Forests and forest protection in Cyprus

by William M. Ciesla¹

Cyprus, an island located in the eastern Mediterranean Basin, was heavily forested prior to human settlement. Human influence since about 6000 BC has significantly changed the area and composition of the island's forests. Approximately 40% of the Island is presently occupied by forest, maquis and garigue vegetation. The dominant tree species in Cyprus' forests is *Pinus brutia*, which has been planted extensively on abandoned agricultural lands and areas burned by wildfire. *P. brutia* forests are subject to periodic wildfire episodes. In addition, young plantations are subject to defoliation by the pine processionary caterpillar, *Thaumetopoea pityocampa* (Lepidoptera: Pityocampidae), and older forests are subject to attack by several species of bark beetles (Coleoptera: Scolytidae). A policy of extensive planting of pines will, most likely, result in continued problems with wildfire, pine processionary caterpillar and bark beetles in the foreseeable future. Long-term measures to effectively manage these problems include examination of opportunities to plant alternative tree species and to manage the vegetation to increase the diversity of the Island's wildland ecosystems.

Key words: Cyprus, forest protection, pine processionary caterpillar, bark beetles, wildfire

Chypre, une île située dans le bassin oriental de la Méditerranée, était densément boisée avant l'arrivée des premiers colons. L'influence humaine datant de 6000 ans av. J.-C. a modifié de façon significative la superficie et la composition des forêts de l'île. Près de 40 % de l'île est présentement occupé par la forêt, le maquis et la garrigue. L'espèce d'arbre dominante dans les forêts de Chypre est le *Pinus brutia*, qui a été planté très fréquemment sur les terres agricoles abandonnées et les terres dévastées par les feux hors contrôle. Les forêts de *P. brutia* connaissent des épisodes périodiques de feux hors contrôle. De plus, les jeunes plantations subissent la défoliation de la chenille processionnaire du pin, *Thaumetopoea pityocampa* (Lépidoptère: Pityocampidae) et les vieilles forêts sont sujettes à des attaques de plusieurs espèces de dendroctone (Coléoptère: Scolytidae). Une politique de plantation extensive de pins résultera, vraisemblablement, en des problèmes continus de feux hors contrôle, et de ravages par la chenille processionnaire du pin et les dendroctones dans un avenir prévisible. Les mesures à long terme pour contrôler efficacement ces problèmes comportent l'étude des possibilités de planter d'autres espèces d'arbres et d'aménager la végétation pour accroître la diversité des écosystèmes sauvages de l'île.

Mots-clés: Chypre, protection des forêts, chenille processionnaire du pin, dendroctones, feux hors contrôle

Introduction

Cyprus, with a land area of about 9250 km², is the third largest island in the Mediterranean Sea. Since 1974, the island has been partitioned into two parts: the Greek Cypriot Community (GCC) in the southern part of the island and the Turkish Cypriot Community (TCC) in the north. Forests, in combination with garigue and maquis vegetation, cover about 40% of the land area of Cyprus (URS Dames and Moore 2001). A combination of an arid to semi-arid climate, frequent wildfire episodes and insect outbreaks, coupled with excessive exploitation by humans and grazing by domestic animals have affected the health and productivity of these forests. This paper provides an overview of forests and forestry in Cyprus, with emphasis on protection of forests from fire and insects.

Historical Background

Prior to human occupation, Cyprus apparently was heavily forested and its low elevation forests apparently contained large numbers of oaks, including *Quercus coccifera* and *Q. infectoria*. However, since early human settlements were established on Cyprus, about 6000 BC, people have depended on these forests as a source of fuel, building materials, game animals and for grazing of domestic livestock.

Cyprus has experienced great fluctuations in human populations and both good and bad economic times as Egyptians, Phoenicians, Persians, Greeks, Ottomans and other societies dominated the island. During Classic times, Cyprus had sufficient forest resources to become an important shipbuilding

center and a timber exporting country. A factor that all of the societies that dominated Cyprus during its long history had in common was the heavy use and abuse of its forests. During the 19th century, the goat population on Cyprus exceeded that of any other island in the Mediterranean Sea. Overgrazing and intentional setting of fires to produce fresh forage for livestock transformed large areas of forest into degraded shrub (garigue and maquis) vegetation. Land clearance and terracing of hillsides for crop production destroyed virtually all of the island's oak forests. Today, with the exception of the endemic golden oak, *Quercus alnifolia*, a low shrub, oak forests no longer exist in Cyprus, other than a few small groves or individual trees (WWF 2001).

When the British assumed control of Cyprus in 1878, its forests were significantly reduced in area and what forest remained was severely degraded. One of the first agencies chartered by the British was a Department of Forestry, which began reforesting areas using both native and introduced species. *Eucalyptus cameldulensis* and other eucalypts were introduced from Australia by British foresters and planted with varying degrees of success. During the 1950s, following accelerated timber harvesting during World War II, the Department of Forestry launched a massive forest recovery effort. This included an accelerated reforestation program and the formal declaration of most forest areas as off-limits to grazing of goats (Sfikas 1996). Pines,

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especially the indigenous *Pinus brutia*, were widely planted, with little or no consideration given to moisture and soil requirements. This resulted in establishment of large areas of pine plantations on unsuitable sites. While many trees survived, growth was slow and the trees developed poor form and were subject to damage by a variety of pests and diseases.

Heavy human pressure on the forests of Cyprus exists to this day. During the Turkish Invasion of 1974, large areas in the northern part of Cyprus burned and today most, if not all wild-fires are of human origin. Extensive afforestation/reforestation programs continue with pines being the preferred plantation species. In addition to being a source of wood products, the forests of Cyprus are also important for recreation and hunting. Moreover, they provide habitat for a unique flora and fauna including many endemic species.

Present Day Conditions

Forests presently cover approximately 175 000 ha of land area in Cyprus (URS Dames and Moore 2001). Some 44 000 ha are located in the northern part of Cyprus (Turkish Cypriot Community or TCC) and 131 000 ha are located in the southern part of the Island (Greek Cypriot Community or GCC). Forests tend to occur at the higher elevations, which receive more precipitation and are, therefore, capable of supporting trees.

In the northern part of Cyprus, the forest area is found primarily in the Pentadactylos (Five Finger) Mountains, a range of low but rugged mountains that parallel the northern coast, and in the Karpas Peninsula. In southern Cyprus, forests are found primarily on the northwest coast, near Cape Arnavut and the Troodos Massif, a highland in the west central portion of the island.

Most of the Island's forests are managed by the Greek and Turkish Cypriot Forestry Departments. Privately owned forests are generally small blocks of wooded farmlands adjacent to the state forests.

Natural vegetation

According to Tsintides and Kourtellarides (1998) the present day natural vegetation of Cyprus can be classified into five groups:

1. Pine forests
2. Garigue and maquis
3. Rocky areas
4. Coastal areas
5. Wetlands

As an island ecosystem, Cyprus is home to a number of endemic species. Some 128 endemic plants are known to occur on Cyprus (Tsintides and Kourtellarides 1998). Undoubtedly, the Island's best-known endemic species is the Cyprian wild sheep or mouflon, *Ovis musimon* ssp. *orientalis*, which is found in the Pathos Forest (Sfikas 1996). Moreover, three species and six subspecies of butterflies are endemic to Cyprus (Makris 2003).

Pine Forests – Pine forests comprise the most important and largest natural habitat of Cyprus' wild flora. They are found at a wide range of elevations, from sea level on the north facing slopes of the Pentadactylos Mountains to the highest summits of the Troodos Massif. Tsintides and Kourtellarides (1998) consider Cyprus' pine forests a climax vegetation community in areas where natural succession is not constantly disrupted by human activities such as repeated fires or overgrazing and where soils are not severely eroded.

Fig. 1. Natural forest of *Pinus brutia*, Makheras Forest, Greek Cypriot Community.

Cyprus's pine forests can be subdivided into two broad zones: 1. The brutia pine zone, dominated by *Pinus brutia* and 2. The black pine or Troodos pine zone, dominated by *Pinus nigra* ssp. *pallasiana*.

The brutia pine zone can occur from sea level to about 1200 m, extending to elevations of 1400 m on south facing slopes. It covers a total area of about 100 000 ha, representing about 11 % of the total area of Cyprus. Mean annual precipitation in this zone ranges from 450 mm to 800 mm. The dominant tree is *Pinus brutia*, a species indigenous to Crete, the eastern Greek Isles, Turkey, Cyprus, Syria, Lebanon and the northern coast of the Black Sea (Fig. 1, Critchfield and Little 1966). Associated tree species include the endemic *Cedrus brevifolia* in the Paphos Forest of western Cyprus, *Cupressus sempervirens* in the Pentadactylos Mountains, the endemic *Quercus alnifolia*, which is confined to the southern part of Cyprus and the endemic *Arbutus andrachne*. *Juniperus phoenicea* is a common associate in the understory of some low elevation *Pinus brutia* forests in the TCC and the dominant tree on the Karpas Peninsula.

The black or Troodos pine zone occupies the highest elevations of the Troodos Forest between 1200–1900 m. They cover a restricted area of about 6000 ha. This area is characterized by relatively high precipitation (800 to 1000 mm annually), snowfall and low winter temperatures (down to –10 degrees C) and cool sum-

mers. The dominant tree in this zone is *Pinus nigra* ssp. *pallasiana*, which forms open forests of large trees. Associated species include *Pinus brutia*, which occurs in mixture with *Pinus nigra* ssp. *pallasiana* at the transition of the brutia and Troodos pine zones and *Juniperus foetidissima*.

Garigues and Maquis – Garigue and maquis vegetation are primarily of human origin. They are the result of destruction of forest followed by periodic burning and overgrazing, which leads to soil erosion and reduction of ecosystem productivity. Where the soil is not severely eroded and other factors, such as slope, aspect and availability of moisture are not limiting, the successional order garigue > maquis > pine forest is followed and eventually pine forest is re-established. In other cases, soils are so severely eroded that the garigue and maquis are the climax vegetation communities, although in most cases there is a slow progression of garigue to maquis to pine forest. These vegetation types are subdivided into three groups as follows:

1. Garigue on dry, eroded soils
2. Garigue on moderately eroded soils
3. Evergreen sclerophyllous shrubs (Maquis)

Garigue vegetation on dry eroded soils occurs at low elevations on the dry eroded hills of the Mesaoria Plain, around Nicosia and in the eastern part of the Larnaka District. High shrubs are completely absent and the vegetation cover rarely exceeds 40–50% of the ground surface.

Garigues on moderately eroded soils are found from sea level up to the Troodos Massif in areas of moderate soil erosion and where vegetation is burnt every 5–15 years. Where the soil has not been severely affected and where fire allows, this garigue may develop into maquis. Garigue vegetation is dominated by the presence of low shrubs with a few higher shrubs and trees. Total ground cover usually exceeds 50% of the surface area. Main tree species in this vegetation zone include *Pistacia* spp., *Ceratonia siliqua*, *Pinus brutia* and *Olea europea*.

The dominant plants of the evergreen sclerophyllous shrub or maquis vegetation zone are shrubs of varying heights (1–5 m) mixed with lower shrubs, herbs and isolated trees. Maquis can be found in coastal zones with precipitation exceeding 450 mm and at higher elevations up to 1000 m. The main species represented in the maquis zone include *Juniperus phoenicea*, *Pistacia lentiscus*, *Ceratonia siliqua*, *Olea europea*, *Cistus* spp., *Salvia fruticosa* and occasional *Pinus brutia*. At higher elevations, the dominant species are *Quercus alnifolia*, *Q. coccifera*, *Pistacia terebinthus*, *Crataegus* spp., *Arbutus andrachne* and others.

Rocky Areas – These comprise a variety of individual habitats including rocky outcrops at low or high altitudes, on limestone or igneous formations, shaded/moist sites or sunny warm sites, gorges or rocky slopes. Vegetation on these sites is sparse and plants only thrive where there is some soil in pockets, clefts or fissures in the rock. Trees and shrubs are usually absent and when present are dwarfed or stunted.

Coastal Areas – Coastal areas consist of a narrow belt, 50 to 150 m in width along the coast. This belt is permanently affected by the salinity of water in the soil and air. Vegetation is mostly low and sparse and is composed of plants that are adapted to these conditions. Trees are generally absent from these sites.

Wetlands – These include stream bottoms, salt lakes, small, marshy areas near springs, reservoirs and artificial lakes. Wetlands are characterized by a constant high availability of water, a high water table, occasionally waterlogged soil and poor soil aeration. Along streams, there is usually dense vegetation, especially where slopes are gentle. Trees and woody plants present on these sites include *Platanus orientalis*, *Alnus orientalis*, *Laurus nobilis*, *Nerium oleander* and *Rubus sanctis*.

Forest plantations

Afforestation/reforestation has been a major activity on Cyprus since the British assumed control of the island in 1878 and organized a Department of Forestry. Today both the GCC and TCC have extensive areas of forest plantations. These have been established on abandoned agricultural lands and areas burned by wildfire. The objective of the afforestation/reforestation is multipurpose: to establish tree cover, protect watersheds and/or provide habitat for wildlife. Because of the relatively poor growing conditions in Cyprus, production of timber is not considered a major objective of the afforestation/reforestation program.

Pines, especially the indigenous *Pinus brutia*, have been the primary plantation species used in Cyprus. Pine plantations have been established throughout the island. In many cases, steep hillsides have been terraced to capture precipitation and ensure higher rates of tree survival. Many of these plantations have been established with little or no consideration of site conditions. For example, during the early years of British rule, an extensive area of *Pinus brutia* plantations was established on the south facing slopes of the Pentadactylos Mountains. Seedling survival was poor and the growth rate of the surviving trees is low. Today, this area consists of an open pine savannah of poorly formed trees and is the site of chronic bark beetle activity.

According to data from TC Forestry Department, approximately 20 000 ha of plantations have been established in the TCC, mostly with pine. This is equivalent to about one half of the forest area of the northern part of Cyprus. More recently, there has been a shift from pure *Pinus brutia* plantations to mixed plantations of *P. brutia*, *P. halapensis* and *Cupressus sempervirens*. These are typically established by planting four individuals of a species along a row, then four individuals of the second species, followed by four individuals of the third species. The GC Forestry Department has been experimenting with mixed plantations of pine and drought tolerant broadleaf species such as wild olive, *Olea europea*.

Recently, the TC Forestry Department has begun to establish community forest plantations near villages. These plantations are established on abandoned agricultural lands in response to requests from villagers. The plantations are dominated by pines and are typically established on sites that are too warm and dry for pines to grow well. These plantations are subject to defoliation by pine processionary caterpillar, *Thaumetopoea pityocampa*, and can expose village residents to the urticating hairs of the mature caterpillars. Also, assuming that these plantations will produce large trees, it puts nearby villages at increased risk of damage by wildfire.

Forest Protection

Wildfire

The climate of the Mediterranean Basin is characterized by cool, wet winters and hot, dry summers. This, coupled with a

long history of human influence, provides conditions that favour the occurrence of frequent wildfires (Agee 1998). Cyprus is no exception. Northern Cyprus, in particular, has suffered several extensive wildfire episodes in recent years. During the Turkish invasion of 1974, for example, over 10 000 ha of forests in the Pentadactylos Mountains burned. Reforestation of these areas has been a continuing process since 1974. In 1995, some 8800 ha burned, mostly on the north facing slopes of the Pentadactylos Mountains. Much of this area has been reforested with plantations of *Pinus brutia*. An additional 3700 ha burned in 1998. Virtually all wildfires are of human origin.

Relatively little is written about the fire ecology of *Pinus brutia*. However, considerable information is available on its western Mediterranean counterpart, *P. halapensis*. Since the two species are closely related, much of this information is also applicable to *P. brutia*.

Both *Pinus halapensis* and *P. brutia* have characteristics that allow them to adapt to fire. They are prolific seeders and can produce small numbers of cones at an early age. A portion of the cones are serotinous and do not open to release seed until exposed to intense heat. This allows burned areas to quickly regenerate to pure pine forests. As these trees get older, they develop a thick bark that enables them to tolerate low intensity wildfires or prescribed burns (Fig. 2, Agee 1998, Liacos 1974).

Agee (1998) considers *Pinus halapensis* as a pine with a high intensity fire regime. Forests dominated by this pine are considered one of the most flammable and fire-prone vegetation types in the Mediterranean Basin. Existing forest fire statistics indicate that about one-third of the area burned in the Mediterranean Basin in recent years has been in *P. halapensis* forests. In Greece, between 1956 and 1971, about 60% of the burned area was in *P. halapensis* and *P. brutia* forests (Liacos 1974). Lightning accounts for only about 2% of the area burned in this region. Most ignitions are of human origin (Agee 1998).

Work by Liacos (1974) in Greece indicates that both *Pinus halapensis* and *P. brutia* are able to survive prescribed burning of the brushy understory vegetation after they have reached an age of 30 years. By this time, the bark of the trees is sufficiently thick to protect the cambium from the temperatures generated by a low-intensity ground fire.

Because *Pinus halapensis*, and probably *P. brutia*, are well adapted to frequent, intense ground fire, these trees may have expanded their ranges into areas once occupied by less fire-tolerant species. On the other hand, repeated fires within a single decade will exhaust pine seed sources, resulting in conversion to garigue or maquis vegetation (Agee 1998).

Insects

Protection of forests from damaging insects is another key management concern. Important insect pests include the pine processionary caterpillar, *Thaumetopoea pityocampa* (Lepidoptera: Pityocampidae)² and several species of bark beetles.

²Two species of pine processionary caterpillars are sometimes recognized: *Thaumetopoea pityocampa* Denis and Schiffmüller in the western Mediterranean and *Th. wilkinsoni* Tams of the eastern Mediterranean (Cyprus, Lebanon, Jordan and Tunisia and Israel). The latter was described from Cyprus in 1925 based on differences in the general coloration of the adult, the genital organs and the structure of scales that cover the extremity of the abdomen of the female adult, which are used to cover the eggs during oviposition. However, research studies in Israel have shown that the two forms respond to the same pheromone and readily interbreed, suggesting that the status of *Th. wilkinsoni* is questionable.

Fig. 2. Thick bark on mature *Pinus brutia* may be an adaptation to low intensity ground fires.

Pine Processionary Caterpillar – Pine processionary caterpillar is regarded as the most damaging pest of pine forests throughout the Mediterranean Region. Natural forests, plantations and ornamental trees are subject to periodic outbreaks. During outbreaks, needles can be stripped from pines in less than a week (Fig. 3). While few trees are killed directly as a result of defoliation, infested trees suffer from reduced growth and large trees have increased susceptibility to attack by bark beetles. The larvae have urticating hairs, which can cause skin rash and eye irritation on contact. Human exposure to the larvae can produce extremely irritating symptoms in some individuals (Speight and Wainhouse 1989). During outbreaks, the entire environment becomes contaminated with microscopic hairs to the extent that campsites and other forest recreation areas become unusable.

Adults emerge in late summer and lay eggs on the needles of host trees. Trees growing in the open or at the edge of forests are preferred for egg laying. Most of the eggs are laid in one large egg mass on a needle, usually in the upper crown. The larvae hatch in late summer-early autumn and begin to feed in colonies on the foliage of host trees. The larvae are gregarious throughout the entire feeding period (Fig. 4). During early winter, the larval colonies construct large silken tents that provide protection from natural enemies and insulation against cold temperatures. Some feeding may occur on sunny days throughout the winter and feeding begins again in earnest in February and March. During the spring, the larvae form single

Fig. 3. Heavy defoliation by pine processionary caterpillar, *Thaumetopoea pityocampa* on young *Pinus brutia* (Photo by Patricia M. Ciesla).

file, head to tail processions and crawl down the main stems of host trees to pupate, as a colony, in the soil. Not all of the pupae produced during a given season emerge as adult moths during the following summer. A portion of the population enters an extended diapause and emerges the following year although some individuals can remain in diapause for five or more years.

The timing of key events in the life history of *Th. pityocampa* can vary significantly according to altitude and latitude. This is regulated primarily by the occurrence of an extended diapause in warmer areas (Buxton 1983, Speight and Wainhouse 1989, Abgrall and Soutrenon 1993).

Hosts include various species of *Pinus* and, occasionally, *Cedrus*. Pines reported as hosts include Aleppo pine, *Pinus halapensis*; Austrian pine, *P. nigra*; Corsican pine, *P. nigra* var. *maritime*; Calabrian pine, *P. brutia*; Maritime pine, *P. pinaster*; Monterey pine, *P. radiata*; and Scotch pine, *P. sylvestris* (Abgrall and Soutrenon 1993). The stone pine, *P. pinea*, an important producer of pine nuts (*pignoli*) in the Mediterranean Region is attacked but is usually not severely damaged. In Cyprus, the primary host is *Pinus brutia*. *P. nigra* ssp. *pallasiana* is also attacked but infestations are generally light and trees are not severely damaged. The endemic true cedar, *Cedrus brevifolia*, occasionally receives minor damage.

Fig. 4. Colony of mature larvae of pine processionary caterpillar, *Thaumetopoea pityocampa*.

Pine processionary caterpillar populations are favoured by warm winter temperatures and relatively dry conditions. The larvae of the pine processionary caterpillar are active during the winter months (November–March) and depend on solar radiation for survival. The nests are warmed by winter sun to several degrees above ambient temperature. In France, the northern limits of the natural range of this insect are defined by a minimum requirement of 1800 hours of sun exposure per year and average minimum January temperatures above -4 degrees C (Hutchon and Demolin 1971). Moreover, this insect's preference for laying eggs in open stands or at the edge of forests is well documented (Buxton 1983, Speight and Wainhouse 1989).

Outbreaks and defoliation tend to be more severe during years with mild winter temperatures and below normal precipitation. Observations by the author in the northern part of Cyprus suggest that pine processionary caterpillar infestations have the following characteristics:

1. Young plantations (< 15 years old and < 2 m in height) tend to suffer more severe damage than older stands.
2. Low elevation sites, generally below 200 m in elevation, tend to suffer more severe damage than high elevation sites.
3. Plantations on south facing slopes tend to be more severely damaged than those on north facing slopes.
4. In mixed plantations of *Pinus brutia* and *P. halapensis*, both species appear to suffer similar levels of defoliation.

A variety of preventative and direct control measures are used to combat this insect. Removal and destruction of branches containing egg masses and larval colonies is effective in small areas such as campsites or picnic grounds and has been widely used in the northern part of Cyprus. Aerial and ground application of chemical and biological insecticides is also widely used. In recent years, diflubenzuron (Dimilin) and the bacterium, *Bacillus thuringiensis*, are the materials that have been used most extensively. These measures are expensive, labour-intensive and there is some concern that even use of a material such as *Bacillus thuringiensis*, could have adverse effects on non-target Lepidoptera including the several species of butterflies endemic to the Island.

Defoliation by pine processionary caterpillar has intensified in recent years, partially due to climatic conditions that favour the insect but also because of the large volume of suitable host material available in the extensive areas of young pine plantations established in recent years to replace forests destroyed by fire. Continuation of a policy of extensive planting of pines, without regard to site conditions will, most likely, result in a continued and chronic problem with pine processionary caterpillar into the foreseeable future. Unless prevention tactics are implemented, this will necessitate a continuation of labour-intensive and costly direct control projects to protect pine resource and minimize human health hazards associated with the urticating hairs of the larvae of this insect.

Bark Beetles – Bark beetles (Family: Scolytidae) are another group of insects that can damage Cyprus' forests. Although this group of insects has not been studied extensively on Cyprus, collection records indicate that about 13 species are associated with either *Cedrus*, *Cupressus* or *Pinus* (Georghiou 1977). Observations by the author indicate that at least three species of pine-infesting bark beetles are damaging to *Pinus brutia*. These include *Orthotomicus* (= *Ips*) *erosus*, *Tomicus* (= *Blastophagus*) *minor* and *Tomicus destruens*. They are capable of attacking living trees under varying degrees of stress and can also attack windthrow and storm breakage, in which they can build up to outbreak levels and attack standing trees.

Orthotomicus erosus typically kills trees in low elevation pine plantations established on extremely dry sites on the south facing slopes of the Pentadactylos Mountains. It appears to be most common from mid-summer to late fall. This insect is also capable of attacking windthrown trees and fresh logging debris, where it can develop into high populations.

Tomicus destruens is closely related to the European pine shoot beetle, *Tomicus piniperda*, which has recently become established in eastern and central North America (Haack *et al.* 1997). The two species are difficult to separate and collections made in Cyprus to date have been identified as *T. piniperda*. Specimens collected by the author during March 2003 were identified as *T. destruens*³. *T. destruens* apparently is the more common species in the low elevations of the Mediterranean Basin and either has two overlapping generations per year or females of the same generation attack more than one tree and produce several broods. *T. piniperda*, on the other hand,

Fig. 5. Galleries and brood of the bark beetle, *Tomicus destruens*, in a *Pinus brutia* branch.

has a Eurasian distribution and has one generation per year. The adults of both species feed in the new shoots of pines to achieve sexual maturity and can cause growth reduction and deformity of young pines (Abgrall and Soutrenon 1993, Nanni and Tiberi 1997, Stauffer 2003).

Observations made by the author during March/April 2003 indicate that *Tomicus destruens* is associated with pine plantations established on low elevation sites and on steep, highly erosive slopes. Group kills of up to 30 trees are common. This insect seems to prefer the thin-barked portions of large pines and often confines its attacks to the upper portions of the bole (Fig. 5).

Tomicus minor is commonly found in the thin barked portions of the upper boles and branches of trees attacked by *Orthotomicus erosus*.

A bark beetle of the genus *Phloeosinus*, probably *P. armatus*, is associated with *Cupressus sempervirens*. This insect uses recently dead trees, windthrow and broken branches as breeding sites and does not appear to be an important tree killing species. Maturation feeding by emerging adults takes place in the branches of vigorous *C. sempervirens* trees, however, and during years when this insect is abundant, it can cause significant feeding damage.

Discussion and Conclusions

The forest and wildland vegetation of Cyprus has been influenced by human activities since about 6000 BC. Activities such as timber harvesting, clearing of land for agriculture and grazing have altered the nature, species composition and dynamics of the Island's forests. Wildland vegetation, consisting of forests, maquis and garigues presently occupies about 40% of the land area. An extensive afforestation/reforestation program, which has been underway since British rule of the island, has expanded the distribution of *Pinus brutia* forests on the island, including to sites not well suited for this species. These forests constitute a simple and, therefore, dynamic ecosystem, subject to frequent episodes of disturbance events such as fire and insect outbreaks. Fire is a constant threat to Cyprus' pine forests and most wildfires are of human origin. Young pine stands are subject to outbreaks of pine processionary caterpillar and older stands are subject to attack by several species of bark beetles.

³Identified by Rudolph Wegensteiner, Institute of Forest Entomology, Forest Pathology and Forest Protection, University of Agricultural Sciences, Vienna, Austria.

Continued heavy human influence, including a policy of extensive planting of pines will, most likely, result in continued problems with wildfire, pine processionary caterpillar and bark beetles in the foreseeable future. Alternative forest management practices, designed to increase the diversity of the Island's forests and reduce the threat of wildfire and insect outbreaks include:

1. Identification of site conditions suitable for establishment of *Pinus brutia* and/or *P. halapensis* plantations. This information can be the basis for development of guidelines that define the conditions under which pine is a viable plantation species and conditions under which pine should be avoided and alternative species considered.
2. Identification of alternative trees and shrubs for afforestation/reforestation on lands that are unsuitable for establishment of pine plantations. Trees and shrubs indigenous to Cyprus should be given priority in species selection. If additional species are needed, priority can be given to species indigenous to the Mediterranean Basin. Identification of suitable alternative species for future afforestation/reforestation programs may require establishment and evaluation of test plantings under a variety of growing conditions and development of techniques to produce seedlings in forest nurseries.
3. Avoid planting of pines near villages. Establishment of pine plantations under these conditions will increase the hazard of human exposure to the urticating hairs of the pine processionary caterpillar. Also, in the long run, these plantations could increase hazard of wildfire near villages. When requests are made for community forest plantings near villages, use species other than pine.
4. On sites favourable for establishment of pine plantations, the establishment of large blocks of pine plantations of the same age should be avoided. Break up large planting areas with blocks of alternative species, such as *Cupressus sempervirens*, or *Pinus pinea*, which is a less desirable food plant for pine processionary caterpillar.

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