

Survey of Pathogens and Parasites of the Engraver Beetle *Ips acuminatus* (Gyllenhal, 1827) (Coleoptera: Curculionidae: Scolytinae) in Turkey

Mustafa Yaman^{1,3}, Gönül Alçı¹, Sabri Ünal², Beyza Gonca Güner¹

¹Department of Biology, Faculty of Science, Karadeniz Technical University, 61080, Trabzon, Turkey; E-mail: muyaman@hotmail.com

²Department of Forest Engineering, Faculty of Forestry, Kastamonu University, Kastamonu, Turkey.

³Faculty of Education, Ordu University, Ordu, Turkey.

Abstract: Pathogens and parasites of *Ips acuminatus* were studied for the first time in Turkey. In total, 530 beetles were examined in 2007, 2008 and 2014. Two pathogens, *Mattesia* sp. (Neogregarinorida: Lipotrophidae), *Chytridiopsis* cf. *typographi* (Microsporea: Chytridiopsidae) and unidentified nematodes were found. The prevalence of these pathogens and parasites were 2.4, 0.9 and 52.1%, respectively. While nematodes were observed during all years, *Mattesia* sp. was observed only in 2008, and *C. typographi* in 2008 and 2014.

Key Words: *Ips acuminatus*, pathogen, parasite, biological control, Turkey

Introduction

During the last decades, bark beetles (Coleoptera: Curculionidae: Scolytinae) are causing problems in the spruce and pine forests of Turkey (ACATAY 1968; EROĞLU 1995; YÜKSEL 1997; KONDUR *et al.* 2006; 2012; YAMAN 2007; YAMAN, RADEK 2008). Several bark beetles cause considerable damage and only a few of them are controlled using pest control strategies. Biological control is one of the most common methods to control bark beetles. Predatory and pathogenic organisms have been largely studied as agents of biological control for these pests (EROĞLU 1995; YÜKSEL 1997). Recently, *Dentroctonus micans* (Kugelann), *Ips sextentatus* (Börner) and *Ips typographus* (L.) have been studied for entomopathogens, aiming to determine the alternative suppressing factors affecting their populations in Turkey (YAMAN 2007; YAMAN, RADEK 2008a; 2012; ÜNAL *et al.* 2009; YAMAN *et al.* 2010). Although *Ips acuminatus* (Gyllenhal, 1827) is one of the most important pests in coniferous forests in Turkey (YÜKSEL *et al.* 2001) and other countries (PERROT 1977; LÉVIEUX *et al.* 1985; FACCOLI *et al.* 2012), there are no records on its pathogens and parasites from Turkey, while only few records about occurrence of parasites and patho-

gens in this pest in other countries exist (BALAZY *et al.* 1987; NEDELCEV *et al.* 2008; GRUCMANOVA *et al.* 2013). Therefore, this bark beetle species becomes more important for the entomopathogenic studies.

In the present study, we aimed to: (1) document the occurrence of pathogenic and parasitic organisms; (2) identify the pathogens and parasites; and (3) compare the infections of pathogenic and parasitic organisms of *Ips acuminatus* suppressing its populations in different years.

Materials and Methods

A total of 530 adult beetles of *Ips acuminatus* were collected in 2007, 2008 and 2014 from Kastamonu Region (41°24'21"N, 34°26'36"E), Turkey, where the beetle causes serious damage. We chose 2014 in order to compare pathogen diversity and infection with the period when the pathogens were observed for the first time. Each beetle was dissected in a Ringer's solution, and wet smears were examined under a light microscope at a magnification of 40x to 1000x. Positive smears were fixed in methanol and stained with Giemsa's dye. All pathogens and para-

sites found were measured and photographed using a microscope with a digital camera and a Soft Imaging System (Olympus, Japan).

Results and Discussion

We recorded two unicellular pathogens and one nematode in *Ips acuminatus* for the first time in Turkey (Table 1): an extraintestinal unidentified nematode (Fig. 1), *Chytridiopsis* cf. *typographi* (Microsporea: Chytridiopsidae) (Fig. 2) and *Mattesia* sp. (Neogregarinorida: Lipotrophidae) (Fig. 3). The pathogens and parasites appeared in different quantities during the outbreaks of the beetle at the studied locality in each year. Light-microscopy observations of fresh smears revealed the pathogens and parasites in different tissues and organs. Nematodes and *Chytridiopsis* cf. *typographi* were found in the haemolymph, and *Mattesia* in the fat body. Nematodes were the most common parasite in *I. acuminatus* and were observed in all years. On average, the infection by nematodes was found to be 52.1%. During the study, only juvenile stages of nematodes were observed. Therefore, we could not identify it to the generic or species level. However, nematodes found in the members of the genus *Ips* have been associated with the orders Diplogasterida, Rhabditida and Tylenchida (see GRUCMANOVA, HOLUSA 2013). We found the nematode parasite in the haemocoel of the beetles. RÜHM (1956) recorded three species (*Contortylenchus acuminata*, *Parasitaphelenchus*

acuminati and *Parasitorhabditis acuminata*) in the haemocoel of *I. acuminatus*. Although several parasitic nematodes have been found in different bark beetles from several countries (YAMAN, RADEK 2008; TAKOV *et al.* 2006; 2007; 2010; BURJANADZE, GOGINASHVILI 2009; KERESLIDZE *et al.*, 2010; GRUCMANOVA, HOLUSA 2013), only a few were recorded from *I. acuminatus*. Recently, NEDELCEV *et al.* (2008) recorded parasitic nematode *Contortylenchus acuminati* in *I. acuminatus* in Bulgaria. We recorded a nematode infection from the same host in Turkey for the first time. We observed high infection of the nematode parasite, reaching up to 68%.

Mattesia sp. infection in the fat body of *I. acuminatus* was observed only in 2008. Thirteen of the examined 177 beetles were found to be infected by this pathogen and the prevalence was 11.1%. Only oocysts of this neogregarine pathogen were observed and typically they were navicular in shape. ZITTERER (2002) was the only author that mentioned *Mattesia* sp. infection in the fat body of *I. acuminatus*. We could speculate that *Mattesia* infections do not occur permanently in the generations of *I. acuminatus* in Turkey. The infection was only observed in 2008, while there was no infection in 2007 and 2014.

We also found the microsporidian pathogen *Chytridiopsis* cf. *typographi* in *I. acuminatus*. This pathogen was observed in 2008 and 2014. Only two of the examined 260 beetles in 2008 and three in 2014 were found to be infected by this pathogen. The prevalence was 0.7% in 2008 and 1.3% in 2014.

Table 1. Pathogens and parasites of the engraver beetle *Ips acuminatus* from Kastamonu, Turkey

Sampling year	Number of examined beetle	Pathogens and parasites found in <i>Ips acuminatus</i>					
		Nematodes	(%)	<i>Mattesia</i> sp.	(%)	<i>C. typographi</i>	(%)
2007	50	22	44	-	-	-	-
2008	260	177	68	13	11.1	2	0.7
2014	220	81	36.8	-	-	3	1.3
Total	530	276	52.1	13	2.4	5	0.9

Table 2. Pathogens recorded from bark beetles in Turkey

Host insect	Pathogen/Parasite	Literature
<i>Dendroctonus micans</i>	<i>Helicospiridium</i> sp.	YAMAN and RADEK (2005, 2008a); YAMAN (2008)
	<i>Mattesia</i> sp.	YAMAN and RADEK (2008)
	<i>Menzbieria chalcographi</i>	YAMAN and RADEK (2012)
	<i>Metschnikowia typographi</i>	YAMAN and RADEK (2008a)
<i>Ips sexdentatus</i>	<i>Gregarina typographi</i>	UNAL <i>et al.</i> (2009)
	<i>Metschnikowia typographi</i>	UNAL <i>et al.</i> (2009)
<i>Ips typographus</i>	<i>Gregarina typographi</i>	YAMAN and BAKI (2010)
<i>Ips acuminatus</i>	<i>Mattesia</i> sp. <i>Chytridiopsis typographi</i>	Present study

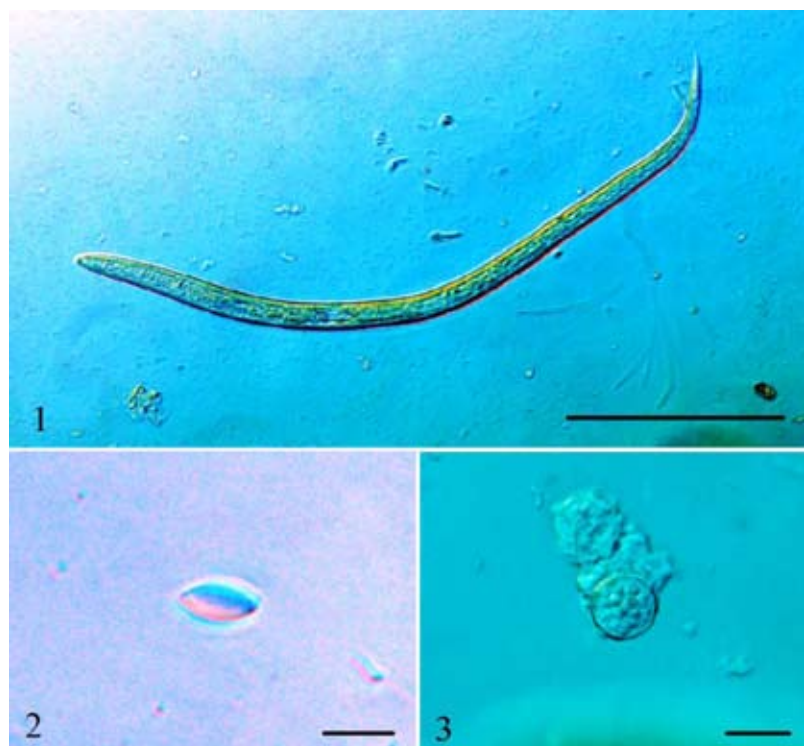


Fig. 1-3. Pathogens and parasites found in *Ips acuminatus*; **1.** Juvenile stage of nematode in the haemolymph of *Ips acuminatus* (scale bar = 50 μ m); **2.** Oocysts of *Mattesia* sp. in *Ips acuminatus* (scale bar = 10 μ m); **3.** Cyst with spores inside of *Chytridiopsis* cf. *typographi* in *Ips acuminatus* (scale bar = 10 μ m)

The results show that *C. typographi* maintains its occurrence in *I. acuminatus* in Turkey throughout the years. There are two earlier records of *C. typographi* from *I. acuminatus* (ZITTERER 2002; TAKOV *et al.* 2007). The present record is the third one from this pest. Comparing the prevalence values, we could conclude that the microsporidian infection in Turkish populations of *I. acuminatus* is lower (1.3%) than in Bulgaria (11.4%; TAKOV *et al.* 2007).

There were some previous studies on pathogens of bark beetles in Turkey (YAMAN 2007; YAMAN, RADEK 2008a, 2012; ÜNAL *et al.* 2009; YAMAN *et al.* 2010) (Table 2). Geographical distributions of pathogens in bark beetles are of great interest and are important in order to understand their biology, evolution, host interaction and pa-

thology. There are numerous articles on pathogens of different bark beetles species (HANDEL *et al.* 2003; WEGENSTEINER 2004; WEGENSTEINER, WEISER, 1995, 1996; WEGENSTEINER *et al.*, 1996; YAMAN, RADEK 2005; 2008; TAKOV *et al.* 2006; 2007; 2010; BURJANADZE, GOGINASHVILI 2009; KERESSELIDZE *et al.*, 2010; GRUCMANOVA, HOLUSA 2013). Only a few of them are on *I. acuminatus* and none of the reported pathogens were isolated from this pest from the European or Asian part of Turkey (Table 2). We should take into account that Asia is a potential source of new and interesting entomopathogens (MURILLO *et al.* 2001). Therefore, the present study, providing data on three pathogens and parasites, is a contribution to the knowledge of the pathogen distribution in *I. acuminatus* in Asia.

References

- ACATAY A. 1968. Türkiye’de yeni bir ladin tahripçisi, *Dendroctonus micans* Kug. – *İ.Ü. Orman Fak. Der.*, A., **18**: 18-36. (In Turkish).
- BALAZY S., J. MICHALSKI, E. KATAJCZAK 1987. Contribution to the knowledge of natural enemies of *Ips acuminatus* Gyll. (Coleoptera: Scolytidae). – *Polskie Pismo Entomologiczne*, **57**: 735-745.
- BURJANADZE M., N. GOGINASHVILI 2009. Occurrence of Pathogens and Nematodes in the Spruce Bark Beetles, *Ips typographus* (Coleoptera: Scolytidae) in Borjomi Gorge. – *Bulletin of the Georgian National Academy of Sciences*, **3** (1):145-150.
- EROĞLU M., 1995. *Dendroctonus micans* (Kug.) (Coleoptera, Scolytidae) in populasyon dinamiğine etki eden faktörler üzerine araştırmalar, I. Ulusal Karadeniz Ormancılık Kongresi, 23-25 Ekim 1995, Trabzon, Bildiriler 3. cilt, 148-159. (In Turkish).
- EROĞLU M., H. ALKAN-AKINCI, G.E. ÖZCAN 2005. Kabuk

- böceği salgınlarının nedenleri ve boyutları. – *Orman ve Av*, **82** (5): 27-34.
- FACCOLI M., V. FINOZZI, F. COLOMBARI 2012. Effectiveness of different trapping protocols for outbreak management of the engraver pine beetle *Ips acuminatus* (Curculionidae, Scolytinae). – *International Journal of Pest Management*, **58**: 267-273.
- GRUCMANOVA S., J. HOLUSA 2013. Nematodes associated with bark beetles, with focus on the genus *Ips* (Coleoptera: Scolytinae) in Central Europe. – *Acta Zoologica Bulgarica*, **65**: 547-556.
- HÄNDEL U., R. WEGENSTEINER, J. WEISER, Z. ZIZKA 2003. Occurrence of pathogens in associated living bark beetles (Col., Scolytidae) from different spruce stands in Austria. – *Journal of Pest Sciences*, **76**: 22-32.
- KERESLIDZE M., R. WEGENSTEINER, N. GOGINASHVILI, M. TVARADZE, D. PILARSKA 2010. Further studies on the occurrence of natural enemies of *Ips typographus* beetles (Coleoptera: Curculionidae: Scolytinae) in Georgia. – *Acta Zoologica Bulgarica*, **62**: 131-139.
- KONDUR Y., N. ÖNER, Z. ŞİMŞEK, 2006. Harmful insects and relationships between certain tree properties in Scots pine (*Pinus sylvestris* L.) of Ilgaz Mountain, Cankiri, Turkey. – *Journal of Biological Sciences*, **6**: 1065-1070.
- KONDUR Y., B.C. BILGILI, Z. ŞİMŞEK, N. ÖNER, S. AYAN, N.V. NICOLESCU, R. KLUMPP 2012. Monitoring the epidemic of bark beetles determined in Uludag fir stands in Ilgaz (Derbent and Doruk) via Landsat satellite images. – *Kastamonu Üniversitesi Orman Fakültesi Dergisi*, **12**: 86-90.
- MURILLO R., D. MUNOZ, J.J. LIPA, P. CABELLERO 2001. Biochemical characterization of three nucleopolyhedrovirus isolates of *Spodoptera exigua* and *Mamestra brassicae*. – *Journal of Applied Entomology*, **125**: 267-270.
- LÉVIEUX J., F. LIEUTIER, A. DELPLANQUE 1985. Scolytid pests of Scots pine. – *Revue Forestière Française*, **37**: 431-440.
- NEDELICHEV S., D. TAKOV, D. PILARSKA 2008. Parasitic and associated nematodes of bark beetles in Bulgaria. – *Acta Zoologica Bulgarica*, Suppl. 2: 83-90.
- PERROT M. 1977. Scolytid beetle attack on pines in the Central Region [of France]. – *Revue Forestière Française*, **30**: 185-198.
- RÜHM W. 1956. Die Nematoden der Ipiden. – *Parasitologische Schriftenreihe*, **6**: 435. p
- TAKOV D., D. PILARSKA, R. WEGENSTEINER 2006. Entomopathogens in *Ips typographus* (Coleoptera:Scolytidae) from several spruce stands in Bulgaria. – *Acta Zoologica Bulgarica*, **58**: 409-420.
- TAKOV D., D. DOYCHEV, R. WEGENSTEINER, D. PILARSKA 2007. Study of bark beetle (Coleoptera, Scolytidae) pathogens from coniferous stands in Bulgaria. – *Acta Zoologica Bulgarica*, **59**: 87-96.
- TAKOV D., D. PILARSKA, R. WEGENSTEINER 2010. List of protozoan and microsporidian pathogens of economically important bark beetle species (Coleoptera: Curculionidae: Scolytinae) in Europe. – *Acta Zoologica Bulgarica*, **62** (1): 201-209.
- TAKOV D., D. DOYCHEV, A. LINDE, S. DRAGANOVA, D. PILARSKA 2011. Pathogens of bark beetles (Coleoptera: Curculionidae) in Bulgarian forests. – *Phytoparasitica*, **59**: 343-352.
- ÜNAL S., M. YAMAN, O. TOSUN, Ç. AYDIN 2009. Occurrence of *Gregarina typographi* (Apicomplexa, Gregarinidae) and *Metschnikowia typographi* (Ascomycota, Metschnikowiaceae) in *Ips sexdentatus* (Coleoptera: Curculionidae, Scolytinae) populations in Kastamonu (Turkey). – *Journal of Animal and Veterinary Advances*, **8**: 2687-2691.
- WEGENSTEINER R. 2004. Pathogens in bark beetles. – In: LIEUTIER F., DAY K. R., BATTISTI A., GREGOIRE J. C., EVANS H. F. (Eds.): *Bark and wood boring insects in living trees in Europe, a synthesis*. Kluwer, Dordrecht, 291-313.
- WEGENSTEINER R., J. WEISER 1995. A new entomopoxvirus in the bark beetle *Ips typographus* (Coleoptera, Scolytidae). – *Journal of Invertebrate Pathology*, **65**: 203-205.
- WEGENSTEINER R., J. WEISER 1996. Untersuchungen zum Auftreten von Pathogenen bei *Ips typographus* (Col., Scol.) aus einem Naturschutzgebiet im Schwarzwald (Baden Württemberg) (in German). – *Anzeiger für Schädlingkunde, Pflanzenschutz, Umweltschutz*, **69**: 162-167.
- WEGENSTEINER R., J. WEISER, E. FÜHRER 1996. Observations on the occurrence of pathogens in the bark beetle *Ips typographus* L. (Coleoptera. Scolytidae). – *Journal of Applied Entomology*, **120**: 199-204.
- YAMAN M. 2007. *Gregarina typographi* Fuchs, a Gregarine Pathogen of the Six-Toothed Pine Bark Beetle, *Ips sexdentatus* (Boerner) (Coleoptera: Curculionidae, Scolytinae) in Turkey. – *Turkish Journal of Zoology*, **31**: 359-363.
- YAMAN M. 2008. Distribution and occurrence of the insect pathogenic alga *Helicosporidium* sp. (Chlorophyta: Trebouxiophyceae) in the populations of the great spruce bark beetle, *Dendroctonus micans* (Kugelann) (Coleoptera: Curculionidae, Scolytinae). – *North-Western Journal of Zoology*, **4**: 99-107.
- YAMAN M., R. RADEK 2005. *Helicosporidium* infection of the great European spruce bark beetle, *Dendroctonus micans* (Coleoptera. Scolytidae). – *European Journal of Protistology*, **41**: 203-207.
- YAMAN M., R. RADEK 2008. Identification, distribution and occurrence of the ascomycete fungus *Metschnikowia typographi* in the great spruce bark beetle, *Dendroctonus micans*. – *Folia Microbiologica*, **53**: 427-432.
- YAMAN M., R. RADEK 2012. *Menzbieria chalcographi*, a new neogregarine pathogen of the great spruce bark beetle, *Dendroctonus micans* (Kugelann) (Curculionidae, Scolytinae). – *Acta Parasitologica*, **53**: 216-220.
- YAMAN M., Ö. ERTÜRK, İ. ASLAN 2010. Isolation of some pathogenic bacteria from the great spruce bark beetle, *Dendroctonus micans* and its specific predator, *Rhizophagus grandis*. – *Folia Microbiologica*, **55**: 35-38
- YÜKSEL B., 1997. The infestations of *Dendroctonus micans* (Kug.) and role of *Rhizophagus grandis* (Gyll.) about establishment of biological equilibrium, III. Ulusal Ekoloji ve Çevre Kongresi Programı, Biyologlar Derneği, Bildiriler Kitabı, 3-5 Eylül 1997, Kırşehir, 375-385. (In Turkish).
- YÜKSEL B., S. KESKİN, K. TOPÇU 2001. The biological characteristics, predators and management of *Ips acuminatus* (Gyll.) in eastern spruce forests. – *Orman Mühendisliği*, **38**: 10-14.
- ZITTERER P.M. 2002. Antagonists of *Ips acuminatus* (Gyllenhal) with special consideration of pathogens. Diploma thesis. – Universität für Bodenkultur Wien, 56 p.

Received: 15.01.2015

Accepted: 23.04.2015