Alien Scolytines on the Osa Peninsula, Costa Rica (Coleoptera: Curculionidae: Scolytinae)

Authors: Morillo, Jhunior A., and Berkov, Amy

Source: Florida Entomologist, 102(3) : 486-489

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.102.0301
Alien Scolytines on the Osa Peninsula, Costa Rica (Coleoptera: Curculionidae: Scolytinae)

Jhunior A. Morillo¹ *, and Amy Berkov¹ ²

Abstract

Alien (exotic) insects threaten trees, landscapes, and ecosystem stability. Bark and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae) are saproxylic beetles that spend most of their life cycles under bark, and often are introduced to new locations through wooden packing materials used in international trade. This project reports the identification of 4 alien species reared on the Osa Peninsula of Costa Rica. Bait branches from 41 trees were exposed to saproxylic beetles in a mosaic of old growth and secondary forest. The branches yielded 6,578 scolytines in 33 species. Four of these were alien species: Coccoptyes cypéri Beeson, Premnobius cavipennis Eichhoff, Xylosandrus crassiusculus Motschulsky, and Xylosandrus morigerus Blandford (all Coleoptera: Curculionidae). At least 1 of the alien species, Premnobius cavipennis, was the most abundant scolytine, represented by 1,476 individuals, and it emerged from almost half of the trees sampled. It was reared from the plant families Lecythidaceae, Sapotaceae, and Fabaceae. Most individuals emerged from bait branches in old growth forest, and were disproportionately abundant at canopy stratum. Only 46 individuals of the economic pest X. crassiusculus were reared from bait branches. Two of the 4 alien scolytines were reared commonly from branches in old growth forest, even though mature forest typically resists invasions of alien species. Unfertilized females can disperse and found colonies by mating with haploid sons, and intra-colony mating promotes rapid population growth; therefore, these life history traits facilitate invasion.

Key Words: Eschweilera biflava; tropical wet forest; invasive species; competitive exclusion

Resumen

Los insectos alienígenas amenazan los árboles, los paisajes y la estabilidad del ecosistema. Los escarabajos de la corteza y ambrosía (Scolytinae) son curculiónidos saproxilicos que pasan la mayor parte de sus ciclos de vida debajo de la corteza, y a menudo se introducen en lugares nuevos a través de materiales de embalaje de madera utilizados en el comercio internacional. Este proyecto reporta la identificación de 4 especies exóticas criadas en la península de Osa de Costa Rica. Las ramas del cebo de 41 árboles fueron expuestas a los escarabajos saproxilicos en un mosaico de bosque con crecimiento antiguo y bosque secundario. Las ramas produjeron 6,578 scolytines en 33 especies. Cuatro de estos fueron especies exóticas: Coccoptyes cypéri Beeson, Premnobius cavipennis Eichhoff, Xylosandrus crassiusculus Motschulsky, y Xylosandrus morigerus Blandford (todo Coleoptera: Curculionidae). Salieron de casi la mitad de los árboles muestreado. Premnobius cavipennis fue la especie más abundante, representada por 1,476 individuos. Se crió en las familias de plantas Lecythidaceae, Sapotaceae y Fabaceae. La mayoría de los individuos emergieron de las ramas de cebo en el bosque antiguo, y fueron desproporcionadamente abundantes en el estrato del dosel. Solo 46 individuos de la peste económica X. crassiusculus fueron criados. Dos de los 4 escarabajos alienígenas se criaron preferentemente de las ramas en el bosque antiguo, a pesar de que los bosques antiguos suelen resistir las invasiones de especies exóticas. Las hembras no fertilizadas pueden dispersar y encontrar colonias por los mismos equipos de historia de vida facilitan la invasión.

Palabras Claves: Eschweilera biflava; bosque húmedo tropical; especies invasoras; exclusión competitiva

Global trade has enormous economic benefits, but it introduces organisms to new environments that lack natural enemies, and often have abundant novel resources. Wood and bark-boring beetles potentially survive intercontinental transport in wood packing materials or logs, in some cases with serious economic cost. In the USA, these introduced pests can cost local governments $1.7 billion annually (Aukema et al. 2011). Alien invasive species also are detrimental to forest ecology; they are among the greatest threats to biodiversity, community structure, and forest sustainability (Pimentel et al. 2001; Keane & Crawley 2002; Kirkendall & Ødegaard 2007). They can transmit novel diseases that impact native species (Snyder & Evans 2006; Kenis et al. 2008) or outcompete native species, decreasing diversity and abundance (Parker et al. 1999; Sala et al. 2000; Clark et al. 2010; Vila et al. 2011; Miller-Piece & Preisser 2012). Disturbed habitats facilitate invasions from introduced species (Leinaas et al. 2015), while old growth habitats with high species richness may be able to resist some invasions (Kirkendall & Ødegaard 2007).

The family Curculionidae (long snout weevils, bark and ambrosia beetles) is one of the most diverse groups of animals in the world, with over 50,000 described species; about half are saproxylic (Oberprieler et al. 2007). They provide important ecosystem services, such as initiating wood decomposition and nutrient recycling. Their ability to live for long periods within woody tissues is a key characteristic that contributes to humans spreading saproxylic beetles globally. If logs are
not treated properly, saproxylic beetles can be transported unnoticed inside wooden packing material and timber (Brockerhoff et al. 2005). The objective of this study was to investigate the community structure of Neotropical saproxylic Curculionidae in Costa Rica. Due to the proximity of the study site to the Panama Canal, we expected to rear alien bark beetles. We expected greater abundance from trees in secondary forest and, due to their association with fungi, at ground stratum. This paper reports the ecological associations of 4 alien scolytines and discusses potential interactions with native scolytines.

**Materials and Methods**

This study was conducted at the Piro Biological Station of Osa Conservation, Osa Peninsula, southwest Costa Rica, Puntarenas Province (8.4100°N, 83.34°W). The site contains a mixture of old growth and secondary forest (about 25 yr old, regenerated from cattle pasture). Annual rainfall is approximately 6,000 mm, and the vegetation is representative of a tropical wet forest (Cornejo et al. 2012). A rearing project (Apr 2013–Jun 2014) investigated community structure of saproxylic beetles (Li et al. 2017; Morillo 2017). The data reported herein represent an extract from that project. Forty-one trees were sampled, including 9 species in 6 families: the Brazil nut family (Eschweileria biflava S.A. Mori, Gustavia brachycarpa Pittier, Lecythidaceae), the fig family (Castilla tunu Hems., Moraceae), the bean family (Lonchocarpus macrophyllus Kunth, Tachigali tessmannii Harms; Fabaceae), the chicle family (Pouteria torta (Mart.) Radlk.; Sapotaceae), the hisbicus family (Apieba tibouron Aubl., Luehea seemannii Planch. & Triana; Malvaceae), and the coffee family (Chimarrhis sp.; Rubiaceae) (see Li et al. 2017 for supplemental documents for tree details, including locations and diameters). Bait branches were cut during the transition to the rainy season (Apr–Jul 2013). For each tree, a single branch was cut. A canopy bait (about 8 cm × 75 cm) was suspended in the tree from which it was cut, and the remaining branch was exposed at ground stratum. After 2 mo, we collected and caged the canopy bait, along with 3 equivalent sections of thick ground branch (about 8 cm × 75 cm), and 6 sections of thin ground branch (about 3 cm × 75 cm) for each tree; we estimate the biomass ratio as 1:3:1 for thick canopy, thick ground, and thin ground branches. Cages were monitored daily until emergence in the abundance of all alien scolytines vs. all other scolytines (a potential sign of competitive exclusion). We calculated the number of emergences per wk for the most abundant alien species, P. cavipennis, and native scolytines, to determine if either group was maturing (and might have colonized the branches) more rapidly.

**Results and Discussion**

The bait branches yielded 8,761 curculionid specimens (91 species in 8 subfamilies). Scolytinae had the highest abundance and species richness, with 6,578 individuals in 33 species (Morillo 2017). Nearly 24% of the scolytine individuals belonged to 4 alien species: C. cypri (N = 30), P. cavipennis (N = 1,476), X. crassiusculus (N = 46), and X. morigerus (N = 7) (Table 1). Eighteen of the 41 trees yielded 1 or more alien species. Eleven trees in old growth (6 species, 5 plant families) yielded 1,509 individuals, while 8 trees in secondary forest (5 species, 3 plant families) yielded only 50 individuals. Overall, fewer than 10 individuals emerged from 13 trees, while almost 97% of the alien scolytines emerged from 3 trees in old growth forest: 2 specimens of E. biflava, and 1 specimen of P. torta.

Three of the alien species emerged from branches cut in both old growth and secondary forest (Table 1; see Morillo 2017 for all specialization categories); C. cypri and X. crassiusculus were considered forest successional stage generalists, and P. cavipennis an old growth specialist. Each of these emerged from 5 plant species, in 3 or 4 families, but each had a preference for Lecythidaceae. Cacctotyphes cypri and X. crassiusculus emerged from both thick and thin branches at ground stratum, while P. cavipennis had a preference for canopy stratum, and at ground stratum individuals emerged in greater abundance from thin branches. Xylosandrus morigerus appeared to be a secondary forest specialist, but was represented by few individuals. This species emerged from 2 tree species in different families, with a preference for Malvaceae, from both thick and thin branches, and at both strata.

The specimens of P. torta that was densely colonized by P. cavipennis (Table 1) yielded few other scolytines (Morillo 2017), but the regression analysis showed no consistent negative correlation between the abundance of alien scolytines and other scolytines (R² = 0.0044; P > 0.74). However, within trees, branches that were heavily colonized by introduced species were not well colonized by other scolytines. Most P. cavipennis emerged from canopy branches, while native scolytines emerged in greatest abundance from thick ground branches. Thin ground branches yielded either P. cavipennis and very few native scolytines (Fig. 1, specimen 31), or native scolytines but few individuals of P. cavipennis (Table 1, specimen 28) (Morillo 2017). Scolytines tended to emerge first from thin ground branches, then from thick ground branches, and finally from canopy branches, but there were no obvious differences in emergence sequence between P. cavipennis and the native scolytines.

For P. cavipennis, this is the first record in Costa Rica with locality data, and for X. crassiusculus, this is the first record on the Osa Peninsula. It is hardly surprising that there are alien scolytines on the Osa Peninsula, given its proximity to the Panama Canal and the port of Colón. The very moist conditions probably favor small-bodied curculionids (Fassbender et al. 2014), especially ambrosia beetles that disperse and feed on symbiotic fungi. The 4 alien scolytines reared in this study are commonly collected in old growth forests, and they are all polyphagous inbreeders (Kirkendall & Ødegaard 2007; Atkinson 2016). These traits facilitate invasions because potential host plants can be readily located, and subsequent population growth is rapid. In this study, alien scolytines were more abundant in old growth forest; habitat fragmentation may favor their establishment and concentration in old growth patches. Given their geographically widespread distributions (Atkinson 2016), these alien species probably are established in other Osa forest reserves (Cornejo et al. 2012), including Corcovado National Park.

The 3 species of Asian origin, C. cypri, X. crassiusculus, and X. morigerus (Kirkendall & Ødegaard 2007), were not abundant in any single branch. Premnoabius cavipennis, of African origin (Zanuncio et al. 2005), reached high population densities in several branches that were sparsely colonized by other scolytines. Its preferential association with canopy branches and thin ground branches (both of which lose
moisture more rapidly than thick ground branches) (Berkov unpublished data), suggests that it is more drought-tolerant than many other scolytines. This is a cause for concern: *P. cavipennis*, along with *P. ambitiosus* (Schauffuss), is an important pest of both healthy and stressed *Eucalyptus* (Myrtaceae) in Brazil (Zanuncio et al. 2005). *Premnobius cavipennis* commonly is collected in Mexico, and its geographic distribution extends throughout Florida (Atkinson 2016). Given its broad host plant range and its ability to build up large populations in branches not favored by other scolytines, *P. cavipennis* may be able to spread into South America and, like *X. crassiusculus*, throughout the eastern US.

Acknowledgments

This project was funded by PSC-CUNY Awards (64264-00 42 and TRA-DA-43-338), jointly funded by the Professional Staff Congress and The City University of New York, and an anonymous donor. Thanks to Dennis Vasquez, Juan Carlos Cruz Díaz, and Melania Muñoz (Osa Conservation) for assistance with permits; Osa Conservation for field support; Reinaldo Aguilar for identifying trees and Christopher Roddick (BBG) for sampling them; Marvin Lopéz for beetle rearing, Thomas Atkinson for scolytine determinations, and Charles O’Brien for ongoing support.

Table 1. Host associations of 4 alien scolytines reared in a mosaic of old growth (OG) and secondary forest (Sec). For each host tree, the number of emergences is listed by partition as Thick Canopy/Thick Ground/Thin Ground.

| Forest stage | Plant family | Plant species (specimen ID) | Species of Scolytinae | CC | PC | XC | XM | Total N |
|--------------|--------------|-----------------------------|-----------------------|----|----|----|----|---------|
| OG Fab       | Tachigali tessmanni (14) | — | 1/0/0 | — | — | 1 |
| OG Fab       | Tachigali tessmanni (18) | — | 14/0/0 | — | — | 14 |
| OG Lec       | Eschweilera biflava (28) | 0/2/0 | 224/4/87 | 0/4/1 | — | 322 |
| OG Lec       | Eschweilera biflava (29) | — | 0/31/0 | — | — | 31 |
| OG Lec       | Eschweilera biflava (31) | 0/5/0 | 230/68/146 | 0/4/0 | — | 353 |
| OG Lec       | Gustavia brachycarpa (40) | 0/6/0 | — | — | — | 6 |
| OG Lec       | Gustavia brachycarpa (42) | 0/0/4 | — | — | — | 4 |
| OG Mal       | Apeiba tibourbou (44) | 0/0/3 | — | — | — | 3 |
| OG Mor       | Castilla tunu (16) | — | — | 0/5/0 | — | 5 |
| OG Sap       | Pouteria torta (17) | — | 663/0/3 | 0/3/0 | — | 669 |
| OG Sap       | Pouteria torta (27) | — | 1/0/0 | — | — | 1 |
| Sec Fab      | Lonchocarpus macrophyllus (35) | 0/1/0 | 0/1/0 | — | — | 2 |
| Sec Lec      | Eschweilera biflava (32) | — | 0/1/1 | 0/7/20 | — | 29 |
| Sec Lec      | Gustavia brachycarpa (33) | 0/0/1 | — | — | — | 1 |
| Sec Lec      | Gustavia brachycarpa (34) | — | 1/0/0 | — | 0/0/2 | 3 |
| Sec Mal      | Apeiba tibourbou (39) | — | — | — | 2/0/0 | 2 |
| Sec Mal      | Apeiba tibourbou (49) | — | — | 0/1/0 | 0/3/0 | 4 |
| Sec Mal      | Luehea seemannii (1) | 0/3/4 | — | — | — | 7 |
| Sec Mal      | Luehea seemannii (6) | 0/1/0 | — | 0/1/0 | — | 2 |

Total N per partition (Canopy/Ground Thick/Ground Thin) 0/18/12 | 1134/105/237 | 0/25/21 | 2/3/2 | 1559

Stage: OG = old growth, Sec = secondary. Plant Family: Fab = Fabaceae, Lec = Lecythidaceae, Mal = Malvaceae, Mor = Moraceae, Sap = Sapotaceae. Adult emergences are shown for 4 alien species: CC = Coccotrypes cyperi, PC = Premnobius cavipennis, XC = Xylosandrus crassiusculus, and XM = X. morigerus. — = no emergences.

Fig. 1. Emergence sequence of scolytine beetles from *E. biflava* (31). Emergences are shown by stratum and diameter: A = Thick Canopy branches, B = Thick Ground branches, C = Thin Ground branches. Solid lines = *P. cavipennis*; dotted lines = native scolytine species.
References Cited

Atkinson TH. 2016. Bark and ambrosia beetles. (online) http://www.barkbeetles.info/index.php (last accessed 14 Apr 2019).

Aukema JE, Leung B, Kovacs K, Chivers C, Britton KD, Englin J, Frankel SJ, Haight RG, Holmes TP, Leibhold AM, McCullough DG, Holle BV. 2011. Economic impacts of non-native forest insects in the continental United States. PloS ONE 6: e24587. doi.org/10.1371/journal.pone.0024587

Brockerhoff E, Bain J, Kimberley M, Knizek M. 2005. Interception frequency of exotic bark and ambrosia beetles (Coleoptera: Scolytinae) and relationship with establishment in New Zealand and worldwide. Canadian Journal of Forest Research 36: 289–298.

Clark KL, Skowronski N, Hom J. 2010. Invasive insects impact forest carbon dynamics. Global Change Biology 16: 88–101.

Cornejo X, Mori SA, Aguilar R, Stevens H, Douwes F. 2012. Phytogeography of the trees of the Osa Peninsula, Costa Rica. Brittonia 64: 76–101.

Fassbender J, Baxt A, Berkov A. 2014. Niches of saproxylic weevils (Coleoptera: Curculionidae) in French Guiana. Coleopterists Bulletin 68: 689–699.

Keane R, Crawley MJ. 2002. Exotic plant invasions and the enemy release hypothesis. Trends in Ecology & Evolution 17: 164–170.

Kenis M, Auger-Rozenberg M, Roques A, Timms L, Pere C, Cock MJ, Settele J, Augustin S, Lopez Vaamonde C. 2008. Ecological effects of invasive alien insects. Biological Invasions 1: 21–45.

Kirkendall RL, Ødegård F. 2007. Ongoing invasions of old growth tropical forests: establishment of three incestuous beetle species in southern Central America (Curculionidae: Scolytinae). Zootaxa 1588: 53–62.

Leinaas HP, Bengtsson J, Janion-Scheepers C, Chown SL. 2015. Indirect effects of habitat disturbance on invasion: nutritious litter from a grazing resistant plant favors alien over native Collembola. Ecology and Evolution 5: 3462–3471.

Li L, Aguilar R, Berkov A. 2017. What shapes cerambycid beetle communities in a tropical forest mosaic? Assessing the effects of host tree identity, forest structure, and vertical stratification. Biotropica 49: 675–684.

Miller-Pierce MR, Preisser EL. 2012. Asymmetric priority effects influence the success of invasive forest insects. Ecological Entomology 37: 350–358.

Morillo J. 2017. Are weevils picky eaters? Community structure and host specificity of Neotropical saproxylic beetles (Coleoptera: Curculionidae). Masters dissertation, City College of New York, New York, USA.

Oberprieler RG, Marvaldi AE, Anderson RS. 2007. Weevils, weevils, weevils everywhere. PloS ONE 6: e24587. doi.org/10.1371/journal.pone.0024587

Parker I, Simberloff MD, Lonsdale WM, Goodell K, Wonham M, Kareiva PM, Williamson MH, Holle BV, Moyle PB, Byers JE, Goldwasser L. 1999. Impact: toward a framework for understanding the ecological effects of invaders. Biological Invasions 1: 3–19.

Pimentel D, McNair S, Janecka J, Wightman J, Simmonds C, O’Connell C, Wong E, Russel L, Zerr J, Aquino T, Tsomondo T. 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. Agriculture, Ecosystem, and Environment 84: 1–20.

Sala OE, Chapin III FS, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-Sanwald E, Huenneke LF, Jackson RB, Kinzig A, Leemans R, Lodge DM, Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Walker M, Wall DH. 2000. Global biodiversity scenarios for the year 2100. Science 287: 1770–1774.

SAS Institute Inc. 2019. JMP ver. 11.0. Cary, North Carolina, USA.

Snyder WE, Evans EW. 2006. Ecological effects of invasive arthropod generalist predators. Annual Review of Ecology, Evolution, and Systematics 37: 95–122.

Vila M, Espinar JL, Hejda M, Hulme PE, Jarosik V, Maron JL, Pergl J, Schaffner U, Sun Y, Pysek P. 2011. Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities, and ecosystems. Ecology Letters 14: 702–708.

Wardhaugh CW, Stork NE, Edwards W. 2013. Specialization of rainforest canopy beetles to host trees and microhabitats: not all specialists are leaf-feeding herbivores. Biological Journal of the Linnean Society 109: 215–228.

Zanuncio JC, Sossai MF, Flechtmann CA, Zanuncio TV, Guimarães EM, Espindula MC. 2005. Plants of Eucalyptus clone damaged by Scolytinae and Platypodidae. Pesquisa Agropecuária Brasileira 40: 513–515.