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Again... "on the necessity of mycosociological studies in Poland"

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The significance and importance of mycocoenological research is stressed and various arguments and examples from the literature are mentioned. The considerations were presented by the Author on the Symposium devoted to the memory of Professor Bogusław Sałata in the 5-th anniversary of his death.

Key words: macromycetes, mycocoenology, mycocoenoses, fungal ecology

INTRODUCTION

Mycocoenology is a part of biocenology. The aim of mycocoenology is an attempt to describe an interdependence between phytocoenosis and fungi occurring within the range of phytocoenosis. All species of fungi growing within the space of phytocoenosis are defined as mycocoenosis, entirely dependent of phytocoenosis. It is a complex of fungi grouppings known as mycosynusia. Position of those grouppings within the structure of phytocoenosis, and simultaneously within the mycocoenosis, their rank and classification is a matter of dispute of many researchers from over 70 years (e.g. Haas 1932; Hueck 1953; Barkman 1973; Winterhoff 1984; Arnolds 1981, 1992).

Nespiak (1958) in his article "On the necessity of mycosociological studies in Poland" writes: "mycosociological studies are dictated by the necessity to broaden phytosociological research. The leading goal of the vegetation science is comprehensive recognition of vegetation".

Mycocoenological research in Europe and in Poland has significant results inspite of the relatively short history of the studies. The basis for this research was the classic phytosociological school of Braun-Blanquet, which created in many European scientific centres stable principles and possibilities for observations conducted on permanent plots.

Recapitulation of the results of mycocoenological research obtained hitherto and professional literature are surveyed in Vol. 19 Handbook of Vegetation Sci-

ence which is devoted to fungi in vegetation science (Winterhoff 1992). The very same fact that the whole volume of this valuable library edition founded by Reinhold Tüxen in 1964 was entirely devoted to fungi, tells its own tale. The decision to iniciate this library edition was taken during the International Botanical Congress in Edinburgh in 1964. It is also worthy to mention the earier laborious work, mycosociological bibliography comprising over 400 items and complied by Tüxen (1964, 1966) in Excerpta Botanica. The topical division of this bibliography is very interesting. Papers dealing with mycorrhiza, monographs of genera, ecological papers, etc. are gathered in subsection "fungi in plant communities" whereas typical mycocoenological research finds its place in subsection "plant communities and fungi".

The aim of this short article is to pay the attention to several problems stressing the significance of mycocoenological studies and encourageing to perform those studies inspite of doubts and methodical difficulties which seem to overwhelm us with obstacles.

DISCUSSION

1. Fungi are significant ecological element defining the type of biological decomposition of organic matter and biomas production. Research performed within the International Biological Program proved, that the energy turnover of the fungi may be four times that of all the lower plants and all animals taken together and their biomass may even be ten times greater (Barkman 1973). Fungi as reducers and symbionts are constant elements of soil and one of the main group participating in its formation and transformation. They perform the mineralization of substratum they grow on. In many cases 90% of the humus is decomposed by fungi, only 5% by bacteria and another 5% by animals (Barkman l.c.)

The fungus cell – hypha is built in 90% by water and the remaining 10% is composed by various organic compounds – proteins (enzyme), polisacharids (glucans, chitin compounds), lipids, phenol compounds, resistant biopolimers (sporopollenins and sterols) and others. Those compounds return back to soil after the necrosis of the mycelium. Vogt et al. (1982) suggest, that the withered mycorrhiza provide the soil with 15-58% nitrogen more than the leaf-fall.

The hypha being on average 5-6μ broad permeates the smallest and narrowest slits, tubes and tubules in the soil and within the plant roots. In one cubic centimetre of soil there is 2-4 cm of roots, 1-2 cm of root-hairs and 50 cm of the hyphae of ectomycorrhizal fungus (Allen 1991). The length of the hyphae of the mycelium exceeds 10^3-10^5 times the length of tree-roots (Read 1991). Hyphal network of mycelium lives in soil only 1-3 days (Burges 1958). Hypha has walls which are metabolically very active. When it contacts with the substrate the dynamic exchange takes place (extracellular digestion) comprising an intensive production of enzymes and absorption of digestive liquid (osmotrophy).

Fungi accumulate enormous amount of carbohydrates. Each tree species has specific set of ectomycorrhizal associates and set of saprotrophic fungi decomposing its wood and debris. The basidiomycete fungi are the only living organisms able to decompose lignin compounds accumulated in wood. Lignins constitutes 25% of the total biomass of a forest and a large part of the other 75% is accessible only when the lignin is broken down (Veerkamp 1992).

From the theoretic and methodic point of view it is worthy to notice here several papers e.g. by Sadowska (1973, 1974), Nespiak et al. (1975), Hołownia (1977, 1978) and Ohenoja and Metsänheimo (1982). They all inform about the high activity of mycelium which manifests in the production of carpophores. The fresh weight of carpophores in subarctic birch forest of Finnish Lapland attains 363 kg/ha per year (Ohenoja and Metsänheimo l.c.). Nespiak et al. (1975) give preliminary results of research done on the estimation of the participation of mycelium fimbrial in the organic mass of humus horizon in forest soil. Their study was undertaken in conviction that fungi are one of the main regulators of energetic management of phytocoenosis.

Mycocoenoses manifest often earlier and more precisely the influence of local factors such as type of organic substance and type of fertilization (Arnolds 1981).

2. *Fungi are an additional element in defining and recognizing plant associations and depend entirely on the ecological conditions of phytocoenosis.* They occur in all forest layers and have mostly wider ecological range than plants. The widest distribution have mainly saprotrophic fungi. Fungi depend entirely on the ecological conditions of phytocoenosis.

Fungi recorded in phytocoenosis often outnumber vascular plants. Šmarda (1972, 1973) showed that in some forests of Moravia fungi species outnumber plants even 10 times. In Poland this phenomenon was recorded in Roztocze (Sałata 1973), on Babia Góra (Bujakiewicz 1981, 1982) and in the Białowieża National Park (Faliński and Mułenko eds 1992). In the results of systematic research (the Project CRYPTO) in one forest section on the area of 140 hectars, during 5 years totally as much as 1992 taxa were recorded, in it 1380 species (69%) of fungi (Faliński and Mułenko eds 1992). Fungi together with lichens (lichenised fungi) compose 1544 species (77%). In fact the share of fungi is still greater since many groups of fungi were not taken into account in the study because of lack of specialists in the field – workers group e.g. for *Dematiaceous* fungi.

Evident is the response of fungi on the functional arrangement hummocks – hollows in the *Carici elongatae-Alnetum* association. The distribution of fungi is marked with regularity in covering both microforms and given substrata (Mułenko and Bujakiewicz 1996; Bujakiewicz 1999).

Very interesting results came from the Netherlands and Western Europe (Barkman 1976, Vries 1976) where fungi were studied in juniper scrubs. Saprotrophic fungi connected with the wood and bark of juniper were the subject of study (Vries 1976). It was stated that the variation of wood-dwelling fungi on juniper is primarily dependent on soil fertility: the *Squarroso-Juniperetum* on fertile soils and the *Dicrano-Juniperetum* on poor soils are different in this respect. Other factors affecting the distribution of fungi are: soil humidity, grazing, admixture of other woody plants, age of the scrub amount of dead wood and presence, cover and floristic composition of epiphytes (mosses, lichens, algae).

Terrestial fungi studied in juniper scrub by Barkman (1973, 1976) consist totally as much as 450 species. In the *Dicrano-Juniperetum* they occurred in 5 terrestrial microhabitats containing 12 microcommunities, which can be divided into 41 terrestrial synusiae, 23 of which consist of fungi alone.

High ecological specialisation of fungi brings about that many of them and sometime groups of species are used as markers for ecological characteristics of trees-

tands. It refers to pH of soil, altitude, degree of alteration (Bujakiewicz 1981) and other factors.

3. *Fungi are important diagnostic element in syntaxonomy of plant communities.* In the Polish geobotanical literature the role and specific character of fungi were appreciated rather soon e.g. in the discussion dealing with the cryptogamous plants and their classification (Kornaś 1957, 1966). The author considers fungi in the discussion on synusia of lower plants in higher plant associations. In this discussion he mentions research done by Pirk (1948) in oak-hornbean forests, where for two subassociations: *Querco-Capinetum corydaletosum* and *Q.C. stachyetosum* over 30 differential taxa of fungi were found. Pirk's (1948) studies also confirm the predominance of fungi species over the vascular plants.

The information on the share of fungi in the forest associations one can find in the volume of Vegetation of Poland (Zarzycki and Szafer eds 1972) in chapter devoted to the description of Wielkopolsko-Kujawski Region.

In Preising (1953) elaboration fungi are treated equally with plants in phytosociological table for the *Calluno-Antennarietum dioicae*. *Cortinarius mucosus* is placed as characteristic to the alliance and to the order. Among the accompanying species one can find e.g. *Hygrophorus cossus*, *Galerina mniophila*, *Xeromphalina campanella*, *Hygrophoropsis aurantiaca*, *Gomphidius roseus* and *Lactarius deliciosus*.

The synthetic – comparative method is used for establishing the indicative value of fungi in plant associations. It is based on recording statistically reliable correlation between the appearance of a fungus species and the plant association. Indicative value of fungi depends on the degree of correlation with the plant association which may be expressed with various measures of characteristics e.g. fidelity, constancy of occurrence and (but not always) abundance of carpophores.

Research performed by Lisiewska (1972, 1974) in beach forests within the eastern part of the *Fagus* area gives a convincing picture of connections of macrofungi with different beech forest types.

Research done in phytocoenoses of lower units of the *Dentario glandulosae-Fagetum*, *Galio-Abietetum* and *Plagiothecio-Piceetum* on Babia Góra massif reveled, that there is additional confirmation of these divisions in the fungi composition (Bujakiewicz 1981, 1982). Mycocoenological studies performed in the *Galio-Abietetum*, distinguished in Poland for the first time on Babia Góra (Celiński and Wojterski 1978) distincly confirmed systematic position of that association in between the orders *Fagetalia* and *Vaccinio-Piceetalia* (Bujakiewicz 1974, 1981, 1982).

Fungi also confirmed differences in the forest habitats occurring on slopes of different exposition e.g. on the northern and southern slopes of Babia Góra massif. They are connected with the milder climate on southern slopes, which are richer in fungi taxa also because of the more diversified habitats formed in connection with the forest management (introduction of various trees alien to montane area, fireplaces, clearings), and more gentle slopes which causes the occurrence of soligenic peat-bogs (Bujakiewicz 1981, 1982).

A provinsional attempt to enumerate the characteristic macrofungi of all important plant communities in France, mainly on the level of alliance and higher syntaxa have been undertaken by Bon and Gehu (1973). For the *Alno-Padion* alliance these authors designated e.g. *Cortinarius alnetorum*, *Gyrodon lividus*, *Lactarius lilacinus*, and *Morchella gigas*. Carbiener et al. (1975) consider for this alliance *Gy-*

rodon lividus and *Paxillus filamentosus* and Bujakiewicz (1989) – *Morchella gigas* and moreover *Entoloma pleopodium*, *Inocybe calospora* and *Melanophyllum eyrei*. Further studies may bring new data for confirmation, revision or decisive changes in recognition of diagnostic rank of fungi species.

4. *Fungi can serve as indicators of changes taking place in plant communities.* It is connected mostly with the important function played by symbionts of trees, shrubs and other groups of plants. The process of succession of forest trees is connected with succession of mycorrhiza.

The phenomenon of succession belongs to the most fascinating in the nature and simultaneously to the least known. To include fungi in syndynamic research seems almost impossible when taking into account their peculiar nature. Courageous attempt of surveying fungi in secondary succession of forest on formerly arable land was undertaken by Kałucka (1999 unpubl.). Studies were performed in the Jelonka reserve and the Czechy Orlańskie reserve near the Białowieska Forest in the unique in Europe research experimental range deliberately established for the strict protection of complex plant communities occurring on formerly arable land. The ecological process of spontaneous secondary succession is here protected. As the result forest comes back on areas formerly deforested. The authoress faced an outstanding goal – to complete a model of succession of vascular plants, bryophytes and lichens – with the fungi.

The subject of the research were basidiomes of macromycetes and ectomycorrhizes. To the quantitative analysis of carpophores and analysis of fungi productivity the authoress used parameters and indicators proposed by Dutch mycocoenological school (Arnolds 1981).

The result of solid, reliable and laborious observations was an ample and diversified material comprising data for over 300 species of basidiomycete fungi presented against the background of developing cycle of coniferous set of secondary succession. Going from psammophilous swards, through juniper-aspen shrub to the pine forest, the authoress shows the distribution of basidiomes of various species of fungi on permanent plots, observing their distinct ecological inclinations. *Inocybe lacera* has its optimum in initial stage, *Hygrophorus hypothejus* in optimal stage and *Tricholoma flavovirens* in terminal phase of optimal stage. The only ectomycorrhizal species which regularly occurs in optimal and terminal stage is *Lactarius rufus*. Contrary to ectomycorrhizal fungi, saprotrophs decomposing the litter mostly occur in several stages e.g. *Marasmius androsaceus* (Kałucka 1999 unpubl.).

The research confirmed among others the hypothesis of existence of definite groups of fungi species connected with the developmental stages of phytocoenoses i.e. "early stage fungi" and "late stage fungi". Ectomycorrhizal fungi impose probably the strongest influence on the direction and the process of regeneration of forest on formerly arable land. In fact ectomycorrhizal fungi themself transform inhospitable to trees postagrarian soil to forest soil. In the stage of juniper-aspen shrub the activity of fungi is the highest.

The authoress collected in five years sufficient material convincing on the functional-structural significance of fungi. The process of succession interpreted usually as changes in vegetation, works in reality in strict cooperation with fungi. It is fungi that start changes in the habitat, decompose organic matter and enrich soil.

Athough the mycocoenological studies contribute to the knowledge on the role of fungi in phytocoenosis only indirectly informing on the character and direction of processes taking place in the nature, their significance is immence. The importance of these studies was recently expressed with the appearance of the laborious guide for ecological and floristic characterisation of fungi in Central Europe (Bresinsky and Besl 1995). As a response for that guide the elaboration of mycocoenological studies in Poland was prepared (Ławrynowicz et al. 2004).

There is still many things to do. First of all the discussion is necessary on the essence of these studies and elaboration of uniform methods of research for simulataneous consideration in the field work of fungi representing various trophic – habitat groups.

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Jeszcze... „o potrzebie badań mikosocjologicznych w Polsce"

Streszczenie

W artykule przytoczono z literatury rezultaty niektórych badań świadczące o wadze i znaczeniu studiów mikocenologicznych. Przedstawiono je w obrębie czterech zagadnień a mianowicie znaczenia grzybów w rozkładzie substancji organicznej i produkcji biomasy, ich znaczenia w określaniu i wyróżnianiu zbiorowisk roślinnych a także roli grzybów jako elementu diagnostycznego, w syntaksonomii zbiorowisk roślinnych i jako wskaźników zmian zachodzących w zbiorowiskach (sukcesja roślinności).