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Bark Beetles (Coleoptera: Curculionidae: Scolytidae) Associated with *Pinus brutia* and *Cupressus sempervirens* in Northern Cyprus

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Abstract. Observations on biology and damage caused by bark beetles (Coleoptera: Curculionidae: Scolytidae) associated with *Pinus brutia* and *Cupressus sempervirens*, two conifers indigenous to northern Cyprus, done between December 2000 and August 2003 are reported. Insect life stages, breeding galleries and/ or damage caused by six species were detected: *Orthotomicus erosus* (Wollaston), *Pityogenes calcaratus* (Eichoff), *P. pennidens* (Reitter), *Tomicus destruens* (Wollaston) and *T. minor* (Hartig) on *Pinus brutia* and *Phloeosinus armatus* Reitter on *Cupressus sempervirens*. The most damaging species detected was *Tomicus destruens*, which was killing pines in groups of up to 30 trees. Other species typically killed single trees, small groups of 2-3 trees or confined their attacks to recently downed trees or storm-damaged material. Data are reported on the occurrence and behavior of each species detected.
Key Words: Bark beetles; *Cupressus sempervirens*; Cyprus; forest insects; forest protection; *Orthotomicus erosus*; *Pinus brutia; Pityogenes calcaratus*; *Pityogenes pennidens*; *Phloeosinus armatus*; Scolytidae; *Tomicus destruens*; *Tomicus minor*

Insectos Escolitídeos (Coleoptera: Curculionidae: Scolytidae) associados a *Pinus brutia* e *Cupressus sempervirens* no Norte do Chipre

Sumário. Neste trabalho apresentam-se os resultados de observações efetuadas entre Dezembro de 2000 e Agosto de 2003 acerca da biologia e danos causados por insetos sub-corticais (Coleoptera: Curculionidae: Scolytidae) em *Pinus brutia* e *Cupressus sempervirens*, duas espécies de coníferas nativas no norte de Chipre. Foram detetados estádios imaturos, galerias e/ou danos causados por seis espécies de insetos: *Orthotomicus erosus* (Wollaston), *Pityogenes calcaratus* (Eichoff), *P. pennidens* (Reitter), *Tomicus destruens* (Wollaston) e *T. minor* (Hartig) em *Pinus brutia* e *Phloeosinus armatus* Reitter em *Cupressus sempervirens*. A espécie mais agressiva foi *Tomicus destruens*, causando a morte de pinheiros em grupos até 30 árvores. As outras espécies foram detetadas tipicamente em árvores mortas isoladas, pequenos grupos de 2-3 árvores ou em material lenhoso de cortes ou afetado por tempestades. Para cada espécie são feitas observações da sua ocorrência e comportamento biológico.
Palavras-chave: Insetos sub-corticais; *Cupressus sempervirens*; Chipre; proteção florestal; *Orthotomicus erosus*; *Pinus brutia; Pityogenes calcaratus*; *Pityogenes pennidens*; *Phloeosinus armatus*; Escolitídeos; *Tomicus destruens*; *Tomicus minor*

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Introduction

Despite over 8000 years of human occupation and influence, approximately 40% of the Eastern Mediterranean island of Cyprus is still occupied by wild vegetation, a significant portion of which is forest cover. Conifer forests, primarily *Pinus brutia*, comprise the island's dominant forest vegetation cover. In addition to *Pinus brutia*, other indigenous conifers include *Pinus nigra* ssp. *pallasiana* in the Troodos Massif, the endemic *Cedrus brevifolia* in the Paphos Forest of western Cyprus and *Cupressus sempervirens* in the Pentadactylos Mountains of northern Cyprus. Several species of *Juniperus* also occur on the island (TSINTEDES and KOURTELLARIDES, 1998). These forests are subject to disturbance events caused by wildfire and insect outbreaks (CIESLA, 2004).

Bark beetles (Coleoptera: Curculioidae: Scolytidae) are known to cause disturbances in Cyprus conifer forests. Officials in the Forestry Department, the Turkish Cypriot Community (TCC) have been concerned about losses incurred in the forests of northern Cyprus due to these insects and have realized some direct control activities, primarily prompt removal and elimination of damaged and infested trees. Despite this concern, few, if any, detailed studies have been done of the biology or economic and ecological impacts of these insects in Cyprus.

This paper reports on the results of field observations of the occurrence, habits and damage caused by several species of bark beetles affecting *Pinus brutia* and *Cupressus sempervirens* in northern Cyprus. These observations were made between December 2000 and August 2003.

Methods

Field evaluations were made in northern Cyprus during four periods:

December 2000
December 2002
March-April 2003
August 2003

All observations were made in or near the Pentadactylos (Five Finger) Mountains, a narrow range of mountains that run roughly parallel to the island's northern coast. *Pinus brutia* is the dominant tree species and *Cupressus sempervirens* is found at higher elevations. *Juniperus phoenicia* occurs as an understory species in many *Pinus brutia* forests and also occurs in pure stands on the Karpas Peninsula. Approximately half of the forest area in the Pentadactylos Mountains is of plantation origin, the plantations having been established following cutting and degradation of the original vegetation or destruction by wildfire. *Pinus brutia* is the major plantation species although *P. halepensis, P. pinea* and *C. sempervirens* have also been planted, usually mixed with *P. brutia*. In recent years, young pine plantations (< 2 m in height) have been subject to defoliation by epidemic populations of pine procession caterpillars, *Thaumetopoea pityocampa* (Lepidoptera: Pityocampidae). Most of the forested areas are readily accessible by a network of forest roads.

Field visits were held with representatives of the Forestry Department of the Turkish Republic of Cyprus who knew of sites where infestations were either present or believed to have a high probability of

occurrence. In addition, sites were examined where bark beetle control operations had either been recently conducted or were underway. In areas where bark beetle activity was detected in standing trees, a subsample of infested trees was felled to obtain data on the portion of tree attacked and the occurrence of associated species in the upper crown.

Preliminary identification of species was based on examination of adults with a 10-x hand lens and egg and larval gallery patterns in the cambium of host trees. Where possible, adults were collected, preserved in 70% ethanol and submitted to specialists for identification. Since many of the sites from which collections were made were relatively remote, Forest Districts were used as the primary reference for the location of field observations and insect collections.

Results

According to records from the insect collection of the Agricultural Research Institute, GCC, Nicosia, the Entomological Museum of Lund University, Sweden (ANON, 2004; GEORGHIOU, 1977) and reports by BROWNE (1968) and LEKANDER (1971), at least 18 species of conifer-infesting Scolytidae were known to occur on Cyprus prior to the observations reported in this paper (Table 1).

Five species of bark beetles were observed on *Pinus brutia* and one on *Cupressus sempervirens* during the field evaluations conducted between 2000 and 2003 (Table 2). Notes on the occurrence and behavior of individual species are reported in the following sections.

Pinus brutia

Orthotomicus erosus – This was one of the most frequent bark beetles encountered in *Pinus brutia* in northern Cyprus. Infestations were found both in standing trees and in windthrow resulting from a storm in February 2003.

Infestations were most frequently encountered in scattered single trees or small groups of 2 - 3 trees in the Dennorya Forest, located on the south--facing slopes of the Pentadactylos Mountains, Kantara Forest District at an elevation of circa 150 m. Attacks occurred in pines planted during the British administration of the island, which were over 100 years old. Despite their age, these pines were relatively small, ca 4-5 m total height and had poor form. Natural forests of *Pinus brutia* are usually found at elevations of 500 m and above on the south facing slopes of this mountain range. In addition to having been established on unfavorable growing sites, these trees had also suffered several successive years of defoliation by the pine processionary caterpillar, *Thaumetopoea pityocampa*.

Other pines infested by *Orthotomicus erosus* were detected in the Versari Forest, Karpas Peninsula, in the Kantara Forest District and throughout the south-facing slopes of the Pentadactylos Mountains in the Alevka and Morfou Forest Districts. These attacks were attributed to several predisposing factors including off-site planting, drought and defoliation by pine processionary caterpillar.

Table 1 - Previous Records of Bark Beetle (Coleoptera: Curculionidae: Scolytidae). Collections from Conifers in Cyprus

Presently Accepted Scientific Name [1]	Reported Scientific Name	Host	Source
Carphoborus pini Eichoff	*Carphoborus pini* Eichoff	*Pinus brutia, P. nigra*	Georghiou, 1977
Carphoborus minimus (Fabricius)	*Carphoborus minimus* (Fabricius)	None given	Anon, 2004
Crypturgus mediterraneus Eichoff	*Crypturgus mediterraneus* Eichoff	None given	Anon, 2004
Crypturgus numidicus Ferrari	*Crypturgus numidicus* Ferrari	None given	Anon, 2004
Crypturgus pusillus (Gyllenhal)	*Crypturgus pusillus* (Gyllenhal)	None given	Anon, 2004
Orthotomicus erosus (Wollaston)	*Orthotomicus erosus* (Wollaston) *Orthotomicus erosus* (Wollaston)	*Pinus brutia, P. nigra*	Anon, 2004 Georghiou, 1977 Browne, 1968
Phloeosinus armatus Reitter	*Phloeosinus andresi* Eggers *Phloeosinus armatus* Reitter	*Cupressus sempervirens*	Anon, 2004 Browne, 1968 Georghiou, 1977
Phloeosinus bicolor (Brulle)	*Phloeosinus aubei* Perris	*Juniperus foetidissima*	Anon, 2004 Browne, 1968 Georghiou, 1977
Phloeotribus caucasicus Reitter	*Phloeotribus caucasicus* Reitter	*Cupressus* sp.	Georghiou, 1977
Pityogenes bistridentatus (Eichoff)	*Pityogenes bistridentatus* (Eichoff)	*Pinus brutia, P. nigra*	Browne, 1968 Georghiou, 1977
Pityogenes pennidens Reitter	*Pityogenes penoideus* Reitter	None given	Anon, 2004
Pityogenes porifrons Eggers	*Pityogenes porifrons* Eggers	*Pinus halepensis*	Georghiou, 1977
Pityogenes quadridens (Hartig)	*Pityogenes quadridens* (Hartig)	*Pinus brutia, P. nigra*	Browne, 1968 Georghiou, 1977
Pityophthorus pubescens (Marsham)	*Pityophthorus pubescens* (Marsham)	*Cedrus brevifolia* (cones)	Browne, 1968 Georghiou, 1977
Tomicus destruens (Wollaston)	*Blastophagus destruens* Wollaston	None given	Lekander, 1971
Tomicus minor (Hartig)	*Blastophagus minor* Hartig	*Pinus brutia, P. nigra*	Browne, 1968 Georghiou, 1977
Tomicus piniperda (L.)	*Blastophagus piniperda* L.	*Pinus brutia, P. nigra*	Anon, 2004; Georghiou, 1977
Xyleborus eurygraphus (Ratzeburg)	*Xyleborus eurygraphus* (Ratzeburg)	*Pinus brutia, P. nigra*	Georghiou, 1977

[1] - Authority for currently accepted scientific names - BRIGHT and SKIDMORE (2002)

Table 2 - Bark Beetle Collections and Observations, Northern Cyprus, 2000-2003

Species	Host	Collection/Observation Dates (month/year)
Orthotomicus erosus (Wollaston)[1]	*Pinus brutia*	12/2000, 08/2003
Phloeosinus armatus (Reitter)[1]	*Cupressus sempervirens*	12/2000, 08/2003
Pityogenes calcaratus (Eichoff) [1]	*Pinus brutia*	08/2003
Pityogenes pennidens (Reitter) [1]	*Pinus brutia*	08/2003
Tomicus destruens (Wollaston)[2]	*Pinus brutia*	03-04/2003
Tomicus minor (Hartig)	*Pinus brutia*	12/2000, 08/2003

[1] Identified by Donald E. Bright, Canadian National Collection of Insects, Ottawa, Ontario (Presently, Colorado State University, Fort Collins, CO, USA).

[2] Identification by Rudolph Wegensteiner, Institute of Forest Entomology, Forest Pathology and Forest Protection, University of Agricultural Sciences, Vienna, Austria.

A small area of concentrated snow breakage of pine (ca 5 ha) occurred in a mature *Pinus brutia* forest during the winter of 2003 on the north facing slopes of the Pentadactylos Mountains in the Alevka Forest Division. No bark beetle attacks were observed in this material during the March/April 2003 field assessment and a recommendation was made for rapid removal and utilization of the damaged trees. This material was removed as recommended and in August 2003, a small number of attacks by *Orthotomicus erosus* were found in the tops and branches that remained in the affected area.

Tomicus destruens - All bark beetle activity observed during March/April 2003 was attributed to a single species, which local foresters and forest workers recognized as *Tomicus piniperda*. Moreover, bark beetles previously collected from *Pinus brutia* in Cyprus, have been identified as *Tomicus (=Blastophagus) piniperda* (ANON, 2004; GEORGHIOUS, 1977). Adult specimens collected during the course of these observations were later identified as *T. destruens*.

T. destruens was the most aggressive tree-killing bark beetle species found in *Pinus brutia* in northern Cyprus. Infestations were detected throughout the western portions of Kantara Forest Division and low elevation pine forests in the Morfou (Güzelyurt) Forest Division. Trees of all sizes were attacked and in some multiple tree infestations both large trees and saplings were killed. Pines under attack were typically of plantation origin, often growing on steep slopes with shallow, rocky, erosive soils. Large, mature pines, with relatively thick bark, had attacks confined to the thin barked portions of the main bole and large branches in the upper crown. In some cases, only the upper third or half of the crown was killed. On smaller trees, generally those with a diameter breast height (dbh) of < 15 cm, attacks occurred along the entire bole. Attacked trees often had large numbers of conspicuous white to pale yellow colored pitch tubes.

In the Kantara Division, active infestations were limited to either single trees or small groups of 2-3 infested trees. In the Morfou Division, on the other hand, infestations of *T. destruens* were more aggressive. Infestation sizes

were larger and consisted of groups of up to 30 infested trees.

T. destruens and *T. piniperda* have often been considered as synonyms because they are morphologically similar and have similar life histories. Unfortunately, because of the similarity of the two species, much of the biological information available on *T. destruens* is included with *T. piniperda*. In addition, the natural ranges of the two species may overlap in portions of the Mediterranean region and existing distributional data on the two species may be confused. WOOD and BRIGHT (1992) consider them separate species and this is supported by recent DNA studies (GALIÁN and GALLEGO, 2000; KOHLMAYR *et al*., 2002). KOHLMAYR *et al.* (2002) illustrate morphological differences in the structure of the antennal club between the two species. In a series of maps showing the distribution of Scolytidae in Turkey, SELMI (n.d.) shows *Tomicus* (reported as *Blastophagus*) *piniperda* to be widely distributed, including many low-elevation sites in coastal regions, which other workers report as the classic habitat for *T. destruens*. Furthermore, SELMI does not report the occurrence of *T. destruens* in Turkey. At least one prior record exists of the occurrence of *Tomicus destruens* in Cyprus (LEKANDER, 1971). Some or all of the previously collected material from Cyprus identified as *T. piniperda*, could also be of this species.

Recent studies in Italy and Spain, using a combination of morphological and molecular analysis have established that *T. destruens* is the species most commonly associated with Mediterranean pines (e.g., *Pinus halepensis, P. pinaster, P. pinea*) whereas *T. piniperda* is associated with "continental" species such as *P. nigra* and *P sylvestris* (FACCOLI *et al*., 2005; GALLEGO *et al*., 2004). While *P. brutia* is the predominant pine species on Cyprus, *P. nigra* var. *caramanica* occurs at the higher elevations of the Trodos Massif and could be a host for *T. piniperda*. Additional work is needed to determine if both *T. destruens* and *T. piniperda* occur in Cyprus and their relative importance as damaging forest pests.

Active infestations of *Tomicus destruens* were only seen during the March-April 2003 field evaluation. The occurrence of *T. destruens* in Cyprus during early spring is in agreement with studies on the life history of this insect reported by ABGRALL and SOUTRENON (1991) in southern France and NANNI and TIBERI (1997) in Italy. Breeding attacks can begin to occur in late August-September and continue into April-May. This insect reportedly has two to three overlapping generations per year.

No other bark beetles occurred in association with *Tomicus destruens.* This is believed to be due to the occurrence of breeding attacks by this species during winter and early spring, before other Scolytidae are active.

Like the closely related *T. piniperda*, brood adults of *T. destruens* reportedly feed on pine shoots. However, there was no evidence of adult feeding on pine shoots in northern Cyprus during the summer of 2003 despite the relative abundance of infested trees earlier in the year.

Tomicus minor – Horizontal egg galleries and vertical larval galleries characteristic of this species were seen in the thin-barked, upper crowns of large *Pinus brutia* attacked by *Orthotomicus erosus*. The association of these two bark beetles was seen in both the Kantara and Morfou Forest Divisions during the

December 2000 and August 2003 observation periods. No *T. minor* adults were collected.

It was unclear which of the two species initiated the attacks. Trees actively infested by both species contained only larvae of *T. minor* but had larvae, pupae and brood adults of *Orthotomicus erosus*, suggesting that brood development of the latter species was more advanced and had, therefore, initiated attack.

In other parts of their geographic range, *Tomicus minor* and *T. piniperda* often attack the same trees. In Sweden, *T. minor* attacks the mid and upper boles of *Pinus sylvestris* and *T. piniperda* attacks the mid and lower boles (LANGSTRÖM and HELLQUIST, 1993). In the Kunming region of southwestern China, where both species attack *P. yunnanensis*, the zones of attack are reversed with *T. minor* infesting the mid to lower bole and *T. minor* attacks trees 1-2 weeks later than *T. piniperda* (HUI and XUE-SONG, 1999).

Pityogenes spp. – Two species of *Pityogenes* were collected from northern Cyprus during the course of these observations.

A series of adults, subsequently identified as *Pityogenes calcaratus*, was collected from a single *Pinus brutia*, about 2 m total height and a maximum stem diameter of 5 cm in a plantation in the Kantara Division on 8 August 2003. The tree had red foliage, indicative of bark beetle attack, and networks of star-shaped galleries, characteristic of *Pityogenes* spp. in the cambium layer. This plantation is known to have suffered defoliation from epidemic populations of pine processionary caterpillar, *Thaumetopoea pityocampa* (Lepidoptera: Pityocampidae), during March 2003. The attack by *P. calcaratus* is believed to be in response to stress from defoliation and/or other factors.

This may be the first report of the occurrence of *Pityogenes calcaratus* in Cyprus. However its occurrence is not considered unusual because this species is reportedly widely distributed throughout Mediterranean pine forests (WOOD and BRIGHT, 1992; GRÜNE, 1979).

A second species of *Pityogenes, P. pennidens* was collected from two sites: one in the Morfou Forest Division and one in the Alevka Forest Division. In the Morfou site, adults were collected on 06 August 2003 from the upper crown of a *Pinus brutia*, ca 25 cm dbh, containing an active infestation of *Orthotomicus erosus* at mid bole (larvae, pupae and brood adults) and galleries characteristic of *Tomicus minor* in the upper crown. The *T. minor* galleries contained larvae. The adults, subsequently identified as *Pityogenes pennidens*, were collected in association with galleries characteristic of *Tomicus minor.* The second collection of this species was made 07 August 2003 in the Alevka Forest Division from residual branches of a *Pinus brutia* that had been cut and removed about 11 days earlier. Similar gallery patterns were observed in *P. brutia* branches broken by the February 2003 snowstorm in the immediate vicinity of this site but this material contained exit holes and no bark beetle life stages.

According to WOOD and BRIGHT (1992) and GRÜNE (1979), *Pityogenes pennidens* is known from the eastern Mediterranean: Greece, Syria, Turkey and the Caucasus region. Material kept in the insect collection of the University of Lund, reported as "*Pityogenes penoideus* (Reitter)" from Cyprus (ANON, 2004) is presumed to be a misspelled report of the same species.

Cupressus sempervirens

A single species, *Phloeosinus armatus*, was found associated with *C. sempervirens*. Life stages, galleries and adult feeding by this species were seen in *Cupressus sempervirens* in the Alevka and Kantara Forest Divisions during December 2000 and August 2003. Observations in northern Cyprus are in conformation with published data on the biology and ecology of this species, indicating that this insect is a secondary invader of green logs and unhealthy trees (BROWNE, 1968).

Galleries characteristic of *Phloeosinus armatus* were detected in a standing dead tree in a ca 80-year old *Cupressus sempervirens* plantation on the south slopes of the Pentadactylos Mountains, Kantara Forest District on 5 December 2000. The xylem of this tree also contained an infestation of flat-headed woodborers (Coleoptera: Buprestidae). The tree may have been predisposed to bark beetle attack due to moisture stress. A tree with a heavy attack of this insect was found on the north-facing slopes of the Pentadactylos Range of the Kantara Forest District on 8 August 2003. This tree was adjacent to a forest road and had recently been pushed over into a shaded area of forest during road maintenance operations. Surrounding standing *C. sempervirens* trees had heavy shoot mortality caused by feeding of brood adults.

Heavy shoot injury to large *Cupressus sempervirens*, due to adult feeding by *Phloeosinus armatus* was also noted in areas north of the Alevka Forest Station, near the summit of the Pentadactylos Range, on 7 August 2003. The damage was associated with heavy breeding attacks in large branches snapped from *C. sempervirens* trees by a storm that deposited heavy snow in the area during February 2003. This same storm also caused considerable mechanical injury to crowns of *Pinus brutia*. Maturation feeding injury was only found in close proximity to trees with storm damage.

Discussion and conclusions

Tomicus destruens was the most damaging bark beetle observed during these field evaluations. In some cases, multiple tree infestations of up to 30 trees occurred. Most infestations occurred on steep slopes in areas of highly erosive soils. Infestations attributed to this insect were found only during March/April 2003. Local forestry officials knew this insect as the closely related species *T. piniperda*.

Orthotomicus erosus was the cause of mortality of single trees or small groups of trees. Most infestations in standing trees occurred in areas where *Pinus brutia* had been planted on poor growing sites. This insect also has the capacity to attack windthrown trees.

Adult feeding on the stems of *Cupressus sempervirens* by *Phloeosinus armatus* was confined to areas where storm damaged branches or other suitable material for breeding attacks occurred. Adults of the genus *Phloeosinus* are known to be vectors of the canker-causing fungus *Seiridium cardinale*, an important pest of *C. macrocarpa* and *C. sempervirens*, via adult feeding (COVASSI *et al*., 1975; FURNISS and CAROLIN, 1977). However, *S. cardinale* has not been reported from Cyprus. Therefore, damage caused by maturation feeding of this insect is presently unsightly but not likely to cause permanent injury.

The other bark beetles encountered

caused relatively minor damage and confined breeding attacks to severely stressed trees, trees initially infested by the more aggressive species or storm damaged material.

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References

ABGRALL, J.F., SOUTRENON, A., 1991. La forêt et ses ennemis. Paris, France: Centre National du Machinisme Agricole du Génie Rural des Eaux et des Forêts (CEMAGREF).

ANONYMOUS, 2004. Coleoptera: Scolytidae present in the Entomological Museum of Lund University. URL. http://www.biomus.lu.se/zoomus/ZooDoc/VetSam/ZooEnt/OrdCol/ListCol/179. Scolytidae

BRIGHT, D.E., SKIDMORE, R.E., 2002. A catalogue of Scolytidae and Platypodidae (Coleoptera), Supplement 2 (1995-1999). Ottawa, Canada: NRC Research Press, 523 pp.

BROWNE, F.G., 1968. Pests & diseases of forest plantation trees. Oxford, UK: Clarendon Press, 1330 pp.

CIESLA, W.M., 2004. Forests and forest protection in Cyprus. *Forestry Chronicle* **80**(1): 107-113.

COVASSI, M., INTINI, M., PANCONESI, A., 1975. Osservazioni preliminari sui rapporti fra *Coryneum cardinale* Wag. e *Phloeosinus aubei* Perr. in Toscana. *Redia* **56**: 159-166.

FACCOLI, M., PISCEDDA, A., SALVATO, P., SIMONATO, M., MASUTTI, L., BATTISTI, A., 2005. Genetic structure and phylogeography of pine shoot beetle populations (*Tomicus destruens* and *T. piniperda*, Coleoptera Scolytidae) in Italy. *Ann. For. Sci.* **62**(2005): 361-368

FURNISS, R.L., CAROLIN, V.M., 1977. Western forest insects. USDA Forest Service, Miscellaneous Publication 1339, 654 pp.

GALIÁN, J., GALLEGO, D., 2000. Investigation of the validity of species status of *Tomicus destruens* (Coleoptera, Scolytidae) using ribosomal DNA. XXI International Congress of Entomology, August 20-26, 2000, Brazil, Abstract Book 1, pp. 950.

GALLEGO, D., CÁNOVAS, F., ESTEVE, M.A., GALIÁN, J., 2004. Descriptive biogeography of *Tomicus* (Coleoptera: Scolytidae) species in Spain. *Journal of Biogeography* **31**(12): 2011–2024.

GEORGHIOU, G.P., 1977. The insects and mites of Cyprus. Athens, Greece: Kiphissa, pp 73-75.

GRÜNE, S., 1979. Handbuch zur bestimmung der europaischen Borkenkäfer (Brief illustrated key to European bark beetles). Hannover, Germany: Verlag M. & H. Schaper, 182 pp. (In German and English).

HUI, Y., XUE-SONG, D., 1999. Impacts of *Tomicus minor* on distribution and reproduction of *Tomicus piniperda* (Col., Scolytidae) on the trunk of the living *Pinus yunnanensis* trees. *Journal of Applied Entomology* **123**: 329-333.

KOHLMAYR, B., RIEGLER, M., WEGENSTEINER, R., STAUFFER, C., 2002. Morphological and genetic identification of the three pine pests of the genus *Tomicus* (Coleoptera, Scolytidae) in Europe. *Agricultural and Forest Entomology* **4**: 151-157.

LANGSTRÖM, B., HELLQUIST, C., 1993. Induced and spontaneous attacks by pine shoot beetles on young Scots pine trees: tree mortality and beetle performance. *Journal of Applied Entomology* **115**: 25-36.

LEKANDER, B., 1971. On *Blastophagus destruens* Woll. & a description of its larva (Col. Scolytidae). *Entomologisk Tidskrift* **92**: 271-276.

NANNI, C., TIBERI, R., 1997. *Tomicus destruens* (Wollaston): biology and behavior in Central Italy. In: Proceedings: Integrating cultural tactics into the management of bark beetle and reforestation pests. USDA Forest Service, Northeastern Research Station, General Technical Report NE-236.

SELMI, E., n.d. Scolytidae of Turkey. URL http://www.orman.istanbul.edu.tr/ento/

TSINTIDES, T.C., KOURTELLARIDES, L., 1998. The endemic plants of Cyprus. Nicosia, Cyprus: Bank of Cyprus Group and Cyprus Association of Professional Foresters, 123 pp.

WOOD, S.L., BRIGHT, D.E., 1992. A catalogue of Scolytidae and Platypodidae (Coleoptera), Part 2, Taxonomic Index. *Great Basin Naturalist Memoirs* **13**: 1553 pp.