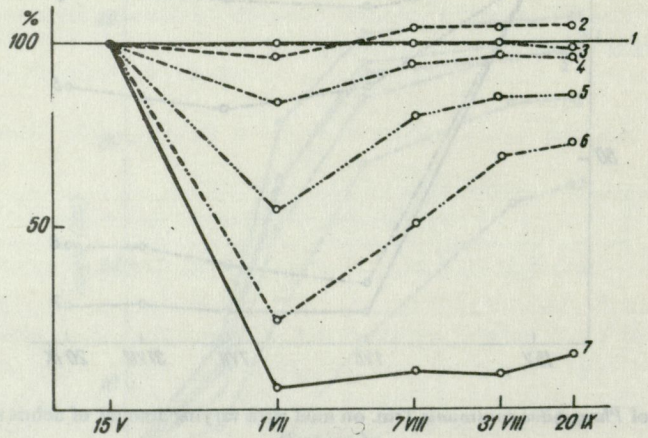

Fig. 5. Growth rate of *Ph. communis* on mud with varying amount of debris of cattail (in % of control)
For explanations see Figure 1

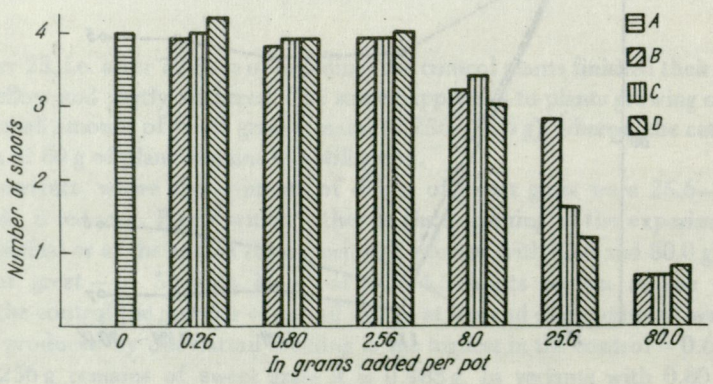

Fig. 6. Number of new shoots produced by one seedling of *Ph. communis*
A – control, *B* – mud with remains of sweet grass, *C* – mud with remains of cattail, *D* – mud with remains of reed

– 3.9 shoots. The greater amount of remains in mud visibly limits the production of new shoots (Fig. 6). At 80.0 g of remains a number of seedlings wither regardless of the kind of addition.

Table II. Biomass of *Phragmites communis* Trin. produced by one seedling on different substrates (in g dry wt)

Kind of substrate	Amount of plant remains added to mud (in g)						
	0	0.26	0.8	2.56	8.0	25.6	80.0
Phragmites communis Trin.	0.63	0.63	0.58	0.47	0.24	0.018	0.004
Typha latifolia L.	0.63	0.66	0.60	0.57	0.34	0.030	0.002
Glyceria maxima (Hartm.) Holnb.	0.63	0.62	0.61	0.56	0.37	0.230	0.002

Also the biomass produced by one seedling decreases as the amount of plant remains increases (Table II). Biomass decreases distinctly beginning with 8.0 g of remains.

4. DISCUSSION

Eutrophication of lakes is mainly connected with mass growth of vascular plants which after death enriched the water with inorganic substance (Solski 1962, Planter 1970). As the secretion and leaching of organic compounds from living plants been frequently observed (Wetzel 1969, Wetzel and Hough 1973) it has to be assumed that after death organic substances are also leached independently of the decomposition of organic matter.

More difficult to decompose plant parts are crushed during autumn storms and accumulate on shores forming frequently thick heaps (Pieczyńska 1972). Chemical processes in such places sometimes result in pushing out the plants growing there. One of the causes may be the intoxication of environment by allelopathic substances released after death by plants or during their decomposition. Guenzi and McCalla (1966) mention several phytotoxic substances extracted from soil containing plant remains.

It is also important in the growth of plant whether the decomposition of plant remains occurs in aerobic or anaerobic conditions. Patrick, Toussoun and Koch (1964) say that: "Under aerobic conditions (...) the organic compounds disappear rapidly and microbial material is synthetized. When oxygen is deficient, volatile fatty acids and other organic acids accumulate, and synthesis of microbial material is supressed". Phytotoxic activity depends on the stage of plant remains decomposition. Kimber (1973) has observed the greatest inhibition in the growth of wheat seedlings in the first 21 days of the decomposition of grasses and legumes. In this experiment the growth of cattail and reed is inhibited the most in the first weeks of decomposition of plant remains (Figs. 1, 3–5).

The broadleaf cattail and reed growing on mud with remains of sweet grass, after the period of inhibited growth, recover their growth rate. Bút the recovery is not observed in the case of

reed growing on mud with remains of cattail and reed. It can be assumed that the phytotoxic substances released during the decomposition of sweet grass decompose much quicker and thus their inhibitory effect is shorter. Only a large amount of remains of sweet grass has an inhibitory effect during the entire vegetation season (Figs. 1, 5).

The effect of inhibitory substances released from remains of cattail and reed is similar at the same doses (Figs. 3, 4).

Under natural conditions, as regards lake rushes, it rarely happens that the substances from dying plants affects young growing plants. The period between autumn withering and litterfall and the spring growth may be sufficient for leaching and decomposition of phytotoxic substances. But, in the case of mechanical destruction of rushes in summer, either due to mass growth of filamentous algae and wave action, or activities of man, the decomposing rush vegetation may limit or even make impossible the reconstruction of damaged rushes.

5. SUMMARY

The influence of dead aboveground parts of several helophytes on the growth of common reed *Phragmites communis* Trin. and broadleaf cattail *Typha latifolia* L. has been analysed. In 1973 the cattail was cultivated on mud with added remains of *Glyceria maxima* (Hartm.) Holnb. In 1974 the reed was cultivated on mud with additions of sweet grass, reed and cattail remains. The cultures were in the field in plastic 5-litre pots. In both years, each pot was given an extra 4 litres of mud and following amounts (in g) of plant remains in each experimental variant: 0 – control, 0.26, 0.8, 2.56, 8.0, 25.6, 80.0 and 256.0. The last breeding variant was not applied in 1974.

Large amounts of plant remains inhibit the growth of reed and common cattail. Such amounts as 80.0–256.0 cause the withering of a number of seedlings.

When adding large amounts of plant remains to mud the growth rate of reed and cattail decreases proportionally to the amount of remains. In the variant with 256.0 g plant remains, plants of both species did not grow at all (Figs. 1, 3–5).

The period of growth inhibition for the cattail lasted about 20 days, counting from the beginning of the culture. Afterwards the growth quickened proportionally to the extent it was formerly inhibited (Fig. 1). The reed growing on mud with remains of sweet grass showed higher growth rate, similarly as that of cattail, after considerable supression of growth in the first period. The growth rate of reed growing on a substrate with cattail and reed remains did not increase.

Addition of large amounts of plant remains limits the production of new reed stalks (Fig. 6) and the biomass of reed and cattail (Table II).

6. POLISH SUMMARY (STRESZCZENIE)

Analizowano wpływ martwych części nadziemnych kilku gatunków helofitów na rozwój trzciny pospolitej *Phragmites communis* Trin. i pałki szerokolistnej *Typha latifolia* L. W 1973 r. hodowano pałkę na mule z różną domieszką szczątków manny *Glyceria maxima* (Hartm.) Holnb. W 1974 r. hodowano trzcinę na mule z różnymi domieszkami szczątków manny, trzciny i pałki. Hodowle prowadzono w terenie i pięciolitrowych wazonach plastykowych. W obydwu latach do każdego naczynia dodano po 4 l mułu i następujące ilości (w g) szczątków roślinnych w każdym wariancie doświadczenia: 0 – kontrola, 0,26, 0,8, 2,56, 8,0, 25,6, 80,0 i 256,0. W 1974 r. nie zastosowano ostatniego wariantu hodowli.

Stwierdzono, że duże ilości szczątków roślinnych hamują rozwój trzciny i pałki szerokolistnej. Bardzo duże ilości szczątków (80,0–256,0 g) powodowały nawet usychanie pewnej liczby sadzonek.

Dodanie dużych ilości szczątków roślinnych do mułu spowodowało obniżenie tempa wzrostu trzciny i pałki, wprost proporcjonalne do ilości szczątków. W wariancie z 256,0 g szczątków rośliny obu gatunków nie rosły zupełnie (fig. 1, 3–5).

U pałki okres zahamowania wzrostu trwał około 20 dni od rozpoczęcia hodowli. Po okresie zahamowania wzrostu nastąpiło jego przyspieszenie – tym większe, im bardziej był przytłumiony uprzednio (fig. 1). U trzciny rosnącej na mule z domieszką szczątków manny obserwowano podobny jak u pałki proces

zwiększenia tempa wzrostu roślin silniej hamowanych w pierwszym okresie hodowli. U trzciny rosnącej na podłożu ze szczątkami pałki i trzciny nie obserwowano zwiększenia tempa wzrostu.

Domieszka dużych ilości szczątków roślinnych ogranicza produkcję nowych źdźbeł u trzciny (fig. 6) oraz produkcję biomasy trzciny (tab. II) i pałki.

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