

Vegetative multiplication and regeneration of *Polytrichum commune* populations

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Abstract

On two permanent meadow surfaces vegetative multiplication, regeneration and renovation of the *Polytrichum commune* populations was studied. In cultures the green, apical parts of the stem and green leaves regenerate most rapidly. In the flagella, the lower parts exhibit a higher viability, towards the apex the process of regeneration is slower. In the field, in spring and autumn, flagella grow profusely out of the brown parts of the plant, thickening the sward and thus renewing and prolonging the life of the *Polytrichum commune* population.

INTRODUCTION

The Kampinos National Park is for many years the subject of systematic bryological research, of the workers of the Botanical Institute of the Warsaw University.

The present observations concerning regeneration of the *Polytrichum commune* population were made in the field in Kampinos and in the laboratory.

Investigations in the field were performed in two vegetation seasons, 1972 and 1973, on two different sites: the Korfowe meadow and the Strzeleckie meadow.

The experimental surfaces of these two meadows differ widely from one another, both as regards moisture and bryoflora which on the meadow Korfowe is much more luxuriant. Here bryophytes prevail such as: *Sphagnum palustre*, *Sph. apiculatum*, *Sph. magellanicum* with a high participation of *Calliergon cuspidatum*, *C. stramineum*, *Drepanocladus aduncus* f. *fluitans*, *Aulacomnium palustre* and many other kinds of moss found on peat meadows.

Polytrichum commune forms here a compact homogeneous, elevated sward. On the lower parts of the meadow frequently the bog form, *Polytrichum commune* f. *uliginosa* occurs.

On the much drier Strzeleckie meadows, *Polytrichum commune* is accompanied by agglomerations of *Hylocomium splendens*, *Dicranum undulatum*, *Scleropodium purum*, *Entodon schreberi*.

METHODS

Field investigations

In March 1972 on the same surfaces of two different meadows: I. the Korfowe meadow and II. the Strzeleckie meadow, 3 × 30 individuals of the *Polytrichum commune* population were marked by fastening a coloured thread to each of the plants.

By means of a special cylinder with bottom surface area of 100 sq. m, samples were cut out in March and November 1972, and the plants producing flagella were counted. On the marked plants the number of flagella was counted, their length was measured and their rate of growth was observed.

In the vegetation season 1973, once a month 3 samples were cut out from *Polytrichum commune* population, from March to November. Observations were recorded on the formation and development of flagella, regeneration of brown parts of stem and leaves and the development of new plants.

Laboratory cultures

Experiment 1. 29. September, 1972. The *Polytrichum* sward with 300 sq. cm surface area was placed in a dry aquarium on the windowsill, covered with a glass plate and watered once a week with tap water (100 ml).

Experiment 2. 2. December, 1973. In each of two crystallizers were planted 20 flagella 3—5 cm long with 1-cm fragments of stem in peat. The newly developing plants were counted and their length was measured.

Experiment 3. 16. February, 1973. On two dishes, with agar, with Knop nutrient solution added (20 ml per 1000 ml of agar) 10 flagella, cut into 46 segments of 1 cm each were placed.

Experiment 4. 30. January, 1973. In each of 3 dishes (on agar as described above) 120 1-cm defoliated segments of *Polytrichum*, were planted in

dish I, the lower part of the stems with nap,
dish II, the middle brown part of the stems,
dish III, the apices of the stems, green parts

Experiment 5. 28. November, 1973. Under identical conditions 120 leaves of *Polytrichum*, green and brown were cultured. The development of new plants was observed during 3 months.

Experiment 6. 28. February, 1973. One hundred cross sections of stems with leaves, green and brown parts, were cultured on agar for more than 3 months.

The plants were illuminated in the laboratory with fluorescent tubes of a joint strength of 360 W for 10 hours daily.

The results are illustrated by diagrams and figures.

RESULTS AND CONCLUSIONS

On the basis of field observations, performed during two vegetation seasons, 1972 and 1973, as well as investigations in the laboratory, the following conclusions may be drawn.

The population of *Polytrichum commune* is characterized by a high ability of multiplication and regeneration, and periodical flooding favours the development of flagella and of new plants from stem and leaf fragments.

In the spring of 1972 flagella were found on 5 per cent of plants in the *Polytrichum* population on the Korfowe meadow, no flagella were noted on the Strzeleckie meadow. In autumn flagella occurred on 60 per cent and on 16 per cent of plants on surfaces I and II, respectively, the latter being much drier.

In September one could observe growth of flagella on the lower, brown parts of the plants, 4, 6 or even 8 on the plant. At first they were light-brown and grew perpendicularly to the stem. As they became longer, they gradually changed their position to one parallel to the stem. After they had reached 8—10—12 cm they detached from the mother plant, giving rise to new individuals (Fig. 1).

Field observations on the growth of flagella proved that it is rapid. In the course of 13 days, from September 16 to 29, 20 labelled flagella elongated by a total of 41 cm, which represents a mean increment of 2 cm per each flagellum (Fig. 2).

In the field, the appearance of green leaves at the apex of the flagella could be observed when they were 8—10 cm long, these were already young individuals contributing to the density of the sward.

In the laboratory green leaves appeared on 95 per cent of the cultured flagella notwithstanding their length.

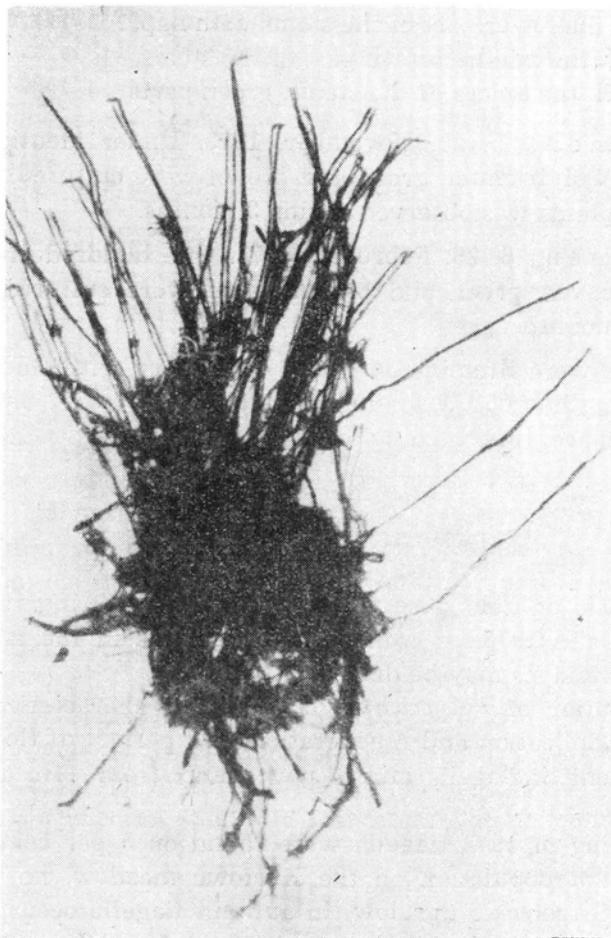


Fig. 1. Flagella growing from brown parts of stems of *Polytrichum commune*

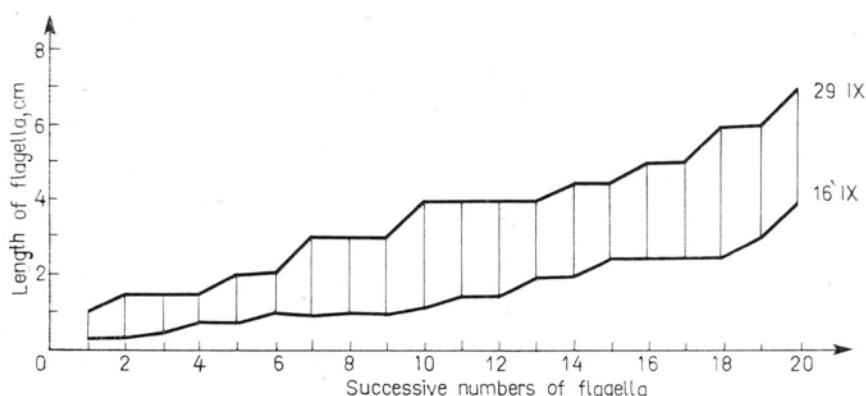


Fig. 2. Elongation of 20 flagella in 13 days (16—29. September 1972) on Korfowe meadow

Polytrichum commune was cultured in the laboratory from September 29 (exp. 1). It thrived for almost 5 months, producing during all this period new flagella from the brown parts of the stem. On 50 individuals chosen at random 168 flagella developed 1 to 3—4 and even 6 cm long. Towards mid February, 1973, the sward began to turn brown and dry up.

Height of plants mm	14 XII 1972	18 XII	21 XII	27 XII	31 XII 1973	3 1	10 1	Joint length of newplants mm
1	2	5	14	18	21	26	28	28
2		1	5	6	7	7	10	20
4				2	9	10	14	56
6				1	3	3	4	24
7				1	-	1	5	35
8				1	1	2	3	24
9						1	9	
No. of new plants	2	6	19	29	41	49	65	196

Fig. 3. Regeneration of 20 intact flagella (experiment 2)

Flagella never grew from the green, apical part of *Polytrichum commune*. On the other hand, it should be stressed that in culture the viability of the green parts, stem and leaves of *Polytrichum commune*, is high.

On whole flagella with the 1 cm long brown part green lateral buds developed after 10—12 days. The flagella did not elongate at all, only

Height of plants (mm)	20 II	24 II	28 II	4 III	8 III	15 III	25 III	4 IV	Joint length of newplants (mm)
1	3	7	6	11	9	6	10	8	8
2			2	4	9	9	8	4	8
4				3	6	8	6	9	36
6				2	3	11	4	7	42
8					4	9	6	6	48
10					2	3	8	12	120
12						-	2	9	108
15						1	3	6	90
18							2	5	90
20							1	3	60
25							1	3	75
27							1		27
No. of new plants	3	7	8	20	33	47	51	73	712

Fig. 4. Regeneration of 10 flagella cut into 46 fragments. Height of growing new plants in mm (experiment 3)

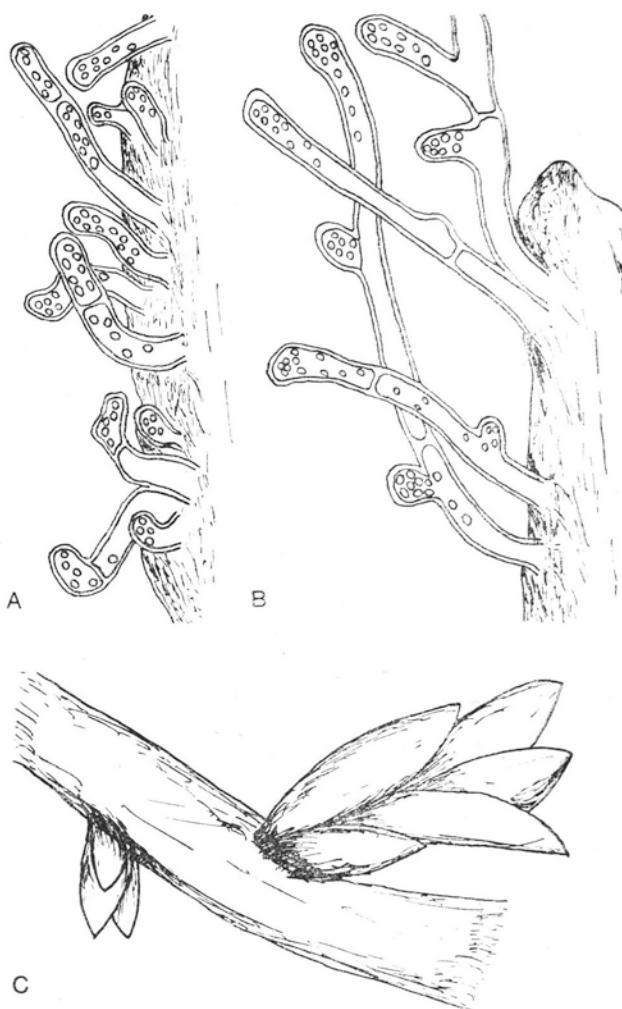


Fig. 5. Regeneration of flagella: A. B — protonemas growing after 5 days C. — buds growing after 10 days

their colour changed from light to dark brown, and from their lower parts, mostly at a height of 1—3 cm gradually new green plants grew. During 39 days 65 plants developed of a joint length of 196 cm. (Fig. 3).

On the other hand, on flagella divided into 1-cm segments already after 5 days the first green buds appeared. In the course of 48 days of culture 73 new plants developed, of a joint length of 712 cm. In the second dish 67 plants developed of joint length of 642 cm. (Fig. 4).

The regeneration of sectioned flagella was seven times higher than that of intact ones, and the first buds appeared 7 days earlier.

In all dishes the lower segments of the flagella showed a much higher viability, the protonemas and buds were most numerous, 3—4 and even 6 on one plant. (Fig. 5. A B C).

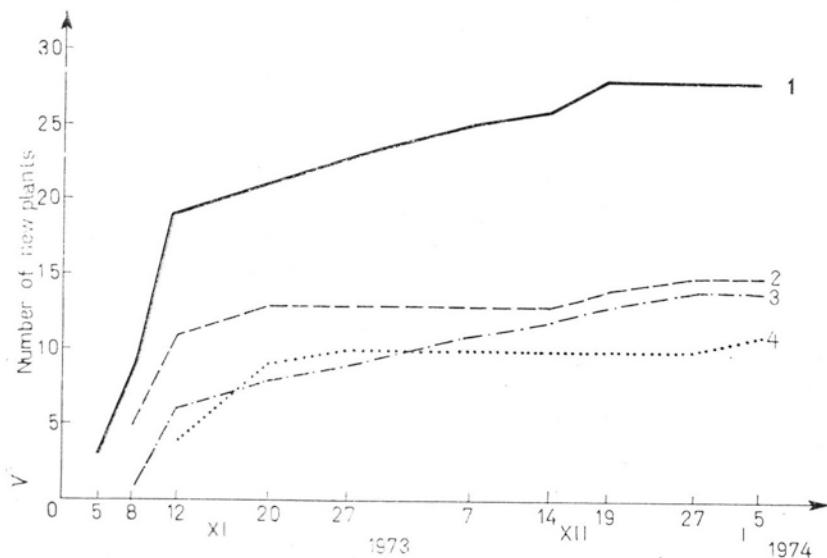


Fig. 6. Regeneration of basal parts of flagella, first-fourth centimeter from below
Fragments: 1 — 1st cm from base, 2 — 2nd cm, 3 — 3rd and 4 — 4th cm

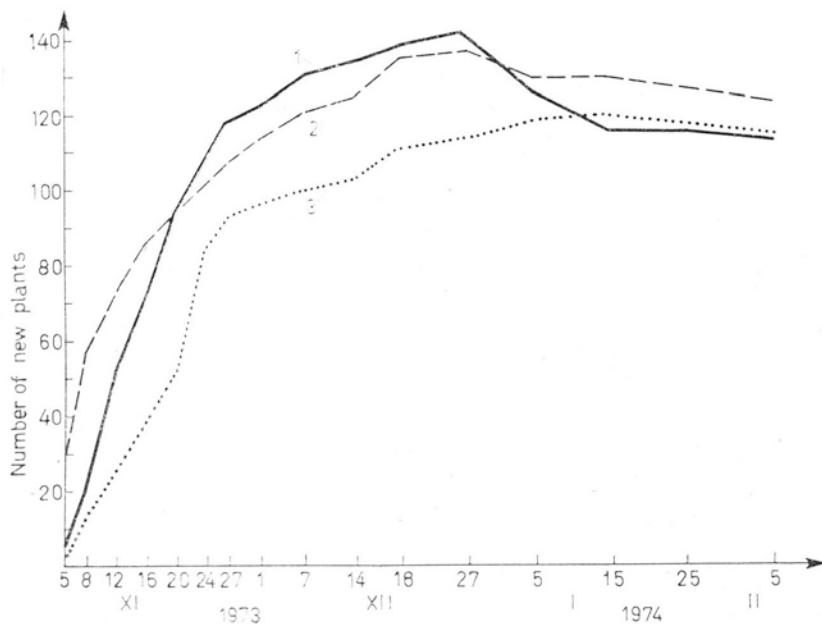


Fig. 7. Regeneration of three parts of stems of *Polytrichum commune*: 1 — green upper part; 2 — brown middle part; 3 — lower downy part

Observations revealed that regeneration is most rapid in the lower parts of the flagella, gradually becoming slower upwards. (Fig. 6).

From the observations on the population of *Polytrichum commune* it results that flagella grow most profusely from the brown part of the

stem, both from the downy part and from the middle one bearing leaves. Flagella never grew from the green, apical part of *Polytrichum commune*. On the other hand it should be stressed that in culture viability of the green parts, stem and leaves of *Polytrichum commune*, is high.

It appeared that the regenerative ability of the three parts of the stem is different. Regeneration is strongest in the green part, where on 109 fragments of the stem new plants developed, which amounts to 91 per cent of the 120 cultured fragments. In the middle part 99 segments, that is 83 per cent, and in the lower part 78 that is 65 per cent (Figs. 7 and 8) regenerated.

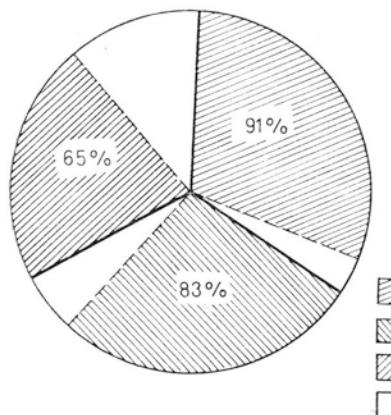


Fig. 8. Percentual ratio of regenerative ability of three fragments of *Polytrichum* stems: 1 — 91%, upper green part; 2 — 83% brown part with leaves; 3 — 65% lower leafless part; 4 — parts of stems not regenerating

Whole green leaves regenerated in 98 per cent, brown ones in 25 per cent (exp. 5). From crossections of *Polytrichum* stems with leaves (exp. 6) from the green part 176 plants developed that is 176 per cent. Here the occurrence of protonemas and 3—4 buds on one leaf fragment was observed. The crossections of brown parts regenerated in 16 per cent, only 16 delicate plants developed, and on 36 crossections protonemas (Fig. 9) appeared.

The first green protonemas appeared, on crossections of green leaves after 6 days, on brown ones after 19 days. This leads to the conclusion that in artificial culture conditions the quickest and strongest is the regeneration of green young parts of the plant. The brown parts regenerate much less intensively, their regenerative ability is noticeable only in field experiments.

The brown, old parts of *Polytrichum* exhibit in natural conditions a high viability, flagella grow in masses from the stems, and from leaf fragments mainly bases and ribs — protonemas and buds of new plants.

Wounding in the laboratory, like division into 1-cm fragments, tearing off the leaves, transverse section of live stems enhanced probably the process of regeneration.

Periodical flooding of the sward decidedly favours the renovation of the *Polytrichum commune* population.

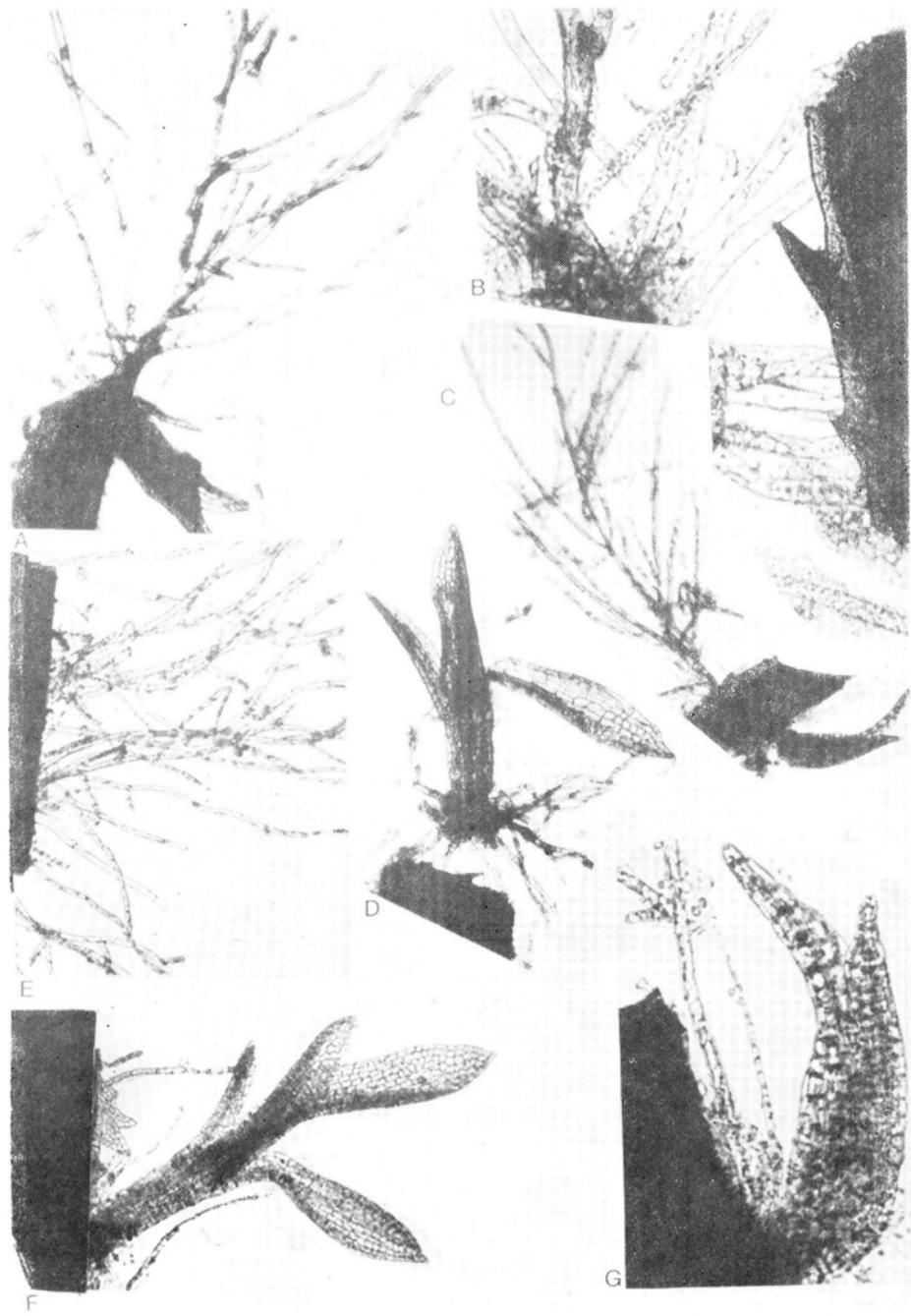


Fig. 9. A. B. C. D. — regeneration from leaf fragments; E. F. G. — from fragments of stem of *Polytrichum commune*

Joint length of new plants, in cm

Successive numbers of flagella

Length of flagella

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Rozmnâżanie wegetatywne i regeneracja populacji *Polytrichum commune*

Streszczenie

Kampinoski Park Narodowy jest od szeregu lat obiektem systematycznych badań briologicznych prowadzonych przez pracowników Instytutu Botaniki Uniwersytetu Warszawskiego.

Obecne obserwacje zostały przeprowadzone nad populacją *Polytrichum commune* w terenie i w pracowni. Badania prowadzono w ciągu dwóch sezonów wegetacyjnych 1972 i 1973 r., na stałych powierzchniach dwóch łąk: Łąki Korfowe — I powierzchnia, Łąki Strzeleckie — II powierzchnia. Obie pow. doświadczalne dość znacznie różnią się między sobą zarówno stosunkami wilgotnościowymi, jak i brioflorą, która na łące Korfowe jest znacznie bogatsza.

W terenie prowadzono obserwacje nad powstawaniem i wzrostem flagelli, na osobnikach znakowanych ($2 \times$ po 30 osobników w populacji *Polytrichum commune*), wiosna i jesienią 1972 r., raz w miesiącu od marca do listopada w 1973 r.

W pracowni wykonano 6 doświadczeń: nad powstawaniem i wzrostem flagelli w darni *Polytrichum commune* o pow. 300 cm^2 . Hodowano flagelle całe i pocięte na 1 cm części, liczono powstające nowe rośliny i mierzyły ich długość. Podobnie obserwowano proces regeneracji na trzech częściach łodyg płonnika; zielonej — szczytowej, brązowej, ulistnionej — środkowej i dolnej — okutnerzonej.

Prowadzono hodowlę liści całych, zielonych i brązowych, oraz przekrojów po przecznych ulistnionej łodygi, części szczytowej i środkowej. Na podstawie obserwacji terenowych i badań eksperymentalnych w pracowni nasuwają się następujące wnioski.

Populacje *Polytrichum commune* cechuje bardzo duża zdolność rozrodu.

W darniach płonnika występują flagelle, szczególnie licznie wiosną i jesienią, w okresie silniejszego podtopienia podłożu.

Flagelle wyrastają z dolnych okutnerzonych i środkowych ulistnionych części łodygi. Po osiągnięciu długości 8—10—12 cm, odpadają od rośliny macierzystej, wytwarzając zielone liście dając nowe osobniki zagęszczające darnę.

W obserwowanych populacjach w listopadzie 1972 r. na powierzchni I, około 60% roślin wytworzyło flagelle, na powierzchni II, znacznie suchszej — 15%.

Regeneracja flagelli pociętych na części (1 cm) była siedmiokrotnie większa niż flagelli całych, a pierwsze pączki nowych roślin pojawiły się o 7 dni wcześniej na fragmentach flagelli.

Hodowle wykazały, że regeneracja jest najszybsza w dolnej części flagelli, ku górze stopniowo maleje. Natomiast zdolność regeneracji trzech części łodyg płonnika: szczytowej, środkowej i dolnej — jest bardzo zróżnicowana. Część zielona, szczytowa regenerowała w 91%, środkowa w 83% a dolna w 78%.

Liście zielone regenerowały w 98%, a brązowe w 25%.

Odcinki ulistnionych łodyg (przekroje poprzeczne) regenerowały z części zielonej w 176%, brązowej w 16%. Wynika stąd, że w sztucznych warunkach hodowli najszybsza i najsilniejsza jest regeneracja części zielonych, młodych, rośliny. Brązowe fragmenty regenerują znacznie słabiej, ich zdolność regeneracji uaktywnia się dopiero w terenie.

Brązowe, stare części płonnika, w warunkach naturalnych wykazują dużą żywotność, z łodyg masowo wyrastają flagelle, z fragmentów liści głównie nasady i żebra — splątki i pączki nowych roślin.

Okaleczenia rośliny przeprowadzone w pracowni jak: pocięcie na 1-centymetrowe odcinki, zrywanie liści, przekroje poprzeczne ulistnionych łodyg, wpłynęły zapewne na zwiększenie procesów regeneracyjnych.

Okresowe podtapianie darni sprzyja zdecydowanie odnawianiu się populacji *Polytrichum commune*.