

**MAJOR PESTS OF MAN-MADE FORESTS IN ISRAEL: ORIGIN,
BIOLOGY, DAMAGE AND CONTROL**

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The important pests of the three main tree genera used in afforestation in Israel are described. The pine pests are the Israeli bast scale, *Matsucoccus josephi*; the pine processionary caterpillar, *Thaumetopoea wilkinsoni*; the bark beetles *Orthotomicus erosus*, *Pityogenes calcaratus* and *Tomicus destruens*; and the Mediterranean shoot moth, *Rhyacionia buoliana thurificana*. The cypress pests are the bark beetles *Phloeosinus armatus* and *P. aubei*. The eucalypt borer *Phoracantha semipunctata* is the sole significant pest of eucalypts. All of these pests, except for the last, are considered endemic species which maintained themselves in the natural relict stands. Routine chemical control operations are conducted only against *T. wilkinsoni*. Natural enemies are capable of keeping the other pest populations under good control if appropriate silvicultural measures and practices are in use.

KEY WORDS: Man-made forests, Israel; *Cupressus*; *Eucalyptus*; *Pinus*; *Matsucoccus josephi*; *Thaumetopoea wilkinsoni*; *Rhyacionia buoliana thurificana*; *Orthotomicus erosus*; *Pityogenes calcaratus*; *Tomicus destruens*; *Phloeosinus armatus*; *Phloeosinus aubei*; *Phoracantha semipunctata*.

INTRODUCTION

Natural scrub forests (maquis), recalling the Californian chaparral, cover about 40,000 ha in the Mediterranean zone. Among the more important species found in this zone are *Quercus ithaburensis* (Tabor oak), *Q. calliprinos* (Kermes oak), *Q. boissieri* (Cyprus oak), *Pistacia palaestina*, *Styrax officinalis*, *Ceratonia siliqua* (carob), and *Pinus halepensis* (Aleppo pine). Small woodlands of *Tamarix* spp. occur in the Saharo-Arabian (desert) zone. These forests are the source of some of the major pests of forest plantations. Forests in Israel consist of two types, natural and planted. Man-made forests covering approximately 70,000 ha have been planted mainly by the Jewish National Fund (26). Conifers amount to some 70% of the afforested area and

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consist mainly of the indigenous species *Pinus halepensis* and *Cupressus sempervirens* (Italian cypress). Among the exotic pines *Pinus brutia* (brutia pine) is the most common. The remaining 30% of the afforested area in Israel is planted mainly with Australian species: *Eucalyptus*, *Acacia* and *Casuarina*. Small areas in the south of the country are planted with various local tamarisks.

No quantitative assessments of damage by insect pests and pathogenic agents in the natural forests have been made, although large numbers of insect species have been recorded from local tree species (12). Their role in the dynamics of the natural forest is still unknown. According to present data, pests of man-made conifer and eucalypt forests play an important role in the dynamics of the stands and are of significant economic importance. *Acacia* spp. and *Casuarina* spp. are almost free of pests.

This paper summarizes and discusses the origin of damage by and control measures against important pests of the major tree genera used for afforestation in Israel: *Pinus*, *Cupressus* and *Eucalyptus*.

FOREST PESTS

Israeli pine bast scale, Matsuccoccus josephi Bodenheimer et Harpaz (Homoptera: Margarodidae)

Matsuccoccus josephi is an endemic species which has maintained itself in the natural relict stands (5). It was discovered in the mid 1930s in young plantations on the southern slopes of Mount Carmel and the Menashe Hills; later on it was recorded in many other afforestation projects. Although the pest is airborne, some of the plantations in Upper Galilee are still uninfested.

The Israeli pine bast scale is considered the most serious pest of *P. halepensis* in Israel. The scale establishes three or four annual generations in mature pines and up to six generations on irrigated seedlings. The crawlers settle on all above-ground parts of the pine. In mature trees the preferred sites are the partially smooth stem sections with scaly bark, the buds, and the base of the needles of fast-growing shoots. The scale population increases between mid winter and early summer (January-May). About 20% of the pine plantations are significantly damaged by the scale (Madar, Golan and Shaphir, unpublished report of J.N.F., 1984). Extensive tree mortality and heavy damage are caused to plantations in northern Samaria and the Judean Hills in the vicinity of Jerusalem. In plantations, mature trees are often killed; this happens only very rarely in natural stands.

Two types of injury are apparent: (i) chronic injury, *i.e.*, slow decline of the tree, which may continue for several decades due to the scale population developing on the stem, which causes the death of the limbs advancing from the lower to the upper parts of the canopy; and (ii) acute injury, *i.e.*, drying of the entire tree crown within a few years, and in extreme cases, within a few months, caused by the scale population occurring on the terminal shoots (8). Severe pest outbreaks are probably

the result of planting large areas within a relatively short period and of unsuitable seed collection practices and seed sources.

The sole control method in forest practice is to prune the lower branches of young trees (3-9 years old). Stem injection with systemic insecticides is limited to trees in parks and camping sites. Aerial sprays of insect growth regulators are under intensive study. Research on the relation between seed origin of *P. halepensis* and susceptibility to *M. josephi* has shown that Greek and Israeli provenances display a greater resistance to the pest than those from North Africa and Spain (18). Therefore, it is planned to use Aleppo pine from Greece and Israel to develop resistant populations.

Pine processionary caterpillar, Thaumetopoea wilkinsoni Tams (*Lepidoptera: Thaumetopoeidae*)

Thaumetopoea wilkinsoni and a closely related species, *T. pityocampa* Schiff., occur in almost all Mediterranean countries. *T. wilkinsoni* was first recorded in Israel in 1937 in a young plantation at Umm Safa in Samaria (4). Since then the pest has spread to other areas. In the north, for example, it was recently recorded on the southern slopes of Mt. Carmel. The question of whether *T. wilkinsoni* is native to Israel remains open.

The pest is univoltine. The larvae aggregate in typical nests and consume the needles of all pine species during winter and early spring and pupate in the soil (10). The adults emerge during the autumn. The hypogeous period may last up to 9 years (9). *T. wilkinsoni* is a major defoliator of young plantations, especially in the south. The population density (number of nests) is negligible in mature plantations (more than 25 years old), when the canopy begins to close (*cf.* ref. 13). *T. wilkinsoni* is a very important pest in urban areas, for medical reasons, as the urticarian hairs of the larvae cause dermatitis and conjunctivitis.

The pest is under good natural control in mature plantations, apparently due to entomophagous soil fungi such as *Metarrhizium anisopliae* Sor. and *Beauveria bassiana* Vuil., which kill the larvae and the pupae in the ground (13). Stem injection with the systemic insecticides dimethoate or monocrotophos is practised in urban areas. Aerial sprays with endosulfan, diflubenzuron and *Bacillus thuringiensis* formulations are in use.

Mediterranean pine shoot moth, Rhyacionia buoliana thurificana Led. (*Lepidoptera: Olethreutidae*)

The Mediterranean pine shoot moth is a subspecies of the European shoot moth, *Rhyacionia buoliana* Schiff., and is found in Israel, Turkey, Syria, Cyprus, Spain (3,27) and Lebanon (Mendel, unpublished data). It is well known in Europe and North America (*e.g.* 1,25). The pest was first recorded and investigated in Israel by Bodenheimer (3) in young plantations of *Pinus pinea*. It survived in relict pine stands in Israel and then spread to new plantations.

The pest has two or three overlapping annual generations in Israel. Observations in *P. halepensis* stands showed that the females usually lay a single egg on the current

year's shoots close to the terminal bud. The neonate larvae bore through the needle for about a week and then penetrate into the bud; the larvae pupate near the exit hole in the bud or shoot. The adults emerge after a few weeks (Mendel, unpublished data).

The shoot moth is a commonly occurring pest of young pine plantations (3-8 years old). Similar findings were recorded abroad in related *Rhyacionia* species (e.g. 7,15). The pest attacks all pine species, particularly those growing on eroded areas. The damage consists of numerous dead shoots which dry out shortly after the emergence of the moths. The infested bud can be recognized earlier by resin exudation at the base. The role of the shoot moth in the stand dynamics is not yet well established. There have been many reports, mainly from the southern foothills of Judea and the northern Negev, on mass mortality of shoots. In Pelugot, for example, during 1981/1982 about 90% of the terminal shoots were killed in 4-year-old *P. halepensis* plantations after shoot moth attack (Mendel, unpublished data). Infestation probably has no effect on the development of trees older than 8 years. Deformation and twisting of stems or branches is negligible. However, due to killing of most of the terminal shoots, the pest may shape the pine into a bushy growth. No control measures are taken against this pest.

Pine bark beetles: *Orthotomicus erosus* (Woll.), *Pityogenes calcaratus* Eichh. and *Tomicus destruens* (Woll.) (Coleoptera: Scolytidae)

The natural distribution area of these three bark beetle species is essentially Mediterranean. In Israel they occur in natural relict stands. Their potential damage is clearly related to the growth stage of the plantations preferred by each species. Records of the damage were obtained in relation to the age of the plantation (23). *T. destruens*, for example, was recorded in 1959, although the first outbreak did not occur until 1977 (11). Outbreaks by these species have been on the increase over the last two decades in Israel with increasing age of potential host crops (14).

Orthotomicus erosus and *P. calcaratus* are active in the warm months and establish about six annual generations. *O. erosus* prefers to colonize the rough-scale sections of the stem of trees older than 5 years. *P. calcaratus* develops in 3- to 8-year-old pines and in the crowns of older trees on the smooth-barked sections of the stem. *T. destruens* breeds throughout the winter, usually in rough-scaled bark sections of stems of mature pines, and establishes a single annual generation. The adults of *T. destruens* feed on green shoots from early August to March (23).

Severe outbreaks occur after excessive thinning followed by a winter with low rainfall, in plots with poor phytosanitation, where there is a lack of ecological adaptation of pine species, or after fire in adjoining stands. *P. calcaratus* also attacks young seedlings affected by the Israeli pine bast scale.

Removal of slash after thinnings and of dying trees after fires or outbreaks is the usual method of prevention. Hymenopterous parasites (24) and the Syrian woodpecker, *Picoides syriacus* (20), play an important role in the population dynamics of these bark beetles.

Cypress bark beetles: Phloeosinus armatus Reiter and P. aubei Perris (Coleoptera: Scolytidae)

The distribution of *P. armatus* is essentially East Mediterranean, whereas that of *P. aubei* includes the entire Mediterranean basin and extends to central Europe (e.g. 29). Both species are common in natural cypress stands in Lebanon (Mendel, unpublished) and there is little doubt that they are native to the area.

Phloeosinus armatus and *P. aubei* share the same habitats in Israel, although the latter is more common in ornamentals than the former. Both species can develop in small branches as well as in large stems. The life histories of *P. armatus* and *P. aubei* differ: the former breeds throughout the year while the latter excavates its galleries from early spring to autumn. They can each establish up to four annual generations. Both species feed on foliage, and in some cases cause the death of numerous shoots (17).

The cypress bark beetles are secondary pests and attack dying trees with a severely affected root system when the stem was damaged by fire. They may also be involved in the spread of cypress canker (28) and of the bark cracking disease (Z. Madar, personal communication). Trees which are affected by either pathogen serve as breeding sites for the beetles.

It is recommended to suppress the beetle population by use of unpruned trap trees in March (16). Hymenopterous species often lead to a high rate of parasitism (17).

Eucalypt borer, Phoracantha semipunctata (F.) (Coleoptera: Cerambycidae)

During the last four decades the eucalypt borer has been spreading in the Mediterranean basin (2), and only a few countries in the area are now free of it. The borer was introduced into Israel in the early 1940s, probably with Australian or South African army stores (6), and was first recorded in a plantation near Haifa (R. Karschon, personal communication). Its introduction was not accompanied by that of its natural enemies.

The eucalypt borer occurs in almost all eucalypt plantations in Israel. It establishes two or three annual generations, depending upon the environment (19). The female lays egg masses under loose bark, in crevices of stems and branches of weakened trees, or on the lower side of felled trees. The larvae feed in the cambium and penetrate into the wood for pupation.

The borer is the sole and most important specific pest of eucalypts in Israel. It attacks trees under temporary water stress and after fire damage. During 1979-1980, after several dry years, heavy damage was recorded mainly in the southern Shefela, western Negev and Hula Valley.

Suppression of the borer population by trap-logs exposed from April onward is recommended. The Syrian woodpecker is an efficient natural enemy of the borer. This bird, which extended its territory during the last two decades in Israel, is highly effective in destroying the larvae and also consumes the eggs on standing trees (22). So far, initial efforts to acclimatize parasitoids from Australia have failed (21).

DISCUSSION

In spite of their limited area, relicts of natural forests in Israel and adjacent countries constitute an important source of insect pests affecting man-made forest plantations. This applies particularly in the case of *P. halepensis* and *C. sempervirens*. In most of these relicts, natural enemies of these pests were preserved and have followed them into new, man-made habitats, preventing the outbreak of mass infestations as long as suitable silvicultural practices were applied. *P. semipunctata* is a major introduction from Australia via South Africa, which took place more than half a century after the first cultivation of eucalypts in this country. Unfortunately, its introduction was not accompanied by that of its natural enemies and their artificial introduction has so far been unsuccessful. However, a local nonspecific predator, the Syrian woodpecker, extended its territory to encompass eucalypt plantations and has become an efficient control agent of the borer. In contrast to the eucalyptus borer, *T. wilkinsoni* is endemic to our area and its natural enemies were recorded in young plantations soon after the spread of their host to formerly bare areas planted with pines (12). However, routine chemical control is needed to keep this defoliator at low population levels until the forest canopy closes.

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