Ecological Associations Between Entomopathogenic Fungi and Pest Insects Recorded in Latvia

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Abstract: Occurrence of entomopathogenic fungi and their host range are studied. Observations of natural epizootics and collecting of diseased insects were done regularly in central and western part of Latvia. Attention was paid to registration of associations between pathogenic fungi and different insect species. Most common insect pathogenic fungi found in Latvia are Conidiobolus obscurus, C. thromboides, Entomophthora muscae, E. aphidis, Entomophthora sp., Beauveria bassiana, Metarhizium anisopliae and Verticillium lecanii. In 2002 fungus Beauveria brongniartii was identified first time in Latvia. European tent caterpillar Malacosoma neustria infected by B. brongniartii were collected.

Key words: entomopathogenic fungi, biodiversity, pest insects.

Introduction

Entomopathogenic fungi cause lethal infections of insects and can regulate their populations in nature by epizootics. Today, about 35 genera more than 400 species entomopathogenic fungi are known. Pathogenic fungi have a broad host range. About 1 800 associations between fungi and different insects were recorded. A host range is the set of species that allow survival and reproduction of a pathogen. The ecological host range is the current, yet evolving, set of species with which a parasite naturally forms symbioses, resulting in viable parasite offspring (Onstad, McManus 1996). Physiological host range is based solely on laboratory observations of infection. Species identified as hosts in the laboratory may not be hosts in the field (Federici, Maddox 1996). An association between pathogen and an insect exists when the host is naturally infected in field or in the laboratory by the pathogen and the infectious propagules are produced. When infection has been attempted but not observed, then no associations exists. The aim of studies was to extend knowledge on diversity and occurrence of entomopathogenic fungi in Latvia. Attention was paid to registration of associations between pathogenic fungi and different insect species.

Researches on entomopathogenic fungi of forest and agricultural pests were carried out in the Institute of Biology since 1957. Observations of natural epizootics and collecting of diseased insects were done regularly in central and western part of Latvia. In recent years information on identified and entomopathogenic fungi was summarised in an informative database "Ecological database of insect pathogens". Database the Latvian obtainable information contains easy diversity of insect pathogens and occurrence in Latvia. Recorded associations between pathogen species (entomopathogenic fungi) and insect species are summarised. Recorded natural epizootics are included.

Methods

Observations of natural epizootics of agricultural and forestry pests were done regularly in different regions of Latvia. Monitoring was done: in central part of Latvia (Jelgavas, Rīgas, Ogres, Bauskas districts and Jūrmala; in western part (Liepājas, Kuldīgas, Talsu and Tukuma districts); in eastern part (Daugavpils district). In summer period greenhouses, orchards, gardens and fields were inspected. Insects with the symptoms mycoses (reduced movement, changes

colour, cuticle covered with fungal mycelia or conidia) were collected. Living insects were used for identification of host species.

Conidia projection method was used for slide Entomophthoralean preparation of (Papierok, Hajek, 1997). For cadavers with conidial cushions preparations of conidia are obtained by film method. Preparations were coloured with Lactophenol-cotton blue or Giemza staining. Hyphae and conidia were observed in the light microscope. Conidia were examined for conidial shape and size, using a microscope fitted with a micrometer. Squash preparations of various infected insect tissues were viewed in microscope by magnification of 400x. Key for the identification given by Balazy (1993)was used. Pure cultures of entomopathogenic fungi excepting Entomophthora muscae, Erynia curvipora were obtained.

Results

Epizootics caused by entomopathogenic fungi are observed rather rarely in Latvia. In years 2000-2002 few natural infections caused by Beauveria Beauveria bassiana, sp., Entomophthora Zoophthora musca and radicans were observed (Table 1). Often we infections cucumber of Trialeurodes vaparariorum and Trips tabaci in greenhouses caused by Verticillium lecanii.

In 2002 monitoring of orchards in Jelgavas district (Glūda) showed that European tent caterpillar *Malacosoma neustria* were infected by fungal infection. Microscopy of 50 collected larvae confirmed that *M. neustria* larvae were infected by *Beauveria brongniartii*. Fungus *B. brongniartii* was identified first time in Latvia.

Since 1957 majority of the pathogens were isolated from the important agricultural and forest pests such as aphids, flies, moth, weevils, thrips, and Colorado beetles. Ten of identified entomopathogenic fungi belong to Zygomycetes, order Entomophthorales: Basidiobolus ranarum Eidam, Basidiobolus sp., Conidiobolus obscurus (Hall et Remaudiere et Keller (= Entomophthora thaxteriana), C. thromboides Drechsler (= E. virulenta), C. coronatus (Cost.) Batko (= E. coronata), Entomophthora sp., E. aphidis Hoffman, E. muscae (Cohn) Fresenius, Erynia curvispora (Nowakowski) Remaudiere & Hennebert, Z. radicans (Brefeld) Batko (=E. sphaerosperma). Entomopathogenic fungi: Basidiobolus sp., B. ranarum, C. obscurus, C. *C*. thromboides. Coronatus. Ε. aphidis. Entomophthora sp. were associated with different species of aphids (Homoptera) (Table 2). Table 2 summarises associations between entomophthoralean fungi and insects found in nature by researchers Ozols (1963), Cinovskij, Jegina (1972), Strazdinja (1972), Jegina et all. (1976, 1977), Petrova et all. (1997), Čudare (1998), Jankevica, Čudare (2003) and the author.

Second group of entomopathogenic fungi isolated in Latvia belongs class Deuteromycetes, order Molinialales. Fungi: Beauveria sp., B. bassiana (Bals.) Vuill., B. brongniartii (Saccardo) Petch, Metarhizium anisopleae (Metschnikov) Sorokin., Verticillium lecanii (Zimmerman) Viegas, Isaria farinosa were identified. Ecological associations between Deuteromycetes and insects recorded by Ozols (1963), Jegina (1972), Čudare (1998) and the author were summarised in Table 3. Ozols (1963) confirmed association between fungus Isaria farinosa and the pea moth Laspeyresia *nigricana* in the field applications.

Table 1. List of ecological associations between pathogenic fungi and insects recorded in 2000 – 2002.

Fungi	Original host	Place of detection	Year
Beauveria bassiana	Leptinotarsa decemlineata	Rigas district, Ropaži	2000
B. bassiana	Ips sexdentatus	Rīgas district, Stopiņi	2001
Beauveria sp.	Agrotis segetum	Liepājas district, Grobiņa	2000

Beauveria sp.	Pieris brassicae	Rīgas district, Saulkalne	2001
B. brongniartii	Malacosoma neustria	Jelgavas district, Glūda	2002
Entomophthora musca	Delia brassicae	Talsu district, Dundaga	2001
Entomophthora musca	Musca domestica	Liepājas district, Liepāja	2002
Zoophthora radicans	Pieris brassicae	Rīgas district, Salaspils	2001
Zoophthora radicans	Pieris brassicae	Rīgas district, Salaspils	2002

Table 2. Associations between entomophthoral fungi (Zygomycetes, Entomophthorales) and pest insects recorded in Latvia since 1957 (Ozols, 1963; Cinovskij, Jegina, 1972; Strazdinja, 1972; Jegina et all., 1976, 1977; Petrova et all., 1997; Čudare, 1998; Jankevica, Čudare, 2003) and original data.

			Fungi								
Host		Basidiobolus ranarum	Basidiobolus sp.	Conidiobolus coronatus	C. obscurus	C. thromboides	Entomophthora aphidis	E. muscae	Entomophthora sp.	Erynia curvispora	Zoophthora radicans
Homoptera											
Aphididae	Acyrthosiphon pisum Kalt.		Е		Е		Е				
	Anuraphis subterranea (Walk.)				Е				Е		
	Aphis acetosae Buckt				Е						
	A. fabae Scop.			Е	Е		Е				
	A. frangulaeKalt.						Е				
	A. pomi DeGeer				Е						
	A. gossypii Glov.				Е						
	Chaetosiphon tetrahodus Walk.				Е				Е		
	D. mali Ferr.				Е						
	Macrosiphum euphorbiae Thomas								Е		
	M. rosae L.			Е	Е				Е		
	M. solanifolii Ashm.										Е
	Myzus cerasi Fabr.				Е						Е
	M. persicae Sulz.	Е	Е		Е	Е	E				
	Neomyzus circumflexum Bucton			Е	Е	Е			Е		
	Rhopalosiphum padi L.				Е						
Psyllidae	Psylla mali Schmiedb.						Е				
Diptera											

Anthomyiidae	Delia brassicae Bouche				Е			
	Delia floralis Fall.				Е			
	Unidentified species						Е	
Muscidae	Musca domestica L.				Е			
Sarcophagidae	Scatophaga stercoraria L.				Е			
Thysanoptera								
Thripidae	Trips tabaci Lind.					Е		
	T. fuscipennis Haliday					Е		
Lepidoptera								
Pieridae	Pieris brassicae L.					Е		Е
Yponomeutidae	Plutella maculipennis Curt.							Е

Legends: E - record of natural epizootic.

Table 3. Associations between entomopathogenic fungi - class Deuteromycetes and pest insects recorded in Latvia since 1957 (Ozols, 1963; Jegina, 1972; Čudare, 1998) and original data.

		Fungi					
Host		Beauveria bassiana	B. brongniartii	Beauveria sp.	Isaria farinosa	Metharizium anisopliae	Verticillium lecanii
Coleoptera							
Curculionidae	Anthonomus pomorum (L.)	Е					
Scolytidae	Tomicus minor (Hart.)	Е					
	Ips sexdentatus (Börner)	Е					
Chrysomelidae	Galeruca tanaceti (L.)	Е					
	Leptinotarsa decemlineata	Е					
	(Say)						
Elateridae	Agriotes sputator (L.)					Е	
	Agriotes obscurus (L.)					Е	
	Athous niger (L.)					E	
	Selatosomus aeneus (L.)					Е	
Diptera							
Anthomyiidae	Delia brassicae Bouche	Е					
Lepidoptera							
Pieridae	Pieris brassicae L.	E		E			
Yponomeutidae	<i>Yponomeuta malinellus</i> Zell.	E					
Tortricidae	Laspeyresia nigricana Steph.				Е		
Lasiocampidae	Malacosoma neustria L.		Е				
Noctuidae	Agrotis segetum Schiff	Е		Е			
Homoptera							
Alyrodidae	Trialeurodes vaparariorum Westw.					Е	Е

Aphididae	Aphis fabae Scop.			Е	
	Myzus persicae Sulz				E
Thysanoptera					
Thripidae	Trips tabaci Lind.			Е	Е

Legends: E - record of natural epizootic.

Discussion

Common insect pathogenic fungi recorded in Latvia are *C. obscurus, C. thromboides, E. muscae, E. aphidis, Entomophthora sp., B. bassiana, M. anisopliae* and *V. lecanii.* Fungus *C. obscurus* was associated with 13 species of aphids. Our observations concur with observations of Balazy (1993), that *C. obscurus* are associated with aphids (Homoptera) and *E. muscae* are associated with flies (Diptera). *Z. radicans* was associated with pests belonging to orders Homoptera and Lepidoptera.

Observations showed that *B. bassiana* had a broad host range. Nine associations between *B. bassiana* and insects were recorded. Fungus *B. bassiana* was isolated from different orders of insects: Coleoptera, Diptera and Lepidoptera. The strains *Beauveria sp.* listed here closely resemble *B. bassiana* (or *B. brongniartii*) but were not so identified because of small (and possibly insignificant) differences in conidia size and/or shape. As next step of identification we will use molecular techniques to differentiate among isolates.

In recent years commercial preparation based on *V. lecanii* was produced and used in plant protection in Latvia, therefore we observed presence of *V. lecanii* in greenhouses (soil and insects).

Conclusions

Since 1957 sixty six ecological associations between entomopathogenic fungi and important agricultural or forest pests: aphids, flies, thripses, cabbage white butterflies, codling moth, pea moth, weevils, Colorado beetles and bark beetles were recorded in Latvia.

Sixteen species of entomopathogenic fungi were identified. Ten of listed species belongs to class

Zygomycetes (Entomophtorales) and six species belongs to class Deuteromycetes (Moliniales). Representatives of genera Entomophthora and Conidiobolus are associated with insect orders: Homoptera, Diptera, Thysanoptera and Lepidoptera. Fungus *C. obscurus* have highest number of recorded associations.

Representatives of genera Beauveria, Metarhizium and Verticillium are associated with pest orders: Coleoptera, Diptera, Lepidoptera, Homoptera and Thysanoptera.

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