

Entomopathogen diversity of Kastamonu region

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Abstract

Aim of study: Microorganisms infecting insects are known as entomopathogen. This group includes viruses, bacteria, protists, fungi and nematodes. They are found in nature and commonly isolated from soil and host insects. They cause desirable (in plant pests and parasitic insects) and undesirable infections (in useful insects such as silkworms, bees, predators) in insects. In this paper we aim to document entomopathogenic organisms that have been recorded from Kastamonu region.

Area of study: This paper is focused on Kastamonu region, which has a special ecosystem with the large forests and mountains. Type of the ecosystem is the main factor effecting entomopathogenic biodiversity in that region.

Material and Methods: Recent situation of entomopathogen biodiversity of Kastamonu region is discussed by comparing entomopathogen records in the literature.

Main results: Till now, several entomopathogenic organisms such as nematodes, microsporidia and fungi which cause desirable and undesirable infections in insects have been isolated from host insects collected in Kastamonu region. Entomopathogen biodiversity of Kastamonu region is documented by discussing and concerning with Kastamonu geography.

Research highlights: Entomopathogenic studies on the useful and harmful insects in Kastamonu region are not enough to represent a large diversity and this area is still virgin to search entomopathogenic organisms.

Keywords: Kastamonu region, Entomopathogen, Biodiversity

Kastamonu bölgesinin entomopatojen çeşitliliği

Özet

Çalışmanın amacı: Böcekleri enfekte eden mikroorganizmalar entomopatojen olarak bilinir. Bu grup virüsleri, bakterileri, protistleri, mantarları ve nematodları içermektedir. Entomopatojenler doğada bulunurlar ve çoğunlukla toprak ya da konak böceklerden izole edilirler. Böceklerde istenen (bitki zararlısı ve parazitik böceklerde) ve istenmeyen (ipek böceği, arılar ve avcı böceklerde) enfeksiyonlara neden olurlar. Bu makalede Kastamonu bölgesinden kaydedilen entomopatojenik organizmaların bir listesinin oluşturulması amaçlanmaktadır.

Çalışma alanı: Kastamonu bölgesi geniş ormanlıklar ve dağlık alanlarıyla özel bir ekosisteme sahip bölgedir. Bu makale Kastamonu bölgesi üzerine kurgulanmıştır. Ekosistem tipi bir bölgede biyoçeşitliliğini etkileyen temel faktördür.

Materyal ve Yöntem: Kastamonu bölgesinin entomopatojen biyoçeşitliliğinin son durumu literatürde mevcut entomopatojen kayıtları ile tartışılarak verilmektedir.

Temel Sonuçlar: Şimdiye kadar, nematod, microsporidyum ve mantarları içeren ve böceklerde istenen ve istenmeyen enfeksiyonlara neden olan bazı entomopatojenler Kastamonu bölgesinden toplanmış böceklerden izole edilmiştir. Kastamonu bölgesindeki entomopatojen biyoçeşitliliği coğrafik yapıyla irdelenerek verilmiştir.

Araştırma vurguları: Kastamonu bölgesindeki faydalı ve zararlı böcekler üzerine yapılan entomopatojenik çalışmalar bölgedeki geniş çeşitliliği temsil etmede yetersiz kalmakta olup, bu bölge entomopatojenik organizmaları araştırmak için bakir alanlara sahiptir.

Anahtar Kelimeler: Kastamonu, Entomopatojen, Biyoçeşitlilik



Introduction

Kastamonu is found in the Western Black Sea region to the north of Turkey. It has lots of valleys, forestlands, mountains, sea-stream coasts and agricultural lands. According to the data of General Directorate of Forestry (URL-1), the richest forest area with 201 million cubic meter in Turkey is found in Kastamonu region. Therefore it contains biotopes for many animal species. These features can make Kastamonu region a rich area in terms of biodiversity.

Natural factors such as climate, geographical factors and ecosystem members effect distribution of living organism on earth. Entomopathogens are known as microorganisms infecting and killing insects, and it is confirmed that the diversity and distribution of entomopathogenic organisms, as a member of ecosystem can be easily effected by different climatic and geographical factors. For example, some strains of nucleopolyhedroviruses isolated from different geographies may present better insecticidal activities, which make them more suitable for their host control and show important differences in biological activity (Murillo et al. 2001). In another example, a Polish NPV isolate was about seven times more infectious than one from Yugoslavia (Ziemnicka 1981, Lameris et al. 1985, Lipa 1998). The entomopathogenic suppressing of

pest populations or infections of useful insects typically involves a complex of entomopathogenic organisms and biotic and abiotic factors in the environment. In this study we aim to document entomopathogenic organisms that have been recorded from Kastamonu region till now by discussing and concerning with Kastamonu geography. In the first section of this paper, we discuss desirable entomopathogenic infections in pest insects including especially forest pests, and in the second section we discuss undesirable infections in useful insects in Kastamonu region, including honey bees and predators.

Entomopathogenic organisms in Kastamonu region

Insect infections caused by entomopathogens in Kastamonu region can be collected in two main groups; Desirable infections (1) and Undesirable infections (2).

(1) Desirable infections

(2) Undesirable infections

Desirable infections are diseases and killings caused by entomopathogenic organisms in harmful insects and always desirable. These entomopathogens are produced in huge amount and used to control insect pests in agricultural area and forests. A list of entomopathogens causing desirable infections on harmful insect in Kastamonu is given in Table 1.

Table 1. Entomopathogens infecting pest insects in Kastamonu region

Entomopathogen species	Host species	Infection rate (%)	Literature
Microsporea			
<i>Chytridiopsis</i> cf. <i>typographi</i>	<i>Ips acuminatus</i> (Col:Curculionidae)	0.9	Yaman et al. 2016
<i>Microsporidium</i> sp.	<i>Crepidodera aurata</i> (Col:Chrysomelidae)	0.8	Yaman et al. 2015
Apicomplexa			
unidentified neogregarine	<i>Crysmela populi</i> (Col:Chrysomelidae)	2.6	Unpublished data
<i>Mattesia</i> sp. (Neogregarinorida)	<i>Ips acuminatus</i> (Col:Curculionidae)	2.4	Yaman et al. 2016
<i>Gregarina typographi</i> (Gregarinidae)	<i>Ips sexdentatus</i> (Col:Curculionidae, Scolytinae)	28.9	Unal et al. 2009
Ascomycota			
<i>Metschnikowia typographi</i>	<i>Ips sexdentatus</i> (Col:Curculionidae, Scolytinae)	3.1	Unal et al. 2009
Nematoda			
unidentified nematode	<i>Ips acuminatus</i> (Col:Curculionidae)	52.1	Yaman et al. 2016

As seen in Table 1, different groups of entomopathogens such as microsporidia, nematode and fungi have been found in Kastamonu region recently. One of them, recently isolated from *Crepidodera aurata* (Col: Chrysomelidae) in Kastamonu by Yaman et al. (2015) is a microsporidian pathogen. Microsporidia causes chronic infections in insects and that makes them important pathogens of pest insects for biological control. It is known from other studies that strains of entomopathogens, isolated from different geographic regions, differ in their biological activity and may thus present a different profile for use in biological control (Murillo et al. 2001). The control of insect pests in that region has relied mostly on chemical pesticides. Unfortunately, this may result in pesticide residues on plants, posing a serious food safety threat, and the use of chemical pesticides should therefore be limited. Furthermore, chemical pesticides affect non-target organisms which sometimes contribute in keeping pest populations on tolerable levels. In organic agricultural production, the use of chemical pesticides is not allowed at all. For these reasons, methods of biological control are preferable and much needed, because they have many advantages over chemical treatments. Several entomopathogenic species such as *Paranosema locustae* (against Rangeland grasshoppers), *N. pyraustae* (against

European corn borer) and LydiMNPV (against the gypsy moth) have been isolated from different localities and they have been the most extensively evaluated for their host pest insects (Bjornson and Oi 2014, Podgwaite 1999). Here I hypothesize that Kastamonu region can be a potential source of new and interesting entomopathogen strains and, so far unknown, naturally occurring entomopathogens that present better insecticidal activities and show important differences in biological activity can be found in Kastamonu region, and our previous studies support this assumption (Yaman et al. 2009, 2015, 2016a). Furthermore Kastamonu has the richest forest area with 201 million cubic meter in Turkey. It is known that natural forest ecosystems are complex structures and consisting of various fauna and flora, climates, numerous other biotic and abiotic factors. Within this complex structures, forest insects cause outbreaks so that it is major concern for land managers (Bjornson and Oi 2014). Numerous entomopathogens have been reported from forest insects and some of them have been used for the regulation of forest pest populations.

Undesirable infections are caused by entomopathogens infecting useful insects such as pollinator and predator insects. Three pathogens infect useful insects in Kastamonu region (Table 2).

Table 2. Entomopathogens infecting useful insects (pollinators and predators) in Kastamonu region

Entomopathogen species	Host species	Infection rate (%)	Literature
<i>Microsporea</i>			
<i>Nosema raphidiae</i>	<i>Raphidia ophiopsis</i> (Raphidioptera: Raphidiidae)	8.3	Yaman et al. 2009
<i>Nosema apis/ceranae</i>	<i>Apis mellifera</i> (Hym: Apidae)	15.2	Guner 2016
<i>Nosema apis/ceranae</i>	<i>Apis mellifera</i> (Hym: Apidae)	13.9	Unal et al. 2014

As seen in Table 2, three pathogens found in Kastamonu region and causing undesirable infections were found to be concerned with both pest control and honey production in that region. Undesirable infections have

negative impact on economically important insects such as pollinators and predators. Predator insects kill and feed on preys during their lifetimes. Healthy and effective predators are always desirable for biological

control of insect pests (Yaman et al. 2012). Therefore, there is a new trend to search for entomopathogenic organisms in predator populations because of a possible pathogen transmission from prey to predator or a natural infection in the predator. There is a supportive example from Kastamonu region. Yaman et al. (2009) identified a new microsporidium from *Raphidia ophiopsis* (Raphidioptera), a natural predator of *Ips* species in Kastamonu region. This microsporidium, *Nosema raphidia* causes disease in the predatory insect, *Raphidia ophiopsis* (Raphidioptera: Raphidiidae). This insect is known as natural enemy of bark beetles in Kastamonu region and any infection in that insect is undesirable. This microsporidian pathogen is the first entomopathogen from not only *R. ophiopsis* but also a member of the order Raphidioptera. The discovery of a microsporidian pathogen infecting a member of the insect order Raphidioptera is not only exciting from a scientific viewpoint, but may also become important for pest control. *R. ophiopsis* is an effective predator of bark beetles under natural conditions in Kastamonu region. It is known that members of the order Raphidioptera feed on mainly soft-bodied arthropods and could therefore play a significant role in integrated pest control (Aspöck, 2002). In this case it is very important to use non-infected insects for rearing, as any infection can decrease the efficiency of the predator, because in many cases, beneficial insects infected by microsporidia exhibit a variety of symptoms such as reduced food consumption, prolonged larval and pupal development, deformed pupae and adults, reduced fecundity and longevity or death (Bjornson and Oi 2014). Furthermore, microsporidia can show more virulent infections in laboratory-reared predators when these insects are under stress (Yaman et al. 2016b). Thus, to find this new microsporidium in the populations of *R. ophiopsis* in Kastamonu region is also very important in this respect.

Another undesirable infection caused by entomopathogens in Kastamonu region is a kind of bee diseases, nosemosis is known as honey bee disease and accepted one of the most important diseases, causing significant economic losses in honey production. Two

microsporidian species *Nosema apis* and *Nosema ceranae* are factor of nosemosis (Chen et al. 2009), and both of them cause undesirable infections in *Apis mellifera* (Hymenoptera: Apidae) in Kastamonu (Ünal et al. 2014). Both pathogens cause nosemosis disease in bee colonies and reduce honey production in that region. 0.4% of total honey production in Turkey is produced in Kastamonu region (Url-2.) Probably nosemosis is one of the important factors for the reason of low production in Kastamonu region. Unfortunately, there is no more information on this disease and not much effort to prevent the distribution of the disease.

The desirable infections caused by entomopathogens in pest insects or undesirable infections in useful insects are more likely a complex interaction of several natural enemies or useful insects, biotic and abiotic factors in the environment. In the literature, there are several studies showing the effect of geographical and ecological factors such as elevation, rainfall, pH, habitat type and distance from the sea on the distribution and biodiversity of entomopathogenic organisms (Constant et al. 1998, Rodrigues et al. 2005, Jabbour and Barbercheck 2008, Jabbour et al. 2011). We think that Kastamonu region has different geographical and ecological factors increasing and effecting the biodiversity of entomopathogens in that region. However, entomopathogenic studies on the useful and harmful insects in Kastamonu region are not enough to represent a large diversity and this area is still virgin to search entomopathogenic organisms.

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