Insects Intercepted on Solid Wood Packing Materials at United States Ports-of-Entry: 1985-1998

Robert A. Haack[1] and Joseph F. Cavey[2]

[1]US Department of Agriculture, Forest Service, North Central Research Station, 1407 S. Harrison Road, East Lansing, Michigan 48823 USA (e-mail: rhaack @fs.fed.us)
[2]US Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, 4700 River Road, Unit 133, Riverdale, Maryland 20737-1236 USA (e-mail: Joseph.F.Cavey @usda.gov)

Introduction

Estimates of the total number of exotic (non-indigenous) organisms that are now established in the United States (US) range from 4,500 (US Congress 1993) to more than 50,000 (Pimentel et al. 2000), of which more than 400 are insects that feed on trees and shrubs and another 20 are disease organisms of trees (Haack and Byler 1993, Mattson *et al.* 1994, Niemela and Mattson 1996). Several of these exotic tree-feeding insects -- gypsy moth (*Lymantria dispar*), smaller European elm bark beetle (*Scolytus multistriatus*), hemlock woolly adelgid (*Adelges tsugae*), and beech scale (*Cryptococcus fagisuga*) -- have already greatly altered forested landscapes throughout the US (Ciesla 1993, Liebhold *et al.* 1995, Morrell and Filip 1996, Wallner 1996, Mattson 1997). It is common for exotic insects to become pests in a new country because they often arrive without their normal suite of natural enemies.

With world trade and travel growing each year, the threat of new biological invasions continues to grow as well. For example, in the 1990s, established populations of three new exotic forest insects were found in the US, including the pine shoot beetle, *Tomicus piniperda* (Coleoptera: Scolytidae) in Ohio in 1992 (Haack and Kucera 1993), the Asian longhorned beetle, *Anoplophora glabripennis* (Coleoptera: Cerambycidae) in New York in 1996 (Haack et al. 1997), and the smaller Japanese cedar longhorned beetle, *Callidiellum rufipenne* (Coleoptera: Cerambycidae) in North Carolina in 1997 (Haack 1998, USDA APHIS 1999). In addition, in May 2000, the first North American report of established populations of the spruce-feeding Eurasian cerambycid *Tetropium fuscum* was made in Halifax, Nova Scotia, Canada.

Exotic plants and animals can easily and unintentionally be transported from one country to another. For aquatic organisms, they often travel in the ballast water of ships (Moyle and Light 1996), while land organisms usually travel with cargo and international travelers (US Congress 1993, Morrell and Filip 1996). With respect to exotic forest insects, they often move with (a) solid wood packing materials like crating, pallets, and dunnage (*i.e.*, the wood braces used to support cargo), (b) whole plants or plant parts such as nursery stock and logs, and (c) manufactured products such as lumber. During

Haack RA and Cavey JF. 2000. Insects intercepted on solid wood packing materials at United States ports-of-entry: 1985-1998. *In*: Quarantine pests, risks for the forestry sector and their effects on foreign trade. Proceedings on CD-ROM of Silvotecna 14, 27-28 June 2000, Concepcion, Chile. CORMA, Concepcion, Chile. 16 p.

the 1990s, there was much interest in importing logs into the US and as a result USDA APHIS (United states Department of Agriculture, Animal and Plant Health Inspection Service) conducted four formal pest risk assessments for the importation of logs from Siberia (USDA Forest Service 1991), New Zealand (USDA Forest Service 1992), Chile (USDA Forest Service 1993), and Mexico (Tkacz et al. 1998). In recent years, concern has turned more to the insects associated with solid wood packing material, especially following the discovery of the cerambycid *Anoplophora glabripennis* in Chicago, Illinois, in 1998 (Poland *et al.* 1998, USDA APHIS 1998). In this paper, we provide summary data on the numbers, kinds, and origins of insects that have been intercepted on wood articles at US ports-of-entry during the years 1985 through 1998. This paper updates two earlier publications that summarized the US interception data for the years 1985-1996 (Haack and Cavey 1997, 1998).

The APHIS Database

Since 1985, USDA APHIS has maintained a national computerized database of pests intercepted at US ports-of-entry. APHIS compiles information on all intercepted organisms considered to be quarantine pests, but does not collect data on non-quarantine organisms such as cosmopolitan pests and predators. Pest interception data are maintained for a variety of different commodities, such as fresh fruit, vegetables, cut flowers, seeds, and wood articles. A number of data fields are recorded for each interception, including the pest species name, year, country of origin, port-of-entry in the US, and commodity. In addition, for insects associated with various wood articles, the type of article is often included, *i.e.*, crating, dunnage, pallets, lumber, poles, woodenware, etc. This paper deals only with insects that were intercepted on wood articles.

It is important to note that for some interceptions not all data fields were completed. This is especially common when insects are collected as larvae, because immature stages of many wood pests cannot be identified to the species level and time constraints do not permit insects to be reared to the adult stage. Under these circumstances, the insect may only be identified to the level of order, family, or genus. In addition, when the exact country of origin cannot be determined for a particular interception, then the most likely continent of origin is recorded. Also, as a result of political changes during the period 1985-1998, some countries that existed in 1985 now no longer exist (*e.g.*, East Germany, Czechoslovakia, Soviet Union), while others have emerged as new nations during the period 1985-1998 (*e.g.*, Slovakia, Russia, Ukraine). For the most part, these changes in political boundaries had little effect on the data presented here. However, where appropriate, data manipulations are footnoted in the tables.

Types of Insects Intercepted on Wood Articles in the US

During the years 1985 through 1998, APHIS made 6952 interceptions of exotic insects on wood articles at nearly all of the 100 port locations throughout the US. The intercepted insects originated from at least 95 countries worldwide, representing 11 insect orders (Table 1) and more than 50 insect families and 200 genera. Nearly 93% of all the

insect interceptions involved beetles (Coleoptera; 6465 of 6952). The next most commonly intercepted insect orders were, in decreasing order, Heteroptera (= Hemiptera in earlier nomenclature) (2.5%), Hymenoptera (1.4%), Isoptera (1.4%), and Lepidoptera (1.0%). Collectively, all interceptions of Collembola, Diptera, Homoptera, Orthoptera, Phasmida, and Thysanoptera represented only 0.8% of the 6952 interceptions on wood articles (Table 1). The preponderance of Coleoptera is not surprising given the large number of bark- and wood-infesting beetle species worldwide, and the fact that many beetle species attack live trees, while others attack recently dead trees, and still others attack wood products (Haack and Slansky 1987). Such life history attributes make beetles very good candidates to be associated with wood articles of all types, especially when bark is still attached. Most of the Heteroptera and Orthoptera probably occurred as hitchhikers with the commodities as a result of handling practices and were not directly associated with the wood articles.

The relative ranking of interceptions by insect order was rather similar among the major world regions (Table 2). In all regions, coleopterans were the most commonly intercepted insect order. Isoptera, Heteroptera, or Hymenoptera were the next most commonly intercepted orders. The largest number of insect orders were represented by the insects intercepted from Europe (9) and Asia (8), whereas the interceptions from the Middle East represented the fewest orders (2; Table 2).

There were 12 families of beetles identified among the 6465 interceptions of Coleoptera. The most commonly intercepted beetle families on wood articles were the Scolytidae (4321 interceptions, 67% of 6465), Curculionidae (896, 14%), Cerambycidae (766, 12%), Bostrichidae (192, 3%), and Buprestidae (143, 2%). The less frequently intercepted beetle families included the Chrysomelidae (21 interceptions), Dermestidae (3), Elateridae (6), Lyctidae (68), Platypodidae (7), Scarabaeidae (7), and Tenebrionidae (13). Similarly, the most commonly intercepted hymenopteran families were the Siricidae (61 of 94 hymenopteran interceptions, 65%) and Formicidae (25, 27%), and the most commonly intercepted lepidopteran family was the Cossidae (8 of 71 lepidopteran interceptions, 11%). It is no surprise that insects in the above families were commonly intercepted on wood articles given that many of their member species have very close associations with wood. Most of the intercepted scolytids were true bark beetles, which live under the bark, rather than those scolytids known as ambrosia beetles, which tunnel into wood. The scolytids made up 62% of all insect interceptions and 67% of the beetle interceptions. True bark beetles are among the first insects to attack the trunks and branches of newly felled trees (Haack and Slansky 1987). Given that solid wood packing materials like crating and dunnage are often made from recently cut trees and that often not all bark is removed, it is logical that scolytids will dominate the list of intercepted insects on wood articles.

For the 1985-1998 period, the most commonly intercepted beetle genera in the families Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, and Scolytidae are listed in Table 3. The intercepted bostrichids represented nine genera of which the three most common were, in decreasing order, *Stephanopachys*, *Sinoxylon*, and

Heterobostrychus. Similarly, of the seven genera of intercepted buprestids the four most common were *Agrilus*, *Melanophila*, *Chrysobothris*, and *Anthxia*. Of 42 genera of intercepted cerambycids, the 12 most common were *Monochamus*, *Ceresium*, *Xylotrechus*, *Hesperophanes*, *Anoplophora*, *Phymatodes*, *Saperda*, *Trachyderes*, *Callidium*, *Lamia*, *Batocera*, and *Callidiellum*. Of 41 genera of intercepted curculionids, the 5 most common were *Pissodes*, *Hylobius*, *Sitona*, *Curculio*, and *Apion*. Of 38 genera of intercepted scolytids the 15 most common were *Pityogenes*, *Orthotomicus*, *Ips*, *Hylurgops, Hylurgus*, *Hypothenemus*, *Tomicus*, *Dryocoetes*, *Hypocryphalus*, *Hylastes*, *Scolytus*, *Taphrorychus*, *Crypturgus*, *Polygraphus*, and *Phloeosinus*.

For those scolytids that were identified to the species level, the 25 most commonly intercepted species are listed in Table 4. Each of these 25 bark beetle species has a relatively large native geographic range, typically covering much of Europe and Asia (Wood and Bright 1992). Not surprisingly, interceptions of each species, especially the top 10, have originated from several countries (Table 4). For example, *Pityogenes chalcographus* was intercepted 452 times on wood articles from 25 different countries during the period 1985-1998. In most cases, Italy, Spain, Belgium, or Germany were the leading sources for each of these 25 scolytids (Table 4).

Of the 25 scolytids that have most frequently been intercepted in the US (Table 4), only *Tomicus piniperda* and *Pityogenes bidentatus* have definitely become established in the US (Haack and Kucera 1993, Hoebeke 1994, Mattson *et al.* 1994). By contrast, some less frequently intercepted exotic scolytids have recently become established in the US. For example, although there were no interceptions of *Hylastes opacus* during the period 1985-1998, this pine- and spruce-feeding bark beetle is now known to be established in the northeastern US (Wood and Bright 1992, Rabaglia and Cavey 1994). Such findings indicate that the rate of interception is not always an accurate indication of which exotics will become established. It should also be noted that the native range of *Dryocoetes autographus* is circumpolar, being found in Europe, Asia, and North America, including the US. So the interceptions of *Dryocoetes autographus* that are listed in Table 4, represent beetles from outside North America.

Although only 2 of the 25 scolytids listed in Table 4 have become established in the US, at least 9 of these 25 species have become established in other countries outside their native range (Marchant and Borden 1976, Wood and Bright 1992): *Pityogenes chalcographus* (introduced into Jamaica), *Orthotomicus erosus* (Chile, Fiji, South Africa), *Hylurgus ligniperda* (Australia, New Zealand, South Africa, Brazil, Chile, Uruguay), *Hylastes ater* (Chile, South Africa), *Polygraphus poligraphus* (South Africa), *Dryocoetes autographus* (Brazil), *Pityogenes bidentatus* (Madagascar), *Phloeosinus rudis* (France), *Orthotomicus laricis* (Chile). Of the 10 scolytids that have been introduced into other countries, eight use pine (*Pinus*) as their primary or secondary host for breeding (Table 4), and pines are either native or have also been introduced in each of the above recipient countries.

Geographic Origins of Insects Intercepted on Wood Articles entering the US

As mentioned above, insects were intercepted on wood articles from 95 different countries during the years 1985-1998 (Table 1). At least a few insects were intercepted on wood articles from every major world region or continent (Tables 2, 5), likely reflecting the large number of countries that export to the US. For example, in 1998, the US imported articles from at least 180 different countries (US Bureau of the Census 1999). For each of the 12 years during 1985-1996, Europe ranked first as the source for most of the insects intercepted on wood articles in the US, with Asia second, and South America typically third (Table 5). However, in 1997 and 1998, Asia was the leading source for insects on wood articles, with Europe second, Central America third, and South America fourth (Table 5). Overall, for the entire 1985-1998 period, 66% of the insect interceptions on wood articles originated from Europe, 21% from Asia, and 5% from South America (Table 5). Note that we considered Russia as part of Asia in our analysis given that most of the Russian interceptions originated from ports in Siberia. It is important to note that during the 1990s, the interception rate for Asia was steadily increasing compared with other world regions, and that Asia ranked first starting in 1997. The rapid increase in the number of interceptions from Asia is primarily due to more interceptions from China and Russia in recent years (Table 6). The sudden rise in the number of interceptions on wood articles from China and Russia is likely a reflection of the dramatic increase in imports to the US from these two countries (Table 7). For example, from 1985 to 1998, China moved from 18th place to 4th place as a percentage of total US imports.

As for the 95 individual countries from which insects were intercepted on wood articles, most of the 6952 interceptions were from Italy (21%), followed in decreasing order by Germany, China, Spain, Belgium, France, India, United Kingdom, Russia, and Brazil (Table 6). During the period 1985-1998, the annual interception rate for the European countries tended to decrease, while it increased for China and Russia (Table 6). In the case of China, it represented only 1.2% of all interceptions in 1985 but represented 11.2% of all interceptions in 1995, 21.2% in 1996, 28.6% in 1997, and 43.5% in 1998 (Table 6). Much of the dramatic increase in the number of interceptions from China in 1997 and 1998 is a direct result of much closer inspection of wood articles from China once the Asian longhorned beetle, *Anoplophora glabripennis*, was discovered in New York in 1996.

Each of the 10 countries listed in Tables 6 and 7 are major trading partners with the US. For example, in 1998, China ranked 4th in total value of all general imports to the US behind Canada (1st), Japan (2nd), and Mexico (3rd). Similarly, in 1998, Germany ranked 5th, United Kingdom was 6th, France was 8th, Italy was 10th, Brazil was 16th, Belgium was 21st, India was 23rd, Russia was 27th, and Spain was 29th (US Bureau of the Census 1999). Generally, as imports increase from a particular country, there will be a concomitant increase in the risk of receiving more exotic pests from that same country. However, the type of cargo surely influences the numbers and types of any associated pests. For example, the most common categories of US imports are road vehicles, electrical machinery and appliances, office machines and computers, and petroleum (US

Bureau of the Census 1999). Given that wood articles are less frequently associated with the above types of products, then countries that export primarily the above types of products to the US (*e.g.*, Japan and Saudi Arabia) will likely ship fewer wood-associated insects.

Detailed information on the numbers and kinds of insects that have been intercepted on wood articles from each South American country is given in Table 8. Insects were intercepted from all South American countries except for French Guiana and Paraguay. US imports from South America were highest for Brazil and Venezuela, and lowest for French Guiana and Paraguay (see Table 7 and footnotes therein). The South American products that were most commonly associated with intercepted insects were tiles, leather, doors, and lumber.

Wood Articles Associated with Insect Interceptions

When considering all the different types of wood articles associated with world trade, crating and dunnage were the two wood articles most often associated with insect interceptions in the US (Table 9). Overall, 45% of the 6952 interceptions were reported on crating, 33% on dunnage, and 6% on pallets. Together these three categories of wood articles represented 84% of the total. Nearly 10% of the wood articles were classified simply as "wood" and so could not be further classified. Some of the other types of wood articles on which insects were found included live trees, logs, lumber, poles, and woodenware. The higher interception rates on crating and dunnage probably reflect the greater ease and thoroughness with which inspections can be made on these two classes of wood articles compared with other types such as pallets.

When the insect interception data were viewed by world region (Table 2), crating had the most interceptions (except in Africa), dunnage was typically second, and pallets were usually third (Table 2). For the 10 countries from which the most interceptions were made (Table 6), crating was the most insect-infested type of wood article from Italy, China, Spain, India, and Brazil, whereas dunnage was the number one source of insects for imports from Germany, Belgium, France, United Kingdom, and Russia. The most common types of cargo associated with these insect interceptions were tiles, marble, and granite from Italy; steel and machinery from Germany; iron, machinery, tiles, and woodenware from China; tiles, marble, and granite from Spain; steel from Belgium; steel from France; ironware and machine parts from India; steel from the United Kingdom; aluminum from Russia; and doors and tiles from Brazil.

Explaining Trends in the Interception Data

The yearly number of insect interceptions on wood articles generally decreased during the years 1985 to 1996 and then increased again in 1997 and 1998 (Table 5). At first such a pattern seems unusual given that total imports to the US have increased every year during this period (Table 7, bottom row). However, there are several important reasons for the observed trends. The most significant change, we believe, has been in the kind of packing materials used by foreign exporters. As APHIS inspectors in the US became increasingly efficient at targeting high-risk cargo and

detecting wood-boring pests in the 1970s and 1980s, US importers paid in both fumigation costs and delays of the infested cargo. Under such circumstances, importers would typically complain to their export shippers and possibly threaten to use different suppliers to avoid the additional costs of fumigation. Probably as a result of such importer pressure, many exporters switched to older or kiln-dried wood, metal, and other non-wood materials for supporting and packing the cargo. Consequently, the volume of US imports with associated wood that was suitable for insect survival declined through the 1980s and 1990s, contributing to a similar decline in pest interceptions through 1996.

Another important factor to consider is the dramatic increase in US imports of perishable goods during the 1980s and 1990s, which far exceeded increases in the number of APHIS inspectors at US ports-of-entry. Because of their perishable nature, goods like fresh fruit, vegetables, and cut flowers generally present a higher risk for pest introduction and thus command more immediate attention by APHIS inspectors than does nonperishable cargo that is simply associated with solid wood packing (*e.g.*, steel, tiles, heavy equipment, and quarry products). At most US ports, inspections of these higher priority items may have reduced the time available to conduct thorough inspections of wood articles and thereby contributed to the general decline in insect interceptions on wood articles from 1985 to 1996.

Another event contributing to reductions in insect interceptions on wood articles, especially in 1996, was a change in US import regulations for wood articles in late 1995 (USDA APHIS 1995). This regulation dealt with the importation of logs, lumber, and other unmanufactured wood articles into the US, and required that all unmanufactured solid wood items be "totally free from bark and apparently free from live plant pests" or be certified as treated for wood pests by the exporting country. Since this regulation became effective in August 1995, pest interceptions from wood articles decreased substantially because (1) APHIS inspectors now only needed to find bark rather than a live insect to require treatment (usually fumigation), and (2) compliance with the regulation by most shippers significantly reduced the incidence of those insects that require bark for their survival, such as bark beetles.

One last important event that influenced the overall interception pattern was the discovery of the Asian cerambycid *Anoplophora glabripennis* in New York in 1996 and then again in Illinois in 1998 (Haack *et al.* 1997, Poland *et al.* 1998). As a result of the 1996 discovery of *A. glabripennis*, APHIS greatly increased its intensity of inspection of wood articles starting in 1997. Wood articles from Asia were often targeted for closer inspection given that *A. glabripennis* is native to China and Korea. As a result of these closer inspections, especially for wood articles from China, the annual insect interception rate increased substantially in 1997 and 1998. Hopefully, the interception rate will again decline in 1999 and beyond, given that APHIS imposed stricter regulations on wood articles from China, beginning in January 1999 (USDA APHIS 1998). As of the time of this writing (May 2000), the USDA APHIS insect interception database, which is nearly complete for 1999, lists only 192 interceptions of insects on wood articles (compared with

611 in 1998). Of these 192 interceptions, only 20 were from China (or about 10% of the 192 interceptions) and so it appears that exporters in China have greatly reduced the number of insects associated with wood articles.

Conclusion

Overall, it is inevitable that more pests will inadvertently be moved from country to country as a result of world trade and tourism. To reduce such risks, all countries should improve their systems of inspection, regulatory treatments, survey methods, and management efforts. Moreover, more research should be focused on risk assessment, mitigation methods, and alternative packing materials (Morrell 1995, Morrell and Filip 1996, Ruesink *et al.* 1995, US Congress 1993). For example, the Insect and Disease Study Group of the North American Forestry Commission has developed a project entitled "The Exotic Forest Pest Information System for North America." This project is aimed at developing an internet site that identifies exotic insects, mites and pathogens with potential to cause significant damage to North American forest resources (see: http://www.exoticforestpests.org). In addition, stricter regulations on solid wood packing materials, as were recently imposed on China by the US (USDA APHIS 1998), should be considered by all countries. At this time, USDA APHIS and Forest Service are preparing new worldwide regulations on solid wood packing materials. One document, which is entitled "Pest Risk Assessment for Importation of Solid Wood Packing Materials into the United States," should be available for public comment during the second half of 2000. Even if stricter regulations are imposed on solid wood packing materials, new introductions of wood-associated pests will likely continue, although at a reduced level. Therefore, whenever possible, countries should employ early detection programs for high-risk exotic pests followed by aggressive eradication efforts to prevent or reduce widespread infestations.

References Cited

Ciesla, W.M. 1993. Recent introductions of forest insects and their effects: a global overview. FAO Plant Protection Bulletin 41: 3-13.

Haack, R.A., and J.W. Byler. 1993. Insects and pathogens: regulators of forest ecosystems. Journal of Forestry 91 (9): 32-37.

Haack B. and D. Kucera. 1993. New introduction - common pine shoot beetle, *Tomicus piniperda* (L.). USDA Forest Service, Northeastern Area, Pest Alert NA-TP-05-93. 2 p.

Haack, R.A. and F. Slansky. 1987. Nutritional ecology of wood-feeding Coleoptera, Lepidoptera, and Hymenoptera. Pages 449-486 *in* F. Slansky Jr. and J.G. Rodriguez (eds.), Nutritional Ecology of Insects, Mites, and Spiders. John Wiley, New York.

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

Haack, R.A. and J.F. Cavey. 1997. Insects intercepted on wood articles at ports-of-entry in the United States: 1985-1996. Newsletter of the Michigan Entomological Society 42(2-4): 1-7.

Haack, R.A. 1998. An exotic bark beetle and wood borer update: old friends and new finds. Newsletter of the Michigan Entomological Society 43(1): 11-12.

Haack, R.A. and J.F. Cavey. 1998. Insects intercepted on wood articles at United States ports-of-entry and two recent introductions: *Anoplophora glabripennis* and *Tomicus piniperda.* Pages 172-187 *in* Proceedings: International forest insect workshop, 18-21 August 1997, Pucon, Chile. Corporacion Nacional Forestal, Santiago, Chile.

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. Entomological News 105: 267-276.

Liebhold, A.M., W.L. MacDonald, D. Bergdahl, and V.C. Mastro. 1995. Invasion by exotic forest pests: a threat to forest ecosystems. Forest Science Monograph 41: 1-49.

Marchant, K.R. and J.H. Borden. 1976. Worldwide introduction and establishment of bark and timber beetles (Coleoptera: Scolytidae and Platypodidae). Simon Fraser University, Burnaby, B.C., Canada, Pest Management Papers No. 6. 76 p.

Mattson, W.J., P. Niemela, I. Millers, and Y. Inguanzo. 1994. Immigrant phytophagous insects on woody plants in the United States and Canada: an annotated list. USDA Forest Service, North Central Forest Experiment Station, General Technical Report NC-169. 27 p.

Mattson, W.J. 1997. Exotic insects in North American forests: ecological systems forever altered. Pages 187-193 *in* Britton, K.O. (ed.), Exotic pests of eastern forests, USDA Forest Service and Tennessee Exotic Pest Plant Council, Nashville, TN.

Morrell, J.J. 1995. Importation of unprocessed logs into North America: a review of pest mitigation procedures and their efficacy. Forest Products Journal 45(9):41-50.

Morrell, J.J. and G. Filip. (eds.) 1996. Importing wood products: pest risks to domestic industries. Proceedings, 4-6 March 1996, Portland Oregon. Oregon State University, Corvallis, Oregon. 148 p.

Moyle, P.B. and T. Light. 1996. Biological invasions of fresh water: empirical rules and assembly theory. Biological Conservation 78: 149-161.

Niemela, P. and W.J. Mattson. 1996. Invasion of North America by European phytophagous insects: legacy of the European crucible? BioScience 46: 740-752.

Peng, J. and Y. Liu. 1992. Iconography of forest insects in Hunan, China. Hunan Forestry Department, Institute of Zoology, Academia Sinica.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs associated with nonindigenous species in the United States. Bioscience 50: 53-65.

Poland, T.M, R.A. Haack, and T.R. Petrice. 1998. Chicago joins New York in battle with the Asian longhorned beetle. Newsletter of the Michigan Entomological Society 43(4): 15-17.

Rabaglia, R.J. and J.F. Cavey. 1994. Note on the distribution of the immigrant bark beetle *Hylastes opacus*, in North America (Coleoptera: Scolytidae). Entomological News 105: 267-276.

Ruesink, J.L., I.M. Parker, M.J. Groom, and P.M. Kareiva. 1995. Reducing the risks of nonindigenous species introductions: guilty until proven innocent. BioScience 45: 465-477.

Tkacz, BM., H.H. Burdsall, G.A. DeNitto, A. Eglitis, J.B. Hanson, J.T. Kliejunas, W.E. Wallner, J.G. O'Brien, and E.L. Smith. 1998. Pest risk assessment of the importation into the United States of unprocessed Pinus and Abies logs from Mexico. USDA Forest Service, General Technical Report FPL-GTR-104.

US Bureau of the Census. 1996. Statistical abstract of the United States: 1996. Washington, DC.

US Congress. 1993. Harmful non-indigenous species in the United States. US Congress, Office of Technology Assessment, Washington, D.C. OTA-F-565. 391 p.

USDA APHIS. 1995. 7 CFR Parts 300 and 319 -- Importation of logs, lumber, and other unmanufactured wood articles. Federal Register, 25 May 1995, 60(101): 27665-27682.

USDA APHIS. 1998. 7 CFR Parts 319 and 354 – Solid wood packing material from China. Federal Register, 18 September 1998, 63(181): 50100-50111.

USDA APHIS. 1999. Japanese cedar longhorned beetle in the eastern United States. Pest Alert, APHIS 81-35-004. 2 p.

USDA Forest Service. 1991. Pest risk assessment on the importation of larch from Siberia and the Soviet Far East. USDA Forest Service , Washington, D.C., Miscellaneous Publication No. 1495.

USDA Forest Service. 1992. Pest risk assessment of the importation of Pinus radiata and Douglas-fir logs from New Zealand. USDA Forest Service, Washington, D.C., Miscellaneous Publication No. 1508.

USDA Forest Service. 1993. Pest risk assessment of the importation of *Pinus radiata*, *Nothofagus dombeyi*, and *Laurelia philippiana* logs from Chile. USDA Forest Service, Washington, D.C., Miscellaneous Publication No. 1517.

Wallner, W.E. 1996. Invasive pests ('biological pollutants') and US forests: whose problem, who pays? EPPO Bulletin 26: 167-180.

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

Table 1. Number of insect interceptions, insect families, insect genera, and relative ranking for the regions or continents of origin for insects intercepted on wood articles at US ports-of-entry, 1985 to 1998, by insect order (Source: USDA APHIS database, Riverdale, Maryland).

	All interceptions (1985-1998)		
Insect order	No. of interceptions	No. of countries	World region of origin (highest source to lowest)*
Coleoptera	6465	85	Europe > Asia > SA > CA > Africa > Car > ME > Oceania
Collembola	1	1	SA
Diptera	14	7	Europe = Asia > Car > CA
Heteroptera	176	22	Europe > Asia > SA > CA > Africa > Car
Homoptera	15	10	Asia > Europe > CA = SA
Hymenoptera	94	23	Europe > Asia > CA > Oceania > SA = Africa
Isoptera	93	31	SA > Asia > Europe > CA > Africa > Car > Oceania
Lepidoptera	71	30	Europe > Asia > CA > Africa > SA > Car > Oceania
Orthoptera	17	9	CA > Europe > SA > Car = Africa
Phasmida	1	1	Europe
Thysanoptera	5	3	*Asia > Europe = Africa
All insects	6952	95	Europe > Asia > SA >CA > Africa > Car > Oceania > ME

*Asia = Asian countries plus Russia (Russia includes all records for the former Soviet Union); CA = Central America including Mexico; Car = Caribbean Islands; ME = Middle East; Oceania = Pacific islands, Australia, and New Zealand; .SA = South America.

Table 2. Number of insect interceptions on crating, dunnage, pallets, and wood/lumber at US ports-of-entry , and relative ranking of the insect orders intercepted from each world region, 1985-1998, by continent or world region of origin (Source: USDA APHIS database, Riverdale, Maryland).

Region of origin *	1985-98 total	Number of interceptions Crating	Dunnage	Pallets	Intercepted insect orders (most to least)**
Africa	91	26	28	0	Col > Lep > Het = Iso > Hym = Thy = Orth
Asia	1478	634	377	65	Col > Hym > Lep > Iso > Het > Hom > Dip > Thy
Central America	196	36	9	1	Col > Lep > Iso = Orth > Hym > Het > Hom
Caribbean	26	5	2	2	Col > Iso > Dip = Lep > Het = Orth
Europe	4609	2245	1687	260	Col >Het >Hym >Lep >Iso >Dip=Orth >Thy >Phas
Middle East	11	4	2	1	Col > Iso
Oceania	12	3	2	0	Col > Hym = Iso > Lep
South America	363	174	74	49	Col > Iso > Het = Lep > Orth > Collembola
Unknown origin	166	11	119	5	Col > Iso > Hym >Het = Lep = Orth = Dip

*Asia includes Russia (Russia includes all records for the former Soviet Union); Central America includes Mexico; Oceania includes all Pacific islands, Australia, and New Zealand.

**Insect orders: Col = Coleoptera; Dip = Diptera; Het = Heteroptera, Hom = Homoptera, Hym = Hymenoptera, Iso = Isoptera, Lep = Lepidoptera, Orth = Orthoptera, Phas = Phasmida, and Thy = Thysanoptera.

Table 3. Most commonly intercepted genera of Bostrichidae, Buprestidae, Cerambycidae, Curculionidae, and Scolytidae on wood articles at US ports-of-entry during 1985-1998, including number of interceptions, number of countries of origin, and the four countries from which the most interceptions were made (Source: USDA APHIS database, Riverdale, Maryland).

Insect genus	No of inter-ceptions	No. of countries of origin	No. of world regions	Top 4 countries of origin (high to low)
Bostrichidae				
Heterobostrychus	22	9	5	Thailand, India, Peru, South Africa
Sinoxylon	56	8	3	India, Pakistan, Venezuela, Singapore
Stephanopachys	86	8	4	Spain, Italy, Chile, France
Buprestidae				
Agrilus	31	7	2	Belgium, Germany, France, India
Anthaxia	6	4	2	Spain, Russia, Turkey, United Kingdom
Chrysobothris	17	9	5	Mexico, Spain, China, Italy
Melanophila	30	8	2	Spain, Greece, Italy, Turkey
Cerambycidae				
Anoplophora	28	1	1	China
Batocera	7	3	1	China, India, Japan
Callidiellum	5	2	1	Japan, China
Callidium	12	6	2	Germany, Spain, China, Japan
Ceresium	101	4	3	China, Korea, Japan
Hesperophanes	36	4	1	China, India, Ukraine
Lamia	10	3	1	Italy, France, Greece
Monochamus	266	25	5	China, Italy, Russia, Spain
Phymatodes	23	9	3	Belgium, Spain, Germany, India
Saperda	15	7	2	Italy, Germany, Russia,
Trachyderes	15	1	1	Brazil
Xylotrechus	99	18	2	China, Germany, Italy, Belgium
Curculionidae				
Apion	25	1	1	Italy
Curculio	153	33	6	Italy, Germany, Costa Rica, China
Hylobius	178	18	2	Germany, United Kingdom, Belgium, Italy
Pissodes	288	22	4	Italy, United Kingdom, Germany, Spain
Sitona	159	6	2	Italy, France
Scolytidae				
Crypturgus	50	12	3	Portugal, Spain, Germany, France
Dryocoetes	130	17	3	China, Germany, Belgium, Italy
Hylastes	92	15	6	Spain, Germany, United Kingdom, Portugal
Hylurgops	278	20	3	Germany, Belgium, United Kingdom, Russia
Hylurgus	206	12	4	Italy, Portugal, Spain, Chile
Hypocryphalus	95	7	3	India, China, Brazil, Japan
Hypothenemus	155	26	6	India, Brazil, Venezuela, Nigeria
Ips	417	29	4	Italy, Germany, Spain, Belgium
Orthotomicus	442	24	4	Spain, Italy, China, France
Phloeosinus	43	6	4	Japan, China, Korea, Mexico
Pityogenes	535	29	4	Germany, Italy, Russia, Belgium
Polygraphus	49	12	3	Italy, Germany, Russia, Belgium
Scolytus	83	18	4	Belgium, France, Italy, China
Taphrorychus	58	9	3	Belgium, Germany, France, Turkey
Tomicus	150	21	3	France, United Kingdom, Italy, Spain

Table 4. Top 25 most commonly intercepted scolytids on wood articles at US ports-of-entry during 1985-1998, including number of interceptions, number of countries of origin, principal host genus, and the four countries from which the most interceptions were made (Source: USDA APHIS database, Riverdale, Maryland).

Scolytid species	No of inter-ceptions	No. of countries of origin	Common host tree genera	Top 4 countries of origin (high to low)
*Pityogenes chalcographus**	452	25	*Picea, Pinus*	Germany, Italy, Russia, Belgium
*Orthotomicus erosus**	381	19	*Pinus*	Spain, Italy, China, Portugal
Hylurgops palliatus	257	18	*Abies*	Germany, Belgium, Italy, United Kingdom
Ips typographus	214	21	*Picea*	Italy, Germany, Russia, Belgium
*Hylurgus ligniperda**	167	12	*Pinus*	Italy, Portugal, Spain, Chile
Ips sexdentatus	136	10	*Pinus*	Italy, Spain, France, Belgium
*Tomicus piniperda**	120	17	*Pinus*	France, United Kingdom, Spain, Italy
*Hylastes ater**	44	8	*Pinus*	Spain, Germany, United Kingdom, France
*Polygraphus poligraphus**	37	7	*Picea*	Italy, Germany, Russia, Belgium
Dryocoetes autographus‡*	35	11	*Picea, Pinus*	Belgium, Italy, Germany, United Kingdom
Pityogenes bistridentatus	32	7	*Pinus*	Spain, Italy, France, Turkey
*Pityogenes bidentatus**	23	6	*Pinus*	France, Spain, Germany, Italy
Taphrorychus bicolor	22	5	*Fagus*	Belgium, Germany, Finland, France
*Phloeosinus rudis**	21	1	*Chamaecyparis*	Japan
*Orthotomicus laricis**	21	8	*Pinus*	Italy, France, Germany, Spain
Crypturgus mediterraneus	19	5	*Pinus*	Portugal, Spain, Italy, France
Ips acuminatus	17	7	*Pinus, Picea*	Italy, Spain, France, Russia
Taphrorychus villifrons	16	4	*Quercus*	Belgium, France, Germany, Latvia
Hylastes attenuatus	16	6	*Pinus*	Spain, Portugal, South Africa, Italy
Scolytus intricatus	12	4	*Quercus*	Germany, Belgium, Italy, France
Hylesinus varius	11	3	*Fraxinus*	Belgium, United Kingdom, Italy
Pityokteines spinidens	11	5	*Abies*	Italy, France, Germany, Russia
Carphoborus minimus	10	3	*Pinus*	Spain, Turkey, Italy
Crypturgus cinereus	10	3	*Abies*	Germany, Spain, Belgium
Pityophthorus pityographus	10	4	*Picea*	Italy, Germany, France, Netherlands

*Species marked with an * have been introduced into other countries outside their native range.
‡*Dryocoetes villosus* has been synonymized with *Dryocoetes autographus* (Wood and Bright 1992), therefore interception data for *Dryocoetes villosus* was added to *Dryocoetes autographus*.

Table 5. Number of insect interceptions on wood articles at US ports-of-entry for the years 1985-1998 by world region of origin (Source: USDA APHIS database, Riverdale, Maryland).

Region of origin*	Number of insect interceptions														85-98
	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	Total
Africa	6	4	9	4	4	5	9	3	5	6	1	4	23	8	91
Asia	85	111	71	53	53	22	20	37	71	148	208	68	197	334	1478
Cen. America	9	10	8	6	7	3	8	8	15	11	12	7	43	49	196
Caribbean	2	3	4	1	3	1	3	0	2	2	2	1	0	2	26
Europe	745	613	509	431	408	209	251	234	322	236	220	88	152	191	4609
Middle East	1	0	0	0	1	0	1	1	3	0	1	1	1	1	11
Oceania	0	0	1	0	1	1	1	2	0	0	0	3	1	2	12
S. America	32	59	53	38	28	8	7	20	24	30	13	5	30	16	363
Unknown	16	33	22	11	6	7	18	9	7	10	6	2	11	8	166
All countries	896	833	677	544	511	256	318	314	449	443	463	179	458	611	6952

*World regions defined as stated in Table 2.

Table 6. Number of insect interceptions on wood articles at US ports-of-entry for the years 1985-1998 for the top 10 countries from which the most interceptions were made (Source: USDA APHIS database, Riverdale, Maryland).

Country of origin	Number of insect interceptions '85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	85-98 Total
Italy	240	139	146	152	185	57	53	75	139	59	49	43	57	96	1490
Germany	147	138	69	67	67	45	46	31	48	45	43	13	11	21	791
China	11	10	5	8	3	3	2	14	33	37	52	38	131	266	613
Spain	121	93	128	89	19	13	11	17	19	16	13	14	26	0	602
Belgium	61	93	43	27	39	26	47	33	25	11	18	2	11	9	445
France	45	26	27	27	32	14	27	10	21	18	29	4	13	9	302
India	33	41	27	15	32	9	3	12	17	9	24	5	16	17	260
UK	25	14	28	12	18	13	22	27	26	18	19	0	3	3	228
Russia	0	8	10	6	4	2	3	3	11	50	72	20	13	13	215
Brazil	10	30	27	19	7	7	4	15	18	18	9	1	5	5	175

Table 7. Value of all general imports to the United States from 10 selected countries for the years 1975, 1985, and 1990 to 1998. Dollar values are not adjusted for inflation to any specific year. Value of all general imports from the South American countries to the US for 1998 are listed in a footnote below.*

Country	US Imports in Billions of Dollars** 1975	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
Italy	2.6	9.7	12.7	11.8	12.3	13.2	14.7	16.3	18.3	19.4	21.0
Germany	5.4	20.2	28.1	26.1	28.8	28.6	31.7	36.8	38.9	43.1	49.8
China	0.3	3.7	15.2	19.0	25.7	31.5	38.8	45.5	51.5	62.6	71.2
Spain	0.8	2.5	3.3	2.8	3.0	3.0	3.6	3.9	4.3	4.6	4.8
Belgium	1.2	3.4	4.6	3.9	4.5	5.1	6.3	6.1	6.8	7.9	8.4
France	2.2	9.5	13.1	13.3	14.8	15.3	16.8	17.2	18.7	20.6	24.1
India	0.5	2.3	3.2	3.2	3.8	4.6	5.3	5.7	6.2	7.3	8.2
United Kingdom	3.8	14.9	20.3	18.4	20.1	21.7	25.1	26.9	29.0	32.7	34.8
Russia	0.3	0.4	1.1	0.8	0.7	1.7	3.2	4.0	3.6	4.3	5.7
Brazil	1.5	7.5	8.0	6.7	7.6	7.5	8.7	8.8	8.8	9.6	10.2
All countries	96.9	345.3	495.0	487.1	532.7	580.5	663.8	743.4	795.3	870.7	913.8

* Value of 1998 imports to the US in billions of dollars: Argentina (2.25), Bolivia (0.22), Chile (2.45), Colombia (4.65), Ecuador (1.76), French Guiana (0.003), Guyana (0.14), Paraguay (0.03), Peru (2.00), Suriname (0.11), Uruguay (0.26), Venezuela (9.28).

**Source: US Bureau of the Census, "Statistical Abstract of the United States" for the years 1976 to 1999.

Table 8. Number and kinds of insects intercepted on wood articles from South American countries at US ports-of-entry for the combined period of 1985-1998 (Source: USDA APHIS database, Riverdale, Maryland).

Country	Insect order	Insect family	Most commonly intercepted genera or species
Argentina (28)*	Coleoptera (4)*	Cerambycidae (2)*	Lamiinae
		Curculionidae (1)	*Heilipus*
		Scolytidae (1)	*Hypothenemus*
	Isoptera (24)	Kalotermitidae (24)	*Cryptotermes*, *Incisitermes*, *Neotermes*
Bolivia (2)	Coleoptera (2)	Curculionidae (1)	*Zygops*
		Scolytidae (1)	*Hylastes*

Table 8, continued

Brazil (175)	Coleoptera (157)	Bostrichidae (11)	*Amphicerus*, *Xylopsocus capucinus*
		Cerambycidae (21)	*Trachyderes*
		Curculionidae (5)	*Catolethrus*, *Cossonus*, *Marshallius*
		Lyctidae (56)	*Lyctus*
		Platypodidae (1)	*Tesserocerus*
		Scolytidae (63)	*Coccotrypes*, *Hypothenemus*
	Collembola (1)	Sminthuridae (1)	Identified to family level only
	Heteroptera (5)	Aradidae (1)	*Neuroctenus punctulatus*
		Lygaeidae (3)	*Minthea rugicollis*
		Miridae (1)	Identified to family level only
	Isoptera (7)	Kalotermitidae (4)	*Cryptotermes*, *Incisitermes*
		Rhinotermitidae (2)	*Coptotermes*
		Termitidae (1)	*Nasutitermes*
	Lepidoptera (3)	Noctuidae (1)	Identified to family level only
		Oecophoridae (1)	Identified to family level only
		Psychidae (1)	Identified to family level only
	Orthoptera (2)	Gryllidae (2)	*Gryllus*
Chile (36)	Coleoptera (34)	Bostrichidae (2)	*Stephanopachys*
		Buprestidae (1)	Identified to family level only
		Curculionidae (1)	Identified to family level only
		Scolytidae (30)	*Hylastes ater*, *Hylurgus ligniperda*
	Hymenoptera (1)	Apidae (1)	*Apis*
	Lepidoptera (1)	Cossidae (1)	Identified to family level only
Colombia (18)	Coleoptera (14)	Cerambycidae (2)	*Euryscelis suturalis*, *Placosternus*
		Curculionidae (1)	Identified to family level only
		Lyctidae (2)	*Lyctus simplex*
		Platypodidae (1)	Identified to family level only
		Scolytidae (7)	*Hypothenemus*
		Tenebrionidae (1)	*Blapstinus*
	Heteroptera (2)	Lygaeidae (1)	*Minthea rugicollis*
		Miridae (1)	Identified to family level only
	Homoptera (1)	Aphididae (1)	Identified to family level only
	Isoptera (1)	Kalotermitidae (1)	*Cryptotermes*
Ecuador (9)	Coleoptera (4)	Bostrichidae (1)	*Heterobostrychus aequalis*
		Curculionidae (1)	Identified to family level only
		Tenebrionidae (2)	*Blapstinus*
	Heteroptera (1)	Miridae (1)	Identified to family level only
	Homoptera (1)	Aphididae (1)	Identified to family level only
	Isoptera (2)	Kalotermitidae (1)	*Cryptotermes*
		Rhinotermitidae (1)	*Heterotermes*
	Lepidoptera (1)	Pyralidae (1)	Identified to family level only
Guyana (8)	Coleoptera (8)	Buprestidae (1)	*Chrysobothris*
		Curculionidae (1)	*Peltophorus*
		Platypodidae (1)	*Platypus*
		Scolytidae (4)	*Hypothenemus*

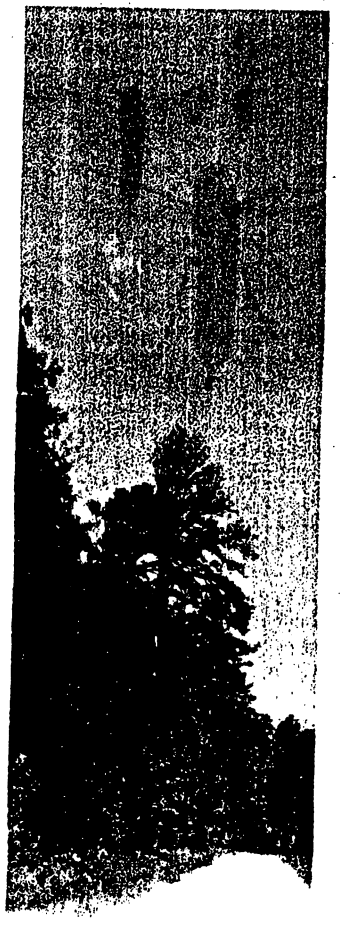
Table 8, continued

Peru (9)	Coleoptera (7)	Bostrichidae (3)	*Heterobostrychus aequalis*
		Curculionidae (1)	Identified to family level only
		Scolytidae (3)	*Hypothenemus*, *Phloeosinus*
	Homoptera (1)	Cicadellidae (1)	Identified to family level only
	Isoptera (1)	Kalotermitidae (1)	*Cryptotermes*
Suriname (3)	Coleoptera (3)	Cerambycidae (1)	Identified to family level only
		Scolytidae (2)	*Hypothenemus*
Uruguay (12)	Coleoptera (6)	Curculionidae (2)	*Pissodes*
		Scolytidae (4)	*Hylurgus ligniperda*
	Isoptera (6)	Kalotermitidae (6)	*Incisitermes modestus*, *Neotermes*, *Rugitermes*
Venezuela (55)	Coleoptera (55)	Bostrichidae (7)	*Sinoxylon conigerum*
		Buprestidae (1)	*Chrysobothris*
		Cerambycidae (3)	*Plagionotus*
		Chrysomelidae (1)	*Altica*
		Curculionidae (5)	Cryptorhynchinae
		Lyctidae (2)	Identified to family level only
		Scolytidae (35)	*Coccotrypes*, *Hylurgus ligniperda*, *Hypothenemus*
		Tenebrionidae (1)	*Blapstinus*
South America (country unknown) (8)	Coleoptera (8)	Bostrichidae (4)	*Heterobostrychus aequalis*, *Sinoxylon conigerum*
		Cerambycidae (2)	*Trachyderes*
		Scolytidae (2)	*Coccotrypes*, *Hypothenemus*

*Total number of interceptions at the country, order, or family level.

Table 9. Number of insect interceptions on wood articles at US ports-of-entry for the years 1985-1998 that were specifically recorded on or in crating, dunnage, or pallets (Source: USDA APHIS database, Riverdale, Maryland).

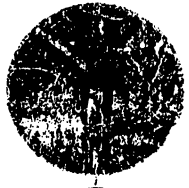
	Number of insect interceptions														
Wood article	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	Total
Crating	479	398	366	327	293	110	110	122	222	168	184	86	126	147	3138
Dunnage	275	326	227	154	187	120	162	140	147	189	180	34	106	65	2312
Pallets	77	61	55	35	10	11	8	18	20	14	29	14	13	18	383

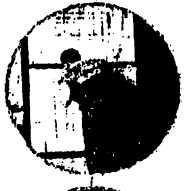


XIII-SILVOTECNIA

QUARANTINE PESTS, RISKS FOR THE FORESTRY SECTOR AND THEIR EFFECTS ON FOREIGN TRADE
27 y 28 de junio de 2000

PLAGAS CUARENTENARIAS, RIESGOS PARA EL SECTOR FORESTAL Y EFECTOS EN EL COMERCIO INTERNACIONAL
27 y 28 de junio de 2000





XIII-SILVOTECNIA

Organizan / Organizers

CORMA
FORESTAL MININCO S.A.
Controladora de Plagas Forestales S.A.
SAG

Patrocinan / Sponsors

Facultad de Cs. Forestales
Facultad de Cs. Forestales
Facultad de Cs. Forestales

Auspician / Sponsors

Holiday Inn
Gestión Turística
Asipco Hotels
BASF
ECOFOR
DEL PACIFICO