

Tomicus piniperda (Scolytidae): a Serious Pest of Yunnan Pine in Southwestern China

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Abstract

The pine shoot beetle, *Tomicus piniperda* (L.), is native to the pine growing regions of Europe, Asia, and northern Africa (Bakke 1968; Långström 1983; Ye 1991). Established populations of *T. piniperda* were first found in North America in 1992 (Haack and Kucera 1993), and as of January 2002, it now occurs in 318 counties in the United States and 51 counties in Canada (Haack and Poland 2002). *Tomicus piniperda* occurs throughout China, but has been most destructive in Yunnan Province in southwestern China (Fig. 1; Haack et al. 1998), where it attacks primarily Yunnan pine, *Pinus yunnanensis* (Ye 1995, 1998, 1999). In Yunnan, the first reports of *T. piniperda* killing Yunnan pine began in the early 1980s (Ye 1991). Since then, more than 200,000 ha. of Yunnan pine forests have been severely damaged and killed (Ye 1999). In recent years, *T. piniperda* populations have been increasing in Yunnan, with more than 100,000 ha of Yunnan pine forests seriously infested as of 2001.

Tomicus piniperda completes one generation per year throughout its entire range. In Yunnan, the new generation adults begin to shoot feed in May and continue through March of the next year (Ye and Li 1994, Ye 1996). When 60-90% of the shoots on individual trees have been attacked and killed by *T. piniperda*, trees become highly susceptible to trunk attack by *T. piniperda* (Hui and Lieutier 1997). Because daily wintertime temperatures in Yunnan are usually >10°C, *T. piniperda* adults overwinter in the shoots rather than at the tree base as they do in the colder parts of their geographic range (Bakke 1968; Långström 1983; Ye 1994, 1996). Reproduction in Yunnan typically begins in November, peaks in February and March, and ends in May. Adult flight is common when air temperatures exceed 15°C. In some cases, *T. piniperda* adults first aggregate in the crowns of selected trees prior to trunk attack (Hui and Lieutier 1997). Trunk attack on these trees usually starts along the upper trunk near the base of the crown, and later spreads downward to the lower trunk (Ye 1995, 1999). Overall, most trunk attacks on Yunnan pine occur in

the upper- and mid-bolts, which is opposite to the attack pattern found on Scots pine, *Pinus sylvestris* (Ye 1995). Overall, *T. piniperda* can seriously injure Yunnan pine because of their extended period of shoot feeding and their ability to directly attack and breed in the trunks of living trees.

Tomicus piniperda occurs throughout much of Yunnan, with the most severe damage occurring in a zone that extends from northwestern to southeastern Yunnan (Ye 1998, 1999). *Tomicus piniperda* is found at elevations between 600-3000 meters in Yunnan, with the highest populations occurring at about 2000 meters. Yunnan pine is the preferred host of *T. piniperda* in Yunnan. The *T. piniperda* outbreak area in Yunnan mirrors the geographic range of Yunnan pine. The average annual precipitation throughout most of *T. piniperda*'s Yunnan range is 700 to 1100 mm. About 20% of the annual rainfall occurs from November to early May when *T. piniperda* adults attack and reproduce in the trunks of live pine trees. Drought stress may be one of the key factors that increase tree susceptibility to *T. piniperda* attack (Ye 1999). The average annual temperature in central Yunnan is 15°C, and varies from an average of 9°C in winter to 23°C in summer. Such warm temperatures allow *T. piniperda* to be active year round in Yunnan.

In Yunnan, *T. piniperda* populations first increased to damaging levels in the early 1980s (Ye 1991). Populations peaked in 1987 and then declined through 1996. In 1997, populations increased again, reaching their highest levels in 2001 (Fig. 1). Moreover, in 2001, *T. piniperda* infested forested areas of Yunnan where it had never been previously reported. The high populations in 2001 may in part be related to several consecutive years of warm and dry winters that preceded 2001. Another factor that may be related to the *T. piniperda* buildup is the widespread cutting of infested trees with no immediate reforestation. As the stands became more open, they apparently became drier, which further increased their susceptibility to *T. piniperda* attack. In addition, during the late 1990s, tree removal often occurred after the brood adults had

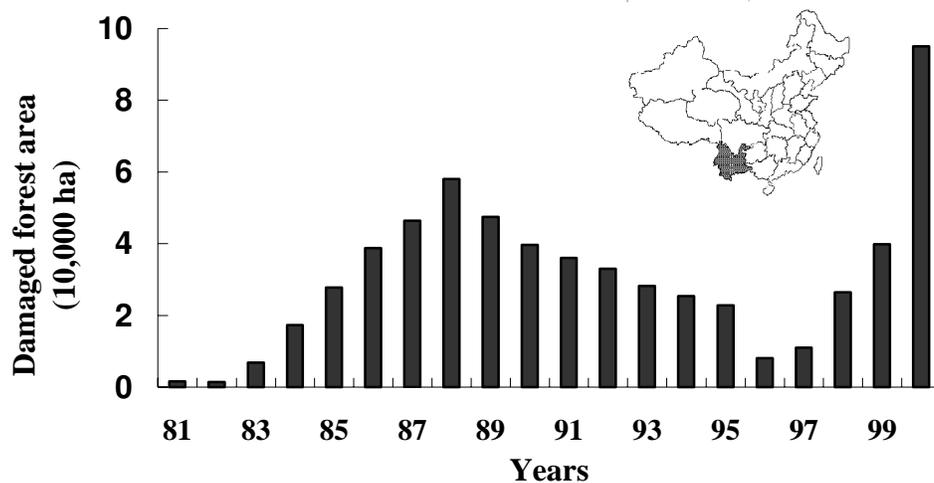


Figure 1.—Total area of Yunnan pine forest severely affected by *Tomiscus piniperda* in Yunnan during the period 1981-2000. In addition, an outline map of China is shown, indicating the location of Yunnan Province (shaded area).

already exited the trees, which therefore did not help in lowering local *T. piniperda* populations.

The pathogenic fungus, *Leptographium yunnanense*, was first reported from galleries of *T. piniperda* in Yunnan in 2000 (Ye and Zhou 2000; Zhou et al. 2000). This bluestain fungus can kill Yunnan pines when artificially inoculated in the trunk, suggesting that this fungus can aid *T. piniperda* in overcoming tree resistance. The bluestain fungus *Ophiostoma minus* can also be isolated from *T. piniperda* adults and their galleries in Yunnan (Ye and Zhou 2000). At high densities, *Ophiostoma minus* can kill Yunnan pines. However, the frequency of isolating *Ophiostoma minus* from *T. piniperda* is much lower in Yunnan than in Europe.

Tomiscus minor has the same geographic distribution as does *T. piniperda* in Yunnan. *Tomiscus minor* tends to attack and breed in trees already attacked by *T. piniperda* (Ye 1997). Because *T. piniperda* typically initiates attack in the upper trunk, *T. minor* tends to colonize the lower and mid trunk (Ye 1997). The within-tree distribution pattern of these two *Tomiscus* species in Yunnan is opposite to that reported on Scots pine in Europe. It is suggested that *T. minor* assists *T. piniperda* in overcoming tree resistance and accelerating tree death (Ye 1997; Ye and Ding 1999).

Thanasimus formicarius (Coleoptera: Cleridae) usually completes one generation per year in Yunnan. Adult *T. formicarius* oviposit in trees that have been attacked by *T. piniperda* (Ye et al. 1999). Oviposition begins in spring and continues through mid-summer. Clerid larvae prey on the immature stages of *Tomiscus* along

with other organisms living under the bark. Until now, *T. formicarius* populations have rarely reached high enough levels to influence *Tomiscus* populations in Yunnan (Ye and Zhao 1995). One possible reason for this lack of impact is that most *T. formicarius* remains in the larval stage long after *T. piniperda* have matured and exited the trees. As the results, little food in the tree allows *T. formicarius* larvae to complete their development. Woodpeckers, such as *Dendrocopos major* and *Picus canus*, have also been found feeding on the immature stages of *T. piniperda*. However, the impact of woodpeckers on *T. piniperda* populations may be limited due to low bird populations in most areas of Yunnan.

Removal of the trunk-infested trees is the primary approach used to control *T. piniperda* in Yunnan. Most trunk-infested trees are cut in April before the new generation of *T. piniperda* have completed development and exited the trees. However, 3-4 cuttings per year are often needed due to *T. piniperda*'s extended period of trunk attack and production of sister broods. As a long-term control strategy, establishment of mixed forests has also been initiated in recent years to increase habitat diversity and abundance of natural enemies, which is hopeful to reduce *T. piniperda* outbreak. Fir (*Cryptomeria fortunei*, *Cunninghamia lanceolata*), cypress (*Platycladus orientalis*, *Calocedrus macrolepis*), and other pine species such as *Pinus armandii* are planted after removal of Yunnan pine. In addition, plans are now underway to augment natural enemy populations in Yunnan pine forests, using in particular the clerid *Thanasimus formicarius*.

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