Chapter II

Literature review

The Scolytidae and Platypodidae live either by burrowing in the material that serves as food, or else in tunnels in which their food is cultivated. These activities can cause tree stress, tree mortality, and quality degradation in timber destined for human uses. However, these activities are also a crucial initial step of woody biodeterioration in forested ecosystems. Estimation of worldwide species number of Scolytidae was listed 5,812 (Wood and Bright, 1992) whereas the species number of Platypodidae was about 1,500 (Beaver, 2000). We can distinguish five fairly distinct forms of feeding, using the terminology suggested by Schedl (1958). Herbiphagy: feeding directly on the tissue of soft, herbaceous plants; Spermatophagy: feeding on seeds, or at least in the outer layers of fruit, only a very small percentage of scolytid species are spermatophagous; Phloeophagy: living in and feeding on the inner, living tissues of the bark. One of the most common habits of the Scolytidae, so much so that the name “bark beetles” is often applied; Xylophagy: living in and feeding on wood; Xylo-mycetophagy: in which the beetles, commonly known as “ambrosia beetles”, live in tunnels in wood but feed on ambrosia fungi that grow on the walls of the burrows. The habit is constant throughout the Platypodidae and occurs in many tropical Scolytidae.

The family Scolytidae comprises three groups: 1) the true bark beetles which mine between the bark and wood, usually engraving both, of the twigs, branches, trunk, and roots of various trees; 2) wood-boring bark beetles which mine directly into the wood and feed on the woody material in both the larval and adult stages; and 3) ambrosia beetles which bore directly and deeply into the sapwood, and in some cases into the heartwood, and feed entirely on fungi which grow on the tunnel walls. Fungal spores are carried by the adults in special cuticular invaginations “mycangia”. Bark beetles are typically soft and yellowish as a new adult but soon harden and turn reddish to dark brown or black. They are small, cylindrical beetles, from about 0.9 to

9.5 mm long (Fig. 1). The larvae are small, white, curved, legless grubs with enlarged thoracic segment. When the adults attack a tree, twig, branch, or log, they construct entrance tunnels directly through the bark to the phloem or into the wood, depending on the species. In the case of ambrosia beetles, boring dust is pushed out through the holes same for bark beetles. Egg tunnels of true bark beetles are constructed from the entrance tunnels along the surface of the wood, cutting through the inner bark and often scarring the wood. Egg tunnels of wood-feeding species are completely within the wood, while those of ambrosia beetles are deep in the sapwood. The latter may be simple, branched, or compound. The females of many species deposit their eggs in niches cut into the sides of the tunnel, cover them with frass, and plug the opening toward the tunnel. Others deposit their eggs in larger niches or in grooves or layers and cover them with boring dust. Still others, particularly some of the ambrosia beetles, place their eggs directly in the tunnels. When bark beetle larvae hatch, they feed perpendicularly from the egg tunnel. The larvae of many species construct galleries with a specific, recognizable pattern. Ambrosia beetle larvae, in contrast, remain in the egg tunnel and feed on fungi growing on its walls. When ready to emerge, the bark beetles gnaw holes through the bark to escape. The majority leave a given tree within a few days. The ambrosia beetle adults emerge through their parent's entrance tunnels.

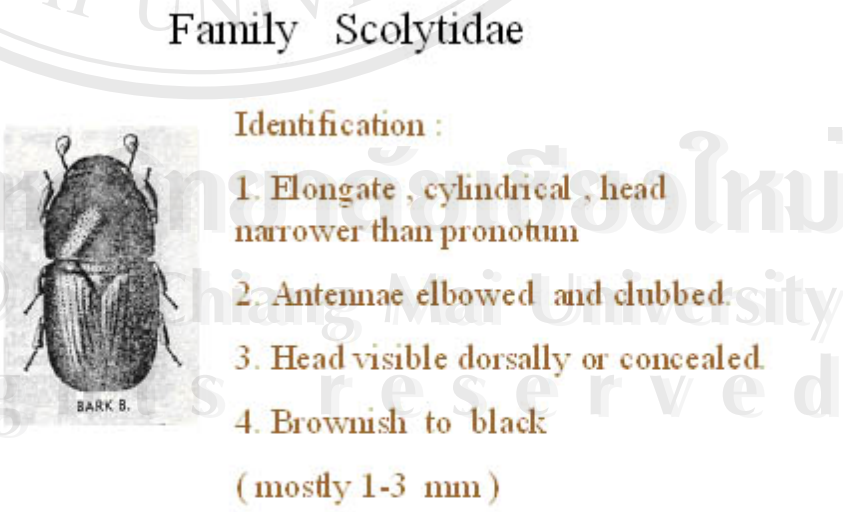

Figure 1 Identification of the Family Scolytidae

Whereas all members of the family Platypodidae (Fig. 2) are ambrosia beetles and they occur principally in the tropics and subtropics. The adults differ from those of other ambrosia beetles in having longer and more slender bodies and a wide head which is flattened in front. Their mycangia usually open through pores on the dorsal surface of the pronotum. Members of this family are usually more destructive than other ambrosia beetles. Their tunnels are more extensive, and they extend deeper into the sapwood and heartwood (Baker, 1972).

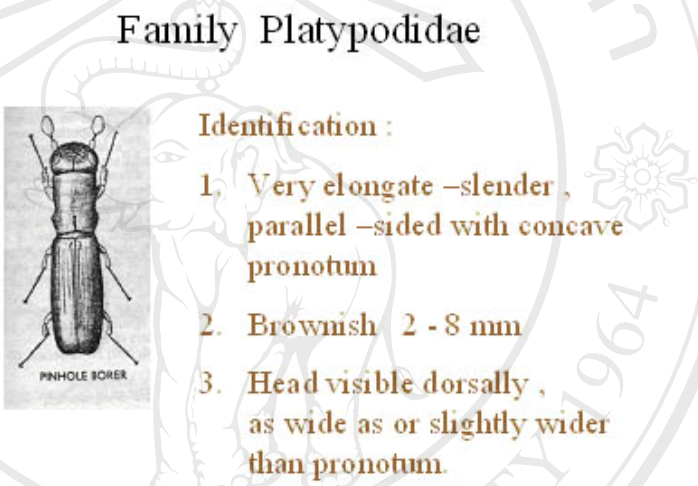

Figure 2 Identification of the Family Platypodidae

As a general rule, true bark beetles attack trees that are weakened or dying due to stress factors such as drought, disease, smog, mechanical injury, or alternation of the water table and root damage. They are also attracted to recently cut wood which still has bark. Once a bark beetle is successfully established in a tree, it emits a chemical called a pheromone which attracts other beetles to the same tree. Once infested, trees almost never recover and control efforts are usually futile. Phloeophagous bark beetles do not attack trees and wood that are dry, drying or de-barked wood (Day, 1996). Wood-boring ambrosia beetles do not consume the wood of their hosts, but build gallery systems in which they cultivate fungi as larval food. One principal difference in aggressiveness between bark and ambrosia beetles is that fewer ambrosia beetles species attack living trees en masse. In recent years, however, there have been reports and observations of normally benign ambrosia

beetles attacking apparently healthy, standing trees, and possibly causing the trees' death (Kühnholz *et al*., 2003).

Nevertheless, the dispersal of the Scolytidae and Platypodidae depends on the range of their hosts and human transport of timber. Dispersal over wide areas is facilitated by the international trade of host species. For example, the most host-tolerant Scolytidae, such as *Hypothenemus eruditus* (Scolytidae) may be carried in a wide variety of dry vegetables matter, including dry, soft, wooden articles such as canes and even book covers (Browne 1961). As international trade is one of the primary pathways by which exotic insects enter other countries, many insects have been intercepted at US Ports of entry. The scolytids were from 117 different countries; the top 12 countries were Italy (1090 interceptions), Germany (756), Spain (457), Mexico (425), Jamaica (398), Belgium (352), France (261), China (25), Russia (247), India (224), U.K. (151), and Portugal (150). Overall, 73% of the scolytids were found in solid wood packing materials, 22% in food or plants, and 5% in other or unspecified materials (Haack, 2003). Asian ambrosia beetle, *Xylosandrus crassiusculus* was introduced from southeast Asia to South Carolina, USA and has caused much damage to many fruit trees and even other agricultural products, such as the sweet potato (Bambara, 1998). Majority of chestnut in Middle Tennessee was attacked by several scolytids (Oliver and Mannion, 2001). Furthermore, tree death is often caused by their associated fungi. Oak decline in Europe and in the US has been linked to *Phytophthora* fungi vectored by platypodid and scolytid beetles (Cassier *et al*., 1996 and McPherson *et al*., 2005).

The first five species of Scolytidae to be described were named by Linnaeus (1758) and placed in his genus *Dermestes*. All are European species, but now placed in other genera. Geoffroy (1762) described the genus *Scolytus* for the species *S. scolytus*, and transferred Linnaeus' species to the genus *Bostrichus*. Fabricius (1801) included 52 species of Scolytid in his monograph, and added the genus *Hylesinus*. He also described the first platypodid species, *Platypus cylindrus*, although in the genus *Bostrichus*. Latreille (1807) was the first to consider the scolytids at the family level, and Shuckard (1840) the platypodids. During 1787 and 1839, some German works; described the impact of *Ips typographus* (Scolytidae) on *Picea abies* in several words e.g. Baümtrockniß (=tree dryness), Wurmtrockniß (=worm dryness) (Seybold *et al.*,

2000). Here, also appeared many monographs from several authors. For example, the monographs of Chapuis (1865) on Platypodidae and Chapuis (1869) on Scolytidae, and monograph of Eichhoff of Scolytidae (including Platypodidae). The first catalogue of Scolytidae (including Platypodidae) was included in the systematic catalogue of Gemminger and Harold (1872), who listed 534 valid species in 60 general. In the first half of the 20th century, there were great advances in bark beetle systematics. Blandford monographed the species of Central America in a series of contributions between 1895-1905. In the set Coleopterorum Catalogus, Hagedorn (1910a) catalogued the genera and species of Scolytidae (1234 species in 115 genera), and Strohmeyer (1912) those of Platypodidae (323 species in 13 genera). Reitter (1913) provided a workable key to the species of Europe and neighbouring countries. In North America, the studies of A.D. Hopkins and M.W. Blackman greatly advanced the work of J.L. LeConte in the previous century. Much more works was also done on tropical species, particulary by the German, Hans Eggers, the Austrian, Karl Schedl, and a Polish researcher, Marian Nunberg. In the second half of the 20th century, major contributions have been made in the palearctic region by A. Balachowsky (France), A. Pfeffer (Czech Republic), V.N. Stark (the former Soviet Union), J. Murayama and A. Nobuchi (Japan). In the Americas, there are important works of S.L. Wood and D.E. Bright, and in the old world tropics, those of F.G. Browne, H. Roberts and R.A. Beaver (United Kingdom). Knowledge of bark beetle classification has benefited from the generic level studies of Wood (1986) on Scolytidae and Wood (1993) on Platypodidae (Knížek and Beaver, 2004).

After the catalogues of Hagedorn (1910a) and Strohmeyer (1912), no further attempt was made to catalogue the families world wide until the work of Wood and Bright (1992) which is not only provided a list of all genera and synonyms, but information on types, host plants and distribution, and a list of references to each species. The catalogue deals with 5,812 species in 225 genera in 25 tribes. Two supplements to this catalogue have appeared (Bright and Skidmore 1997, 2002) updating the work to 1999 (Knížek and Beaver, 2004).

Classification of bark and ambrosia beetles follow the morphological species concept, which is both the fundamental nomenclatural unit in taxonomy and a unit of evolution. The hierarchy rank of Scolytidae and Platypodidae is Family, Subfamily,

Tribe, Genus, Species. Scolytidae will be arranged into 2 subfamilies: Hylesininae and Scolytinae, each comprised with 11 and 14 tribes respectively (Wood, 1986). Platypodidae will be arranged into 3 subfamilies: Coptonotinae, Tesserocerinae and Platypodinae, each comprised with 3, 2 and 1 tribe respectively (Wood, 1993).

The Scolytidae and Platypodidae exhibit three distinct types of mating behavior, which include monogamy, moderate polygamy, and inbreeding. A mating system is always uniform throughout a genus and frequently, but not invariably, throughout a tribe. A monogamy is very common. It is invariable rule in the Platypodidae, Scolytinae and Scolytoplatypinae, and is found also in at least a great majority of the Hylesininae, and in numerous tribes and lesser groups of the Ipinae. Moderate polygamy occurs in among Ipini species. Inbreeding occurs throughout the Scolytid ambrosia beetle tribe Xyleborini and also in some phloeophagous and spermatophagous genera of other tribes, such as the Cryphalini and Crypturgini (Browne, 1961). Outbreeding species means producing equal numbers of males and females, while in inbreeding species will often be adaptive for females to bias their offspring sex ratio toward females. Females regularly produce exactly one male per brood and that one male fertilize all of their sisters. Males of inbred taxa commonly are dwarfed, weakly sclerotized and incapable of flight. Inbreeding is more frequent in the tropics and becomes rare in colder and drier climates (Kirkendall, 1993).

In 1974, there were observations on flight of Scolytidae and Platypodidae in a tropical forest plantation in Papua New Guinea and found that species of Xyleborini (Scolytidae) and Platypodini (Platypodidae)were the most common (Gray, 1974b, a). In 1975, a checklist of 70 species of Scolytidae and 26 species of Platypodidae from Thailand which are classified into six faunal elements : Palearctic (4 species), Indian (18 species), Malaysian (23 species), Indo- Malaysian (22 species), Circumtropical (16 species) and Endemic (13 species) were provided, most of the present collections were made in Northern Thailand near the town of Chiang Mai, and on the nearby mountains, Doi Suthep and Doi Pui, to the west of the town (Beaver and Browne, 1975). Further works from Beaver in 1990 and 1999, thirty-two species of Scolytidae and one Platypodidae beetles from the north provinces (Chiang Mai and Mae Hong Son) and the south provinces (Trang and Songkla) of Thailand were presented for the first time. Traps baited with attractants are one of the most widely used and practical

methods for detection and survey of insect populations, scolytids included (Flechtmann *et al*., 2000). There was also a report on scolytids and platypodids from Ranong province. Beetles were collected with various methods including their removal from Rhizophoraceous timber (*Progenius* sp. and *Xyleborus* sp.) and light traps (Platypodidae; *Platypus* sp., *Diacavus* sp., *Crossotarsus* sp. and Scolytidae; *Xyleborus* sp., *Dryocoetini* sp., *Ipini* sp., *Hypothenemus* sp., *Ericryphalus* sp.) (Murphy and Meepol 1990). Hutacharern and Tubtim (1995) have provided a list of species from known host plants in Thailand. Eleven species of Scolytidae and 4 species of Platypodidae are pests of forest products and 14 species of Scolytidae are pests of forest trees.

There are no reports of extensive damage caused by species in both families in Thailand. However, certain species caused much damage in other Asian countries. On the Japanese islands of Honshu and Kyushu, mortality of several Japanese oaks (*Quercus crispula* Blume, *Q. serrata* Thunb. ex Murray, and others) was caused by an ambrosia beetle, *Platypus quercivorus* Murayama. The beetles attacked apparently healthy trees, which subsequently developed wilt symptoms. It is hypothesized that the oak tree death was caused by a pathogenic fungus transmitted by the beetles (Kinuura, 1994). In southern China, Yunnan province, the pine shoot beetle *Tomicus piniperda* (Scolytidae), which is native to the pine growing region of Europe, Asia and northern Africa, has been reported as a serious pest and has caused the destruction of many hundred thousand hectares of Yunnan pine (Ye *et al.*, 2002).