Insect Pathogens and Entomopathogenic Nematodes
Biological Control in IPM Systems

Edited by:
Ralf-Udo Ehlers, Neil Crickmore, Juerg Enkerli, Itamar Glazer, Martin Kirchmair, Miguel Lopez-Ferber, Sigrid Neuhauser, Hermann Strasser, Cezary Tkaczuk, Michael Traugott

IOBC wprs Bulletin
Bulletin OILB srop
Vol. 66, 2011

International Organisation for Biological and Integrated Control of Noxious Animals and Plants
Organisation Internationale de Lutte Biologique et Intégrée contre les Animaux et les Plantes Nuisibles
West Palearctic Regional Section / Section Régionale Ouest Paléarctique
Occurrence of pathogens and nematodes of bark beetles (Coleoptera, Scolytidae) from coniferous forest in different region of Georgia

M. Burjanadze¹, M. Lortkipanidze², A. Supatashvili¹, O. Gorgadze²
¹Vasili Gulisashvili Forest Institute, 7 Mindelli str., Tbilisi 0186, Georgia; ²Institute of Zoology of Ilia State University, 25 Chavchavadze Av., Tbilisi 0168, Georgia

Abstract: The aim of this research was to identify pathogens and nematodes and establish their distribution in a variety of bark beetles species from different locations and different altitude. Various pathogen species and nematodes were observed. Gregarina typographi was present in I. typographus (9.2-24.7%) and I. sexdentatus (35.3%) in high prevalence; Chytridiopsis typographi was found in I. typographus (3-6.7%) and in Tomius piniperta (4.7%). Low infestations with Metschnikowia sp. (1-3%) Menzhiera sp. (1.8%) were detected in I. typographus only from one locality. Two species of parasitic nematodes was detected: Contortylenchus diplogaster (16.9-41.9%) occurred in the population of I. typographus, Contortylenchus pseudodiplogaster (21.2%) in I. sexdentatus. Multiple infections were observed with G. typographi and nematodes in combination.

Keywords: Ips typographus, Ips sexdentatus, Tomius piniperta, Gregarina typographi; Chytridiopsis typographi, Metschnikowia sp.; Menzhiera sp; Contortylenchus diplogaster, Contortylenchus pseudodiplogaster

Introduction

Bark beetles are some of the most dangerous pests of coniferous trees in Georgia. These pests cause enormous economic loss and during intensive outbreaks can attack healthy standing trees. Control of bark beetles is difficult because of their cryptic habits: majority of the life cycle stages occur under the bark of host trees. The occurrence and epizootiology of pathogens in bark beetles is one of the least studied aspects in their population dynamics. Recent studies brought evidence of several new pathogen species in bark beetles (Haidler et al., 2003; Händel et al., 2003, 2005; Wegensteiner et al., 2005; Burjanadze et al., 2008; Takov et al., 2007; Yaman et al., 2008). The aim of our study was to investigate pathogen species and nematodes of bark beetle from different region of coniferous forest in Georgia and to improve knowledge on the pathogens, their infections in different bark beetle populations.

Material and methods

Bark beetles were collected in 2009/2010 at seven different locations in four regions of Georgia: three locations in Samtske-Javakheti, two locations in Caucasian mountain; one location in Lower Qartly and one location in Middle Qartly, at altitudes ranging from 700m to 1700m. They were collected from cutted infested log sections of trees or by peeling off infested bark by hand, out of their galleries in the phloem of Picea orientalis and Pinus sosnovskyi. Log sections and bark with beetles were brought to the laboratory and kept at 5 ±1°C. Only living or slowly moving beetles were dissected under a stereomicroscope and the whole gut, gonads, fat body and other organs were removed for examination. Diagnosis for
Results and discussion

Bark beetles species dissected were the spruce bark beetle – *Ips typographus* L, the pine bark beetle – *Ips sexdentatus* (Börner) and the pine shoot beetle – *Tomicus piniperda* L. Date and site of collection and host plant are presented in Table 1.

Table 1. Bark beetles collected from different sites of coniferous forest in Georgia (2009-2010)

<table>
<thead>
<tr>
<th>Location</th>
<th>Bark beetle</th>
<th>Altitude (m.a.s.l.)</th>
<th>Plant host</th>
<th>Collected beetles</th>
<th>Data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samtskhe-Javakheti</td>
<td>Tsagveri (BBG)</td>
<td><em>Ips typographus</em></td>
<td>1000</td>
<td>105</td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td>Patara Tsemi (BBG)</td>
<td><em>Ips typographus</em></td>
<td>1630</td>
<td>77</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td>Rabathi (Ak)</td>
<td><em>Ips sexdentatus</em></td>
<td>1550</td>
<td>85</td>
<td>2009</td>
</tr>
<tr>
<td>Caucasian Mountain</td>
<td>Shovi</td>
<td><em>Ips typographus</em></td>
<td>1710</td>
<td>110</td>
<td>2009</td>
</tr>
<tr>
<td>Caucasian</td>
<td>Oni</td>
<td><em>Ips typographus</em></td>
<td>1620</td>
<td>65</td>
<td>2010</td>
</tr>
<tr>
<td>Lower Qartly</td>
<td>Shavnabada</td>
<td><em>Tomicus piniperda</em></td>
<td>700</td>
<td>48</td>
<td>2009</td>
</tr>
<tr>
<td>Middle Qartly</td>
<td>Khashuri</td>
<td><em>Tomicus piniperda</em></td>
<td>850</td>
<td>42</td>
<td>2010</td>
</tr>
</tbody>
</table>

In total, 532 beetles were dissected individually, from all investigation area (*I. typographus* = 357; *I. sexdentatus* =90, *T. piniperda* =113). The pathogens and nematodes found are presented in Table 2.

The protozoan species, *Gregarina typographi* (Sporozoa, Gregarinidae) was found in the mid-gut lumen (size of gamontes: 50-95μm x 105-220μm) of adult beetles of *Ips typographus* and *Ips sexdentatus* from all investigated areas. Several stages of this pathogen, such as trophozoite, gamont and cyst were recorded. Infection was detected in 9.2-24.7% in *I. typographus* and 35.3% in *I. sexdentatus*. The pathogens were present in both species and sometimes in high prevalence (Wegensteiner et al., 2004; Händel et al., 2005; Takov et al., 2007; Yaman, 2007; Burjanadze, 2010).

In light microscopical observations of fresh smears of *I. typographus*, the microsporidium *Chytridiopsis typographi* Weiser (1954) could be identified in the cells of the midgut epithelium (spores 1.5-2.0 x 2.0-2.5μm; thick walled pansporoblasts: 10-20μm in diameter). This pathogen was found in *I. typographus* and infection rates were lower in all region (3-6.7%).
Table 2. Occurrence of pathogens and nematodes in bark beetle and infection rates (in %) from different part of Georgia in 2009-2010 (D.b= Dissected beetles; G.t= Gregarina typographi; Ch.t= Chrytriodipsis typographi; Met.sp=Metschnikowia sp.; Men.sp=Menzibieria sp.; Nem=Nematodes; n=number)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Bark beetle</th>
<th>D.b</th>
<th>Infected</th>
<th>G.t</th>
<th>Ch.t</th>
<th>Met.sp</th>
<th>Men.sp</th>
<th>Nem.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(n)</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Tsagveri</td>
<td><em>I. typographus</em></td>
<td>105</td>
<td>55</td>
<td>52.3</td>
<td>26</td>
<td>24.7</td>
<td>7</td>
<td>6.7</td>
</tr>
<tr>
<td>PataRTsemi</td>
<td><em>I. typographus</em></td>
<td>77</td>
<td>37</td>
<td>48.1</td>
<td>14</td>
<td>18.1</td>
<td>4</td>
<td>5.2</td>
</tr>
<tr>
<td>Rabathi</td>
<td><em>I. sexdentatus</em></td>
<td>85</td>
<td>55</td>
<td>64.7</td>
<td>30</td>
<td>35.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shovi</td>
<td><em>I. typographus</em></td>
<td>110</td>
<td>47</td>
<td>42.7</td>
<td>19</td>
<td>17.2</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>Oni</td>
<td><em>I. typographus</em></td>
<td>65</td>
<td>16</td>
<td>24.6</td>
<td>6</td>
<td>9.2</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Shavnbada</td>
<td><em>T. piniperda</em></td>
<td>48</td>
<td>7</td>
<td>14.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Khashuri</td>
<td><em>T. piniperda</em></td>
<td>42</td>
<td>7</td>
<td>16.6</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>4.7</td>
</tr>
</tbody>
</table>

There are several reports in the literature about *Ch. typographi* as a pathogen of *I. typographus* (Barjanadze et al., 2008; Händel et al., 2005, Wegenstainer 1994, Takov et al., 2007). During this study the pathogens was found in low frequency (4.7%) in populations of *Tomicus piniperda* as well. The pathogen *Ch. typographi* infecting *Tomicus piniperda* is reported from Georgia for the first time.

During this study, two pathogens *Metschnikowia* sp. (like *Metschnikowia typographi*) and *Menzibieria* sp., were found and with low infection levels in *I. typographus* only from Shovi locality. The rate of ascomycete infection by *Metschnikowia* sp. was 1-3%. However, asc of this fungus were found free in the hemolymph in large numbers. The ascomycete fungus *Metschnikowia typographi* infects *Ips typographus*, the mid-gut lumen and surrounding cells (Weiser et al., 2003; Wegensteiner et al., 2005; Unal et al., 2009).

Different species of nematodes occurred: *Contortylenchus diplogaster* in the population of *I. typographus*, *Contortylenchus pseudodiplogaster* in *I. sexdentatus*. They were found in the gut and on the surface of the body. Bark beetle numbers infected by nematodes ranged between 16.9-41.9% in population of *I. typographus*, 21.2% in *I. sexdentatus* and 11.9% in *T. piniperda*.

Several life stage of *Contortylenchus* spp., such as eggs, larvae, adult (mostly females) were observed. Females of the species were found in the hemolymph and usually 1-3, maximum 7 individuals were found in one bark beetle. Larvae were observed in the hemolymph and gut lumen, eggs in the hemolymph. *Contortylenchus* species as endoparasitic nematodes of bark beetles from Georgia were described by G. Kakulia (1989). Multiple infections were observed with *G. typographi* and nematodes in combination.

Acknowledgements

The research has been supported by Shota Rustaveli National Science Foundation, Georgia, Project ST08/8-514, 2009-2011.
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