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# Studies on the mycoflora of meadow soil in Kazuń

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Results are reported of two-year qualitative and quantitative studies of the soil micoflora on mown and unmown meadows overgrown with vegetation of the *Arrhenatheretum medioeuropaeum* association (Br.-Bl. 1919) Oberd. 1952. On the unmown plot the mycoflora was more abundant and varied than on the mown one. Atmospheric conditions were found to exert an influence of the specific composition of the mycoflora. No influence of mowing on the number of colonies of the isolated fungi could be demonstrated.

The present investigations were undertaken in order to identify the fungal flora in the meadow soil and study the influence of mowing on its specific composition. It seemed also of interest to establish whether there is a relation between mowing and the number of fungal colonies in the soil.

## AREA INVESTIGATED AND CLIMATIC CONDITIONS

The studies were performed on meadows near the village Kazuń situated on an open plain on which floodplain forest had been felled and the soil taken under cultivation and pasture because of the fertility of the silt soil.

These meadows as regards floristics and phytosociology have been elaborated in detail by Traczyk (1971) and Sadowska (1973). Traczyk classified them to the association *Arrhenatheretum medioeuropaeum* (Br.-Bl. 1919) Oberd. 1952. The soil pH was acid varying in the limits of 5.0-5.5.

The climatic conditions in the period of investigations 1971/1972

varied widely. In 1971 the weather was warm and dry, whereas in 1972 precipitation was exceptionally abundant, more than twice that in the preceding year (Table 1).

Table 1

Temperature and precipitation in the years 1971 and 1972 (Legionowo Meteorological Station)

| Months | | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|
| Temperature °C | 1971 | 15.9 | 16.4 | 19.7 | 19.7 | 11.0 | 8.3 | 2.3 |
| | 1972 | 13.9 | 17.5 | 21.2 | 17.1 | 12.0 | 6.1 | 4.1 |
| Precipitation mm | 1971 | 24.4 | 57.4 | 14.0 | 42.9 | 38.9 | 56.1 | 28.1 |
| | 1972 | 68.7 | 125.6 | 126.7 | 134.8 | 100.8 | 20.8 | 40.2 |

## MATERIAL AND METHODS

Two closely neighbouring sites were chosen for the studies: a patch of mown and a patch of unmown meadow. Nearby, at a distance of about 30 m ran a draining ditch with young alders (*Alnus glutinosa*) on its banks. From each plot (50 m²) soil samples were taken from the surface layer (0-5 cm) of the soil at monthly intervals in the period from 19 May to 19 November in 1971 and from 15 May to 15 Nov. in 1972. One of the meadows was mown twice during the season.

Three methods of isolation of fungi from the soil were used: the plate method of Warcup in Mańka's modification (1961), the method of Krzemieniewska (1925) applied for cultures of dung cultures and the dilution plate method (Strzelczyk 1968). The latter was also used when the number of fungal colonies in the soil was determined.

For culture the following media were used: glucose-potato agar, Martin's glucose-peptone agar and Czapek-Dox agar.

## MYCOFLORA OF THE MEADOW

In 1971, 56 species of fungi were isolated (Table 2) from the plots of mown and unmown meadow. Most common were *Trichoderma lignorum* and *T. glaucum* found in samples from both plots in all months. Dominant were, however, species from the genus *Penicillium*. The acid pH of the soil seemed to favour their growth. It was interesting that they were mainly isolated (7 species) from samples taken on the mown soil, and on the unmown plot only two species were found. It is difficult to tell whether this was accidental or not.

The greatest number of species was noted in July (17) and May (18).

Table 2
Appearance of fungi in the particular months in 1971 on the soil of the mown /+/ and unmown /o/ plots

| Species \ Months | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|
| Trichoderma lignorum | + o | + o | + o | + o | + o | + o | + o |
| Trichoderma glaucum | + o | + o | + o | + o | + o | + o | + o |
| Penicillium sublateritium | + | | | | | | |
| Cladosporium epiphyllum | + | | | | | | |
| Oidiodendron griseum | + | | | | | | |
| Penicillium stockii | + | | | | | | |
| Stemphylium ilicis | + | | | | | | |
| Penicillium lanosum | + | | | | | | |
| Penicillium chermesinum | + | + | | | | | |
| Mucor microsporus | o | | | | o | | |
| Verticillium cellulosae | o | | | | | | |
| Mucor hiemalis | o | | | | | | + |
| Monocillium exsolum | o | | | | | | |
| Aspergillus candidus | o | | | | | | |
| Aspergillus carneus | o | | | | | | |
| Penicillium commune | | + | | | | | |
| Arthrobotrys oligospora | | + | o | o | + o | | |
| Mucor spinosus | | o | | | + o | | o |
| Mucor globosus | | o | | o | + o | + o | + |
| Stysanus stemonitis | | o | + | o | + o | | |
| Sepedonium chrysospermum | | o | | | | | |
| Myrothecium roridum | | | + | o | | | o |
| Acrostalagmus cinnabarinus | | | + | | | | |
| Syncephalis sphaerica | | | + | | | | |
| Botryotrichum piluliferum | | | + | | | | + o |
| Arthrobotrys kirghisica | | | + | | | | |
| Dactylella leptospora | | | + | | | | |
| Trichothecium roseum | | | + | | | | |
| Penicillium duclauxi | | | + | | | | |
| Spicaria griseola | | | o | | | | |
| Tetraploa ellisii | | | o | | | | |
| Arthrobotrys pravicovii | | | o | | | | |
| Dactylella brochopaga | | | o | | | | |
| Dactylella lysipaga | | | o | | | | |
| Penicillium citrinum | | | | + | | | |
| Stachybotrys alternans | | | | + | | | |
| Stachybotrys atra | | | | + | | | |
| Penicillium claviforme | | | | + | | | |
| Penicillium rubrum | | | | + | | | o |
| Leptosphaeria modesta | | | | o | | | |
| Piptocephalis freseniana | | | | o | | | |
| Pullularia pullulans | | | | | + | | |
| Sordaria lappae | | | | | o | | |
| Gliocladium roseum | | | | | o | | |
| Alternaria humicola | | | | | o | | |
| Thamnidium elegans | | | | | o | | |
| Piptocephalis tieghemiana | | | | | o | | |
| Chaetomium globosum | | | | | o | | |
| Pleospora herbarum | | | | | o | | + |
| Ascobolus furfuraceus | | | | | o | | |
| Penicillium granulatum | | | | | o | | + o |
| Penicillium corymbiferum | | | | | o | | o |
| Penicillium chrysogenum | | | | | | + | |
| Cylindrocarpon heteroclei | | | | | | o | |

Table 3

Appearance of fungi in the particular months in 1972 in the soil of the mown /+/ and unmown /o/ meadow

| Species \ Months | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|
| Trichoderma lignorum | + o | + o | + o | + o | + o | + o | + o |
| Mucor hiemalis | + o | + o | + o | + o | + o | + o | + o |
| Cladosporium herbarum | + o | + o | | | + o | + o | + o |
| Cladosporium epiphyllum | + o | + o | | | | | |
| Alternaria geophila | o | o | | | | | |
| Volutella ciliata | o | o | | | | | |
| Acremoniella atra | o | o | | | | | |
| Torula convoluta | o | o | | | | | |
| Verticillium cellulosae | o | o | | | | | |
| Epicoccum nigrum | o | | | | | | |
| Cephalosporium charticola | o | | | | | | |
| Stachybotrys atra | | + | | | | | |
| Penicillium frequentans | | + | | + | + | | |
| Humicola grisea | | + o | + o | | | | |
| Penicillium chrysogenum | | + o | | | | | |
| Penicillium purpurogenum | | + o | + o | + o | | | |
| Absidia glauca | | + o | + o | | | | |
| Botryotrichum piluliferum | | o | + o | | | | |
| Fusarium lini | | o | o | | | | |
| Penicillium tardum | | o | o | | | | |
| Dactylella brochopaga | | o | o | | | | |
| Cladosporium lignicola | | | + | | | | |
| Trichothecium roseum | | | + | | | | |
| Stachybotrys alternans | | | + | | | | |
| Mucor spinosus | | | + | + | + o | + o | o |
| Stysanus stemonites | | | + o | | | | |
| Chaetomium globosum | | | + o | | | | |
| Chaetomium olivaceum | | | + o | | | | |
| Spicaria griseola | | | o | | | | |
| Dactylella lisipaga | | | o | | | | |
| Arthrobotrys oligospora | | | o | + o | + | | o |
| Botrytis cinerea | | | o | o | | | |
| Arthrobotrys kirghizica | | | | + | | | |
| Penicillium sublateritium | | | | + | | | |
| Penicillium herquei | | | | + | + | | + |
| Trichoderma glaucum | | | | + o | + o | o | |
| Sordaria lappae | | | | o | | | |
| Syncephalis sphaerica | | | | o | | | |
| Penicillium granulatum | | | | o | + | + | |
| Penicillium commune | | | | | + | | |
| Penicillium citrinum | | | | | + | + | + |
| Penicillium claviforme | | | | | + | + | + |
| Alternaria humicola | | | | | o | o | o |
| Piptocephalis tieghemiana | | | | | o | o | o |
| Penicillium rubrum | | | | | o | o | o |
| Mucor globosus | | | | | o | o | |
| Thamnidium elegans | | | | | o | | |
| Penicillium lanoeum | | | | | o | | |
| Mucor microsporus | | | | | o | | |
| Piptocephalis freseniana | | | | | | o | o |
| Penicillium steckii | | | | | | o | |
| Penicillium roqueforti | | | | | | o | o |
| Ascobolus furfuraceus | | | | | | o | o |
| Zygorhynchus moelleri | | | | | | | o |
| Mucor heterosporus | | | | | | | o |

Analogous investigations were performed on both plots in 1972. A total of 55 fungal species were isolated (Table 3). As in in the preceding year, the composition of the mycoflora was diversified but somewhat differently. The most frequent species was *Trichoderma lignorum* and *Mucor hiemalis* which were found over the entire period of study in samples from both plots. *Cladosporium herbarum* was also common. *Mucor hiemalis* found in 1971 only twice (May, Sept.) was present in each sample in 1972. Probably the frequent and profuse, but not violent, rainfall favoured its development. It also promoted growth of *Penicillium* which were also among the dominating fungi, and the number of their species was particularly high in the second half of summer and in autumn. Most of them appeared on the mown meadow.

The greatest number of fungal species was noted in 1972 in June, July and September.

Quantitative studies were undertaken in 1972 in order to find whether there was any relation between the abundance of fungi in soil and mowing. On the unmown plot the number of fungal colonies (table 4) per 1 g of soil varied from 206 thous. (August) to 403 thous. (May). On the mown meadow the variations were wider — from 130 thous. (August) to 603 thous. (September). It is noteworthy that after each mowing (in July and September) the number of fungi decreased. This may have been due to the raking of the mown grass associated with removal of organic detritus necessary for the development of fungi. The soil was also exposed by mowing, and, owing to this, sun and wind reduced to a higher extent the soil moisture, this affecting unfavourably the development of the mycoflora.

Table 4

Number of fungal colonies isolated in 1972 (thous./1 g of soil)

| Months | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|
| Unmown plot | 403 | 250 | 223 | 206 | 473 | 210 | 353 |
| Mown plot | 373 | 233 | 150 | 130 | 603 | 273 | 556 |

Of course mowing was not the only factor influencing the changes in the abundance of fungi in the soil. No less important were, probably, atmospheric conditions in the given months. July was the month with highest temperature and at the same time highest rainfall. It is possible that these extremal conditions caused a decrease in the number of fungi in August. Most numerous fungal colonies appeared in September with a moderate amount of precipitation and temperature.

## DISCUSSION

Mycological investigations on meadows can supply interesting information on the differentiation of the specific composition of the fungal flora in dependence on various factors. Among these important are also no doubt not only the kind of soil, but the climatic conditions. The results of investigations depend, however, largely on the methods applied.

In 1972, instead of Warcup's method the dilution plate method was applied, which allows the calculation of the number of fungal colonies per gram of dry weight of the soil and makes isolation of particular strains easier. Thus, it is possible to establish the specific composition of a given plant association. It should be borne in mind, however, that quantitative determination of fungi in the soil by this method does not give a true picture, since during preparation of a soil suspension in water, a single hypha may be disrupted into several parts, each of which will be treated as a separate unit. Moreover, this method, as many others, is in some extent selective and does not ensure the isolation of many species which are known for certain to occur in the soil. In spite of these reservations, it is a valuable method, since by its application for regular determinations at relatively short time intervals, changes in the number of colonies can be recorded. In the case of Warcup's method, it would seem that introduction of soil into the agar would speed up the development of hyphae present in it. It is, however, not the case, since the development of colonies on agar depends on the rate of growth of the fungi, and the number of fungi developing rapidly from spores in the soil is so large that it makes development of colonies from hyphae difficult. Thus, each of these methods has its shortcomings, this does not, however, disqualify them for mycological studies.

Both methods applied to the studies of the Kazuń meadows gave essentially the same picture: in both cases almost the same number of species was isolated (54 and 55) with 22 species common to both the plots.

In the course of two years from the whole area under study a total of 76 species were isolated (Table 5). On the mown meadow 42 species were recorded, and on the unmown one 56. The larger number of species on the unmown plot seems to indicate that the processes of mineralization of organic matter were more intensive on it than on the mown plot. Several characteristic species were isolated on the former, known for their ability of cellulose degradation such as *Volutella ciliata*, *Alternaria geophila*, *Fusarium lini* and *Chaetomium olivaceum*. Further evidence of the intensity of the mineralization processes on the unmown plot is also the larger number of representatives of *Mucolares* than on

the mown plot. These fungi are active in the breakdown of protein substances, being the first organisms appearing on plant debris. The occurrence of larger numbers of *Mucorales* was possible owing to the high moisture of the soil on the unmown plots. Another factor producing a favourable microclimate were the high grasses prevailing during the entire vegetation period, preventing air circulation and drying up of the humus.

As earlier mentioned, on both plots fungi of the genus *Penicillium* were abundant. In 1971 most of them appeared in summer between May and September. In 1972 their maximum appearance fell to the autumn period. This difference was probably due to different atmospheric conditions in these years. *Penicillium* species are considered by some authors as characteristic for spring and autumn (B a d u r a 1964), and by others they are mentioned as occurring frequently in summer (M o r r o w

Table 5

Distribution of particular fungal species on mown and unmown meadow

| Species | Mown plot | | Unmown plot | |
|---|---|---|---|---|
| | 1971 | 1972 | 1971 | 1972 |
| Mucor hiemalis Wehmer | + | + | + | + |
| Trichoderma lignorum /Tode/ Harz | + | + | + | + |
| Trichodermaglaucum Abbott | + | + | + | + |
| Cladosporium epiphyllum Pers. | + | + | + | + |
| Arthrobotrys oligospora Fres. | + | + | + | + |
| Botryotrichum piluliferum Sacc. et March. | + | + | + | + |
| Penicillium granulatum Bainier | + | + | + | + |
| Stysanus stemonites /Pers./ Corda | + | + | + | + |
| Mucor spinosus van Tieghem | + | | + | + |
| Mucor globosus Fischer | + | | + | + |
| Myrothecium roridum Tode ex Fr. | + | | + | |
| Penicillium rubrum Stoll | + | | + | + |
| Syncephalis sphaerica van Tieghem | + | | | + |
| Penicillium lanosum Westling | + | + | | + |
| Penicillium steckii Zaleski | + | + | | + |
| Arthrobotrys kirghizica Soprunow | + | + | | |
| Stachybotrys atra Corda | + | + | | |
| Stachybotrys alternans Bon. | + | + | | |
| Penicillium claviforme Bainier | + | + | | |
| Penicillium citrinum Thom | + | + | | |
| Penicillium commune Thom | + | + | | |
| Penicillium sublateritium Biourge | + | + | | |
| Trichothecium roseum Link ex Fr. | + | + | | |
| Penicillium duclauxi Delacroix | + | | | |
| Penicillium chermesinum Biourge | + | | | |
| Penicillium puberulum Bainier | + | | | |
| Stemphylium ilicis Tengwall | + | | | |
| Oidiodendron griseum Robak | + | | | |
| Dactylella leptospora Drechsler | + | | | |
| Pullularia pullulans /de Bary/ Berkhout | + | | | |
| Aspergillus carneus Blochwitz | + | | | |

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Penicillium frequentans Westling | | + | | |
| Penicillium herquei Bainier and Sartory | | + | | |
| Cladosporium lignicola Corda | | + | | |
| Gongronella butleri /Lendner/ Peyronel et Dal Vesco | | + | | |
| Cladosporium herbarum Link ex Fr. | | + | | + |
| Humicola grisea Traaen | | + | | + |
| Penicillium purpurogenum Stoll | | + | | + |
| Penicillium chrysogenum Thom | | + | | + |
| Absidia glauca Hagem | | + | | + |
| Penicillium roqueforti Thom | | + | | + |
| Chaetomium globosum Kunze ex Fr. | | + | + | + |
| Mucor microsporus Namyslowski | | | + | + |
| Piptocephalis tieghemiana Matruchot | | | + | + |
| Piptocephalis freseniana de Bary | | | + | + |
| Thamnidium elegans Link | | | + | + |
| Sordaria lappae Fetchnia | | | + | + |
| Ascobolus furfuraceus Pers. ex Fr. | | | + | + |
| Spicaria griseola Saccardo | | | + | + |
| Dactylella brochopaga Drechsler | | | + | + |
| Dactylella lisipaga Drechsler | | | + | + |
| Verticillium cellulosae Daszewska | | | + | + |
| Alternaria humicola Oudemans | | | + | + |
| Monocillium exsolum Batista et Heine | | | + | |
| Aspergillus candidus Link | | | + | |
| Penicillium coryabiferum Westling | | | + | |
| Sepedonium chrysospermum /Bull./ Fr. | | | + | |
| Acrostalagmus cinnabarinus Corda | | | + | |
| Cylindrosporium heraclei Libert | | | + | |
| Leptosphaeria modesta /Desmazieres/ Winter | | | + | |
| Leptostromella filicina Saccardo | | | + | |
| Pleospora herbarum /Fr./ Rabenhorst | | | + | |
| Tetraploa ellisii Cooke | | | + | |
| Arthrobotrys pravicovii /Soprunov/ Sidorova Gorlenko et Malepina | | | + | |
| Mucor heterosporus Fischer | | | | + |
| Alternaria geophila Daszewska | | | | + |
| Epicoccum nigrum Link | | | | + |
| Volutella ciliata /Alb. et Schw./ Fr. | | | | + |
| Cephalosporium charticola Lindau | | | | + |
| Acremoniella atra /Corda/ Saccardo | | | | + |
| Torula convoluta Harz | | | | + |
| Fusarium lini Bolley | | | | + |
| Penicillium tardum Thom | | | | + |
| Botrytis cinerea Pers. ex Fr. | | | | + |
| Chaetomium olivaceum Cooke and Ellis | | | | + |
| Zygorhynchus moelleri Vuillemin | | | | + |

1933; Farrow, 1954). On the meadows in Kazuń these species were isolated in almost equal numbers in all seasons and do not seem to have any special requirements as regards temperature.

Both the plots lay close together and differed as regards maximum appearance of fungi. In 1971 maximal appearance in respect to the number of species was noted on the mown meadow in July, and on the unmown one in September, whereas in 1972 species were most numerous on the mown meadow in September and on the unmown plot in

June. The difference in abundance of fungi in the particular years was due to the completely different atmospheric conditions. High temperature and rainfall in the given month caused the appearance in the next month of such fungal groups for which these conditions were optimal, this affecting the over-all result (Fig. 1).

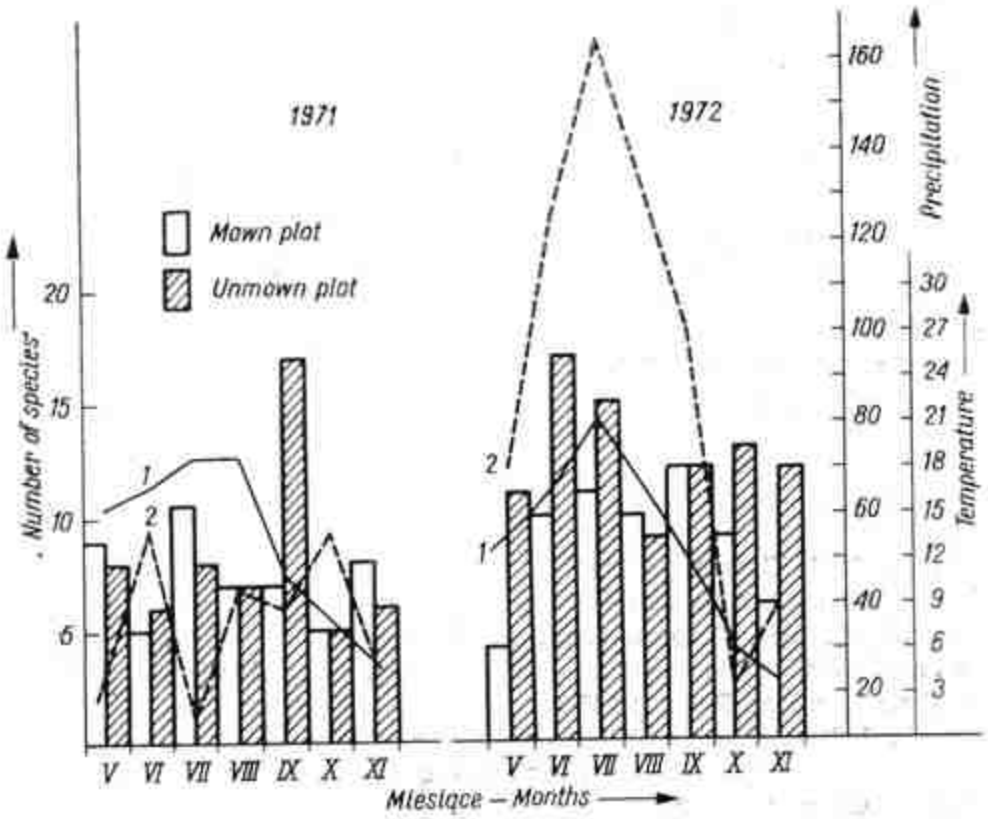


Fig. 1. Variation of number of fungal species on unmown plot and on mown plot in particular months versus temperature (1) and precipitation (2) in the years 1971 and 1972

For both plots 22 species in common were recorded, 8 of which appeared simultaneously and regularly in both years (Table 5). These species were: *Mucor hiemalis, Trichoderma lignorum, T. glaucum, Cladosporium epiphyllum, Arthobotrys oligospora, Botryotrichum piluliferum, Penicillium granulatum* and *Stysanus stemonites*. The floristic composition and water conditions differed but little as far as soil is concerned and this explains the relatively high number of species common to both sites. No doubt the close vicinity (10 m) of the plots played a role here too.

As already mentioned, more species were found on the unmown meadow. This plot was protected by high grasses from the scorching sunrays, so that the soil could preserve adequate moisture necessary for the development of fungi. Moreover, more organic matter was

available there in the from of dead plant remains than on the mown meadow where everything was raked away with the mown grass.

The quantitative studies did not give an answer to the question whether mowing affects the number of fungi in the soil. If we compare the data from both plots (Table 4), small differences are seen, probably due to changes in the atmospheric conditions in the particular years.

On the mown meadow maximum fungal appearance as regards the number of species coincided with their greatest abundance (September). On the unmown meadow these maxima fell to different months. It would seem, therefore, that the high grasses and the layer of dead plants on the unmown plot attenuated to some extent the atmospheric changes. Thus, investigations carried out in the course of one or two vegetation seasons may give only orientational results and should be repeated in the following years.

The authors are deeply indebted to professor dr. A. Skirgiełło for guidance in the course of this work.

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## Z badań nad mikoflorą gleby łąkowej w Kazuniu

Streszczenie

Do badań wytypowano równoległe i położone blisko siebie dwa płaty łąki, koszony i nie koszony, obydwa po 50 m². Próby pobierano w odstępach miesięcznych od maja do listopada 1971 i 1972 r. Do izolowania grzybów z gleby zastosowano rozcieńczeniową metodę płytkową, kultur nawozowych Krzemieniewskiej oraz metodę płytek glebowych Warcupa w modyfikacji Mańki. Rozcieńczeniowa metoda płytkowa została w roku 1972 wykorzystana również do obliczenia liczebności kolonii grzybów wyizolowanych z gleby.

Ogółem w ciągu 2 lat wyizolowano z całego terenu 76 gatunków grzybów:

z łąki koszonej — 42 gatunki, a z nie koszonej — 56. Stwierdzono 22 gatunki wspólne; najpospolitszymi okazały się: *Trichoderma lignorum, T. glaucum, Mucor hiemalis, Cladosporium herbarum* i *C. epiphyllum*. Na płacie nie koszonym wystąpiło więcej gatunków, niż na koszonym. Łąka nie koszona stwarza więc dogodniejsze warunki dla rozwoju mikoflory glebowej, gdyż znajdujący się na powierzchni gleby przez cały sezon wegetacji kobierzec traw pozwala zachować jej odpowiednią wilgotność i łagodzi zmiany warunków atmosferycznych.

Okresy wegetacyjne, w ciągu których prowadzono badania, różniły się bardzo pod względem wysokości temperatury, a zwłaszcza opadów, co spowodowało, iż maksymalny pojaw gatunków grzybów w poszczególnych latach przypadł na różne miesiące.

Badania ilościowe nie pozwoliły na stwierdzenie wpływu koszenia na liczebność grzybów w glebie. Badania tego typu powinny być powtórzone w następnych latach.