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Entomopathogens in populations of the European cockchafer, *Melolontha melolontha* (Coleoptera: Scarabaeidae)

Mustafa YAMAN*
Department of Biology, Faculty of Science, Karadeniz Technical University, Trabzon, Turkey

*Corresponding Author:
E-mail:yaman@ktu.edu.tr

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Abstract

Melolontha melolontha L. (Coleoptera: Scarabaeidae) is one of the most serious and widespread bug and its larvae cause extensive and lethal damage to the roots of young trees. Pathogenic organisms infecting insects are known as entomopathogen. This group includes viruses, bacteria, protists, fungi and nematodes. They cause desirable infections in pest insects. Up to known, several entomopathogenic organisms such as viruses, bacteria, fungi and protists have been found in *M. melolontha* populations in Turkey and isolated from this pest. Some of them have been tested as biological control agents against this pest. These entomopathogens are the most promising organisms found in *M. melolontha* populations. In this presentation, a review of recent situation of entomopathogenic organisms found in or tested against *M. melolontha* in Turkey is presented with comparing other entomopathogens found in its populations in the World.

Keywords: Melolontha melolontha, entomopathogen, Biological control, Turkey

INTRODUCTION

Melolontha melolontha L. (Coleoptera: Scarabaeidae) has caused considerable losses in plant production and forestry in several countries [1, 2, 3, 4, 5, 6, 7]. Attacks of the pest species are both in adult and larval stage. The larvae cause extensive and lethal damage to the roots of young trees while the adults attack the leaves from different species of forest trees and fruit trees [5, 8, 9]. The use of chemical insecticides to control *M. melolontha* has been considerable reduced due to environmental and public health concerns [7]. Similar situation has become in Turkey. Till now, *Melolontha melolontha* has been controlled with an organophosphorus insecticide, chlorpyrifos-ethyl applied into soil in Turkey [10]. Hovewer, this chemical insectiside has several toxic effects on the environment and other living organisms [11, 12, 13]. Finally the use of this insecticide has been forbidden in Turkey. It is seem that population density of *M. melolontha* will increase so that it becomes abundant and important pest species. On the other hand, entomopathogenic organisms (EPOs) are the most promising control agents. Therefore some efforts have been spent to develop different entomopathogens against this pest. There are numerous papers on enthomopathogens of *M. melolontha*, such as viruses, ricketsia, bacteria, nematodes and fungi [8, 14, 15, 16, 17], but a few records of pathogens causing diseases in *M. melolontha* populations in Turkey. In this paper, a review of recent situation of entomopathogenic organisms found in *M. melolontha* populations or tested against this pest in Turkey is given with a comparison other pathogens in the literatures.

Entomopathogens in *M. melolontha* populations (according to the literatures)

Different groups of entomopathogens cause disease in *M. melolontha* and are of interest as agents for natural control of this pest. Several entomopathogenic organisms from different groups were isolated and identified [16, 19]. *Adelina melolonthae* (Apicomplexa: Adeleidae), a coccidian protistan pathogen infecting the fat body of *M. melolontha* was firstly recorded by Tuzet [18] and later found by Kharazi-Pakdel and Amargier [19] and Yaman et al. [6]. *Nosema melolonthae*, a microsporidium (Microspora) is another pathogen isolated and identified from *M. melolontha* [19]. *N. melolonthae* has been shown as promising candidate for biological control of *M. melolontha* [20].

A list including entomopathogens of *M. melolontha* is given in the Table 1. A rich bacterial species are studied for *M. melolontha*. Nine bacteria, two spore-forming and seven non spore-forming have been found concerning with *M. melolontha*. Similar to bacterial pathogens, different protist species were isolated from *M. melolontha*. In total four species of apicomplexan pathogens were recorded from *M. melolontha*, but no record of a neogregarine from other countries. Additional to apicomplexan, one microsporidium pathogen, *Nosema melolonthae* and three fungal pathogens, *Beauveria brongniartti*, *Beauveria bassiana* and *Metarhizium anisopliae* were isolated from this pest (Table 1).

Table 1. Entomopathogens found in *M. melolontha* populations in the World (according to literatures; [16] and [27]).

Entomopathogen group	Entomopathogen species
Viruses	*Melolontha melolontha Entomopoxvirus (MmEPV)*
Bacteria	*Rickettsiella popilliae Enterobacter cloacae Diplococcus melolonthae Bacillus septicus insectorum Pseudomonas fluorescens Pseudomonas septida Serratia marcescens Bacillus haplostermus Paenibacillus popilliae*
Apicomplexa	*Adelina melolontae Euspora fallax Monocystis sp. Pseudomonocystis hopliae*
Microspora	*Nosema melolonthae*
Fungi	*Beauveria brongniartti Beauveria bassiana Metarhizium anisopliae*

Entomopathogens in *M. melolontha* populations in Turkey

Viruses, bacteria, neogregarines and coccidia have been found in *M. melolontha* populations in Turkey (Table 2) [6], however studies on entomopathogenic organisms of this pest have been limited.

Table 2. Entomopathogens found in M. melolontha populations in Turkey.

Entomopathogen species	Host species	Literature
Viruses	MmEPV	[6, 21]
Bacteria	*Bacillus thuringiensis, B. sphaericus, B. weihenstephanensis, Pseudomonas sp., Enterobacter sp. Acinetobacter sp.*	[22]
Apicomplexa	unidentified neogregarine	[6]
Coccidia	*Adelina sp.*	[6]
Nematoda	*Heterorhabditis bacteriophora Steinernema feltiae*	[25]

Viral pathogen found in *M. melolontha* was firstly found in Trabzon and identified as an entomopoxvirus, MmEPV [21]. Recently Yaman et al. [6] recorded this virus from different population of *M. melolontha* in Kocaeli by confirming a new infected- *M. melolontha* population in Kocaeli, which is far from Trabzon and at the different geographic region.

Bacterial pathogens from *M. melolontha* populations in Turkey were isolated and identified [22]. Seven bacterial isolated from this pest were identified as *Pseudomonas sp., Bacillus thuringiensis, B. sphaericus, B. weihenstephanensis, Pseudomonas sp., Enterobacter sp*. and *Acinetobacter sp*. using morphological, physiological, and biochemical characteristics. Pathogenic activity of these bacteria on larvae of *M. melolontha* were also evaluated. The insecticidal activity of the bacteria were found as 40% with Pseudomonas sp., 80% with Bacillus thuringiensis, 50% with *Pseudomonas* sp., 20% with *Enterobacter* sp., 60% with *B. sphaericus*, and 80% with *B. weihenstephanensis*. According to the authors, *B. thuringiensis* and *B. weihenstephanensis* isolates and crystal of *B. thuringiensis* may be valuable as biological control agents.

Recently, Yaman et al. [6] found three pathogens; two protistan pathogens, a coccidian and a neogregarine, and one entomopoxvirus in the populations of *M. melolontha* in Turkey. According to that study, first one was a neogregarine pathogen and infects the fat body of the beetle. The neogregarine infection was observed in only adults of *M. melolontha* collected from Kocaeli. Neogregarine infection reeached to 36%.

Second protistan pathogen found by Yaman et al. [6] in *M. melolontha* populations was a coccidian. This pathogen was also observed in the fat bodies of the larvae. Cooccidian infection varied from 2 to 7.5%.

Additional to natural pathogens found in *M. melolontha* populations, different entomopathogenic organisms have been tested against this pest as potential biological control agents. Fătu et al. [23] tested entomopathogenic bioproduct based on *Beauveria brongniartii* on *M. melolontha* larvae (L 2-L3). According to this study, the cumulative effect of the biological product provided a decreased density of larval populations under economic threshold level. Ferron and Hurpin [24] studied on the possible joint action of microorganisms pathogenic for *M. melolontha*. For this they determined the effects of simultaneous or consecutive contamination of the larvae of *M. melolontha* with entomopathogenic organisms, *Beauveria tenella* and *Entomopoxvirus melolonthae*. According to this study, the results showed that the presence of the virus increased the susceptibility of the larvae to the fungus, and 1-5 times as many larvae were killed by *B. tenella* in the groups reared in doubly contaminated peat as in groups reared in peat without the virus.

Erbaş et al. [25] isolated seven entomopathogenic nematodes from the soil samples and identified five isolates as *Heterorhabditis bacteriophora* and two isolates as *Steinernema feltiae*. The efficacy of *H. bacteriophora* and *S. feltiae* isolates were tested on *M. melolontha* larvae [25]. One hundred percent mortality was obtained from two *H. bacteriophora* isolates at a concentration of 2000 IJs/mL at 25 °C.

Laznik et al. [26] studied the efficacy of entomopathogenic nematode *Steinernema feltiae* in controlling third-stage larvae of *M. melolontha* under laboratory conditions. They tested at 20 and 25 ºC and at four different concentrations of nematode suspension. Higher mortality rate (27 %) of white grubs was obtained for strain C76 of S. feltiae rather than for commercial product (20 %). They determined the highest mortality rate (53 %) at highest concentration of nematode suspension and 20 ºC with this strain.

Lakatos and Tóth [8] found that *Heterorhabditis downesi* Strain 267, was highly effective in the soil test using two dose. According to this study the *H. downesi* strain 267 caused about 90% and 50% mortalities at a dose of 1,000 and 100 IJs per gram of soil, respectively at the optimum temperature 20°C.

Several groups of entomopathogens cause disease in *M. melolontha* and are of interest as agents for natural control of this pests. There is a new interest in using enthomopathogens

for biological control of plant pest insects in Turkey. Despite Turkey has potential to find and develope entomopathogens species, studies on entomopathogenic organisms infecting *M. melolonthae* have limited. In this paper, a review of entomopathogenic organisms infecting *M. melolontha* is presented to sitimulate scientist to find possible biological control strategies to control *M. melolontha* populations.

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