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## Frequency and distribution of insect species on trunks in burnt pine forests of Greece

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The bark and wood boring insects found on burnt trees of three pine species (*Pinus nigra*, *P. brutia*, and *P. halepensis*) are classified according to their frequency of incidence and their distribution in the trunk: – species attacking the tree trunk on its whole length: *Orthotomicus longicollis* and *O. erosus*; – species attacking the tree trunk on its whole length except for the upper, very thin sections of the crown: *Tomicus piniperda*, *Melanophila cuspidata*, *Phaenops chalcea*, and *Acanthocinus griseus*; – species attacking the lower and middle trunk: *Ips sexdentatus*, *Anthaxia sturanyi*, *Crioccephalus tristis*, *Crypturgus numidicus*, *Rhagium inquisitor*, *Sirex noctilio*, *Xyleborus eurygraphus*, and *Acanthocinus aedilis*; – species attacking the middle and upper trunk: *Monochamus galloprovincialis*, *Tomicus minor*, *Pogonochaerus perroudi*, *Chrysobothris solieri*, *Phaenops formaneki*, and *Pityogenes calcaratus*; – species restricted to the upper section of the trunk and the branches: *Ernobius mollis*, *Dicerca moesta*, *Pissodes notatus*, and *Anthaxia laticeps*.

Keywords: Bark and wood boring insects, pine insects, Greek entomofauna, insect ecology, forest fires.

### INTRODUCTION

In Greece, pine forests are burnt more frequently than the forests of any other tree species. During the decade 1984–1993, an average of 330 fires per year have been reported in pine forests, while the burnt area had an annual mean of 14202 ha (MARKALAS AND PANTELIS, 1996). Even severely burned tree trunks maintain their commercial timber value, provided they have not been infested by bark and wood boring insects (TSOUMIS & VASSILIOU, 1983–1984; RUSODIMOS, 1986). Insect species of the above groups begin to attack the burnt pine trees immediately after the fire, and they are responsible for the reduction in value of the timber as well as for the death of many trees which have not been directly destroyed by the fire (GEISZLER *et al.*, 1984; MARKALAS, 1989a, 1991). Insect species boring into bark and wood of specific sections of a tree trunk vary according to the height and diameter of the stem and the bark thickness of the section (PRICE, 1975; LÖYTTYNIEMI & UUSVAARA, 1977; NEVES *et al.*, 1978).

In this study, bark and wood boring insects attacking the stem of burnt trees of *Pinus nigra*, *P. brutia* and *P. halepensis* were studied in relation to the frequency of their incidence and the part of the stem they attacked.

### MATERIAL AND METHODS

In the last 10 years a large number of pine trees, damaged at various degrees by forest fires, was examined for insect attack. The investigations were conducted in burnt stands of three different pine species: *Pinus nigra* in the region of Grammos-Kastoria, *P. brutia* in the regions of Thessaloniki and Thasos island, and *P.*

Tab. 1. Height above ground level of the various log-sections and their diameter for the three pine species checked.

Number of log-section	Height of section above ground (m)	Diameter class (cm)		
		<i>P. nigra</i>	<i>P. brutia</i>	<i>P. halepensis</i>
1	1.5–2.0	23–30	21–23	19–20
2	3.5–4.0	20–26	18–20	17–18
3	5.5–6.0	19–21	15–16	14–15
4	7.5–8.0	16–17	12–13	11–12
5	9.5–10.0	12–13	9–10	7–9
6	11.5–12.0	8–10	6–8	5–6

*halepensis* in the regions of Euboea, Attika, and Korinthia. Trees, damaged or burnt by the same fire, were cut down at different time intervals after the fire in order to increase the possibility of including insect species with different flight periods. For the same reason trees that were destroyed by fire in the same area but at different seasons of the year were cut down as well. After felling the trees, log-sections of 50 cm were cut off every 2 m of stem height, beginning at 1.5 m above ground (Tab. 1). All log-sections were then transported to the laboratory and enclosed in chipboard boxes 30x30x70 or 40x40x100 cm and kept outdoors. The adult insects boring out of the infested log-sections were gathered in small, transparent jars, which were attached to the boxes, and collected every 2–3 days (MARKALAS, 1987a).

The felled trees used in the study were not always of the same diameter and height. Therefore, the range of diameter for each log-section is given in Tab. 1 in relation to pine species and their height above ground level.

To describe the frequency of the insects, three degrees were used: low, moderate, and high frequency. The classification of each insect to a specific degree of frequency was made regarding: a) the number of the adult insects boring out of each log-section, b) the total area of the log-section occupied by every insect species, and, c) the area each insect needs for growing up.

## RESULTS AND DISCUSSION

On the logs of *Pinus nigra* 12 insect species have been identified, all of them belonging to the Coleoptera (Tab. 2). Of these only *Orthotomicus longicollis* has been found in logs of all tree heights and in high frequency. All other insect species have shown a lower or higher preference for specific parts of the tree stem. The insects found in the lower to middle parts of the trunk are *O. erosus*, *Ips sexdentatus*, *Crypturgus numidicus*, and *Rhagium inquisitor*. Only *I. sexdentatus* showed a high frequency. The insects restricted to the middle parts of the trunk were *Acanthocinus aedilis* and *Tomicus minor*, both in relatively high frequency. The remaining 5 species preferred the upper and thinner parts of the trunk (Tab. 2).

The logs of *P. brutia* were attacked by 11 coleopterous and 1 hymenopterous species. Of these only 4 species (*O. longicollis*, *O. erosus*, *C. numidicus*, and *Ernobius mollis*) were also found in *P. nigra*. In all the sections of the trunk *O. longicollis* and *O. erosus* were identified, whereas *T. piniperda* was absent in the very

Tab. 2. Frequency and distribution on the trunk of bark and wood boring insects attacking trees of three pine species after forest fires.

Insect species (family)	<i>Pinus nigra</i>		<i>Pinus brutia</i>		<i>Pinus halepensis</i>	
	Frequency	Log No.	Frequency	Log No.	Frequency	Log No.
<i>Orthotomicus longicollis</i> (Scolytidae)	high	1-6	low	1-6	low	1-5
<i>Orthotomicus erosus</i> (Scolytidae)	low	1-4	high	1-6	high	1-6
<i>Tomicus piniperda</i> (Scolytidae)			high	1-5	moderate	1-4
<i>Melanophila cuspidata</i> (Buprestidae)			high	1-4	high	1-5
<i>Phaenops chalcea</i> (Buprestidae)					moderate	1-5
<i>Acanthocinus griseus</i> (Cerambycidae)			high	2-5	high	1-5
<i>Ips sexdentatus</i> (Scolytidae)	high	1-4				
<i>Anthaxia sturanyi</i> (Buprestidae)					moderate	1-4
<i>Criocephalus tristis</i> (Cerambycidae)			high	1-3	high	1-4
<i>Crypturgus numidicus</i> (Scolytidae)	moderate	1-4	high	1-3	high	1-3
<i>Rhagium inquisitor</i> (Cerambycidae)	moderate	1-3				
<i>Sirex noctilio</i> (Siricidae)			moderate	1-3		
<i>Xyleborus eurygraphus</i> (Scolytidae)					low	1-3
<i>Acanthocinus aedilis</i> (Cerambycidae)	high	2-5				
<i>Monochamus galloprovincialis</i> (Cerambycidae)	moderate	4-6			high	2-5
<i>Tomicus minor</i> (Scolytidae)	high	3-5				
<i>Pogonochaerus perroudi</i> (Cerambycidae)			high	3-6	high	3-6
<i>Chrysobothris solieri</i> (Buprestidae)			moderate	4-6	moderate	4-6
<i>Phaenops formaneki</i> (Buprestidae)	moderate	4-6				
<i>Pityogenes calcaratus</i> (Scolytidae)			moderate	4-6	high	4-6
<i>Ernobius mollis</i> (Anobiidae)	low	5-6	low	5-6	low	5-6
<i>Dicerca moesta</i> (Buprestidae)	low	5				
<i>Pissodes notatus</i> (Curculionidae)	moderate	6			moderate	6
<i>Anthaxia laticeps</i> (Buprestidae)					low	6

thin parts of the upper trunk. The lower and middle trunk was preferentially attacked by *Melanophila cuspidata*, *Criocephalus tristis*, *Crypturgus numidicus*, and the hymenopterous *Sirex noctilio*. Of the remaining insect species, *Acanthocinus griseus* infested the middle trunk, *Pogonochaerus perroudi* the middle and upper trunk, whereas *Pityogenes calcaratus*, *Chrysobothris solieri*, and *E. mollis* preferred the most thin-barked parts of the upper trunk.

The greatest number of insects (total 17 species) were identified from log-sections of *Pinus halepensis*, which is the most fire stricken tree species in Greece (MARKALAS & PANTELIS, 1996). Besides the hymenopteran *S. noctilio*, all other 11 species mentioned for *P. brutia* were also found in *P. halepensis*, with almost the same frequency and distribution on the trunk (Tab. 2). Of the remaining 6 insect species, *Phaenops chalcea* and *Anthaxia sturanyi* were absent only on the upper parts of the trunk. *Xyleborus eurygraphus* was restricted to the lower thick-barked parts of the trunk, whereas *Monochamus galloprovincialis* was not found on logs with large diameter and thick bark, which originated from the lower trunk. Finally, *Anthaxia laticeps* and *Pissodes notatus* were found only on the upper part of the tree trunk and on the branches as well.

From the above mentioned species, economically important are only those either boring into the wood of trees destroyed by fire or attacking the bark of trees not fully destroyed, but stressed by the flames (MARKALAS, 1992).

To the first group belong mainly *Criocephalus tristis* and *Monochamus galloprovincialis*, because they are found in high population densities. They bore galleries deep into the wood of the relatively thick parts of the lower and middle trunk. *Melanophila cuspidata* is also found in large numbers attacking the lower and middle trunk, but its boring activity in the wood is restricted to the pupation chambers and does not bore very deep (only 2–3 cm) into the wood.

In the second group, the most important insects are *Tomicus piniperda* and *Orthotomicus erosus* which attack and cause the death of damaged trees in stands of *P. brutia* and *P. halepensis*, and *T. minor* and *O. longicollis* in stands of *P. nigra*. These insects are also among the most common species in Greek pine forests, developing outbreaks in stands growing on rocky, shallow, eroded and infertile soils, especially after prolonged periods of severe drought (KALIDIS & MARKALAS, 1988, 1990; MARKALAS, 1987b, 1989b, 1992).

Trees sampled in different periods after the fire or from fires occurring during different seasons of the year, were attacked by the same or different insect species, depending on the flight period of the insect (start and duration of the flight, number of generations per year). For example, trees burnt early in the year (spring) were attacked by almost all insect species mentioned above. Trees burnt late in the year (end of summer or autumn) were only attacked by insects active soon after the fire. Often, these trees were attacked in the following year also by the early flying insects, provided there was enough free space for their brood production.

#### ZUSAMMENFASSUNG

Häufigkeit und Verteilung von Insektenarten in Kiefernstämmen nach Waldbränden in Griechenland. – Die rinden- und holzbohrenden Insekten an durch Feuer geschädigten Bäumen dreier Kiefernarten (*Pinus nigra*, *P. brutia* und *P. halepensis*) wurden nach ihrer Häufigkeit und Verteilung am Stamm klassifiziert: – Arten, die den ganzen Stamm befallen: *Orthotomicus longicollis* und *O. erosus*; – Arten, die den ganzen Stamm ausser den sehr dünnrindigen Teilen der Oberkrone befallen: *Tomicus piniperda*, *Melanophila cuspidata*, *Phaenops chalcea* und *Acanthocinus griseus*; – Arten, die den Unter- und Mittelschaft befallen: *Ips sexdentatus*, *Anthaxia sturanyi*, *Criocephalus tristis*, *Crypturgus numidicus*, *Rhagium inquisitor*, *Sirex noctilio*, *Xyleborus eurygraphus*, und *Acanthocinus aedilis*; – Arten, die den Mittel- und Oberschaft befallen: *Monochamus galloprovincialis*, *Tomicus minor*, *Pogonocherus perroudi*, *Chrysobothris solieri*, *Phaenops formaneki* und *Pityogenes calcaratus*; – Arten, die sich auf den Oberschaft (Äste eingeschlossen) beschränken: *Ernobius mollis*, *Dicerca moesta*, *Pisodes notatus* und *Anthaxia laticeps*.

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