The biodiversity of fungi parasitizing weeds in Lithuania

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Species composition of fungi parasitizing weeds in Lithuania was ascertained with a particular reference to biocontrol. The disease distribution and severity were evaluated. Over the years of investigations (1995–2002), 34 fungal species were identified on 17 weed species. The most widespread in Lithuania were *Septoria polygonorum, Monodidymaria chenopodii, Ramularia inaequale, R. cynarea, Puccinia taraxaci*, and *P. punctiformis.* Leaf-spotting disease agents – *Septoria convolvuli, S. polygonorum, Monodidymaria chenopodii, Ramularia inaequale* and rusts – *Puccinia punctiformi, P. absinthii* showed high aggressiveness to host (the area of affected leaves reached 75–90%). Some strains of pathogenic fungi were isolated into pure culture for the experiments on biological peculiarities and effect on host fitness. This is the first step of a detailed investigation on mycobiota of weeds in Lithuania.

Key words: weeds, disease distribution, pathogenicity, biocontrol

INTRODUCTION

Weeds continue to cause damage in agriculture, reducing yield and quality of crops by competing for water, nutrients, and sunlight with cultivated plants and by spreading agents of diseases. Some disease agents can spread directly (some rusts, ergot, mildews, and leaf-spotting diseases); on the other hand, the weeds can be an intermediate host of the agents of cultivated plant diseases (non-autoecious rusts, for example). Another group of pathogens of wide specialization can spread with seeds (smuts, ergot, leaf-spotting, and root rot agents). Losses caused by the spreading of seed-borne diseases can be various. They depend upon environmental conditions, plant susceptibility, and agrotechnics [18]. Modern agriculture and the proper usage of chemical herbicides have greatly decreased the number of weeds, however, they continue to cause significant losses. The side-effect of herbicides is undoubted. On the other hand, some weeds acquired resistance to chemical herbicides. There are over 100 weed species with biotypes known to be resistant to herbicides: *Amaranthus* spp., *Atriplex patula* L., *Bromus tectorum* L., *Capsella bursa-pastoris* (L.) Medik., *Chamomilla suaveolens* L., *Chenopodium album* L., *Chenopodium spp., Echinochloa crus-gali* (L.) Beauv., *Matricaria matricarioides* (Less.) Port., *Poa annua* L., *Fallopia convolvulus* (L.) Á. Löve, *Persicaria* spp., etc. [1, 13, 23]. Therefore, plant pathogens have been suggested as one of the possible means of controlling the weed populations as an alternative to chemical herbicides. Various types of integrative approaches to biological control of weeds in crops have been studied within the framework of a concerted European Research Programme (COST-816). During the period 1994–1999, some 25 institutions from 16 countries have concentrated on five target weed complexes (*Ascochyta caulina-Chenopodium album; Senecio vulgaris-Puccinia lagenophorae; Ascochyta convolvuli-Convolvulus* spp.; *Amaranthus* spp.*-Alternaria alternata* and *Trematophoma lignicola; Orobanche* spp.-*Fusarium* spp.) [12, 16, 19]. There have been no detailed investigations on the pathogens causing weed diseases in Lithuania; the aggressiveness and other biological properties of disease agents have not been studied, either. The article reports on the mycobiota associated with most widespread weeds in Lithuania with particular reference to fungal pathogens for biological control.

MATERIALS AND METHODS

The object of investigations were fungi parasitizing weeds in Lithuania. The weed species were selected from different families: abundant species in Lithuanian flora (*Asteraceae* Dumort., *Fabaceae* Lindl. *Lamiaceae* Lindl.), families including cultivated as well as weedy plants (*Chenopodiaceae* Vent., *Polygonaceae* Juss.), and a family including only weedy plants in Lithuania (*Convolvulaceae* Juss.). 243 numbers of herbarium specimens of plant diseases (prepared in a standard plant press) were collected in random locations of different habitats in 1995–2002 in Akmenė, Alytus, Anykščiai, Kaišiadorys, Kaunas, Kėdainiai, Kretinga, Marijampolė, Mažeikiai, Molėtai, Radviliškis, Raseiniai, Rokiškis, Šakiai, Šilalė, Šilutė, Švenčionys, Trakai, Ukmergė, Utena, Varėna, Vilnius, Zarasai districts, Neringa and Palanga towns and in Kaunas Botanical Garden of Vytautas Magnus University. The herbarium specimens are deposited in the Herbarium of Institute of Botany (BILAS). Disease distribution was measured by visual assessment of the percentage of infected plants in a particular location. Disease severity was scored by numbers of pustules per leaf of a plant at the low affect or, when pustules became too numerous to count, ratings of percentage of plant surface affected by comparison with a scale of scores 1–5: 1 = <10% of the injured surface of leaves; 2 = = 10–25%; 3 = 25–50%; 4 = 50–75% and 5 = = >75%. For evaluation of leaf-spotting and powdery mildew disease severity, the same scale – percentage of the injured surface of leaves – was used [22]. The plant pathogenic fungi were identified on the species level with the aid of several books, publications and guides of plant diseases [3–6, 8, 9, 14, 15, 24–27].

RESULTS AND DISCUSSION

In general, little attention has been paid to the pathogens of non-crop plants. Recent investigations of fungal pathogens as biocontrol agents of weeds have focused on this aspect of phytopathology [20].

During the years of investigation, 34 fungal species ascribed to 5 classes according to the modern taxonomy – *Ascomycetes* (*Erysiphe* R. Hedw. ex DC.: Fr., *Sphaerotheca* Lév.), *Hyphomycetes* (*Cercospora* Fresen., *Monodidymaria* U. Braun, *Mycovellosiella* Rangel, *Passalora* Fr., *Ramularia* Unger, *Stenella* Syd.), *Coelomycetes* (*Ascochyta* Lib., *Septoria* Sacc.), *Uredinomycetes* (*Coleosporium* Lév., *Melampsora* Castagne, *Puccinia* Pers.: Pers., *Uromyces* (Link) Unger), and *Ustilaginomycetes* (*Ustilago* (Pers.) Roussel.), parasitizing the most important weed species in Lithuania were identified [19, 24]. The list of fungi and hosts is presented in Table 1.

Table 1. **The fungi parasitizing weeds in Lithuania**

Weeds		Fungi
Family	Species	
1	*2*	*3*
Annual		
Asteraceae Dumort.	*Centaurea cyanus* L.	*Puccinia cyani* (Schltdl.) Pass.
		P. jacea Otth
	Tripleurospermum perforatum (Merat) M. Lainz	**Puccinia absinthii* (Hedw. f.) DC.
Chenopodiaceae Vent.	*Chenopodium album* L.	*Monodidymaria chenopodii* (Speg.) U. Braun
		Ascochyta chenopodii (P. Karst.) Died.
	Atriplex patula L.	**Passalora dubia* (Riess.) U. Braun
Euphorbiaceae Juss.	*Euphorbia helioscopia* L.	*Melampsora helioscopae* (Pers.) Castagne
		Sphaerotheca euphorbiae (Castagne) E.S. Salmon
Lamiaceae Lindl.	*Galeopsis tetrahit* L.	*Septoria galeopsidis* Westend.
Polygonaceae Juss.	*Fallopia convolvulus* (L.) Į. Löve	*Puccinia polygoni* Alb. et Schw.
	Persicaria maculosa Gréy	*Septoria polygonorum* Desm.
		Ustilago persicaria Cifferi
	Polygonum aviculare L.	*Erysiphe polygoni* DC. ex St.-Amans
		Uromyces polygoni-avicularae (Pers.) P. Karst.
Rubiaceae Juss.	*Gallium aparine* L.	*Puccinia punctata* Link
Perennial		
Asteraceae Dumort.	*Artemisia vulgaris* L.	*Puccinia absinthii* (Hedw. f.) DC.
		Erysiphe artemisiae Grav.
		Septoria artemisiae Pass.
		Mycovellosiella ferruginea (Fuckel) Deighton
	Cirsium arvense (L.) Scop.	*Puccinia punctiformis* (Str.) Röhl.
		Stenella kansensis (Syd.) U. Braun
		Ramularia cynarae Sacc.
		Erysiphe cichoracearum DC. ex Merat
		Ascochyta cirsii Died.

Table 1 (continued)

1	2	3
	Sonchus arvensis L.	*Coleosporium sonchi* (Schum.) Lév.
		Erysiphe cichoracearum DC. ex Merat
	Taraxacum officinale F. H. Wigg.	*Ramularia inaequale* (Preuss) U. Braun
		Puccinia taraxaci (Rebent.) Plowr.
		Sphaerotheca fuliginea (Schltdl. : Fr.) Pollacci
Convolvulaceae Juss.	*Convolvulus arvensis* L.	*Erysiphe convolvuli* DC. ex St.-Amans
		Mycovellosiella convolvuli (Tracy et Earle) U. Braun
		Septoria convolvuli Desm.
		***Ascochyta convolvuli* Fautrey
Fabaceae Lindl.	*Vicia cracca* L.	*Erysiphe pisi* DC. ex St.-Amans
		Uromyces viciae-craccae Const.
Lamiaceae Lindl.	*Mentha arvensis* L.	*Puccinia menthae* Pers.

* The species was found for the first time in Lithuania on this host.
** The species was found for the first time in Lithuania.

Plant pathogenic fungi – *Erysiphe artemisiae* Grav., *Septoria polygonorum* Desm., *S. convolvuli Desm., S. galeopsidis* Westend., *Monodidymaria chenopodii* (Speg.) U. Braun, *Ramularia inaequale* (Preuss) U. Braun, *R. cynarae* Sacc., rusts – *Puccinia absinthii* (Hedw.f) DC., *P. taraxaci* (Rebent.) Plowr., *P. punctiformis* (Str.) Röhl. were identified as regular members of their host mycobiota. The fungus *Ascochyta convolvuli* Fautrey was found for the first time in Lithuania, for two species (*Passalora dubia* (Riess.) U. Braun and *Puccinia absinthii* (Hedw. f.) DC.) new hosts (*Atriplex patula* L. and *Tripleurospermum perforatum* (Merat) M. Lainz) in Lithuania were ascertained. According to symptoms all diseases can be divided into four main groups (Table 2).

The systemic pathogen, autoecious fungus *P. punctiformis,* is most harmful to the host in the uredia stage. The first single uredia appear in spring and quickly occupy up to 90% of leaf surface. Because of that hard invasion of the pathogen, the observed plants in several locations (Vilnius and Molėtai districts) died in 13–16 days, other ones grew sickly and died before flowering. According to the literature [10], the main inoculum of this pathogen is teliospores, however, under our conditions this pathogen spreads by uredospores in summer, while single telia form up at the end of the host vegetative season and are not so abundant. Another autoecious fungus, *P. absinthi*, in the second half of summer covered up to 75% of *Artemisia vulgaris* leaf surface. The damage of the rust species (*P. punctata, P. polygoni*) caused to host reached single pustules per leaf and had a little apparent effect on host fitness. Powdery mildew affected a lot of plant surface (*E. convolvuli* 50–75%, *E. artemisiae* up to 90%), however, they have not a decisive significance for plant survival, because they appear in the end of the vegetative season. Leaf-spotting disease agents (*Stenella kansensis, Septoria convolvuli, S. galeopsidis, S. polygonorum, Monodidymaria chenopodii, R. absinthii, R. cirsii, R. inaequele, Ascochyta convolvuli*) cause discrete spots on leaves and debilitate the host. *St. kansensis, M. chenopodii, R. absinthii, R. cirsii* cause small spots (10–25% of leaf surface) and injure single plants, while *S. convolvuli, S. polygonorum, S. galeosidis, R. inaequale* cause an extreme effect (damage 75–100% of leaf surface) and injure up to 90% of plants in all locations studied. Evaluation of diseases is presented in Table 2. In some cases there were two pathogens found on the same host. For example, in 7 locations from 12 on *Taraxacum officinale* F. H. Wigg. the leaf-spotting agent *Ramularia inaequale* (Preuss) U. Braun was found together with the rust *Puccinia taraxaci* (Rebent.) Plowr., in 5 locations from 20 on *Cirsium arvense* (L.) Scop. the rust *Puccinia punctiformis* (Str.) Röhl. was found together with the leaf-spotting agent *Ramularia cynarae* Sacc., and only in 2 locations the latter was detected alone. The mildew *Erysiphe cichoracearum* DC. ex Merat on *Sonchus arvensis* L. was found together with the rust *Coleosporium sonchi* (Schum.) Lév., the leaf-spotting disease agent *Mycovellosiella ferruginea* (Fuckel) Deighton on *Artemisia vulgaris* L. was detected with the rust *Puccinia absinthii* (Hedw.f.) DC. Such a double systemic and local infection is more harmful to the plants. Some authors suggested to use a combined systemic (*Puccinia punctiformis*) and necrotrophic (*Phoma* Sacc., *Botrytis* P. Mich. ex Pers., *Fusarium* Link : Fr.) infection

Table 2. **Disease evaluation in weedy plants**

Type of disease	Agent	Disease evaluation	
		Distribution %	Severity scores
Necrotic (leaf-spots)	*Septoria convolvuli, S. galeopsidis, S. polygonorum, Ramularia inaequale*	75–100	5
	Ascochyta chenopodii, Mycovellosiella convolvuli	<25	3–4
	Ascochyta cirsii, A. convolvuli, Monodidymaria chenopodii, M. ferruginea, Passalora dubia, Ramularia cynarae, Septoria artemisiae, Stenella kansensis	From single plants up to 25	1–2
Powdery mildews	*Erysiphe artemisiae*	75–100	4–5
	E. polygoni, E. convolvuli, E. cichoracearum	~50	4
	Sphaerotheca euphorbiae, S. fuliginea, E. pisi	Single plants	1–2
Rusts	*Puccinia punctiformis*	100	5
	P. absinthii	~50	5
	P. taraxaci	75–100	1–2
	P. menthae, Uromyces viciae-craccae	~50	3–4
	Coleosporium sonchi, Melampsora helioscopae, Puccinia cyani, P. jacea, P. polygoni, P. punctata, Uromyces polygoni-avicularae	Single plants	1–2
Smut	*Ustilago persicaria*	In single locations 75–100	5

for the biological control of Canadian thistle (*Cirsium arvense* (L.) Scop.) [2]. It seems that most potential agents for biocontrol must belong to castrators (for example, *Ustilago persicaria*). However, in this case the problem is cultivation *in vitro*. Killers are the second major group of candidates for biocontrol. These pathogens cause seedling damping-off or wilting diseases. Many of them have a wide specialization and can damage cultivated plants as well as weeds. The third broad division of the pathogens (debilitators) that cause discrete lesions or chronic infections of some part of a plant (leaf-spotting and antracnose disease) are suitable for biological control of weedy plants [7]. Leaf-spotting disease agents (*Septoria convolvuli*, *S. polygonorum*, *Ramularia inaequale*, *Mycovellosiella convolvuli, Ascochyta chenopodii*) characterized by aggressiveness were isolated into a pure culture for experiments on their biological peculiarities and effect on host fitness.

CONCLUSIONS

1. During the years of investigations (1995–2002), 34 fungal species were ascertained on 17 most economically important weed species in Lithuania. One fungal species, *Ascochyta convolvuli*, was found for the first time in Lithuania, for two fungal species (*Passalora dubia* and *Puccinia absinthii*) new hosts (*Atriplex patula* and *Tripleurospermum perforatum* respectively) in Lithuania were ascertained.

2. In the period of investigation, most widespread in Lithuania were *Septoria polygonorum, Monodidymaria chenopodii, Ramularia inaequale, R. cynarea, Puccinia taraxaci*, and *P. punctiformis.*

3. Leaf-spotting disease agents (*Septoria convolvuli, S. polygonorum, Monodidymaria chenopodii, Ramularia inaequale*) and rusts (*Puccinia punctiformis, P. absinthii*) showed a high aggressiveness to host (disease severity reached 75–100%).

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PIKTŽOLES LIETUVOJE PARAZITUOJANČIŲ MIKROMICETŲ RŪŠIŲ ĮVAIROVĖ

S a n t r a u k a

Piktžolėms naikinti naudojamos įvairios mechaninės bei cheminės priemonės. Pastaraisiais dešimtmečiais paaiškėjo, kad piktžolės įgyja atsparumą herbicidams, kurių neigiamas poveikis aplinkai yra neginčytinas. Todėl atsiranda būtinybė kurti alternatyvią kovos su piktžolėmis strategiją. Vienas tokių bandymų yra parazitinių organizmų pritaikymas piktžolių populiacijoms reguliuoti. 1995–2002 m. Botanikos institute ištirta piktžoles parazituojančių grybinių ligų sukėlėjų rūšių sudėtis, įvertinant ligos išplitimą ir intensyvumą. Identifikuoti 34 rūšių fitopatogeniniai grybai, parazituojantys plačiausiai Lietuvoje paplitusių 17 rūšių piktžoles. Dideliu patogeniškumu pasižymėjo dėmėtligių sukėlėjai *Septoria convolvuli, S. polygonorum, Monodidymaria chenopodii, Ramularia inaequale* ir rūdžių sukėlėjai *Puccinia punctiformis, P. absinthii.* Kai kurių grybų kamienų išskirtos grynos kultūros tolimesniems tyrimams.

Raktažodžiai: piktžolės, ligų paplitimas, patogeniškumas, biologinė kova

Аудрюс Качергюс

БИОРАЗНООБРАЗИЕ ГРИБОВ, ПАРАЗИТИРУЮЩИХ НА СОРНЫХ РАСТЕНИЯХ В ЛИТВЕ

Р е з ю м е

В системе мероприятий по контролю численности сорных растений применяются как механические, так и химические средства. Последние десятилетия появились данные о сорняках, устойчивых к гербицидам. Поэтому необходима альтернативная система борьбы с сорняками. Одним из таких положительных опытов является применение паразитных организмов в качестве агентов биологического контроля. В 1995–2002 гг. определены видовой состав фитопатогенных грибов, паразитирующих на сорных растениях в Литве, распространение и интенсивность болезни. Идентифицировано 34 видов фитотрофных грибов на 17 видах сорняков. Возбудители пятнистостей *Septoria convolvuli, S. polygonorum, Monodidymaria chenopodii, Ramularia inaequale* и ржавчины *Puccinia punctiformis, P. absinthii* выделялись высокой патогенностью к растению хозяину. Изолированные чистые культуры некоторых штаммов грибов планируется использовать для дальнейших исследований.

Ключевые слова: сорняк, распространённость болезней, патогенность, биологическая борьба