Exotic bark- and wood-boring Coleoptera in the United States: recent establishments and interceptions[1]

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Abstract: Summary data are given for the 25 new species of exotic bark- and wood-boring Coleoptera first reported in the continental United States between 1985 and 2005, including 2 Buprestidae (*Agrilus planipennis* and *Agrilus prionurus*), 5 Cerambycidae (*Anoplophora glabripennis*, *Callidiellum rufipenne*, *Phoracantha recurva*, *Sybra alternans*, and *Tetrops praeusta*), and 18 Scolytidae (*Ambrosiodmus lewisi*, *Euwallacea fornicatus*, *Hylastes opacus*, *Hylurgops palliatus*, *Hylurgus ligniperda*, *Orthotomicus erosus*, *Phloeosinus armatus*, *Pityogenes bidentatus*, *Scolytus schevyrewi*, *Tomicus piniperda*, *Xyleborinus alni*, *Xyleborus atratus*, *Xyleborus glabratus*, *Xyleborus pelliculosus*, *Xyleborus pfeilii*, *Xyleborus seriatus*, *Xyleborus similis*, and *Xylosandrus mutilatus*). In addition, summary interception data are presented for the wood-associated beetles in the families Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, Lyctidae, Platypodidae, and Scolytidae, based on the USDA Animal and Plant Health Inspection Service "Port Information Network" database for plant pests intercepted at US ports of entry from 1985 to 2000. Wood-associated insects were most often intercepted on crating, followed by dunnage and pallets. The five imported products most often associated with these 8341 interceptions were tiles, machinery, marble, steel, and ironware. A significantly higher proportion of the most frequently intercepted true bark beetles have become established in the United States compared with the less frequently intercepted species.

Résumé : L'auteur présente des données sommaires au sujet des 25 nouvelles espèces exotiques de coléoptères, perceurs de l'écorce et xylophages, rapportées pour la première fois sur le continent américain de 1985 à 2005, incluant deux buprestidés (*Agrilus planipennis* et *Agrilus prionurus*), cinq cérambicidés (*Anoplophora glabripennis*, *Callidiellum rufipenne*, *Phoracantha recurva*, *Sybra alternans* et *Tetrops praeusta*) et 18 scolytidés (*Ambrosiodmus lewisi*, *Euwallacea fornicatus*, *Hylastes opacus*, *Hylurgops palliatus*, *Hylurgus ligniperda*, *Orthotomicus erosus*, *Phloeosinus armatus*, *Pityogenes bidentatus*, *Scolytus schevyrewi*, *Tomicus piniperda*, *Xyleborinus alni*, *Xyleborus atratus*, *Xyleborus glabratus*, *Xyleborus pelliculosus*, *Xyleborus pfeilii*, *Xyleborus seriatus*, *Xyleborus similis* et *Xylosandrus mutilatus*). De plus, des données sommaires d'interception sont présentées pour les insectes associés au bois dans les familles des bostrichidés, buprestidés, cérambicidés, curculionidés, lyctidés, platypodidés et des scolytidés à partir de la base de données « Réseau d'information portuaire » du Service d'inspection sanitaire des végétaux et des animaux du Département de l'agriculture des États-Unis pour les ravageurs des végétaux interceptés aux ports d'arrivée des États-Unis de 1985 à 2000. Les insectes associés au bois ont été le plus souvent interceptés sur les emballages à claire-voie, suivis par le bois d'arrimage et les palettes. Les cinq produits importés les plus souvent associés à ces 8341 interceptions étaient les tuiles, la machinerie, le marbre, l'acier et les articles en fer. Une proportion significativement plus élevée des vrais insectes de l'écorce les plus souvent interceptés se sont établis aux États-Unis comparativement aux espèces les moins souvent interceptées.

[Traduit par la Rédaction]

Introduction

The international movement of exotic (non-native) forest insects is a threat to forest sustainability worldwide (Chornesky et al. 2005). International trade, through increased volume, speed, and number of trading partners, is the principal method by which exotic insects are moved among countries (USDA APHIS 2000; National Research Council 2002). More than 2000 species of exotic insects are now established in the United States (US) (US Congress 1993), of which about 400 feed on trees and shrubs (Mattson et al. 1994). Several exotic tree-feeding insects have severely impacted forest ecosystems throughout the US during the 1900s (Liebhold et al. 1995), while other more recent arrivals threaten to spread nationwide, for example, *Agrilus planipennis* Fairmaire (Poland and McCullough 2006) and *Sirex noctilio* Fabricius (Hoebeke et al. 2005).

Insects are often transported on commodities such as nursery stock, cut flowers, fresh food, seed, wood packing material, logs, and lumber (Wood 1977; Siitonen 2000; Haack 2001; Dobbs and Brodel 2004; USDA APHIS 2004*a*). Wood packing material, like crating and pallets, often harbors bark- and wood-boring insects, especially when (1) manufactured from recently cut trees, (2) not treated with heat or chemicals, or

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(3) bark is retained (USDA APHIS 2000). Because of growing awareness of the threat posed by untreated wood packing material, new worldwide standards for wood treatment were recently proposed (FAO 2002) and are now being adopted by individual countries (e.g., USDA APHIS 2004*b*).

The order Coleoptera (beetles) is the most commonly intercepted order of insects found in association with wood packing material. For example, Coleoptera constituted 84% of the intercepted insects associated with wood in both Chile (Beeche-Cisternas 2000) and New Zealand (Bain 1977) and 92% in the US (Haack 2001). It is understandable that Coleoptera constitute the vast majority of insect interceptions on wood articles considering that there are thousands of beetle species worldwide that specialize in attacking live trees, recently dead trees, and lumber (Haack and Slansky 1987).

Recently established Coleoptera in the US

During the 21-year period from 1985 to 2005, at least 25 species of exotic bark- and wood-boring Coleoptera were collected or reported for the first time in the continental US (Table 1). This list was compiled from online searches of scientific literature databases and Internet Web sites devoted to exotic pests as well as consultations with national insect identifiers through September 2005. These 25 species include 2 species of Buprestidae, 5 Cerambycidae, and 18 Scolytidae. The exact year of establishment and mode of entry into the US are unknown for all 25 species. Nevertheless, wood packing material was the likely pathway for many of these species given that they are commonly intercepted in such items. A brief summary is given below for each of these 25 exotic beetles.

There have been many recent changes in Coleoptera taxonomy (Arnett et al. 2002). However, in the present paper, I used the traditional nomenclature of the 1980s and 1990s because it matched that used by the USDA Animal and Plant Health Inspection Service (APHIS) when they cataloged interceptions of plant pests (see next section). The major taxonomic changes in Arnett et al. (2002) that are relevant to this paper involve (1) reclassifying Lyctidae to subfamily status (Lyctinae) within Bostrichidae and (2) reclassifying Platypodidae and Scolytidae to subfamily status (Platypodinae, Scolytinae) within Curculionidae.

Exotic Buprestidae

Adult Buprestidae are commonly called metallic wood borers, and their larvae are known as flatheaded wood borers. Some species attack and kill apparently healthy trees, but most infest weakened, recently cut, or dead trees. Larvae of some species (e.g., *Agrilus*) feed almost entirely in the cambial region, while others tunnel and feed in wood (Haack and Slansky 1987). Two species of exotic tree-infesting buprestids were first found in the US between 1985 and 2005 (Table 1). A US federal quarantine was initiated for one of these beetles, the emerald ash borer (*Agrilus planipennis*).

Agrilus planipennis was first found in the US in Michigan in 2002 (Haack et al. 2002). Surveys soon indicated that this Asian beetle was killing millions of ash (*Fraxinus*) trees in Michigan and that all native ash species appeared susceptible (Liu et al. 2003). A US federal quarantine was imposed on the known infested areas in 2003 (USDA APHIS 2003) and is still in effect as of 2005. The quarantine regulated movement of ash logs, chips, nursery stock, and firewood. As of 2005, several isolated populations of *Agrilus planipennis* had been found in the states of Indiana, Maryland, Michigan, Ohio, and Virginia (Liu et al. 2003; Poland and McCullough 2006). Most of the newly detected infestations resulted from inadvertent movement of infested ash firewood, logs, and nursery stock prior to the beetles' discovery and subsequent quarantine. *Agrilus planipennis* was also discovered in Ontario, Canada, in 2002 in an area adjacent to the Michigan infestation (Haack et al. 2002). Efforts to contain *Agrilus planipennis* are ongoing in both Canada and the US, including removal of infested trees along with removal of a buffer of uninfested ash trees at selected sites (Poland and McCullough 2006).

Agrilus prionurus Chevrolat was first reported in the US in Texas in 2003 (Haack 2003). It was found attacking western soapberry (*Sapindus drummondii* Hook. & Arn.) trees in urban areas of Austin, Texas. This beetle is native to Mexico (Blackwelder 1944). Its occurrence in Texas is thought to have resulted from the movement of firewood from Mexico to Texas (D. McCoy, personal communication, 2005).

Exotic Cerambycidae

Adult Cerambycidae are commonly called longhorned beetles, and their larvae are known as roundheaded wood borers. Some species feed on herbaceous vegetation or attack apparently healthy trees, but most cerambycids attack weakened, recently cut, or dead trees (Haack and Slansky 1987; Hanks 1999). Larvae of some cerambycid species feed in the cambial region, while others feed in wood. Five species of exotic tree-infesting cerambycids were reported as established in the US between 1985 and 2005 (Table 1). A US federal quarantine was established for only one of these five cerambycids, the Asian longhorned beetle (*Anoplophora glabripennis* (Motschulsky)). In addition, *Tetropium fuscum* (Fabricius) is a European cerambycid that occurs in Canada but is not yet known to occur in the US. It was first identified in Halifax, Nova Scotia, in 1999 (Smith and Hurley 2000). Efforts to eradicate *T. fuscum* are underway in Nova Scotia, given that it can attack and kill living spruce (*Picea*) trees (Mushrow et al. 2004).

Anoplophora glabripennis, a native of China and Korea, was first found in New York City in 1996 (Haack et al. 1997). Elsewhere in the US, established populations of *Anoplophora glabripennis* were first found in urban areas of Illinois in 1998 and New Jersey in 2002 (Haack 2003). This beetle attacks both stressed and apparently healthy hardwood trees in a variety of genera such as *Acer*, *Aesculus*, *Populus*, *Salix*, and *Ulmus*. Tree mortality occurs after several years of successive attack. Given this beetle's wide host range and ability to kill healthy trees, a US federal quarantine was initiated in 1997 (USDA APHIS 1997). The quarantine regulated movement of all potential host material and is still in effect as of 2005. An eradication program was initiated in 1997, involving cutting and chipping of all infested trees. As of August 2005, 6244 infested trees had been removed in New York, 1553 in Illinois, and 635 in New Jersey. In 2005, no infested trees were found in Illinois; however, a few infested trees were located in both New Jersey and New York. Elsewhere,

Table 1. Exotic bark- and wood-feeding Buprestidae, Cerambycidae, and Scolytidae first reported to be established in the continental United States between 1985 and 2005.

Species	Probable continent or country of origin	First reported or collected		No. interceptions (1985–2000)		First detected as part of official survey	Reference§
		Year	State*	Species†	Genus‡		
Buprestidae							
Agrilus planipennis Fairmaire	Asia	2002	MI	0	37/38	No	9
Agrilus prionurus Chevrolat	Mexico	2003	TX	0	37/38	No	5
Cerambycidae							
Anoplophora glabripennis (Motschulsky)	Asia	1996	NY	5	26/31	No	8
Callidiellum rufipenne (Motschulsky)	Asia	1997	NC	13	2/16	No	5, 19
Phoracantha recurva Newman	Unknown	1995	CA	0	2/2	No	10
Sybra alternans (Wiedemann)	Asia	1992	FL	25	1/26	No	1, 27
Tetrops praeusta (L.)	Europe	1996	ME	0	0	No	16, 31
Scolytidae (ambrosia beetles)							
Ambrosiodmus lewisi (Blandford)	Asia	1990	PA	0	0/1	No	12
Euwallacea fornicatus (Eichhoff)	Asia	2002	FL	0	0/6	No	5
Xyleborinus alni (Niisima)	Asia	1996	WA	0	1/1	Yes	20
Xyleborus atratus Eichhoff	Asia	1987	TN	0	21/30	No	2, 3
Xyleborus glabratus Eichhoff	Asia	2002	GA	0	21/30	Yes	4, 5, 22
Xyleborus pelliculosus Eichhoff	Asia	1987	PA	0	21/30	No	2
Xyleborus pfeilii (Ratzeburg)	Eurasia	1992	MD	0	21/30	No	20, 29
Xyleborus seriatus Blandford	Asia	2005	MA	0	21/30	Yes	14
Xyleborus similis Ferrari	Asia	2002	TX	0	21/30	Yes	4, 23
Xylosandrus mutilatus (Blandford)	Asia	2002‖	MS	0	1/2	No	4, 24, 26
Scolytidae (bark beetles)							
Hylastes opacus Erichson	Eurasia	1987	NY	1	22/133	No	25
Hylurgops palliatus (Gyllenhal)	Eurasia	2001	PA	283	25/309	Yes	4, 15
Hylurgus ligniperda (Fabricius)	Eurasia	2000‖	NY	195	47/242	Yes	13
Orthotomicus erosus (Wollaston)	Eurasia	2004	CA	359	35/434	Yes	6, 17
Phloeosinus armatus Reitter	Eurasia	1989	CA	0	26/48	No	30
Pityogenes bidentatus (Herbst)	Eurasia	1988	NY	25	21/611	No	11
Scolytus schevyrewi Semenov	Asia	2003‖	CO	0	78/92	Yes	5, 18, 21
Tomicus piniperda (L.)	Eurasia	1992‖	OH	145	31/182	No	7

*State abbreviations: CA, California; CO, Colorado; FL, Florida; GA, Georgia; MA, Massachusetts; MD, Maryland; ME, Maine; MI, Michigan; MS, Mississippi; NC, North Carolina; NY, New York; OH, Ohio; PA, Pennsylvania; TN, Tennessee; TX, Texas; WA, Washington.

†Number of interceptions in the PIN database between 1985 and 2000 that were identified to the species level.

‡Values represent the number of interceptions for each genus that were only identified to the genus level, e.g., "37/38" represents that 37 of the 38 *Agrilus* interceptions were only identified to the genus level, while 1 of the 38 interceptions were identified to species, but it was something other than *A. planipennis* or *A. prionurus*.

§Reference: (1) Arnett et al. 2002, (2) Atkinson et al. 1990, (3) Atkinson et al. 1991, (4) Haack 2001, (5) Haack 2003, (6) Haack 2004, (7) Haack and Poland 2001, (8) Haack et al. 1997, (9) Haack et al. 2002, (10) Hanks et al. 1998, (11) Hoebeke 1989, (12) Hoebeke 1991, (13) Hoebeke 2001, (14) E.R. Hoebeke, personal communication, 2005, (15) Hoebeke and Acciavatti 2006, (16) Howden and Howden 2000, (17) Lee et al. 2005, (18) Liu and Haack 2003, (19) Maier and Lemmon 2000, (20) Mudge et al. 2001, (21) Negrón et al. 2005, (22) Rabaglia 2003*a*, (23) Rabaglia 2003*b*, (24) Rabaglia 2003*c*, (25) Rabaglia and Cavey 1994, (26) Schiefer and Bright 2004, (27) Thomas 2000, (28) Thomas 2005, (29) Vandenberg et al. 2000, (30) Wood 1992, (31) Yanega 1996.

‖*Hylurgus ligniperda* was first reported in 2000 but specimens had been collected in the general area as early as 1994. *Scolytus schevyrewi* was first reported in 2003 but specimens collected in 1998 were later found. *Tomicus piniperda* was first reported in 1992 but specimens from 1991 were later found. *Xylosandrus mutilatus* was first reported in 2002 but specimens collected in 1999 were later found.

established populations of *Anoplophora glabripennis* were first found in Austria in 2001, Canada in 2003, France in 2003, and Germany in 2004. Active eradication programs were initiated in each of these countries (Haack 2003; Hérard et al. 2005).

Callidiellum rufipenne (Motschulsky) is native to China, Korea, and Japan. It primarily attacks trees in the families Cupressaceae and Taxodiaceae such as *Chamaecyparis*, *Cryptomeria*, *Cupressus*, *Juniperus*, and *Thuja*. Established populations were first detected in North Carolina in 1997 and then in Connecticut in 1999 (Maier and Lemmon 2000). Additional populations have been detected in the nearby states of Massachusetts, New Jersey, New York, and Rhode Island (Lundgren 2001). Although considered a secondary pest in

Asia, it was found attacking apparently healthy *Thuja* nursery stock in Connecticut (Maier and Lemmon 2000). Elsewhere, *C. rufipenne* has become established in Italy (Campadelli and Sama 1989).

Phoracantha recurva Newman was first found in the US in California in 1995 (Hanks et al. 1998). As of 2005, this Australian *Eucalyptus*-infesting borer has only been reported from California within the continental US. *Phoracantha semipunctata* (F.), another Australian *Eucalyptus*-infesting borer, is also established in California, being first found in 1984 (Scriven et al. 1986). Larvae of both *Phoracantha* species feed in the cambial region of the tree, resulting in tree death. *Phoracantha recurva* and *Phoracantha semipunctata* have become established in several countries in Africa, Asia, Europe, the Pacific, and South America, where eucalypts were introduced (Smith et al. 1997).

Sybra alternans (Wiedemann), an Asian beetle, was first found in the continental US in Florida in 1992, being collected from dead limbs of *Ficus* plants (Thomas 2000). As of 2005, there have been no reports of economic damage or range expansion in the continental US.

Tetrops praeusta (L.), a European beetle, was first reported in the northeastern US in 1996 (Yanega 1996) and later in Quebec, Canada (Landry 2001). This twig-infesting cerambycid has been reported from many species of hardwood trees and shrubs in Europe, but is most commonly found on species of Rosaceae, such as *Crateagus* and *Malus* (Yanega 1996; Howden and Howden 2000). There have been no reports of economic damage in North America.

Although not known to be established in the US, as many as five *Anoplophora chinensis* (Forster) adults emerged and took flight from Korean bonsai maple trees that were being held outdoors in a nursery in Washington State in 2001 (Haack 2003). Given that this borer attacks a wide range of living hardwood trees (Lingafelter and Hoebeke 2002), Washington State initiated an eradication program in 2002, even though establishment of the beetle was not confirmed. Washington State removed about 1000 potential host trees within 200 m of the nursery and injected a systemic insecticide in 1500 additional potential host trees that were growing within 200–400 m of the nursery (Haack 2003). No *Anoplophora chinensis* life stages or associated damage have been found near the nursery during annual surveys through 2005. Elsewhere, established populations of *Anoplophora chinensis* were discovered in Italy in 2000 and in France in 2003. As of 2005, *Anoplophora chinensis* populations appear eradicated in France but not in Italy (Hérard et al. 2005).

Exotic Scolytidae

The two major groups of Scolytidae are the bark and ambrosia beetles (Haack and Slansky 1987). Adult bark beetles tunnel and breed at the bark–wood interface, and their larvae feed primarily on inner bark (phloem). By contrast, adult ambrosia beetles tunnel in wood and inoculate the gallery walls with fungi (the "ambrosia") that serve as food for their larvae. Bark and ambrosia beetles are usually vectors of fungi and other microorganisms that grow in the woody host tissues (Kuhnholz et al. 2001; Kirisits 2004). Scolytids usually attack stressed or recently fallen host material, but some can attack and kill apparently healthy hosts. In general, male and female bark beetles locate each other and mate on the new host that is being colonized. By contrast, brother–sister mating is common among ambrosia beetles, with new galleries being initiated by only the mated females. Eighteen species of exotic scolytids were first reported in the US between 1985 and 2005, including 10 ambrosia beetles and 8 bark beetles (Table 1). A US federal quarantine was initiated for only 1 of these 18 scolytids, the pine shoot beetle (*Tomicus piniperda* (L.)). In addition to the aforementioned 18 scolytids, the European hardwood-infesting ambrosia beetle *Trypodendron domesticum* (L.) has been found in Canada but not yet in the US. It was first collected in British Columbia in 1997 (Humble 2001) and in Prince Edward Island in 1998 (Haack 2003).

Ambrosiodmus lewisi (Blandford), an Asian ambrosia beetle, was first collected in the US in Pennsylvania from dead oak (*Quercus*) branches in 1990 (Hoebeke 1991). There have been no further reports of range expansion or damage by this beetle in the US. In Asia, *Ambrosiodmus lewisi* has a wide host range, including species of *Acer*, *Ailanthus*, *Alnus*, *Cinnamomum*, *Ficus*, *Populus*, *Prunus*, *Quercus*, *Rhus*, and *Salix* (Hoebeke 1991; Wood and Bright 1992).

Euwallacea fornicatus (Eichhoff), an Asian ambrosia beetle, was first collected in the US in Florida in 2002 (Haack 2003). The Florida specimens were recovered from the trunk of a live royal poinciana (*Delonix regia* (Bojer)) tree. In 2004, *E. fornicatus* was collected for the first time in California, where it was attacking live *Acer*, *Alnus*, *Platanus*, and *Robinia* trees (R.L. Penrose, personal communication, 2005). Wood and Bright (1992) list more than 30 hardwood genera as hosts of *E. fornicatus* in Asia. Elsewhere, *E. fornicatus* was reported to be established in Panama (Wood and Bright 1992).

Hylastes opacus Erichson was first collected in the US in New York in 1987 (Rabaglia and Cavey 1994). It has now been collected from several more eastern US states, Oregon, and in Ontario and Quebec, Canada (Bright and Skidmore 1997; Mudge et al. 2001; B.D. Gill, personal communication, 2005). This Eurasian bark beetle breeds primarily in *Pinus*, but can infest *Larix* and *Picea* (Wood and Bright 1992). In the US, *Hylastes opacus* has been collected in recently cut pine stumps and logs; there have been no reports of economic damage. Elsewhere, *Hylastes opacus* was reported to be established in South Africa (Wood 1992).

Hylurgops palliatus (Gyllenhal), an Eurasian bark beetle, was first trapped in the US in Pennsylvania in 2001 and later reported in New York and Ohio (Haack 2001; Hoebeke and Acciavatti 2006). To date, there have been no reports of damage or hosts in the US. In Eurasia, *Hylurgops palliatus* breeds in several species of *Abies*, *Cedrus*, *Larix*, *Picea*, and *Pinus* (Wood and Bright 1992; Hoebeke and Acciavatti 2005).

Hylurgus ligniperda (Fabricius), a Eurasian *Pinus*-infesting bark beetle, was first trapped in the US in New York in 1994; however, established populations in the same area were not confirmed until 2000 (Hoebeke 2001). The New York population has not spread to nearby states as of 2004 (Petrice et al. 2004). Another established population of *Hylurgus ligniperda* was found in California in 2003 (R.L. Penrose, personal communication, 2005). In the US, *Hylurgus ligniperda* has been reared from pine stumps and cut logs;

there have been no reports of economic damage. *Hylurgus ligniperda* has also been introduced into Australia, Brazil, Chile, Japan, New Zealand, South Africa, and Uruguay (Wood and Bright 1992).

Orthotomicus erosus (Wollaston) was first collected in the US in California in 2004 (Haack 2004). This Eurasian *Pinus*-infesting bark beetle was collected primarily from recently cut pine logs and stumps in California (Lee et al. 2005). To date, there have been no reports of economic damage in the US. Elsewhere, *O. erosus* has been introduced to Chile, South Africa, and Swaziland (Wood and Bright 1992; Haack 2001). The report by Wood and Bright (1992) that *O. erosus* was established in Fiji was apparently incorrect (Brockerhoff et al. 2006).

Phloeosinus armatus Reiter was first collected in the US in California in 1989 (Wood 1992). This *Cupressus*-infesting bark beetle is native to the Mediterranean region (Wood and Bright 1992). Within the US, *Phloeosinus armatus* is still restricted to California as of 2005, although its range has expanded (R.L. Penrose, personal communication, 2005). In California, *Phloeosinus armatus* has been collected from both live trees and cut logs of *Cupressus* (Wood 1992; R.L. Penrose, personal communication, 2005). Species of *Juniperus* and *Thuja* have also been listed as hosts in the Mediterranean region (Bright and Skidmore 1997).

Pityogenes bidentatus (Herbst) was first collected in the US in New York in 1988 (Hoebeke 1989) and in Pennsylvania in 2002 (R.E. Acciavatti, personal communication, 2005). It breeds primarily in *Pinus*, but has also been recorded from *Abies*, *Larix*, *Picea*, and *Pseudotsuga* (Wood and Bright 1992; Bright and Skidmore 1997). In New York, it has been reported from *Pinus* trees and logs (Hoebeke 1994). Elsewhere, *Pityogenes bidentatus* is reported to be introduced into Madagascar (Wood and Bright 1992).

Scolytus schevyrewi Semenov was first reported in the US in Colorado in April 2003 (Liu and Haack 2003). By December 2003, this Asian bark beetle had been found throughout most of the western US. In 2004, *S. schevyrewi* was found in several eastern US states (Negrón et al. 2005). The discovery of *S. schevyrewi* from coast to coast in less than 2 years suggests that this species was introduced many years earlier. In fact, Negrón et al. (2005) reported that after examining several insect collections, specimens were located that had been collected as early as 1998 in Colorado. *Ulmus* is the only confirmed host in the US at this time (Negrón et al. 2005); *S. schevyrewi* has been collected from both live trees and cut wood. In Asia, *S. schevyrewi* has been recorded primarily from *Ulmus*, but also from species of *Caragana*, *Eleagnus*, *Prunus*, *Pyrus*, and *Salix* (Wood and Bright 1992; Liu and Haack 2003). Laboratory studies have shown that *S. schevyrewi* is capable of carrying spores of the Dutch elm disease fungus *Ophiostoma novo-ulmi* Brasier, but so far actual disease transmission in the field has not been documented. (Negrón et al. 2005).

Tomicus piniperda was first reported in the US in Ohio in 1992. Later, beetles that had been previously collected in Michigan in 1991 were identified as *T. piniperda* (Haack and Poland 2001). *Tomicus piniperda* was first discovered in nearby Ontario, Canada, in 1993. As of 2005, *T. piniperda* was known to occur in 14 US states, from Minnesota to Maine, and in the 2 Canadian provinces of Ontario and Quebec. This bark beetle is native to Eurasia and North Africa. It breeds primarily in *Pinus*, but occasionally will infest *Abies*, *Larix*, and *Picea* (Wood and Bright 1992). Anticipating severe losses from this beetle, a US federal quarantine was initiated in 1992 (USDA APHIS 1992), and a similar Canadian quarantine began in 1993. The quarantines regulated movement of *Pinus* logs, Christmas trees, nursery stock, and bark from infested to uninfested areas (Haack and Poland 2001). Both quarantines were still in effect as of 2005, even though *T. piniperda* related damage has been low in North America (Morgan et al. 2004).

Xyleborinus alni (Niisima) was first trapped in the US in Washington State in 1996 and in nearby British Columbia, Canada, in 1995 (Mudge et al. 2001). This Asian ambrosia beetle has also been trapped in several eastern US states (R.E. Rabaglia, personal communication, 2005) and several countries in Europe (Bright and Skidmore 1997). *Alnus* is the only reported host to date in the US (Mudge et al. 2001). There have been no reports of damage in North America as of 2005. In Eurasia, *X. alni* has been collected from species of *Alnus*, *Betula*, *Corylus*, *Quercus*, *Salix*, and *Tilia* (Mudge et al. 2001; Wood and Bright 1992).

Xyleborus atratus Eichhoff was first collected in the US in Tennessee in 1987 and was subsequently collected in Florida, Georgia, Maryland, Virginia, and West Virginia (Atkinson et al. 1990, 1991; Peck and Thomas 1998). This Asian ambrosia beetle has been trapped in several other states in the eastern US (R.E. Rabaglia, personal communication, 2005). There have been no published reports of hosts or damage in the US as of 2005. In Asia, *X. atratus* has been reported from both conifers and hardwoods, including species of *Acer*, *Alnus*, *Aralia*, *Betula*, *Camellia*, *Carpinus*, *Fagus*, *Malus*, *Morus*, *Pinus*, *Prunus*, *Quercus*, and *Ulmus* (Atkinson et al. 1990; Wood and Bright 1992).

Xyleborus glabratus Eichhoff was first trapped in the US in Georgia in 2002 (Haack 2001; Rabaglia 2003*a*) and later collected in Florida and South Carolina in 2005. In the US, *X. glabratus* has been associated with mortality of redbay (*Persea borbonia* (L.) Spreng.)) and has also been collected from live sassafras (*Sassafras albidum* (Nutt.) Nees) trees (D.R. Miller, personal communication, 2005). In Asia, *X. glabratus* has been recorded from hardwood species such as *Lindera*, *Litsea*, and *Shorea* (Wood and Bright 1992).

Xyleborus pelliculosus Eichhoff was first collected in the US in Pennsylvania in 1987 and then in Maryland in 1989 (Atkinson et al. 1990). This Asian ambrosia beetle has been trapped in several other eastern US states (R.E. Rabaglia, personal communication, 2005). There were no published reports of hosts or damage in the US as of 2005. In Asia, *X. pelliculosus* has been recorded on species of *Acer*, *Castanopsis*, *Quercus*, and *Shiia* (Wood and Bright 1992).

Xyleborus pfeilii (Ratzeburg), a Eurasian ambrosia beetle, was first collected in the US in Maryland in 1992 (Vandenberg et al. 2000). It was also trapped in California (R.L. Penrose, personal communication, 2005), Oregon (Mudge et al. 2001), and British Columbia, Canada (Humble 2001). The only reported host in the US to date has been pawpaw (*Asimina triloba* (L.) Dunal) in Maryland (Vandenberg et al. 2000). There have been no reports of economic damage in the US.

In Eurasia, *X. pfeilii* breeds in both conifers and hardwoods, including *Abies*, *Acer*, *Alnus*, *Castanea*, *Chamaecyparis*, *Diospyros*, *Fagus*, *Populus*, *Quercus*, and *Ulmus* (Wood and Bright 1992). The report of *X. pfeilii* being introduced into New Zealand by Wood and Bright (1992) is apparently incorrect (Brockerhoff et al. 2003). Recent publications with the species name spelled with a single terminal *i* (*pfeili*) are incorrect (Ratzeburg 1837).

Xyleborus seriatus Blandford was first trapped in the US in Massachusetts in 2005 (E.R. Hoebeke, personal communication, 2005). There have been no reports of hosts or damage in the US to date. This Asian ambrosia beetle has been recorded from many species of conifers and hardwoods in Asia, including *Acer*, *Aesculus*, *Betula*, *Chamaecyparis*, *Cryptomeria*, *Fagus*, *Larix*, *Pinus*, *Prunus*, *Quercus*, *Thuja*, *Tilia*, and *Tsuga* (Wood and Bright 1992).

Xyleborus similis Ferrari was first trapped in the US in Texas in 2002 (Haack 2001; Rabaglia 2003*b*). There have been no reports of hosts, damage, or range expansion in the US as of 2005. This Asian ambrosia beetle also occurs in many African and Pacific countries (Wood and Bright 1992; Rabaglia 2003*b*). Outside the US, *X. similis* has been reported from several tree species, including *Hevea*, *Pinus*, *Shorea*, and *Theobroma* (Wood and Bright 1992).

Xylosandrus mutilatus (Blandford) was first reported in the US in Florida and Mississippi in 2002 (Haack 2001; Rabaglia 2003*c*). Schiefer and Bright (2004) noted that some previously unidentified specimens of *X. mutilatus* had been collected as early as 1999 in Mississippi. This Asian ambrosia beetle was also collected in Texas in 2005 (R.E. Rabaglia, personal communication, 2005). There have been no hosts or damage reports in the US as of 2005. In Asia, *X. mutilatus* attacks many hardwood species, including *Acer*, *Albizzia*, *Carpinus*, *Castanea*, *Cornus*, *Fagus*, *Lindera*, *Osmanthus*, and *Swietenia* (Wood and Bright 1992; Schiefer and Bright 2004).

Other exotic wood-feeding Coleoptera

Relatively few bark- and wood-infesting bostrichids, curculionids, lyctids, and platypodids have been reported as established in the US since the 1800s (Mattson et al. 1994; Arnett et al. 2002). Considering the wood-feeding bostrichids, *Heterobostrychus aequalis* (Waterhouse), *Sinoxylon conigerum* Gerstaecker, and *Xylopsocus capucinus* (Fabricius) are considered established in Florida, and *Heterobostrychus brunneus* (Murray) is considered established in California (Peck and Thomas 1998; Arnett et al. 2002). In addition, *Heterobostrychus hamatipennis* (Lesne) may be established in Florida (Frank and McCoy 1992; Peck and Thomas 1998), and *Sinoxylon ceratoniae* (L.) may be established in California (Arnett et al. 2002). Of the 29 exotic curculionids listed by Mattson et al. (1994) that feed on woody plants in North America, only one was described as a borer: the poplar-and-willow borer, *Cryptorhynchus lapathi* (L.), a European weevil first reported in New York in 1882. Regarding the wood-feeding lyctids, *Lyctus brunneus* (Stephens), *Lyctus linearis* (Goeze), and *Trogoxylon aequale* (Wollaston) are considered established in the US (Gerberg 1957). The lyctid *Minthea rugicollis* Walker was considered established in Florida by Frank and McCoy (1992), but actual establishment was later questioned by Peck and Thomas (1998). I am not aware of any exotic platypodids that are established in the continental US.

Early detection programs

Of the 25 exotic beetles listed in Table 1, 8 species were first detected in the US as part of formal early detection programs funded by various state and federal agencies. These eight species were all scolytids: four ambrosia beetles and four bark beetles (Table 1). Exotic scolytids were one of the principal insect groups targeted in these surveys, which employed flight-intercept traps baited with attractants such as ethanol, alpha-pinene, and ipsdienol (Mudge et al. 2001; Negrón et al. 2005; Hoebeke and Acciavatti 2006). The initial discoveries of the 2 buprestids, 5 cerambycids, and the other 10 scolytids listed in Table 1 were usually made by members of the public who reported damaged trees or by insect collectors or scientists while conducting field work. The recent discovery of *Sirex noctilio* in New York also resulted from a formal trapping program (Hoebeke et al. 2005). The high number of initial detections that resulted from formal trapping programs indicates the value of such surveys in early detection of new exotics.

Coleoptera interceptions on wood

Since 1985, USDA APHIS has maintained a national computerized database for plant pests of quarantine significance that were intercepted at US ports of entry. The database is known as the Port Information Network, or PIN. This is a very large database containing more than 500 000 insect interception records for the period 1985–2000 (Haack 2001). It is important to understand that the inspection process has certain biases. For example, it is estimated that less than 2% of the international cargo that arrives in the US is inspected (National Research Council 2002). Inspectors often target high-risk cargo and pathways. Negative finds, where no organisms are found, are not included in the PIN. Moreover, usually only those pests categorized as “actionable” or “reportable” are entered in the PIN. Typically, APHIS considers insects that attack live plants to have higher quarantine significance than insects that infest dead plants. In the case of the Scolytidae, for example, this policy results in true bark beetles having higher quarantine significance than ambrosia beetles, given that bark beetles as a group more often breed in live trees than do ambrosia beetles. Therefore, a higher percentage of bark beetle interceptions are included in the PIN compared with ambrosia beetles. Some entire insect families are not included in the PIN because of the aforementioned policy, for example, the Anobiidae. In addition, APHIS may at times target specific groups of insects or countries for certain lengths of time. Given these biases, it is apparent that PIN data should be used with caution. Nevertheless, the PIN still provides valuable historical information on the most common types of pests that have entered the US, pathways by which they arrived, countries of origin, and associated products. This paper provides summary data for several families of bark- and wood-boring Coleoptera that were intercepted at US ports of entry between the years 1985 and 2000.

When I queried the PIN database, I restricted the search to the years 1985–2000 for the beetle families that are commonly

Table 2. Summary data for 8341 Coleoptera interceptions at US ports of entry from 1985 to 2000 by insect family (source: USDA APHIS Port Information Network database).

Family*	No. of interceptions identified				No. identified		No. of interceptions associated with wood articles if given				Top five associated products in decreasing order
	Total	Family-level only	Genus-level only	Species level	Genera	Species	Crating	Dunnage	Pallets	Wood	
BOS	414	52	115	247	16	16	137	33	28	150	Tiles, woodenware, melons, machinery, marble
BUP	245	41	182	22	16	10	80	51	7	39	Tiles, marble, machinery, steel, mesquite
CER	1642	448	1048	146	79	41	390	269	57	408	Tiles, iron, ironware, machinery, marble
CUR	875	118	714	43	44	17	420	326	33	95	Tiles, steel, machinery, marble, granite
LYC	102	72	11	19	3	3	64	4	3	15	Doors, tiles, artware, bamboo, housewares
PLA	55	19	36	0	2	0	3	4	3	8	*Dracaena* plants, pineapples, bananas, woodenware, doors
SCO	5008	1547	1002	2459	40	60	2179	1841	348	601	Tiles, marble, machinery, steel, parts
Total	8341	2297	3108	2936	200	147	3273	2528	479	1316	Tiles, machinery, marble, steel, ironware

*Insect families: BOS, Bostrichidae; BUP, Buprestidae; CER, Cerambycidae; CUR, Curculionidae; LYC, Lyctidae; PLA, Platypodidae; SCO, Scolytidae.

associated with wood, that is, Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, Lyctidae, Platypodidae, and Scolytidae. Because many of the curculionid and scolytid interceptions were associated with food items, I further restricted the search within those two families to include only those interceptions where the insects were found in association with wood. Insects intercepted on goods from Canada are generally not considered to be of quarantine importance to the US and therefore are seldom entered in the PIN. I therefore removed the few interception records from Canada in the subsequent analyses.

APHIS personnel complete “PPQ Form 309A” for each actionable or reportable interception and enter the data in the PIN. The PIN database can be searched by any of 25 data fields. I requested the following information for each interception: taxon (insect family, genus, species), country of origin, imported product (e.g., marble, steel, tiles), type of material infested (e.g., crating, dunnage, pallet), interception date, and the port city where the interception was made. At times, insects were only identified to family or genus, which is common when only larvae are collected. Similarly, the exact country of origin could not always be determined. On such occasions, inspectors enter the continent of origin if known. As a result of political changes between 1985 and 2000, several countries that existed in 1985 did not exist in 2000, while many new nations emerged during the same period. For ease of manipulating the data set, I assigned all interceptions from Czechoslovakia to the Czech Republic, and those from the USSR to Russia. To examine the data at a continent scale, I assigned each country to a continent or world region, that is, Africa, Asia, Central America, the Caribbean, Europe, the Pacific, and South America. In this analysis, I assigned Russia and Turkey to Asia, Mexico to Central America, and Australia and New Zealand to the Pacific region.

Overview of the interception data

In the analyses that follow, I used data from 8341 beetle interceptions made during the 16-year period from 1985 to 2000. This data set included all interceptions of Bostrichidae (414 interceptions), all Buprestidae (245), all Cerambycidae (1642), the wood-associated Curculionidae (875), all Lyctidae (102), all Platypodidae (55), and the wood-associated Scolytidae (5008) (Table 2). Note that the paper by Haack (2001) dealt with all intercepted Scolytidae (6825 interceptions), whereas only the wood-associated scolytid interceptions (5008) are considered in the current paper. Of the 8341 interceptions, approximately 72% were identified to genus and 35% to species (Table 2). Overall, 200 genera and 147 species were identified (Table 2). Undoubtedly, many more genera and species would have been identified if all intercepted beetles had been identified to species.

Of the seven beetle families treated here, Scolytidae was the most commonly intercepted family, accounting for 60% of US interceptions (Fig. 1). Cerambycidae and Curculionidae were the next most commonly intercepted families. Interception data for wood-associated arthropods have also been published for Chile (1059 arthropod interceptions (1053 insects) between 1995 and 1999; Beeche-Cisternas 2000) and New Zealand (523 insect interceptions between 1972 and 1974; Bain 1977). The Chilean data include information on all wood-associated insects that were found and thus provide a

Fig. 1. Percentage of wood-associated beetle interceptions that were members of the families Bostrichidae (BOS), Buprestidae (BUP), Cerambycidae (CER), Curculionidae (CUR), Lyctidae (LYC), Platypodidae (PLA), and Scolytidae (SCO) in Chile (770 interceptions between 1995 and 1999; Beeche-Cisternas 2000), New Zealand (396 insect interceptions between 1972 and 1974; Bain 1977), and the United States (8341 interceptions; source: USDA APHIS Port Information Network database). See text for details.

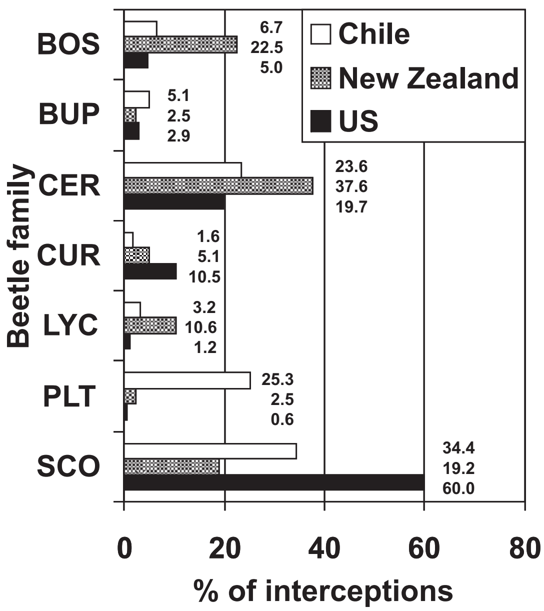
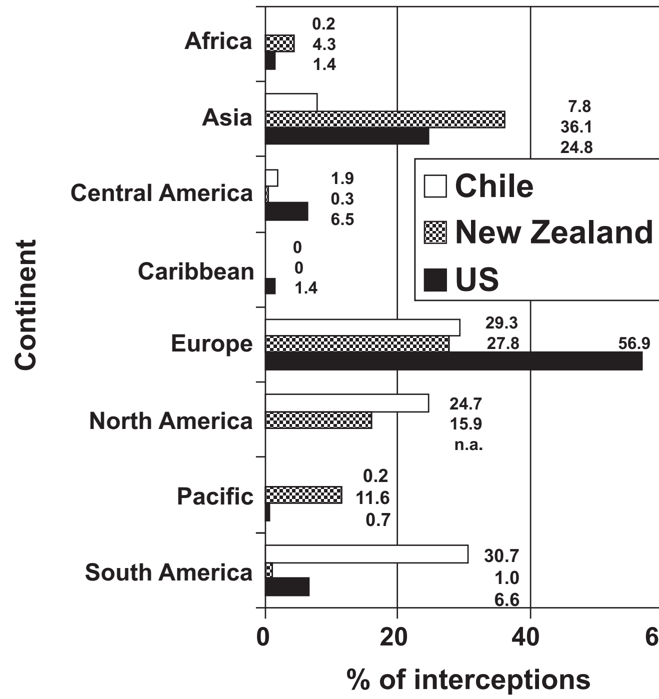


Fig. 2. Percentage of wood-associated insect interceptions that originated from various world regions and were intercepted in Chile (1059 arthropod interceptions between 1995 and 1999; Beeche-Cisternas 2000), New Zealand (396 insect interceptions in the families Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, Lyctidae, Platypodidae, and Scolytidae between 1972 and 1974; Bain 1977), and the United States (8341 interceptions; source: USDA APHIS Port Information Network database). See text for details.



more complete picture of the kinds and numbers of insects commonly encountered on wood. The New Zealand data include just those insects that were intercepted on wood and submitted for identification. The seven beetle families addressed in the present paper represented 73% of the 1059 Chilean interceptions, with scolytids, platypodids, and cerambycids being most common (Fig. 1). Similarly, these seven beetle families represented 76% of the 523 New Zealand interceptions, among which the cerambycids, bostrichids, and scolytids were most common (Fig. 1). Allen and Humble (2002) provide details on bark- and wood-boring insects reared from dunnage and wood spools.

Crating was the most common type of wood article to be infested, followed by dunnage and pallets (Table 2). In many cases, the inspectors did not specify what type of wood article was infested, but entered simply “wood”. The higher number of insect interceptions on crating and dunnage reflects in part the greater ease and thoroughness by which these items can be inspected compared with pallets. Similarly, in New Zealand, scolytids were most often intercepted on dunnage and crating and less so on lumber, pallets, and logs (Brockerhoff et al. 2006).

For all 8341 interceptions, the 10 products most often associated with infested wood articles were tiles (1281 interceptions), machinery (407), marble (407), steel (373), ironware (231), parts (231), granite (220), iron (95), aluminum (94), and woodenware (86). The 10 products most often associated with beetle-infested crating were tiles (1004 interceptions), marble (309), machinery (264), granite (171), parts (155), ironware (152), aluminum (46), woodenware (43), glass (40), and steel (39). Similarly, the 10 products most often associated with infested dunnage were steel (301), machinery (76), aluminum (42), marble (30), tubes (24), granite (23), tiles (21), parts (20), ironware (18), and wire (8). And the 10 products most often associated with infested pallets were tiles (89), parts (40), machinery (22), books (16), marble (8), housewares (7), hardware (6), paper (6), tools (5), and chemicals (5).

Continent of origin

The US intercepted wood-associated beetles from all major world regions between 1985 and 2000 (Fig. 2). Most interceptions during this 16-year period were on imports from Europe (57%), followed by Asia, Central America, South America, Africa, the Caribbean, and the Pacific. The relative ranking of the continents varied over time (Table 3). For example, interceptions from Asia accounted for 13% of the total during the period 1985–1988, compared with 40% during the period 1997–2000 (Table 3). By contrast, interceptions from Europe declined from 73% to 34% during these same two periods. In the case of Chile (Beeche-Cisternas 2000) and New Zealand (Bain 1977), most interceptions were made on products from South America and Asia, respectively (Fig. 2).

The number of interceptions made at 4-year intervals between 1985 and 2000 is presented for each beetle family by continent in Table 3. To explore interception frequency over time, I expressed the interception data for each family as a percentage of total interceptions for each 4-year period and performed linear regression analysis after arcsin transformation. Overall, cerambycid interception frequency increased significantly over time ($F_{[1,2]}$ = 22.4; $P < 0.042$), while scolytid interception frequency decreased ($F_{[1,2]}$ = 51.0; $P < 0.02$). These trends resulted primarily from the dramatic rise in cerambycid interceptions from Asia and the major drop in scolytid interceptions from Europe (Table 3).

Although the value of total US imports significantly increased ($F_{[1,14]}$ = 167.3; $P < 0.0001$) over time from US$336 billion in 1985 to $1218 billion in 2000 (Fig. 3; US Census Bureau 2001), the overall number of wood-associated insect interceptions per year has fallen ($F_{[1,14]}$ = 10.6; $P < 0.006$) (Table 3). Haack (2001) presented several reasons to help explain this apparent paradox. For example, between 1985 and 2000, many exporters shifted from solid wood to other materials that were less suitable for insects, such as plywood, particle board, or metal. There was also a change in US import regulations starting in 1996 that required that all unmanufactured solid wood items be "totally free from bark" or else be certified by the exporting country as treated for wood pests (USDA APHIS 1995). This regulation allowed APHIS inspectors to require treatment (e.g., fumigation) simply when bark was found, and thus finding actual insects was not required. At the same time, compliance among foreign exporters increased, resulting in lower insect incidence.

Country of origin

Wood-associated insects were intercepted from 113 countries in the US between 1985 and 2000 (summary data by country (Table S1) are also available).[2] The US state of Hawaii was included in Table S1 because Hawaiian goods are generally inspected prior to shipment to the continental US. Of the 113 countries, 19 were African, 23 Asian, 10 Central American, 13 Caribbean, 32 European, 5 Pacific, and 11 South American.

The top 15 countries of origin for intercepted wood-associated insects are listed for the US as well as Chile and New Zealand in Table 4. Italy ranked first for the US, accounting for about 17% of the 8341 interceptions between 1985 and 2000. By contrast, the US ranked first for both Chile (23% of 1059 interceptions from 38 countries) and New Zealand (13% of 396 interceptions from 34 countries) (Table 4). The information presented in Tables 4 and S1 indicates that practically all countries have inadvertently exported insects to other countries on wood products.

The number of insect interceptions made per year in the US is shown in Fig. 3 for the top five countries of origin (Belgium, China, Germany, Italy, and Spain). To explore these trends, I expressed the interception data for each country as a percentage of total interceptions by year followed by arcsin transformation. Linear regression indicated that the interception frequency significantly decreased over time for Belgium ($F_{[1,14]}$ = 49.4; $P < 0.0001$), Germany ($F_{[1,14]}$ = 44.0; $P < 0.0001$), and Italy ($F_{[1,14]}$ = 5.0; $P < 0.043$); increased for China ($F_{[1,14]}$ = 23.5; $P < 0.0003$); but was not significant for Spain ($F_{[1,14]}$ = 2.1; $P > 0.17$). The decline in interceptions from Belgium, Germany, and Italy was primarily due to a reduction in scolytid interceptions, whereas the increase in interception frequency from China was mostly due to a rise in cerambycid interceptions.

Details on US interceptions and imports from China and Italy are given in Table 5. Overall, the data indicate (1) the rapid increase in interception frequency and value of general imports from China and (2) the decline in interception frequency from Italy, even though the value of Italian imports grew (Table 5). As mentioned previously, *Anoplophora glabripennis* was discovered in New York in 1996 and then in Illinois in 1998. These discoveries in part brought about closer inspection of wood packing material from China as well as stricter regulations on wood from China (USDA APHIS 1998). The rapid increase in cerambycid interceptions from China during 1997–2000 (Table 5) reflects both the rapid increase in total imports from China to the US as well as more targeted inspections by APHIS on Chinese goods. Figure 3 indicates (1) the dramatic increase in interception frequency on goods from China in 1997 and 1998 as a result of more targeted inspections and (2) the sharp drop in interceptions on Chinese products in 1999 following the new wood regulations (USDA APHIS 1998) and high Chinese compliance.

The number of borer genera identified from each country is listed by beetle family in Table S1. Of the 200 identified genera for all 7 beetle families, the most genera identified for any single country was 63 genera for imports from Italy. Other countries from which 30 or more beetle genera were identified included China (56 genera), Mexico (48), Germany (35), Spain (35), Japan (34), Brazil (33), France (33), India (33), Russia (31), and Belgium (30).

The number of US states in which borers were intercepted is listed for each country in Table S1. Borers from China and Germany were each intercepted in the largest number of US states (26). Other countries whose insects were intercepted in 15 or more US states included Spain (25 US states), Italy (22), Belgium (21), France (21), Japan (20), India (19), Mexico (18), and Russia (17). The five most frequently intercepted genera from each originating country are listed in Table S1 by beetle family. Also presented in Table S1 are the number of interceptions made on each major type of wood article (crating, dunnage, pallets, and other) by country and the top three products imported from each country that were most often associated with beetle-infested wood.

Intercepted insects by receiving US state

APHIS inspectors intercepted wood-associated insects in 40 of the 50 US states between 1985 and 2000 (Fig. 4). Bostrichids were reported in 23 US states, and similarly buprestids in 23, cerambycids in 32, curculionids in 28, lyctids in 8, platypodids in 12, and scolytids in 33 (Table 6). Individual interception maps for each of the seven beetle families (Fig. S1) are available on this journal's Web site and upon request from the Depository for Unpublished Data. Most interceptions were made in US states with maritime

[2] Supplementary data (Table S1. Summary interception data by country; Fig. S1. Interception data by family and US state) for this article are available on the journal's Web site (http://cjfr.nrc.ca) or may be purchased from the Depository of Unpublished Data, Document Delivery, CISTI, National Research Council Canada, Building M-55, 1200 Montreal Road, Ottawa, ON K1A 0R6, Canada. DUD 4066. For more information on obtaining material refer to http://cisti-icist.nrc-cnrc.gc.ca/irm/unpub_e.shtml.

Table 3. Number of Bostrichidae, Buprestidae, Cerambycidae, wood-associated Curculionidae, Lyctidae, Platypodidae, and wood-associated Scolytidae interceptions at US ports of entry at 4-year intervals between 1985 and 2000, number of intercepted genera and the four most commonly identified genera by continent of origin from 1985 to 2000 (source: USDA APHIS Port Information Network database), and the total value of general imports to the United States by 4-year intervals in billions of US dollars (unadjusted for inflation; US Census Bureau 2001 and earlier editions).

	No. of interceptions at 4-year intervals						
Continent	Total	1985–1988	1989–1992	1993–1996	1997–2000	No. of genera	Top four genera
Bostrichidae	414	135	63	68	148	16	*Sinoxylon*, *Stephanopachys*, *Heterobostrychus*, *Micrapate*
Africa	6	1	1	1	3	2	*Heterobostrychus*, *Sinoxylon*
Asia	166	64	30	25	47	8	*Sinoxylon*, *Heterobostrychus*, *Xylothrips*, *Micrapate*
Central America	40	23	8	7	2	9	*Melalgus*, *Stephanopachys*, *Amphicerus*, *Prostephanus*
Caribbean	19	16	2	0	1	6	*Melalgus*, *Micrapate*, *Apate*, *Heterobostrychus*
Europe	81	24	11	17	29	4	*Stephanopachys*, *Heterobostrychus*, *Sinoxylon*, *Xylothrips*
Pacific	6	1	3	0	2	2	*Apate*, *Xylothrips*
South America	76	6	7	17	46	11	*Micrapate*, *Dexicrates*, *Sinoxylon*, *Prostephanus*
Unknown	20	0	1	1	18	6	*Heterobostrychus*, *Xylopsocus*, *Amphicerus*, *Sinoxylon*
Buprestidae	245	80	35	44	86	16	*Melanophila*, *Buprestis*, *Chrysobothris*, *Agrilus*
Africa	9	2	3	2	2	4	*Chrysobothris*, *Acmaeodera*, *Buprestis*, *Sphenoptera*
Asia	71	30	5	9	27	9	*Buprestis*, *Agrilus*, *Chrysobothris*, *Melanophila*
Central America	31	2	10	5	14	7	*Chrysobothris*, *Acmaeodera*, *Agrilus*, *Chalcophora*
Caribbean	3	0	1	0	2	1	*Actenodes*
Europe	107	42	15	20	30	7	*Melanophila*, *Agrilus*, *Chrysobothris*, *Buprestis*
Pacific	5	0	0	2	3	1	*Castiarina*
South America	10	1	1	3	5	2	*Anthaxia*, *Chrysobothris*
Unknown	9	3	0	3	3	5	*Agrilus*, *Chrysobothris*, *Melanophila*, *Buprestis*
Cerambycidae	1642	211	287	458	686	79	*Monochamus*, *Xylotrechus*, *Ceresium*, *Hesperophanes*
Africa	30	4	8	13	5	8	*Sophronica*, *Diadelia*, *Monochamus*, *Ceresium*
Asia	811	49	94	223	445	40	*Monochamus*, *Ceresium*, *Hesperophanes*, *Xylotrechus*
Central America	204	30	64	55	55	26	*Acanthoderes*, *Stenodontes*, *Eburia*, *Monochamus*
Caribbean	76	10	28	32	6	13	*Elaphidion*, *Leptostylus*, *Heterachthes*, *Trachyderes*
Europe	354	78	60	87	129	23	*Monochamus*, *Xylotrechus*, *Tetropium*, *Phymatodes*
Pacific	36	7	8	10	11	3	*Sybra*, *Ceresium*, *Monochamus*
South America	85	25	19	23	18	15	*Trachyderes*, *Paramallocera*, *Eburia*, *Monochamus*
Unknown	46	8	6	15	17	14	*Xylotrechus*, *Phymatodes*, *Monochamus*, *Callidium*
Curculionidae	875	299	239	180	157	44	*Pissodes*, *Hylobius*, *Sitona*, *Apion*
Africa	6	1	3	0	2	3	*Pissodes*, *Sitona*, *Sternochetus*
Asia	94	7	11	40	36	14	*Pissodes*, *Shirahoshizo*, *Hylobius*, *Niphades*
Central America	31	3	1	4	23	8	*Zascelis*, *Conotrachelus*, *Cossonus*, *Cryptorhynchus*
Caribbean	0					0	
Europe	705	272	216	126	91	27	*Pissodes*, *Hylobius*, *Sitona*, *Apion*
Pacific	0					0	
South America	19	6	5	6	2	6	*Pissodes*, *Cossonus*, *Heilipus*, *Marshallius*
Unknown	20	10	3	4	3	4	*Pissodes*, *Hylobius*, *Hypera*, *Sipalinus*
Lyctidae	102	55	36	5	6	3	*Minthea*, *Lyctus*, *Trogoxylon*
Africa	2	2	0	0	0	1	*Minthea*
Asia	11	4	1	3	3	3	*Minthea*, *Lyctus*, *Trogoxylon*
Central America	2	0	2	0	0	0	Identified to Lyctidae only
Caribbean	4	1	2	0	1	2	*Trogoxylon*, *Minthea*
Europe	4	2	2	0	0	1	*Lyctus*
Pacific	0					0	
South America	77	45	28	2	2	3	*Lyctus*, *Minthea*, *Trogoxylon*
Unknown	2	1	1	0	0	1	*Minthea*
Platypodidae	55	12	11	14	18	2	*Platypus*, *Tesserocerus*
Africa	0					0	
Asia	5	1	0	2	2	1	*Platypus*
Central America	33	8	9	7	9	2	*Platypus*, *Tesserocerus*
Caribbean	1	0	1	0	0	0	Identified to Platypodidae only
Europe	4	1	1	1	1	2	*Platypus*
Pacific	1	1	0	0	0	1	*Platypus*
South America	8	1	0	3	4	2	*Platypus*, *Tesserocerus*
Unknown	3	0	0	1	2	1	*Platypus*

Table 3 (*concluded*).

Continent	No. of interceptions at 4-year intervals					No. of genera	Top four genera
	Total	1985–1988	1989–1992	1993–1996	1997–2000		
Scolytidae	5008	2215	1074	1032	687	40	*Pityogenes*, *Ips*, *Orthotomicus*, *Hylurgops*
Africa	67	14	15	16	22	9	*Hypothenemus*, *Orthotomicus*, *Pityophthorus*, *Hylastes*
Asia	914	236	126	392	160	28	*Hypocryphalus*, *Orthotomicus*, *Hypothenemus*, *Dryocoetes*
Central America	199	20	21	30	128	15	*Ips*, *Pityophthorus*, *Gnathotrichus*, *Dendroctonus*
Caribbean	14	3	8	1	2	6	*Hypothenemus*, *Coccotrypes*, *Pityophthorus*, *Cnemonyx*
Europe	3488	1790	839	531	328	28	*Pityogenes*, *Ips*, *Orthotomicus*, *Hylurgops*
Pacific	11	3	2	4	2	4	*Hylurgus*, *Crypturgus*, *Hylastes*, *Ips*
South America	197	94	30	37	36	21	*Hypothenemus*, *Hylurgus*, *Hylastes*, *Coccotrypes*
Unknown	118	55	33	21	9	17	*Pityogenes*, *Hylurgops*, *Ips*, *Orthotomicus*
No. of interceptions	8341	3007	1745	1801	1788		
Total imports (US$, billions)		1562	1988	2783	4025		

ports along the Atlantic Ocean, Pacific Ocean, Gulf of Mexico, and the Great Lakes. Large numbers of interceptions were also made at major US airports and the land border crossings with Mexico. Interceptions were also made in a few foreign countries where preclearance inspections were completed prior to export to the US, for example, ports in Chile, New Zealand, and South Korea. The preclearance interceptions are listed as “other” in Fig. 1. In addition, interceptions were made in Puerto Rico and the US Virgin Islands and entered in the PIN because these nations serve as official US ports of entry. These island nations also export goods to the continental US and therefore were also listed as exporting countries in Table S1.

Given the rapid increase in shipping international cargo inside containers, which are seldom opened until they reach their final destination, there will likely be a shift in the locations where exotic insects first become established from near ports of entry to distribution centers throughout the country. Stanaway et al. (2001) found insects, both dead and alive, in 39% of 3001 shipping containers that were inspected in Australia.

The 25 exotic beetles listed in Table 1 were first detected in 16 US states (the shaded states in Fig. 4). Fourteen of these states have major maritime ports, while two are inland (Colorado and Tennessee). Of course, the state where an insect is first found is not necessarily the state in which it first became established. Nevertheless, there were three states (California, New York, and Pennsylvania) where 3 of the 25 new exotic beetles were first found and two states (Florida and Texas) where 2 of the exotics were first found (Table 1). For the 48 contiguous US states, there was a significant ($F_{[1,46]} = 21.4$; $P < 0.0001$) positive linear relation between number of wood-associated beetle interceptions between 1985 and 2000 and number of newly detected exotic beetles between 1985 and 2005.

Genera of intercepted insects

Of the 8341 insect interceptions, 6044 (72%) were identified to the genus level, representing 200 identified genera (Table 6). For each genus, information is presented in Table 6 on the number of interceptions made, the number that were further identified to species, the number of originating continents and countries, the top five countries of origin, and the number of US states where the interceptions were made. Again, I used the taxonomic entries as they appeared in the PIN, although I recognize many taxonomic changes have occurred recently. For example, the genus *Apion* is listed under Curculionidae in Table 6, but has now been reassigned to the family Brentidae (Arnett et al. 2002). There were broad similarities in the genera of beetles intercepted in the US with those intercepted in Chile (Beeche-Cisternas 2000) and New Zealand (Bain 1977).

The bostrichids in the PIN were intercepted in 23 US states and identified to 16 genera (Table 6). They were intercepted from 46 countries, with the top 5 being India (76 interceptions), Spain (68), Chile (34), Thailand (28), and Mexico (20) (Tables 6 and S1). The five most frequently intercepted genera were *Sinoxylon*, *Stephanopachys*, *Heterobostrychus*, *Micrapate*, and *Melalgus*. Individuals of *Heterobostrychus* and *Stephanopachys* were each intercepted from the most countries (16).

The buprestids in the PIN were intercepted in 23 US states and identified to 16 genera (Table 6). They were intercepted from 43 countries, with the top 5 being Spain (40 interceptions), Turkey (31), Mexico (21), Belgium (18), and Italy (17) (Tables 6 and S1). The five most frequently intercepted genera were *Melanophila*, *Buprestis*, *Chrysobothris*, *Agrilus*, and *Anthaxia*. Individuals of *Chrysobothris* were intercepted from the most countries (15).

The cerambycids in the PIN were intercepted in 32 US states and identified to 79 genera (Table 6). They were intercepted from 93 countries, with the top 5 being China (497 interceptions), Italy (130), Russia (116), Mexico (114), and Belgium (43) (Tables 6 and S1). The five most frequently intercepted genera were *Monochamus*, *Xylotrechus*, *Ceresium*, *Hesperophanes*, and *Tetropium*. Individuals of *Monochamus* were intercepted from the most countries (29).

The wood-associated curculionids in the PIN were intercepted in 28 US states and identified to 44 genera (Table 6). They were intercepted from 52 countries, with the top 5 being Italy (325 interceptions), the United Kingdom (77), Germany (75), Belgium (59), and Spain (39) (Tables 6 and S1). The five most frequently intercepted genera were *Pissodes*, *Hylobius*, *Sitona*, *Apion*, and *Hypera*. Individuals of *Pissodes* were intercepted from the most countries (22).

The lyctids in the PIN were intercepted in 8 US states and identified to 3 genera (Table 6). It is important to note that only 30 of 102 lyctid interceptions were identified to genus. The lyctids were intercepted from 21 countries, with the top

Fig. 3. Number of wood-associated insect interceptions made per year at US ports of entry that originated from the top five countries of origin (Belgium, China, Germany, Italy, and Spain) and all remaining countries (source: USDA APHIS Port Information Network database), and the value of total US imports (US$, billions; US Census Bureau 2001) per year between 1985 and 2000.

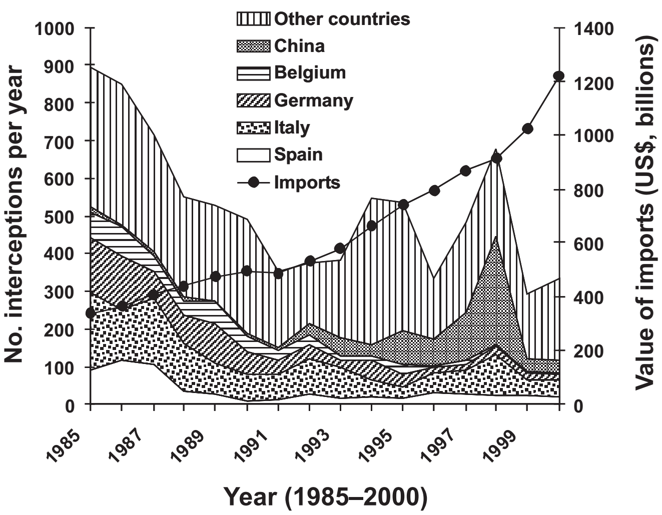


Table 4. Top 15 countries of origin for insects intercepted on wood packing material at ports of entry in Chile, New Zealand, and the United States.

Country (no. of interceptions)		
Chile*	New Zealand†	United States‡
US (247)	US (50)	Italy (1427)
Brazil (115)	Japan (41)	Germany (854)
Germany (91)	India (32)	China (793)
Argentina (90)	Australia (20)	Spain (611)
Italy (83)	Malaysia (15)	Belgium (466)
India (37)	Fiji (14)	Russia (341)
Peru (33)	Philippines (13)	India (336)
Colombia (29)	UK (13)	Mexico (317)
Ecuador (27)	Germany (8)	France (308)
Spain (27)	China (7)	UK (234)
Austria (26)	Ghana (7)	Brazil (180)
France (26)	Hong Kong (7)	Japan (161)
Mexico (18)	Italy (6)	Portugal (144)
Belgium (17)	Singapore (6)	Chile (110)
China (16)	Papua New Guinea (5)	Turkey (97)

*Source: Beeche-Cisternas (2000), based on 1059 interceptions between 1994 and 1999. All wood-associated insect interceptions were included.

†Source: Bain (1977), based on 396 wood-associated insect interceptions between 1972 and 1974 for the families Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, Lyctidae, Platypodidae, and Scolytidae.

‡Based on the 8341 interceptions treated in this paper between 1985 and 2000.

5 being Brazil (62 interceptions), Colombia (8), India (6), Italy (3), and China (2) (Tables 6 and S1).

The platypodids in the PIN were intercepted in 12 US states and identified to 2 genera (Table 6). They were intercepted from 17 countries, with the top 5 being Costa Rica (20 interceptions), Mexico (8), Guatemala (4), Brazil (2), and Colombia (2) (Tables 6 and S1). Wood (1993) recently revised the family Platypodidae and created several new genera from *Platypus*, which represented 94% of all platypodids identified to genus in the PIN.

The wood-associated scolytids in the PIN were intercepted in 33 US states and identified to 40 genera (Table 6). They were intercepted from 80 countries, with the top 5 being Italy (943 interceptions), Germany (735), Spain (424), Belgium (346), and France (254) (Tables 6 and S1). The five most frequently intercepted genera were *Pityogenes*, *Ips*, *Orthotomicus*, *Hylurgops*, and *Hylurgus*. Individuals of *Pityogenes* were intercepted from the most countries (33).

Interception frequency and establishment

Of the 25 recently established beetle species listed in Table 1, only 9 appeared in the PIN database between the years 1985 and 2000. Neither of the 2 recently established buprestids, nor any of the 10 recently established species of ambrosia beetles, appeared in the PIN. This is not surprising given that only 1 of 38 *Agrilus* (Buprestidae) interceptions and 18 of 40 ambrosia beetle interceptions had been identified to the species level (Table 1). Moreover, as mentioned previously, ambrosia beetles were seldom entered in the PIN, given that APHIS usually regarded them as nonactionable when intercepted. However, three of the five recently established cerambycids and six of the eight bark beetle species were listed in the PIN (Table 1). It is of interest to note that *Anoplophora glabripennis* and *Callidiellum rufipenne*, as well as the genera *Anoplophora* and *Callidiellum*, first appeared in the PIN in 1997, reflecting the stronger emphasis on identifying intercepted cerambycids by APHIS after the discoveries in the US of *Anoplophora glabripennis* in 1996 and *Callidiellum rufipenne* in 1997. The fact that six of the eight newly established bark beetles were in the PIN database reflects (1) that bark beetles are among the first borers to infest recently felled trees and are common associates of most tree species used for dunnage and wood packing, (2) the greater ease at which these insects can be collected during inspection, for example from just under the bark versus extraction from inside wood, and (3) the greater likelihood that adults are recovered, given that scolytid parent adults and brood are found in the same galleries versus only brood (usually larvae) are found in the galleries of buprestids and cerambycids. Identification to the species level usually requires adult insects.

For the wood-associated scolytids in the PIN that were identified to the species level (2459 interceptions), the 15 most commonly intercepted species were all bark beetles, including *Pityogenes chalcographus* (L.) (517 interceptions), *Orthotomicus erosus* (359), *Hylurgops palliatus* (283), *Ips typographus* (L.) (253), *Hylurgus ligniperda* (195), *Ips sexdentatus* (Boerner) (151), *Tomicus piniperda* (145), *Hylastes ater* (Paykull) (73), *Polygraphus poligraphus* (L.) (41), *Pityogenes bistridentatus* (Eichhoff) (36), *Orthotomicus laricis* (Fabricius) (28), *Pityogenes bidentatus* (25), *Ips acuminatus* (Gyllenhal) (23), *Taphrorychus bicolor* (Herbst) (23), and *Phloeosinus rudis* Blandford (22). Of these 15 scolytid species, the 2nd (*O. erosus*), 3rd (*Hylurgops palliatus*), 5th (*Hylurgus ligniperda*), 7th (*Tomicus piniperda*), and 12th (*Pityogenes bidentatus*) most commonly intercepted species were known to be established in the US as of 2005 (Table 1).

To investigate further the relationship between interception frequency and establishment in the US, I calculated for

Fig. 4. Number of wood-associated insect interceptions made in individual US states between 1985 and 2000. CT, Connecticut; DE, Delaware; FL, Florida; HI, Hawaii; MA, Massachusetts; MD, Maryland; NJ, New Jersey; PR, Puerto Rico; RI, Rhode Island; VI, Virgin Islands; other, interceptions made in Chile, New Zealand, or South Korea during preclearance inspections prior to export to the United States (source: USDA APHIS Port Information Network database).

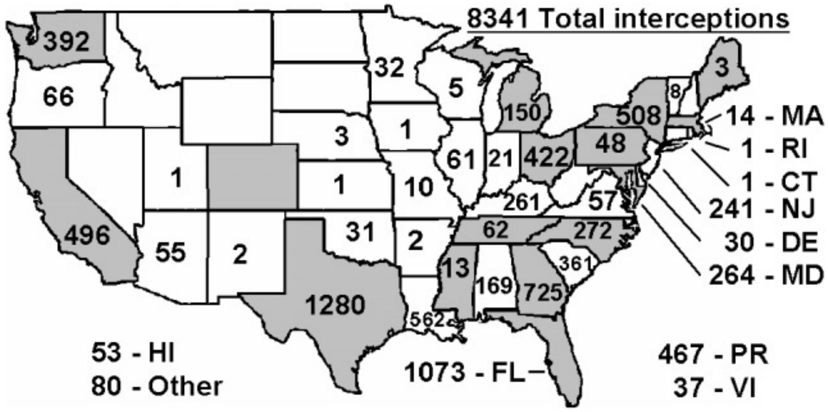


Table 5. Number of Bostrichidae, Buprestidae, Cerambycidae, wood-associated Curculionidae, Lyctidae, Platypodidae, and wood-associated Scolytidae interceptions at US ports of entry at 4-year intervals between 1985 and 2000 that originated from China (not including Hong Kong) and Italy (source: USDA APHIS Port Information Network database), and the total value of general imports to the US from China and Italy summed over 4-year intervals in billions of US dollars (unadjusted for inflation; US Census Bureau 2001 and earlier editions).

		No. of interceptions at 4-year intervals			
Family	Total	1985–1988	1989–1992	1993–1996	1997–2000
China					
Bostrichidae	15	4	3	0	8
Buprestidae	11	2	0	1	8
Cerambycidae	497	15	21	104	357
Curculionidae	37	0	2	10	25
Lyctidae	2	0	0	2	0
Platypodidae	2	1	0	1	0
Scolytidae	229	16	17	118	78
Total	793	38	43	236	476
% of overall total*		1	2	13	27
Value of imports (US$, billions)		23	72	167	315
% of overall total*		1	4	6	8
Italy					
Bostrichidae	9	6	3	0	0
Buprestidae	17	4	0	2	11
Cerambycidae	130	27	22	26	55
Curculionidae	325	64	120	73	68
Lyctidae	3	1	2	0	0
Platypodidae	0	0	0	0	0
Scolytidae	943	543	172	106	122
Total	1427	645	319	207	256
% of overall total*		21	18	11	14
Value of imports (US$, billions)		43	49	63	88
% of overall total*		3	2	2	2

*Percentage values were generated by dividing the country totals given in the present table by the overall totals given at the bottom of Table 3.

each of the 51 true bark beetle species identified in the PIN (see list in Haack 2001) its percentage of the 2426 interceptions of true bark beetles between 1985 and 2000. Of the 51 species, there were 12 species that each accounted for 1% or more of the 2426 interceptions, while 39 species each accounted for less than 1% of the total. Overall, 5 of the 12 most commonly intercepted bark beetles were known to be established in the US as of 2005, whereas only 1 of the 39 less frequently intercepted species was established. These two proportions differed significantly ($P < 0.002$, Fisher's

Table 6. Summary data by genus for the Bostrichidae, Buprestidae, Cerambycidae, wood-associated Curculionidae, Lyctidae, Platypodidae, and wood-associated Scolytidae intercepted at US ports of entry between 1985 and 2000 (source: USDA APHIS Port Information Network database).

	No. of interceptions					
Genus	Total	Identified to species level	No. of continents	No. of countries	Top five countries of origin in decreasing order	No. of receiving US states
Bostrichidae	414	247	7	46	IN, ES, CL, TH, MX*	23
Amphicerus	6	0	2	4	MX, BR, EC, HN	2
Apate	3	1	2	3	AS, DO, DM	1
Bostrychopsis	1	0	1	1	CO	0
Dexicrates	11	11	1	1	CL	4
Heterobostrychus	40	38	6	16	TH, IN, CN, GT, PE	11
Melalgus	18	0	2	6	DO, CR, SV, GT, HN	3
Mesoxylion	1	0	1	1	JP	0
Micrapate	24	16	4	9	CL, PE, JM, LA, BR	8
Neoterius	5	5	1	1	CL	3
Prostephanus	11	8	2	2	CL, MX	7
Sinoxylon	131	118	5	16	IN, TH, PK, SG, VE	16
Stephanopachys	87	32	4	11	ES, MX, IT, CL, RU	14
Xylobiops	4	0	3	3	MX, IN, TT	2
Xylodeleis	2	2	1	1	EC	1
Xylopsocus	10	9	4	4	BR, HN, CN, TT	7
Xylothrips	8	7	3	5	CN, AU, IN, MY, ES	4
Buprestidae	245	22	7	43	ES, TR, MX, BE, IT	23
Acmaeodera	4	0	2	3	MX, EG, GT	4
Actenodes	1	1	1	1	DO	1
Agrilus	38	1	3	11	BE, DE, IL, FR, IN	11
Anthaxia	19	6	3	7	CL, ES, TR, IT, RU	5
Belionota	3	1	1	2	IN, ID	3
Buprestis	39	1	3	11	TR, ES, IT, IN, JP	10
Castiarina	4	0	1	1	AU	1
Chalcophora	3	0	3	2	CN, MX	3
Chrysobothris	39	2	5	15	MX, ES, IT, CN, TR	12
Eurythyrea	1	1	1	1	IT	1
Melanophila	44	6	3	11	ES, GR, IT, TR, CN	10
Ovalisia	5	2	1	1	JP	5
Phaenops	1	0	1	1	TR	1
Polycesta	1	1	1	1	MX	1
Sphenoptera	1	0	1	1	Africa	1
Taphrocerus	1	0	1	1	MX	1
Cerambycidae	1642	146	7	93	CN, IT, RU, MX, BE	32
Acanthocinus	7	0	2	5	RU, BE, DE, JO, NL	4
Acanthoderes	14	5	1	4	CR, HN, MX, NI	6
Acyphoderes	1	0	1	1	BR	1
Aglaophis	1	1	1	1	MX	1
Anaglyptus	1	0	1	1	JM	1
Anelaphus	3	0	2	3	IT, MX, PA	2
Anoplophora	31	5	1	2	CN, JP	10
Apomecyna	1	1	1	1	IN	1
Apriona	2	0	1	1	CN	1
Asemum	5	0	2	4	CN, RU, TR, UA	4
Ataxia	2	0	1	2	HN, MX	2
Batocera	23	2	2	6	PH, CN, IN, HN, JP	6
Callidiellum	16	14	1	2	JP, CN	7
Callidium	15	0	2	8	DE, ES, RU, BE, CN	9
Ceresium	114	0	4	7	CN, KR, JP, MY, MA	14
Chlorida	5	5	3	5	CO, CR, DO, SCr, SLu	1
Chlorophorus	8	1	2	4	IN, CN, TH, IN	5
Clytus	1	0	1	1	Unknown	1
Coptops	1	0	1	1	IN	1

Table 6 (*continued*).

Genus	No. of interceptions: Total	No. of interceptions: Identified to species level	No. of continents	No. of countries	Top five countries of origin in decreasing order	No. of receiving US states
Demonax	1	0	1	1	JP	1
Dendrobias†	2	0	1	1	MX	2
Dere	1	1	1	1	CN	1
Diadelia	2	0	1	1	GH	2
Dihammus	3	0	3	3	GY, NL, PH	2
Diorthus	1	0	1	1	IN	1
Eburia	11	0	2	3	MX, PA, PE	5
Elaphidion	15	0	3	10	AG, BS, PR, SCr, CR	4
Epepeotes	1	0	1	1	Asia	1
Euryscelis	1	1	1	1	CO	1
Eutetrapha	1	1	1	1	HK	1
Glenea	1	0	1	1	CN	1
Hesperophanes	51	0	2	5	CN, IN, JP, KR, UA	13
Heterachthes	4	0	1	2	SCr, SCh	0
Ibidion	1	0	1	1	AG	0
Lagocheirus	1	1	1	1	CR	1
Lamia	10	4	2	4	IT, CN, FR, GR	7
Leptostylus	13	0	3	9	CR, SV, SCr, DR, GT	3
Lepturges	7	0	3	4	MX, BR, GT, SCr	3
Liopinus	1	0	1	1	MX	1
Mallambyx	2	2	2	2	FR, TT	2
Megacyllene	1	0	1	1	MX	1
Molorchus	4	0	2	3	IT, AT, RU	3
Monochamus	432	20	6	29	CN, RU, IT, ES, MX	24
Neoclytus	3	1	3	3	BR, DO, MX	2
Nyssodrysina	1	0	1	1	GT	1
Oberea	1	0	1	1	DE	1
Odontocera	1	0	1	1	BR	1
Oreodera	1	1	1	1	HN	1
Oxymerus	1	0	1	1	Unknown	0
Oxypleurus	1	1	1	1	ES	0
Palaeocallidium	1	0	1	1	JP	1
Paramallocera	5	0	1	2	CO, EC	1
Parmena	8	3	2	4	IT, JP, FR, SN	4
Parmenonta	1	0	1	1	GT	1
Petrognatha	1	1	1	1	Africa	1
Phoracantha	2	0	2	2	BR, ZA	1
Phymatodes	44	0	2	12	BE, CN, DE, RU, IT	16
Placosternus	1	0	1	1	CO	1
Plagionotus	3	1	2	2	CN, VE	2
Platyarthron	2	2	1	2	CR, GT	1
Prosoplus	3	0	2	2	MX, ID	2
Psacothea	2	2	2	2	MY, MX	2
Pterolophia	1	0	1	1	CN	1
Purpuricenus	1	0	1	1	CN	1
Pyrrhidium	10	8	2	2	BE, ZA	6
Rhagium	10	0	2	6	IT, BE, DE, FR, JP	6
Saperda	21	6	3	10	IT, RU, DE, UA, IN	9
Semanotus	2	0	2	2	CN, SCr	1
Sophronica	3	0	1	2	GM, NG	1
Stenodontes	14	0	3	6	CR, MX, CO, DR, HN	5
Stizocera	2	0	1	2	BZ, MX	2
Stromatium	5	4	2	3	CN, CR, TR	3
Styloleptus	3	0	2	3	BS, DO, NL	2
Sybra	26	25	2	2	HI, IN	2
Tetropium	45	19	2	7	IT, CN, DE, JP, ES	14
Trachyderes	18	1	2	4	BR, DO, AG, SCr	0

Table 6 (*continued*).

Genus	No. of interceptions: Total	No. of interceptions: Identified to species level	No. of continents	No. of countries	Top five countries of origin in decreasing order	No. of receiving US states
Trichoferus[†]	2	0	1	1	CN	2
Xylotrechus	126	7	3	22	CN, DE, IT, RU, BE	19
Xystrocera	5	0	1	2	IN, JP	3
Curculionidae	875	43	5	52	IT, UK, DE, BE, ES	28
Acalles	1	0	1	1	IT	1
Apion	27	0	1	1	IT	2
Baris	1	0	1	1	FR	1
Ceutorhynchus	3	0	1	2	IT, GR	1
Chlorophanus	1	0	1	1	Asia	1
Conotrachelus	1	0	1	1	CR	1
Cossonus	5	0	3	4	DE, BE, BR, GT	3
Cryptorhynchus	3	0	2	2	CN, CR	3
Curculio	3	0	2	3	CZ, JP, KR	3
Dorytomus	2	0	1	1	IT	1
Gerstaeckeria	1	0	1	1	IN	1
Heilipus	1	0	1	1	AR	1
Hexarthrum	1	0	1	1	IT	1
Hylobius	181	6	2	18	DE, UK, BE, IT, PL	19
Hypera	17	1	1	4	IT, ES, FR, PT	7
Larinus	3	1	2	3	IT, RU, UK	3
Lixus	1	0	1	1	IT	1
Marshallius	2	0	2	2	BR, CR	2
Mecaspis	1	1	1	1	IT	1
Mecinus	4	1	1	1	IT	2
Mecopus	1	0	1	1	IN	1
Niphades	4	1	1	2	CN, JP	4
Otiorhynchus	9	0	1	1	IT	4
Peltophorus	1	0	1	1	GY	1
Phaenomerus	2	0	1	2	CN, SG	2
Phyllobius	1	0	1	1	IT	1
Pissodes	280	21	4	23	IT, UK, DE, BE, ES	18
Polydrusus	1	0	1	1	DE	1
Rhynchaenus	1	0	1	1	MX	1
Rhynchites	1	1	1	1	GR	1
Rhyncolus	7	0	3	4	TR, IT, MX, ES	4
Rhyssomatus	1	0	1	1	MX	1
Rhytidoderes	1	1	1	1	ES	1
Shirahoshizo	13	0	1	1	CN	6
Sipalinus	2	0	1	1	CN	2
Sitona	162	7	2	6	IT, FR, ES, EG, GR	8
Smicronyx	1	0	1	1	IT	1
Sphenophorus	1	0	1	1	IT	1
Stenocarus	1	1	1	1	IT	1
Sternochetus	2	1	2	2	KE, ES	1
Tomolips	1	0	1	1	CN	1
Tychius	2	0	1	1	IT	1
Zascelis	2	0	1	2	HN, MX	2
Zygops	1	0	1	1	BO	1
Lyctidae	102	19	6	21	BR, CO, IN, CN, IT	8
Lyctus	12	6	3	6	CO, IT, BR, CL, IN	3
Minthea	14	12	4	10	BR, IN, AG, CO, EC	4
Trogoxylon	4	1	3	4	DO, HT, IN, PE	2
Platypodidae	55	0	6	17	CR, MX, GT, BR, CO	12
Platypus	34	0	5	13	CR, MX, GT, BO, BR	8
Tesserocerus	2	0	2	2	BR, GT	1

Table 6 (*concluded*).

Genus	No. of interceptions: Total	Identified to species level	No. of continents	No. of countries	Top five countries of origin in decreasing order	No. of receiving US states
Scolytidae	5008	2459	7	80	IT, DE, ES, BE, FR	33
Ambrosiodmus	1	1	1	1	MY	1
Araptus	1	0	1	1	BR	1
Carphoborus	21	16	2	5	ES, IT, TR, DE, IL	11
Chramesus	1	0	1	1	MX	1
Cnemonyx	1	0	1	1	TT	1
Coccotrypes	20	0	5	7	BR, IT, BS, CR, JM	7
Cryphalus	54	7	2	12	CN, IT, IN, PH, FR	11
Crypturgus	54	32	4	15	PT, ES, DE, FR, BE	14
Cyrtogenius	6	0	1	3	CN, HK, KR	4
Dendroctonus	13	0	1	1	MX	1
Dryocoetes	159	39	3	19	CN, DE, BE, IT, UK	19
Euwallacea	6	6	1	1	CN	4
Gnathotrichus	22	0	2	3	MX, GT, IT	3
Hylastes	133	111	7	18	ES, CL, DE, IT, FR	18
Hylesinus	13	9	1	4	UK, IT, BE, UA	9
Hylurgops	309	284	4	22	DE, BE, IT, UK, RU	22
Hylurgus	242	195	6	17	IT, PT, CL, ES, FR	21
Hypocryphalus	102	1	3	8	IN, CN, BR, CI, JP	12
Hypothenemus	172	1	6	28	IN, BR, VE, CN, CI	12
Ips	501	444	5	31	IT, DE, ES, RU, BE	26
Orthotomicus	434	399	4	25	ES, IT, CN, DE, PT	22
Pagiocerus	1	0	1	1	BR	1
Phloeosinus	48	22	4	7	JP, CN, BE, KR, MX	12
Phloeotribus	6	4	4	6	GR, IL, MX, PT, ES	6
Pityogenes	611	590	3	33	DE, IT, RU, BE, ES	24
Pityokteines	17	14	2	6	IT, DE, FR, AT, GR	6
Pityophthorus	51	11	6	13	MX, ZA, IT, DE, GT	12
Polygraphus	59	43	3	13	IT, DE, RU, CN, UK	15
Pseudopityophthorus	1	0	1	1	MX	1
Pseudothysanoes	1	0	1	1	DO	0
Pteleobius	1	1	1	1	IT	1
Scolytodes	2	0	2	2	BR, DE	2
Scolytus	92	14	4	19	BE, CN, IT, FR, RU	16
Taphrorychus	67	40	4	12	BE, DE, FR, TR, CZ	15
Tomicus	182	151	3	21	FR, IT, UK, ES, BE	19
Trypodendron	11	11	2	5	IT, DE, BE, FR, TR	4
Xyleborinus	1	0	1	1	CN	1
Xyleborus	30	9	5	12	CN, IT, GR, TR, IN	9
Xylechinus	13	3	2	4	IN, IT, JP, NL	7
Xylosandrus	2	1	1	2	BE, DE	2

*Country codes: AG, Antigua; AR, Argentina; AS, American Samoa; AT, Austria; AU, Australia; AW, Aruba; BE, Belgium; BO, Bolivia; BR, Brazil; BS, Bahamas; BZ, Belize; CI, Ivory Coast; CL, Chile; CN, China; CO, Colombia; CR, Costa Rica; CV, Cape Verde; CZ, Czech Republic; DE, Germany; DM, Dominica; DO, Dominican Republic; EC, Ecuador; EE, Estonia; EG, Egypt; ES, Spain; FI, Finland; FR, France; GH, Ghana; GM, Gambia; GT, Guatemala; GR, Greece; GY, Guyana; HI, Hawaii; HK, Hong Kong; HN, Honduras; HT, Haiti; ID, Indonesia; IL, Israel; IN, India; IR, Iran; IT, Italy; JM, Jamaica; JP, Japan; JO, Jordan; KE, Kenya; KR, South Korea; LA, Laos; LT, Lithuania; LV, Latvia; MA, Morocco; MX, Mexico; MY, Malaysia; NG, Nigeria; NI, Nicaragua; NL, Netherlands; NZ, New Zealand; PA, Panama; PE, Peru; PH, Philippines; PK, Pakistan; PL, Poland; PT, Portugal; RU, Russia; SCh, St. Christopher, British Virgin Islands; SCr, St. Croix, US Virgin Islands; SE, Sweden; SG, Singapore; SLu, St. Lucia; SN, Senegal; SV, El Salvador; SZ, Swaziland; TH, Thailand; TR, Turkey; TT, Trinidad and Tobago; UA, Ukraine; UK, United Kingdom; VE, Venezuela; ZA, South Africa.

†*Dendrobias* has been synonymized under *Trachyderes*, and *Trichoferus* has been synonymized under *Hesperophanes*.

exact test), indicating a positive relationship between interception frequency and establishment. Similar relationships were reported by Brockerhoff et al. (2006).

It is noteworthy that no new species of wood-boring curculionids were reported as established in the continental US between 1985 and 2005, especially species of *Hylobius* and *Pissodes*, considering that these two genera were frequently intercepted. By contrast, the North American pine-infesting weevil *Pissodes nemorensis* has become established in South Africa and has caused significant damage (Gebeyehu and Wingfield 2003).

Conclusions

Exotic forest insects threaten forest resources worldwide. International trade facilitates the spread of these pests given that insects can move (1) in the actual product being transported (e.g., nuts, seeds, logs, lumber, nursery stock), (2) in the associated wood packing material or dunnage, or (3) as hitchhikers on ships, containers, and airplanes (Wood 1977; Wallenmaier 1989; Haack 2001; Dobbs and Brodel 2004).

Although the PIN database only includes records for a small percentage of all insects that enter US ports, it is still a valuable resource that provides historical information on those pests considered by USDA APHIS to be of quarantine significance. The fact that about 60% of the wood-associated beetles recorded in the PIN were scolytids, with the vast majority being bark beetles, provides evidence as to why thorough bark removal is important to eliminate this group of pests. Recognizing this threat, USDA APHIS required that beginning in 1996 all wood packing material entering the US should be free of bark (USDA APHIS 1995). Nevertheless, complete debarking is difficult to achieve, as evidenced by inspections in 2001 where bark was found in 10%–15% of maritime shipments and 1% of air shipments that contained wood (USDA APHIS 2000). For borers that develop inside wood, bark removal is usually not sufficient to kill them if they have already entered the wood at the time of debarking. Heat treatment and fumigation with methyl bromide are common practices used to kill many classes of wood-associated pests (Morrell 1995), and currently these are the only two procedures that have been endorsed internationally for wood packing material (FAO 2002). The US formally supported these international wood-treatment standards in 2004 (USDA APHIS 2004*b*), as have many other countries. If these standards are adopted worldwide and compliance is high, then there should be a dramatic reduction of pests being transported in wood. However, the current international standards for wood packing material do not require complete debarking of wood if properly treated (FAO 2002). The degree to which insects and other organisms colonize wood after treatment, especially if some bark is present, has not been well studied. The current FAO standards will be modified and expanded to include new treatments based on future research. Even if these new standards were fully implemented worldwide, tree-infesting insects could still be moved through other pathways such as bonsai trees, nursery stock, as well as holiday and household decorations that use tree trunks, bark, or fruit (Mudge et al. 2001; Haack 2003). The US has recently implemented more stringent regulations on imported bonsai (USDA APHIS 2004*c*) and is considering new regulations on nursery stock (USDA APHIS 2004*a*). Individual countries can lower the likelihood of establishment and subsequent spread of exotic organisms through pest and pathway risk assessments, improved inspection and treatment techniques, development of molecular diagnostic tools, and early-detection surveys (Allen and Humble 2002; National Research Council 2002; USDA APHIS 2002; Chornesky et al. 2005).

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References

Allen, E.A., and Humble, L.M. 2002. Nonindigenous species introductions: a threat to Canada's forests and forest economy. Can. J. Plant Pathol. **24**: 103–110.

Arnett, R.H., Jr., Thomas, M.C., Skelley, P.E., and Frank, J.H. Editors. 2002. American beetles. Vol. 2. Polyphaga: Scarabaeoidea through Curculionoidea. CRC Press, Boca Raton, Fla.

Atkinson, T.H., Rabaglia, R.J., and Bright, D.E. 1990. Newly detected exotic species of *Xyleborus* (Coleoptera: Scolytidae) with a revised key to species in eastern North America. Can. Entomol. **122**: 93–104.

Atkinson, T.H., Rabaglia, R.J., Peck, S.B., and Foltz, J.L. 1991. New records of Scolytidae and Platypodidae from the U.S. and Bahamas. Coleopt. Bull. **45**: 152–164.

Bain, J. 1977. Overseas wood- and bark-boring insects intercepted at New Zealand ports. N.Z. For. Serv. Tech. Pap. 63.

Beeche-Cisternas, M.A. 2000. Riesgos cuarentenarios de insectos asociados a embalajes de madera y maderas de estiba de cargas de internacion en Chile. *In* Proceedings: International Conference on Quarantine Pests for the Forestry Sector and their Effects on Foreign Trade, Concepcion, Chile, 27–28 June 2000. CORMA, Concepcion, Chile. [In Spanish.]

Blackwelder, R.E. 1944. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America, Part 2. U.S. Natl. Mus. Bull. **185**: 189–341.

Bright, D.E., and Skidmore, R.E. 1997. A catalog of Scolytidae and Platypodidae (Coleoptera), supplement 1 (1990–1994). NRC Research Press, Ottawa, Ont.

Brockerhoff, E.G., Knížek, M., and Bain, J. 2003. Checklist of indigenous and adventive bark and ambrosia beetles (Curculionidae: Scolytinae and Platypodinae) of New Zealand and interceptions of exotic species (1952–2000). N.Z. Entomol. **26**: 29–44.

Brockerhoff, E.G., Bain, J., Kimberley, M.O., and Knížek, M. 2006. Interception frequency of exotic bark and ambrosia beetles (Coleoptera: Scolytinae) and relationship with establishment in New Zealand and worldwide. Can. J. For. Res. **36**: 263–268.

Campadelli, G., and Sama, G. 1989. First record in Italy of a Japanese cerambycid: *Callidiellum rufipenne* Motschulsky. Boll. Ist. Entomol. "Guido Grandi" Univ. Stud. Bologna, **43**: 69–73.

Chornesky, E.A., Bartuska, A.M., Aplet, G.H., Britton, K.O., Cummings-Carlson, J., Davis, F.W., et al. 2005. Science priorities for reducing the threat of invasive species to sustainable forestry. Bioscience, **55**: 335–348.

Dobbs, T.T., and Brodel, C.F. 2004. Cargo aircraft as a pathway for the entry of nonindigenous pests into South Florida. Fla. Entomol. **87**: 65–78.

FAO (Food and Agriculture Organization). 2002. International standards for phytosanitary measures: guidelines for regulating wood packaging material in international trade. FAO Publ. 15, Rome, Italy.

Frank, J.H., and McCoy, E.D. 1992. The immigration of insects to Florida, with a tabulation of records published since 1970. Fla. Entomol. **75**: 1–28.

Gebeyehu, S., and Wingfield, M.J. 2003. Pine weevil *Pissodes nemorensis*: threat to South African pine plantations and options for control. S. Afr. J. Sci. **99**: 531–536.

Gerberg, E.J. 1957. A revision of the New World species of powder-post beetles belonging to the family Lyctidae. USDA For. Serv. Tech. Bull. 1157.

Haack, R.A. 2001. Intercepted Scolytidae (Coleoptera) at U.S. ports of entry: 1985–2000. Integr. Pest Manage. Rev. **6**: 253–282.

Haack, R.A. 2003. Exotics, exotics, exotics: newly detected bark and wood boring beetles in the U.S. Newsl. Mich. Entomol. Soc. **48**(3–4): 16–17.

Haack, R.A. 2004. *Orthotomicus erosus*: a new pine-infesting bark beetle in the United States. Newsl. Mich. Entomol. Soc. **49**(3–4): 3.

Haack, R.A., and Poland, T.M. 2001. Evolving management strategies for a recently discovered exotic forest pest: the pine shoot beetle, *Tomicus piniperda* (Coleoptera). Biol. Invasions, **3**: 307–322.

Haack, R.A., and Slansky, F. 1987. Nutritional ecology of wood-feeding Coleoptera, Lepidoptera, and Hymenoptera. *In* Nutritional ecology of insects, mites, and spiders. *Edited by* F. Slansky and J.G. Rodriguez. John Wiley, New York. pp. 449–486.

Haack, R.A., Law, K.R., Mastro, V.C., Ossenbruggen, H.S., and Raimo, B.J. 1997. New York's battle with the Asian long-horned beetle. J. For. **95** (12): 11–15.

Haack, R.A., Jendek, E., Liu, H., Marchant, K.R., Petrice, T.R., Poland, T.M., and Ye, H. 2002. The emerald ash borer: a new exotic pest in North America. Newsl. Mich. Entomol. Soc. **47**(3–4): 1–5.

Hanks, L.M., Paine, T.D., Millar, J.G., and Campbell, C. 1998. Another tree-killing pest of eucalyptus invades California. Calif. Plant Pest Dis. Rep. **16**: 19–21.

Hanks, L.M. 1999. Influence of the larval host plant on reproductive strategies of cerambycid beetles. Annu. Rev. Entomol. **44**: 483–505.

Hérard, F., Jollivet, C., and Reynaud, P. 2005. Gestion des foyers de capricornes asiatiques en France, Autriche, Allemagne et Italie, l'éradication est lancée. Phytoma-L.d.v. **583**: 22–26.

Hoebeke, E.R. 1989. *Pityogenes bidentatus* (Herbst), a European bark beetle new to North America (Coleoptera: Scolytidae). J. N.Y. Entomol. Soc. **97**: 305–308.

Hoebeke, E.R. 1991. An Asian ambrosia beetle, *Ambrosiodmus lewisi*, new to North America (Coleoptera: Scolytidae). Proc. Entomol. Soc. Wash. **93**: 420–424.

Hoebeke, E.R. 1994. New records of immigrant bark beetles (Coleoptera: Scolytidae) in New York: attraction of conifer-feeding species to ethanol-baited trap logs. Entomol. News, **105**: 267–276.

Hoebeke, E.R. 2001. *Hylurgus ligniperda*: a new exotic pine bark beetle in the United States. Newsl. Mich. Entomol. Soc. **46**(1–2): 1–2.

Hoebeke, E.R., and Acciavatti, R.E. 2006. *Hylurgops palliatus* (Gyllenhal), an Eurasian bark beetle new to North America (Coleoptera: Curculionidae: Scolytinae). Proc. Entomol. Soc. Wash. **108**: 267–273.

Hoebeke, E.R., Haugen, D.A., and Haack, R.A. 2005. *Sirex noctilio*: discovery of a Palearctic siricid woodwasp in New York. Newsl. Mich. Entomol. Soc. **50**(1–2): 24–25.

Howden, H., and Howden, A. 2000. *Tetrops praeusta* (L.) (Coleoptera: Cerambycidae), a potential pest? Insecta Mundi, **14**: 220.

Humble, L.M. 2001. Invasive bark and wood-boring beetles in British Columbia, Canada. *In* Protection of world forests from insect pests: advances in research. *Edited by* E. Alfaro, K. Day, S. Salom, K.S.S. Nair, H. Evans, A. Liebhold, F. Lieutier, M. Wagner, K. Futai, and K. Suzuki. IUFRO World Series Vol. 11, Vienna, Austria. pp. 69–77.

Kirisits, T. 2004. Fungal associates of European bark beetles with special emphasis on the ophiostomatoid fungi. *In* Bark and wood boring insects in living trees in Europe: a synthesis. *Edited by* F. Lieutier, K.R. Day, A. Battisti, J.-C. Grégoire, and H.F. Evans. Kluwer Academic, Dordrecht, Netherlands. pp. 181–235.

Kuhnholz, S., Borden, J.H., and Uzunovic, A. 2001. Secondary ambrosia beetles in apparently healthy trees: adaptations, potential causes and suggested research. Integr. Pest Manage. Rev. **6**: 209–219.

Landry, L.P. 2001. *Tetrops praeusta* (Linne), une addition a la faune des Cerambycidae (Coleoptera) du Quebec. Fabreries, **26**: 26–27.

Lee, J.C., Smith, S.L., and Seybold, S.J. 2005. Mediterranean pine engraver. USDA Forest Service, State and Private Forestry, Pacific Southwest Region Pest Alert R5-PR-016.

Liebhold, A.M., MacDonald, W.L., Bergdahl, D., and Mastro, V.C. 1995. Invasion by exotic forest pests: a threat to forest ecosystems. For. Sci. Monogr. **41**: 1–49.

Lingafelter, S.W., and Hoebeke, E.R. 2002. Revision of *Anoplophora* (Coleoptera: Cerambycidae). The Entomological Society of Washington, Washington, D.C.

Liu, H., and Haack, R.A. 2003. *Scolytus schevyrewi* [online]. National Information Center for State and Private Forestry, Washington, D.C. Available from http://www.spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=163&langdisplay=english [cited 12 December 2004].

Liu, H., Bauer, L.S., Gao, R., Zhao, T., Petrice, T.R., and Haack, R.A. 2003. Exploratory survey for emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae), and its natural enemies in China. Great Lakes Entomol. **36**: 191–204.

Lundgren, J.G. 2001. *Callidiellum rufipenne* [online]. National Information Center for State and Private Forestry, Washington, D.C. Available from http://www.spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=87&langdisplay=english [cited 12 December 2004].

Maier, C.T., and Lemmon, C.R. 2000. Discovery of the small Japanese cedar longhorned beetle, *Callidiellum rufipenne* (Motschulsky) (Coleoptera: Cerambycidae), in live arborvitae in Connecticut. Proc. Entomol. Soc. Wash. **102**: 747–754.

Mattson, W.J., Niemela, P., Millers, I., and Inguanzo, Y. 1994. Immigrant phytophagous insects on woody plants in the United States and Canada: an annotated list. USDA For. Serv. Gen. Tech. Rep. NC-GTR-169.

Morgan, R.E., de Groot, P., and Smith, S.M. 2004. Susceptibility of pine plantations to attack by the pine shoot beetle (*Tomicus piniperda*) in southern Ontario. Can. J. For. Res. **34**: 2528–2540.

Morrell, J.J. 1995. Importation of unprocessed logs into North America: a review of pest mitigation procedures and their efficacy. For. Prod. J. **45**(9): 41–50.

Mudge, A.D., LaBonte, J.R., Johnson, K.J.R., and LaGasa, E.H. 2001. Exotic woodboring Coleoptera (Micromalthidae, Scolytidae) and Hymenoptera (Xiphydriidae) new to Oregon and Washington. Proc. Entomol. Soc. Wash. **103**: 1011–1019.

Mushrow, L., Morrison, A., Sweeney, J., and Quiring, D. 2004. Heat as a phytosanitary treatment for the brown spruce longhorn beetle. For. Chron. **80**: 224–228.

National Research Council, Committee on the Scientific Basis for Predicting the Invasive Potential of Nonindigenous Plants and Plant Pests in the United States, Board on Agriculture and Natural Resources. 2002. Predicting invasions of nonindigenous plants and plant pests. National Academy Press, Washington, D.C.

Negrón, J.F., Witcosky J.J., Cain, R.J., LaBonte, J.R., Duerr, D.A., McElwey, S.J., Lee, J.C., and Seybold, S.J. 2005. The banded elm bark beetle: a new threat to elms in North America. Am. Entomol. **51**: 84–94.

Peck, S.B., and Thomas, M.C. 1998. A distributional checklist of the beetles (Coleoptera) of Florida. Arthropods Fla. Neighb. Land Areas, **16**: 1–180.

Petrice, T.R., Haack, R.A., and Poland, T.M. 2004. Evaluation of three trap types and five lures for monitoring *Hylurgus ligniperda* (Coleoptera: Scolytidae) and other scolytids in New York. Great Lakes Entomol. **37**: 1–9.

Poland, T.M., and McCullough, D.G. 2006. Emerald ash borer: invasion of the urban forest and threat to North America's ash resource. J. For. **104**. In press.

Rabaglia, R. 2003*a*. *Xyleborus glabratus* [online]. National Information Center for State and Private Forestry, Washington, D.C. Available from http://spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=148&langdisplay=english [cited 8 January 2005].

Rabaglia, R. 2003*b*. *Xyleborus similis* [online]. National Information Center for State and Private Forestry, Washington, D.C. Available from http://spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=146&langdisplay=english [cited 8 January 2005].

Rabaglia, R. 2003*c*. *Xylosandrus mutilatus* [online]. National Information Center for State and Private Forestry, Washington, D.C. Available from http://spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=149&langdisplay=english[cited 8 January 2005].

Rabaglia, R.J., and Cavey, J.F. 1994. Note on the distribution of the immigrant bark beetle, *Hylastes opacus*, in North America (Coleoptera: Scolytidae). Entomol. News, **105**: 277–279.

Ratzeburg, J.T.C. 1837. Die Forst-insecten oder Abbildung und Beschreibung der in den Wäldern Preussens und der Nachbarstaaten als schädlich oder nützlich bekannt gewordenen Insecten. Vol. 1, Die Käfer. Nicolai, Berlin. [In German.]

Schiefer, T.L., and Bright, D.E. 2004. *Xylosandrus mutilatus* (Blandford), an exotic ambrosia beetle (Coleoptera: Curculionidae: Scolytinae: Xyleborini) new to North America. Coleopt. Bull. **58**: 431–438.

Scriven, G.T., Reeves, E.L., and Luck, R.F. 1986. Beetle from Australia threatens *Eucalyptus*. Calif. Agric. **40**(July–Aug.): 4–6.

Siitonen, J. 2000. Beetles (Coleoptera) imported to Finland on Russian roundwood. *In* Invasive species and timber imports from Russia: review of current knowledge by Nordic experts. *Edited by* B. Okland. Aktuelt fra skogforskningen, **4-00**: 11–18.

Smith, G., and Hurley, J.E. 2000. First North American record of the Palearctic species *Tetropium fuscum* (Fabricius) (Coleoptera: Cerambycidae). Coleopts. Bull. **54**: 540.

Smith, I.M., McNamara, D.G., Scott, P.R., and Holderness, M. (*Editors*) 1997. Quarantine pests for Europe. 2nd ed. CAB International, Wallingford, UK.

Stanaway, M.A., Zalucki, M.P., Gillespie, P.S., Rodriguez, C.M., and Maynard, G.V. 2001. Pest risk assessment of insects in sea cargo containers. Aust. J. Entomol. **40**: 180–192.

Thomas, M.C. 2000. *Ficus aurea* (Florida strangler fig, golden fig) – *Sybra alternans* (Wiedemann), a longhorned beetle. *In* Triology Technical Report. Vol. 39, issue 3. *Edited by* N.C. Coile. Florida Division of Plant Industry, Gainesville, Fla.p. 5.

Thomas, M.C. 2005. Another Asian ambrosia beetle, *Xyleborus glabratus* Eichhoff (Scolytinae: Curculionidae) [online]. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Fla. Pest Alert. Available from http://www.doacs.state.fl.us/pi/enpp/ento/x.glabratus.html [cited 26 January 2006].

US Census Bureau. 2001. Statistical abstract of the United States: 2000. US Census Bureau, Washington, D.C.

US Congress. 1993. Harmful non-indigenous species in the United States. US Congress, Office of Technology Assessment, OTA-F-565, Washington, D.C.

USDA APHIS. 1992. 7 CFR Part 301 – pine shoot beetle. Federal Register, 19 November 1992, **57**: 54 492 – 54 499.

USDA APHIS 1995. 7 CFR Parts 300 and 319 – importation of logs, lumber, and other unmanufactured wood articles. Federal Register, 25 May 1995, **60**: 27 665 – 27 682.

USDA APHIS. 1997. 7 CFR Part 301 – Asian longhorned beetle; quarantine regulations. Federal Register, 7 March 1997, **62**: 10 412 – 10 419.

USDA APHIS. 1998. 7 CFR Parts 319 and 354 – solid wood packing material from China. Federal Register, 18 September 1998, **63**: 50 100 – 50 111.

USDA APHIS. 2000. Pest risk assessment for importation of solid wood packing materials into the United States. [online]. Available from http://www.aphis.usda.gov/ppq/pra/swpm [cited 23 September 2005].

USDA APHIS. 2003. 7 CFR Part 301 – domestic quarantine notices. Subpart – emerald ash borer. Federal Register, 14 October 2003, **68**: 59 088 – 59 091.

USDA APHIS. 2004*a*. 7 CFR Part 319 – nursery stock regulations. Federal Register, 10 December 2004, **69**: 71 736 – 71 744.

USDA APHIS. 2004*b*. 7 CFR Part 319 – importation of wood packaging material. Federal Register, 16 September 2004, **69**: 55 719 – 55 733.

USDA APHIS. 2004*c*. 7 CFR Part 319 – importation of artificially dwarfed plants in growing media from the People's Republic of China. Federal Register, 16 January 2004, **69**: 2481–2491.

Vandenberg, N.J., Rabaglia, R.J., and Bright, D.E. 2000. New records of two *Xyleborus* (Coleoptera: Scolytidae) in North America. Proc. Entomol. Soc. Wash. **102**: 62–68.

Wallenmaier, T. 1989. Wood-boring insects. *In* Plant protection and quarantine. Vol. 2. *Edited by* R.P. Kahn. CRC Press, Boca Raton, Fla. pp. 99–108.

Wood, S.L. 1977. Introduced and exported American Scolytidae (Coleoptera). Great Basin Nat. **37**: 67–74.

Wood, S.L. 1992. Nomenclatural changes and new species in Platypodidae and Scolytidae (Coleoptera), Part II. Great Basin Nat. **52**: 78–88.

Wood, S.L. 1993. Revision of the genera of Platypodidae (Coleoptera). Great Basin Nat. **53**: 259–281.

Wood, S.L, and Bright, D.E. 1992. A catalog of Scolytidae and Platypodidae (Coleoptera), Part 2: taxonomic index. Great Basin Nat. Mem. **13**: 1–1553.

Yanega, D. 1996. Field guide to northeastern longhorned beetles (Coleoptera: Cerambycidae). Illinois Natural History Survey Manual 6, Champaign, Ill.