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MARIA LISIEWSKA, STANISŁAW BALCERKIEWICZ

Macrofungi in orchards treated with herbicides

Großpilze in mit Herbiziden behandelten Obstplantagen

Die vorliegende Studie befaßt sich mit der Pilzflora von intensiv bewirtschafteten Obstplantagen in der Umgebung von Poznan in Polen. Diese Anlagen sind – ähnlich wie bei uns – hohen Belastungen besonders durch verschiedene Herbizide ausgesetzt. Außerdem kommen noch hohe Düngergaben hinzu. Das führt zur Herausbildung völlig neuer, nicht natürlicher Pflanzengesellschaften im Unterwuchs der Plantagen, die durch besonders resistente Moose und Unkräuter charakterisiert sind.
Die mykologischen Untersuchungen wurden an 34 Standorten in 15–40 Jahre alten Plantagen während der Jahre 1988 und 1989 durchgeführt. Neben terrestrischen Pilzen wurden auch Holzbewohner untersucht. Insgesamt konnten 80 Arten von Großpilzen nachgewiesen werden, drei Viertel davon Blätterpilze (vgl. Tab. 5 u. 6). Dabei ergaben sich Unterschiede der Pilzflora in Abhängigkeit vom konkreten Standort und der Art und dem Alter der Obstbäume. Zahlreichen Einzelheiten werden diskutiert. Tab. 5 u. 6 bringen Übersichten der Pilze in den Pflanzengesellschaften.
Titel der Tabellen:
Tab. 1: Herbizidgaben in den untersuchten Obstanlagen in den Jahren 1988/1989
Tab. 2: Bodenacidität (pH-Werte) in den A 1 – Horizonten
Tab. 3: Niederschlag in mm (Monate I. . .XII) in den Jahren 1988/1989, rechts Jahressummen
Tab. 4: Durchschnittliche Temperaturen in °C (Aufbau wie Tab. 3)
Tab. 5: Makromyceten auf dem Boden und an Pflanzenresten in den Obstanlagen
Tab. 6: Makromyceten an Holz in den Obstanlagen (abgefallene Zweige, abgeschnittene Äste, Stümpfe etc.)
Red.

Introduction

In the modern pomology, chemicultivation is put into practice on a large scale both to preserve fruit trees and to eliminate weeds. Under the influence of the applied herbicides considerable changes in vegetation take place. The treated herbicides do not only impoverish the flora, but on the other hand they favour some species of plants, and contribute to the origin and spread of new synanthropic plant communities (BALCERKIEWICZ, RUSIŃSKA 1987; BALCERKIEWICZ et al. 1988).

So far, in orchards mycological investigations have been carried out from phytopathological and mycotrophical points of view. No detailed studies have been made on the influence of herbicides on macrofungi occurring in orchards. In the article about macrofungi found in anthropogenic vegetation on the sand dune „Wingertsbuckel" in S. W. Germany, WINTERHOFF (1983) mentioned a rich mycoflora of the *Poa pratensis* subsp. *angustifolia* – community in old fallow orchards.

The aim of this research was to study the mycoflora of orchards against the background of the applied technologies of orchard cultivation providing differentiation of habitats, as well as to discover whether under the influence of herbicides specific fungal species can be introduced as in case of spore plants (mosses and liverworts).

Technologies of orchard cultivation

Poznań Province as well as the whole region of Wielkopolska is famous of high agriculture.

Recently in the agricultural landscape more attention is payed to orchard cultivations. In the environs of Poznań the following fruit trees are cultivated: apple trees (52,2 %), cherry trees (15 %), plum-trees (12,3 %), pear-trees (9,7 %) and sweet cherry-trees (5,9 %).

In orchards, various methods of soil cultivation are used, spraying trees with herbicides

and plant pesticides as well as the fertilization and irrigation securing the optimal conditions for the growth and high yielding of fruit trees.
Usually, in the first years after planting of fruit trees, so called „bare fallow" remains. It results from the repeated shallow loosening of the superficial soil layer in order to eliminate weeds. In late summer, inter-rows used to be sown with covering plants which are ploughed enriching the soil in organic and mineral substances.

In many years' orchards we can frequently observe a permanent turfness of inter-rows and herbicide fallow in rows of trees. In the last years the herbicide fallow is introduced on whole area of the orchard. The list of the main herbicides treated in the investigated orchards is shown in table 1. The rows are also regularly fertilized. Nitrogen fertilizers are applied in spring before and after the flowering of fruit trees. Phosphatic and potassium fertilizers are usually used in autumn. On bare fallow manuring can be used as well.
The distance between fruit trees in a row is different, ranging from 2.5 to 8 m, and between rows – from 4 to 5 m. Rows treated with herbicides are usually 1.5–3.0 m wide, and the inter-rows are 2.5–3.5 m wide containing ruts about 0.30 m wide.

General characteristic of the investigated area

Mycological observations were carried out in orchards of four localities: Przybroda, Pamiatkowo, Tarnowo Podgórne and Paczkowo. They are situated on the Wielkopolska-Kujawy Lowland in the environs of Poznań (the capital of the province, about 600 000 inhabitants) in a distance: Pamiatkowo – 30 km, Przybroda – 25 km and Tarnowo Podgórne – about 20 km north-west from Poznań, and Paczkowo – 20 km east from Poznań.
Orchards are placed on a flat area, 85–87 m above sea level.
The soils in the investigated orchards belong mainly to the brown type and glayed podzolic soils formed of loamy sands on loamy subsoil. The mother rock is pleistocene moraine loam. The soils are weakly acid (pH 4.5–5.5) in the A_1 horizon (Tab. 2).

The climate in the environs of Poznań has a transitional character from the atlantic in W. Europe to continental climate in E. Europe. The average annual precipitation is 519 mm and the average many years' air temperature is 8.2 °C (HOŁUBOWICZ 1987). In 1988, the sum of precipitation was higher in comparison with the average sum – 631.4 mm, but the year 1989 was extremely dry – 335.4 mm of precipitation (Tab. 3). During the period under study the average annual air temperature was nearly the same and higher than the many years' air temperature (Tab. 4). Winds are rather strong, mainly from western directions.

Plant communities of orchards against the background of differentiated habitats
Herbicide fallow in rows of fruit trees and mown lawn in inter-rows are prevailing in the studied orchards (Fig. 2). The majority of fruit trees are apple trees. The general characteristic of vegetation of selected orchards is based on non-published results of complex investigations (BALCERKIEWICZ et al. 1988).

Under the influence of the applied high doses of herbicides, new so far not known types of plant communities have been formed. They are usually ruderal communities, extremely specialized. The best example is the association Erigeronto-Bryetum (BALCERKIEWICZ, RUSIŃSKA 1987) occurring most frequently on the herbicide fallow in rows of fruit trees. The characteristic feature of this association is the dominating role of bryophytes (*Marchantia polymorpha*, *Bryum argenteum*, *B. caespiticium*, *Ceratodon purpureus* etc.) as well as the participation of herbaceous plants, eg. *Erigeron canadensis*, *Epilobium adenocaulon*, *Geranium pusillum*, *Taraxacum officinale*, *Atriplex patula* and others. On habitats treated with high doses of herbicides some field weeds such as *Stellaria media*, *Senecio vulgaris*, *Erophila verna* and *Digitaria ischaemum* are common.
Beside the communities of annual weeds (Erigeronto-Bryetum, Erophilo-Arabidopsetum, *Senecio vulgaris*- and *Poa annua*-communities), there occur the communities of deep rooting geophytes of Agropyretalia order (Agropyretum repentis, Convolvulo-Brometum inermis, *Equisetum arvense*- and *Carex hirta* – communities). On herbicide fallows, the

community with plagiotropic mosses dominated by *Brachythecium rutabulum* and *Eurhynchium hians* can be also observed.

The flora of bare fallow consists mainly of nitrophilous plants belonging to the class Stellarietea mediae. The association Echinochloo-Setarietum and *Stellaria media* – community have been distinguished there.

Inter-rows are very often soded with grass mixture and regularly cut down. In the floristic composition of the inter-row lawn and its ruts, hemicryptophytes predominate. They are connected with meadow and carpet communities.
Of plant associations described in inter-rows, there prevail Lolio-Plantaginetum with dominant plants: *Lolium perenne, Taraxacum officinale, Festuca rubra, Poa pratensis, Cerastium vulgatum,* and other grassy communities belonging to Molinio-Arrhenatheretea s. l. class.

In the ruts, there are communities with *Poa annua* and *Stellaria media.*
In inter-rows treated with herbicides we can observe plant communities usually occurring on the herbicide fallow in rows.

In all investigated orchards, the following species are very common: *Taraxacum officinale, Stellaria media, Erigeron canadensis, Agropyron repens, Poa annua, Capsella bursa-pastoris* and *Polygonum aviculare.* In total, 195 species of plants were recorded (BALCERKIEWICZ et al. 1989).

Material and methods

The material for the elaboration has been gathered from 34 stands in orchards of the following fruit trees: apple trees, pear trees and hazel in the Experimental Station of the Agricultural Academy in Przybroda; apple, cherry and sweet cherry trees in the State Horticulture Farm in Pamiatkowo; apple and plum trees in private farms in Paczkowo and Tarnowo Podgórne. The orchards are 15–40 years old.
The present studies were based on mycological observations made in two vegetation seasons from April 1988 till October 1989 during 15 visits in all above mentioned orchards. In the course of those visits, possibly uniform small and narrow patches of different area of various plant communities were studied. They werde situated in the following habitats:
1. herbicide fallow in rows: Erigeronto-Bryetum, *Agropyron repens-, Poa annua-,* and *Brachythecium-Eurhynchium* – communities;
2. herbicide fallow in inter-rows: Erophilo-Arabidopsetum;
3. bare fallow in inter-rows: Echinochloo-Setarietum and *Stellaria media* – community;
4. inter-row lawn: Lolio-Plantaginetum;
5. ruts of an inter-row lawn: *Poa annua* – community;
6. yards with cut out wood.

Two ecological groups of macrofungi regarding the substratum were taken into consideration, namely fungi growing on the ground and plant remains, and fungi growing on wood (fallen twigs, cut out branches, trunks and stumps of fruit trees).
On the basis of data obtained in respect of substratum and the abundance of fruiting macrofungi, two tables (Tab. 5 and 6) for all fungal species occurring in the particular plant communities were elaborated.
Degree of abundance is indicated according to JAHN et al. (1967): a – abundant, n – numerous, r – rare.

Another abbrevations used in tables:
1. localities: Prz – Przybroda, Pam – Pamiatkowo, Pacz – Paczkowo, TP – Tarnowo Podgórne;

2. fruit trees: a – apple, p – pear, pl – plum, ch – cherry, sch – sweet cherry, h – hazel.
The nomenclature is after MOSER (1983), supplemented according to MUNK (1957), MOSER (1963), KREISEL (1967), DENNIS (1981) and JÜLICH (1984).

The soil reaction (pH) in A_1 horizon in depth of 2–5 cm of various habitats, where mac-

Table 1
Herbicides treated in the investigated orchards in 1988-1989

Name of herbicide	Active substance	Dose	Period	Fruit tree	Locality
Azotop 80	simazin	1,5-3,0 kg/ha	I, II	a, p, h	Prz
Casoron G	2,6-dichlobenil	50 kg/ha	V	h	Prz
Chwastox	natrium salt MCPA	3 l/ha	III, IV	a, pl	Prz, Pacz
Gesaprim 50	50% atrazin	3 kg/ha	V	a, pl	Pacz, TP
Gesatop 50	50% simazin	3 kg/ha	VI	a, pl	Pacz
Gramoxone	20% parakwat	3 l/ha	V	a, pl	Pacz
Kerb 50 W	propyzamid	3-4 kg/ha	I, XI, XII	a, p, ch, h	Prz, Pam
Pielik	80% natrium salt 2,4-D	1,5 kg/ha	III	a	Prz
Reglone	20% dikwat	2-4 l/ha	V, VI	a, sch	Prz, Pam, TP, Pacz
Roundup	glyfosat	4 l/ha	VI	a, sch	Pam

Table 2
Soil acidity (pH) in A1 horizon

Locality	Rows							Inter-rows							Bare fallow	
	Erigeronto-Bryetum					Agropyron repens - comm.		Erophilo--Arabid.		Lolio-Plantaginetum					Stell. media - comm.	
	a	pl	ch	sch	h	a	p	a	pl	a	p	ch	sch	h	a	pl
Pam	4,5	.	5,0	4,5	.	.	.	.	.	5,0	.	5,0	4,5	.	.	.
Prz	4,5	.	.	.	5,0	.	5,5	.	.	4,5	5,0	.	.	5,0	.	.
Pacz	5,0	5,0	.	.	.	.	.	5,0	5,0	.	.	.	.	.	.	.
TP	.	5,0	.	.	.	5,0	.	.	.	.	.	.	.	.	5,0	5,0

Table 3
Sum of precipitation (mm)

Month / Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual precipitation
1988	46,6	49,4	50,8	25,7	22,6	122,7	152,8	35,8	42,7	6,1	34,0	42,2	631,4
1989	7,6	16,4	13,2	30,9	18,2	25,8	61,2	42,6	21,4	25,2	24,8	43,1	335,4

Table 4
Average air temperature (^{0}C)

Month / Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average annual temperature
1988	1,9	2,0	1,2	7,9	15,6	16,1	18,7	17,1	13,6	8,8	1,0	2,4	8,3
1989	2,1	4,0	5,9	8,9	14,2	16,2	18,9	17,9	14,9	10,2	1,9	-1,2	9,5

Table 5
Macrofungi on ground and plant remains in orchards

Habitat	Bare fallow			Herbicide fallow in rows																Rut of a lawn			Inter-row lawn					
Plant community	Ech. - Set.	Stell. media - comm.		Erigeronto-Bryetum									Brachyth. -Eurhyn. - comm.		Agropyron repens - comm.				Poa annua - comm.			Poa annua - comm.			Lolio-Plantaginetum					
Fruit tree	a	a	pl	a	a	a	p	pl	ch	sch	h		pl	sch	a	a	p	h	a	ch	h	a	p	ch	a	a	p	ch	sch	h
Locality	TP	TP	TP	Prz	Pacz	Pacz	Prz	Pacz	Pacz	Pacz	Prz		Pacz	Pacz	Pacz	Prz	Prz	Prz	Prz	Pacz	Prz	Prz	Prz	Pacz	Pacz	Prz	Prz	Pacz	Pacz	Pacz	Prz
Conocybe rickenii	n	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pholiotina mairei	n	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrocybe arvalis	.	r	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panaeolus subbalteatus	.	.	r	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agaricus campester	.	.	.	n	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a
Clitocybe dealbata	.	.	.	n	.	.	.	.	n	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Coprinus atramentarius	.	.	.	r	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.
Coprinus comatus	.	.	.	r	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marasmius languidus	.	.	.	r	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Psilocybe inquilina	.	.	.	r	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Gerronema marchantiae	.	.	.	.	a	.	.	.	.	.	.		r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycoperdon lividum	.	.	.	.	n	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mycena stylobates	.	.	.	.	r	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clitocybe fragrans	.	.	.	.	r	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n
Bovista nigrescens	.	.	.	.	r	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marasmius oreades	.	.	.	.	n	.	.	.	n	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Vascellum pratense	.	.	.	.	r	.	.	.	n	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Bovista plumbea	.	.	.	.	r	.	r	.	.	.	.		.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Bovista pusilla	.	.	.	.	n	r	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Entoloma sepium	.	.	.	.	.	a	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leptopodia albipes	.	.	.	.	.	.	.	a	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Peziza granulosa	.	.	.	.	.	.	.	.	r	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Conocybe subovalis	.	.	.	.	.	.	.	.	r	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stropharia coronilla	.	.	.	.	.	.	.	.	.	r	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.

Scleroderma verrucosum	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Laccaria laccata	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hebeloma crustuliniforme	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hebeloma sacchariolens	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Flammulaster granulosus	.	.	.	.	.	.	.	.	.	.	r	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyathus olla	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.
Psathyrella fatua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	n	.	.	.
Panaeolus retirugis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Hypholoma sublateritium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Coprinus plicatilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	r	.	.	.	.	r	.	n	.	.	n	.
Mycena avenacea v. roseofusca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	a	.	.	.	.	.	.	.	.	.	.	.	.
Marasmius epiphyllus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	r	.	.	.	.
Coprinus lagopus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.	.	.	.
Psathyrella vernalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	r	.	.	.	r	.	n	.	.
Tubaria pallidospora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
Coprinus xanthothrix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.
Psathyrella conopilea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.
Coprinus silvaticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.
Marasmius splachnoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.	.	.	.	.
Psathyrella pseudocasca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	n	.	.	.	.
Psathyrella subnuda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	n	.	.	.	.	r	.	.
Entoloma sericeum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.
Psathyrella prona	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.
Psathyrella velutina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.
Psathyrella frustulenta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.
Pholiotina appendiculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.
Pholiotina arrhenii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	n	.	.	.	.
Psathyrella corrugis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Psathyrella gyroflexa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Psilocybe semilanceata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Bolbitius vitellinus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Conocybe semiglobata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Conocybe siliginea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Conocybe tenera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Psathyrella gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	n	.	.	.
Mycena avenacea v. avenacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	n	.	.	n
Stropharia cyanea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.
Coprinus hemerobius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.
Melanoleuca melaleuca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.

Table 6
Macrofungi on wood in orchards
(fallen twigs, cut out branches, trunks etc.)

Habitat	Bare fallow	Herbicide fallow in rows							Herb fallow in inter.	Inter-row lawn		Cut out wood-yard	
Plant community	Stell. media – comm.	Erigeronto-Bryetum					Brach. -Eurh. – comm.	Poa annua – comm.	Eroph. – Arabi-dop.	Lolio-Plantag.		–	–
Fruit tree	pl	a	a	p	pl	sch	ch	ch	a	a	ch	a	a
Locality	TP	Prz	Pacz	Prz	TP	Pam	Pam	Pam	Pacz	Prz	Pam	TP	Prz
Hypholoma fasciculare	n	.	.	.	.	.	.	.	.	.	.	.	.
Psathyrella candolleana	n	.	.	.	.	.	.	.	.	.	.	.	.
Psathyrella obtusata	.	n	.	.	.	.	.	.	.	r	.	.	.
Trametes hirsuta	.	r	.	.	.	.	.	.	.	.	.	n	.
Bjerkandera adusta	.	n	.	.	r	.	.	n	.	.	.	.	.
Tubaria furfuracea	.	n	n	.	.	.	n	n	n	a	n	.	.
Nectria coccinea	.	n	n	.	.	.	.	.	.	.	.	.	.
Trametes zonata	.	.	n	.	.	.	.	.	.	.	.	.	.
Nectria cinnabarina	.	.	.	n	.	n	.	.	.	.	.	n	n
Trametes pubescens	.	.	.	.	.	r	.	.	.	.	.	.	.
Mycena galericulata	.	.	.	.	.	r	.	.	.	.	.	.	.
Phellinus tuberculosus	.	.	.	.	.	.	.	r	.	.	.	.	.
Polyporus varius	.	.	.	.	.	.	.	r	.	r	.	.	.
Polyporus ciliatus	.	.	.	.	.	.	.	.	.	.	r	.	.
Polyporus arcularius	.	.	.	.	.	.	.	.	.	.	r	n	.
Schizophyllum communae	.	.	.	.	.	.	.	.	.	.	.	n	.
Trametes versicolor	.	.	.	.	.	.	.	.	.	.	.	.	n

rofungi were collected, was measured with the colorimetric method of HELLIGE (Tab. 2). The sum of precipitation (Tab. 3) and the average air temperature (Tab. 4) in the years of mycological observations were taken from the Meteorological Institute in Poznań.

Macrofungi collected from the orchards have been included into the fungal herbarium of the Department of Plant Ecology and Environment Protection, Adam Mickiewicz University.

Discussion of results and conclusions

During two vegetation seasons in the years 1988–1989, in the studied orchards near Poznań in total 80 species of macrofungi were recorded. Most of them belong to Basidiomycetes class, mainly of Agaricales order (60 species).
The results presented in table 5 show in general a distinct difference among fungal flora growing on the ground and litter debris in the herbicide fallow in rows and that occurring in the inter-row lawns.

The patches of Lolio-Plantaginetum association in the inter-rows were dominated by many species of the genus *Psathyrella (P. prona, P. velutina, P. frustulenta, P. corrugis, P. pseudocasca, P. gyroflexa, P. gracilis)* as well as some species of *Conocybe (C. semiglobata, C. siliginea, C. tenera).* Besides, *Pholiotina appendiculata, P. arrhenii, Entoloma sericeum* and *Bolbitius vitellinus* were also found among grasses in apple orchards only.

Most of the species were usually reported from a wide range of grassland types. They were noted on meadows and in grass by roadsides e. g. *Pholiotina appendiculata, Entoloma sericeum* and the above mentioned species of the genus *Psathyrella.* Species of the genus *Bolbitius, Conocybe, Melanoleuca* belong to nitrophilous fungi, reported from fertile, manured soils in gardens and pastures (SADOWSKA 1973, 1974; ARNOLDS 1982; KREISEL 1987 and others). *Mycena avenacea* var. *typica* seems to be a species locally characteristic of Lolio-Plantaginetum association in the studied orchards. It was growing numerously in groups on grass litter under apple trees, pear trees and hazel. ARNOLDS (1982) considers this species reported from different grass communities as one of the few *Mycena* species with a prominent preference for grasslands and other grassy communities. In inter-row lawns of cherry and sweet cherry trees only few species of macrofungi were observed, namely *Coprinus hemerobius, C. plicatilis, Psathyrella subnuda* and *P. vernalis* usually found in the herbicide fallow in rows as well. They have a rather wide ecological range; they were reported both from fertilized grasslands and fields and poor, dry grasslands, grassy roads and forests (SADOWSKA 1973, ARNOLDS 1982, KREISEL 1987).

The differentiating species of *Poa annua* – community occurring in the ruts of a lawn were *Psathyrella conopila, Coprinus silvaticus* and *Marasmius splachnoides.* They were fruiting on pressed grass remains between short herbs. Especially *Psathyrella conopila* also was reported from ruts by KREISEL (1987).

In relation to inter-row lawns, the herbicide fallow in rows had a rich mycoflora differentiated in dependence on plant communities.

In patches of *Poa annua* – community a couple of fungal species were common with that plant community in the ruts of a lawn, namely *Psathyrella vernalis* and *Coprinus xanthothrix.* Besides, *Coprinus lagopus* and *Tubaria pallidispora,* reported from open spaces amongst grass on loamy soils, were the differentiating species for this loose plant community. *Marasmius epiphyllus* was growing abundantly on petioles of apple leafs fallen on the herbicide fallow. It was also observed, but accidentally only, in the inter-row lawn on the same substratum.

In patches with *Agropyron repens* – community interesting is the tufty occurrence of a wood-saprophyte *Hypholoma sublateritium* on rhizomes of *Agropyron repens.* The similar phenomenon was described by ZABŁOCKA (1953), who found shoots of strawberry plants invaded by the mycelium of *Hypholoma fasciculare*, a known wood-saprophyte.

The author tries to trace back the invasion of strawberry plants by this fungus to a previous appearance of *Hypholoma fasciculare* in the neighbourhood of some apple trees. Since the trees had been removed, the vacated ground was planted with strawberries. It seems that *Hypholoma fasciculare* can become a parasite fungus. May be *Hypholoma sublateritium* could be also a parasite or mycorrhizal species on rhizomes just of *Agropyron repens.* Another differentiating taxon was *Mycena avenacea* var. *roseofusca.* It was found growing abundantly in two patches with *Agropyron repens* and *Geranium pusillum* in herbicide fallows under pear trees and hazels. This variety of *Mycena avenacea* is less frequently recorded than the typical one. It has not been distinguished yet in the studied grasslands in Poland. In Europe it was reported for instance from more or less dry grasslands (ARNOLDS 1982) as well as in W. Germany in Poa – community and *Syringa vulgaris* thickets in old orchards (WINTERHOFF 1983 sub *Mycena roseofusca* (KÜHNER) BON), and from sheep pastures belonging to Gentiano-Koelerietum association (WINTERHOFF 1987). *Cyathus olla,* noted on grass litter both in *Agropyron* – and *Poa annua* – communities, is the characteristic species of weakly acid dry swards (ARNOLDS 1982, KREISEL 1987).

Especially two herbicide fallow communities are mycofloristically interesting, where plagiotropic mosses (*Brachythecium-Eurhynchium* – community) and *Marchantia polymorpha* (Erigeronto-Bryetum) dominated. First of all *Gerronema marchantiae* (=*G. postii* s. l.), a rare carbophilous species (KREISEL 1987), was found several times on *Marchantia polymorpha* both in herbicide rows and in inter-rows in apple orchards, and singly among *Eurhynchium hians* in a plum orchard. Another interesting species connected with mosses is *Flammulaster granulosus,* fruiting numerously in herbicide fallow under sweet cherry trees and singly under hazel. On naked soil intensively treated with herbicides, two species of Pezizales were observed. The first of them was *Leptopodia albipes (=Helvella spadicea)* found in groups under plum trees and the latter one *Peziza granulosa* growing solitary under cherry trees. *Peziza granulosa* was reported by PETERSEN (1970) from experimental plots which were burnt or treated with $CaCO_3$. Both species are rather rare, noted in gardens and forests on naked sandy soils (MOSER 1963).

The patches of the herbicide fallow where *Marchantia polymorpha* prevailed are also distinguished by macrofungi appearing in rather anthropogenic ruderal habitats, in dry and poor grasslands on sandy soils, e.g. *Lycoperdon lividum (=L. spadiceum)*, *Bovista pusilla*, *B. plumbea*, *B. nigrescens*, *Clitocybe dealbata* etc.

Noteworthy are macrofungi found on the herbicide fallow in rows under hazel, such as: *Scleroderma verrucosum, Laccaria laccata, Hebeloma crustuliniforme* and *H. saccharіolens.* They are reported from deciduous forests, mainly those with *Corylus avellana* as well as from recultivated coal mine dumps (LISIEWSKA et al. 1986).

Frequently superficially harrowed and manured patches of a bare fallow were very poor in macrofungi. Only few coprophilous species were observed there: *Conocybe rickenii, Panaeolus subbalteatus, Pholiotina mairei* and *Agrocybe arvalis.*

Xylophilous macrofungi were recorded less frequently because of a scarce occurrence of rotten wood in the investigated orchards. Besides, they were attached more to wood than to the habitat or plant community. Nevertheless, a greater number of fruit bodies was observed in herbicide rows, where stumps of cut out fruit trees and fallen twigs occured (Tab. 6).

Of xylophilous fungi, *Phellinus tuberculosus* (=*P. pomaceus*) growing on the broken branch of a cherry tree is a noteworthy species. It is a typical, common orchard parasite living on wood of fruit trees, mainly those of *Cerasus* and *Prunus* (DOMAŃSKI 1975, KREISEL 1987). Rather rare woodland fungi – *Trametes pubescens* and *T. zonata (=T. multicolor)* were found on branches and stumps of sweet cherry and apple trees. Several species were noted on fallen twigs both on the herbicide fallow and in the inter-row lawn, e.g. *Tubaria furfuracea*, which is known to occur in a wide variety of habitats (AR-

NOLDS 1982), *Psathyrella obtusata* prefering ruderal and eutrophic habitats (KREISEL 1987), and *Polyporus varius* growing singly on twigs of apple and cherry trees. Fruit bodies of *Hypholoma fasciculare* and *Psathyrella candolleana* were recorded on a bare fallow on wood of plum trees.

Some species known from open and sunny habitats (also in gardens and orchards) such as: *Schizophyllum commune, Polyporus arcularius* and *Trametes hirsuta* were found on cut out branches of apple trees stored in wood-yards in the studied orchards.
Patches planted with fruit trees (especially apple trees) about 20 years ago were the richest regarding the number of fungal species. In young apple tree plantations as well as in patches with very old sweet cherry trees (planted in 1950) the lowest number of species was observed. It may be explained that in case of young plantations, plant communities are not yet well developed, while the studied very old orchards were rather neglected; they were not treated with herbicides, overgrown with weeds and the lawn was not mown. An intensive turfness is unfavourable for the fructification of macrofungi.

The results obtained from the analysis of fungal flora against the background of differentiated habitats in orchards correspond with the results of the analysis of bryoflora and that of vascular plants. The mycoflora of the studied orchards is rather rich in spite of the abundant application of herbicides, and it has a specific character.

A particular roll is played by synantropic, mainly ruderal fungal species, as well as macrofungi appearing on dry, poor and burnt places. On the other hand, the absence of certain fungal genera in herbicide fallow can be caused by the negative influence of chemicultivation (e.g. artificial fertilizers). This phenomenon has been described on experimental plots treated with different fertilizers (PETERSEN 1970; HEINRICH, WOJEWODA 1976; LANGE 1982).

Seasonal appearance of macrofungi was noted in orchards as well, modified by atmospheric conditions. First fruit bodies were recorded in April 1988 and 1989. The following fungi may be assumed as characteristic spring ones: *Leptopodia albipes, Gerronema marchantiae, Entoloma sepium, Psathyrella vernalis, P. subnuda* and *Tubaria furfuracea.* The summer of 1989 was very poor in fungi. A long-lasting drought with high temperature in full summer and early autumn (Tab. 3) made the fructification of fungi impossible in these periods. They appeared numerously in October 1989.

Taking into consideration that the mycological studies were carried out during two vegetation seasons with unfavourable weather conditions in 1989, further observations in orchards should be continued.

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Anschrift der Verfasser:
Prof. Dr. habil. M. LISIEWSKA, Doc. Dr. habil. S. BALCERKIEWICZ,
Dept. of Plant Ecology and Environment Protection,
Adam Mickiewicz University, Al. Niepodległosci 14,
Pl- 61-713 Poznan, Polen