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Rapid Communication

# New records of two invasive ambrosia beetles (Curculionidae: Scolytinae: Xyleborini) to mainland China

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## Abstract

Here we report new records of two invasive ambrosia beetles, *Xyleborus affinis* and *X. ferrugineus*, in mainland China. For *X. affinis*, 89 specimens were collected at 12 locations from five hosts (*Eucalyptus robusta, Eucalyptus* sp., *Hevea brasiliensis, Schefflera octophylla* and *Sindora glabra*) during 2014–2019. In 2019, there are only two samples of *X. ferrugineus* found in a dead log in Guangdong province. We suspected that both were likely introduced to China through international trade, and *X. affinis* may have arrived by natural dispersal. More investigation and research are needed to determine distribution, biology and ecology of these two *Xyleborus* species in China.

**Key words:** *Xyleborus affinis*, *Xyleborus ferrugineus*, invasive alien species, new distribution, Asia, forest pest

## Introduction

The probability of introducing alien species has increased significantly in recent times. Human activity, including globalization of trade and travel has contributed to the spread of alien insects to new areas. Invasive insects are the most serious threats to global forests in the 21st century, not only causing economic losses, but also have an impact on ecosystem services and biodiversity (Gohli et al. 2016; Dara et al. 2019; Inward 2019).

Xyleborine ambrosia beetles are a monophyletic clade within the hyper-diverse bark beetles (Coleoptera: Curculionidae: Scolytinae). These organisms have evolved the symbiotic evolutionary mode referred to as fungal farming (Hulcr and Stelinski 2017). Most Xyleborine ambrosia beetles are harmless to forests. Nevertheless, this group also includes some of the most invasive and destructive forest and timber pests (Hulcr et al. 2017).

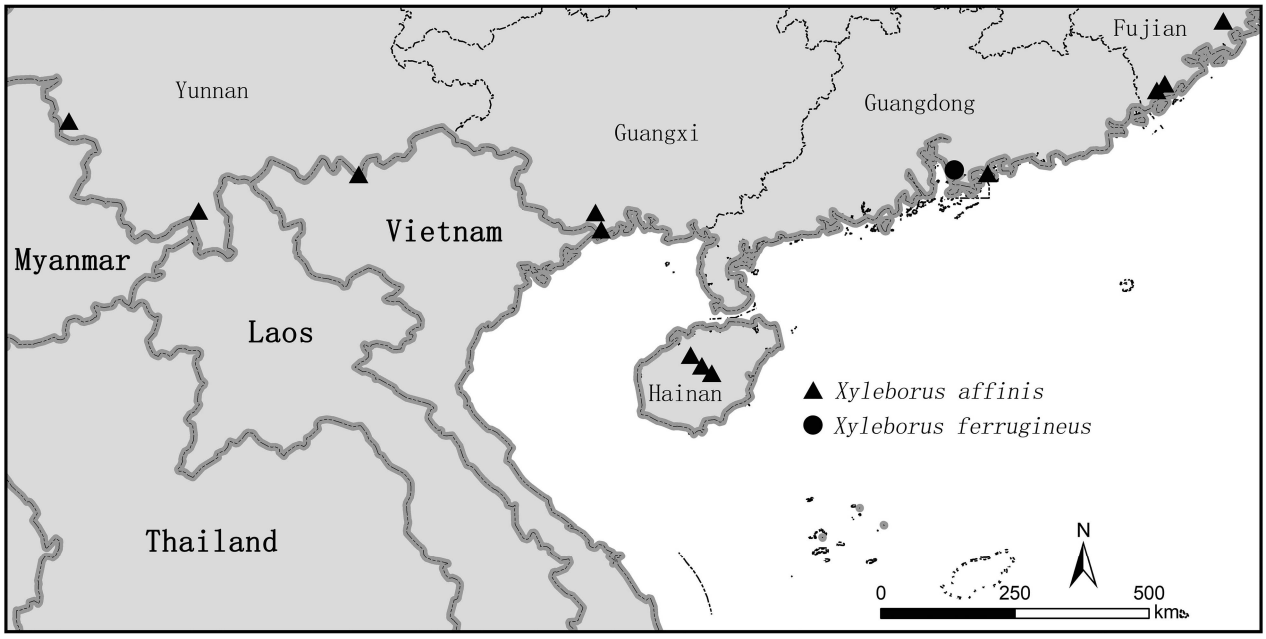


**Figure 1.** Occurrence locations of two *Xyleborus* species based on field investigation in southern China.

*Xyleborus* Eichhoff, as a polyphyletic genus of more than 400 known species, is the most complex ambrosia beetles of the tribe Xyleborini distributed throughout the world (Smith and Hulcr 2015). Some species of *Xyleborus* are major invasive forest pests. For example, *Xyleborus glabratus* Eichhoff, has nearly eradicated several native Lauraceae species in the southeastern USA and has become a threat to the Florida avocado industry (Hughes et al. 2015; Shearman et al. 2015; Hulcr et al. 2017).

Currently, only eight *Xyleborus* species, *X. affinis*, *X. festivus*, *X. glabratus*, X. *insidiosus*, *X. muticus*, *X. perforans*, *X. pfeilii*, *X. yunnanensis*, have been previously recorded as native or established species in mainland China (Yin et al. 1984; Wood and Bright 1992; Cognato et al. 2019; Li et al. 2020; Smith et al. 2020). Here, we provide more information about this genus based on the specimens recently detected in mainland China. *Xyleborus affinis* Eichhoff and *X. ferrugineus* (Fabricius), which share similar habits and behaviors (Schedl 1963; Wood 1982; Ohno et al. 1988; Ohno 1990; Wood and Bright 1992; Wood 2007), have been collected repeatedly in recent years. And, we offer diagnostic characters and known distribution of these two species, as well as discussion and suggestions of further management measures.

## Materials and methods

The field study was carried out from 2014 to 2019 in seven provinces, Yunnan, Guizhou, Guangxi, Guangdong, Hainan, Jiangxi, and Fujian in South China (Figure 1, Supplementary material Table S1). Specimens were collected by multiple methods, such as light trap, bottle trap with 75% ethanol as an attractant, and direct collecting from infested material.

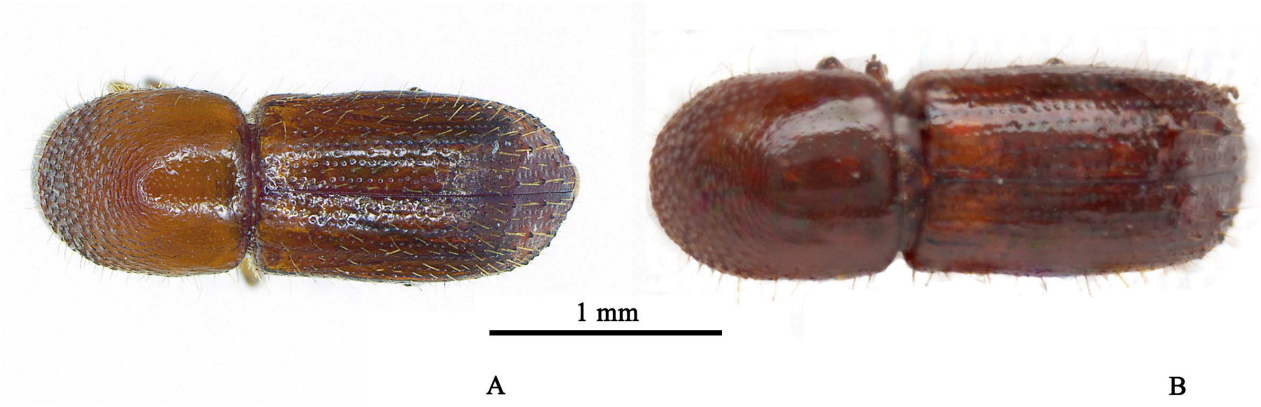


**Figure 2.** Adults female of *Xyleborus affinis* (A) and *X. ferrugineus* (B). Photographs by W. Lin(A) and Y. Ruan (B).

The beetles were identified by comparing the external morphological features with published articles (Wood 2007; Gomez et al. 2018). The maps were created in ArcMap 10.4.1. All photographs were taken with Digital Microscope Leica DVM6A. Specimens are deposited in Forest Entomology Collection, University of Florida (UF) and Jiangxi Agriculture University.

## Results

### *Xyleborus affinis* Eichhoff, 1868

Diagnosis. Elytral declivity shagreened and dull especially for dry specimen (Figure 2A); declivital interstriae 1, 3 armed with uniformly sized small granules. The distinct shagreened declivity is not present in other local *Xyleborus* beetle species with similar body size, such as *X. perforans*.

Notes. In total, 89 female specimens of *X. affinis* were collected at 12 locations from five identified host plant (*Eucalyptus robusta, Eucalyptus* sp., *Hevea brasiliensis, Schefflera octophylla* and *Sindora glabra*) in China (Table S1). Among them, 16 samples were collected in Yunnan province during 2014 to 2018. 62 specimens were collected from Hainan Island in October and November 2016. Eight specimens were collected in Fujian province during 2017 to 2019. Two females were collected in Guangxi province on March 2018 and one female was collected in Guangdong province in July 2018.

### *Xyleborus ferrugineus* (Fabricius, 1801)

Diagnosis. Elytral declivity shining; elytral declivity with a pair of large tubercles on interstriae 3 and a pair of small denticles on interstriae 1 at the declivital summit; and interstriae 2 unarmed (Figure 2B). In China, *X. ferrugineus* is bigger than *X. affinis*, but usually similar size as *X. pfeilii*. The tubercles on the declivity can easily differentiate the two species.

On 26$^{th}$, March 2019, two females of *X. ferrugineus* were found in a dead log (probably *Litchi chinensis*) in a Litchi orchard in Shenzhen, Guangdong province (Table S1), which is the only known location for this beetle in mainland China.

## Discussion

*Xyleborus affinis* and *X. ferrugineus*, which have been recorded in Africa, Asia and Oceania, coexist in many areas in the world (Wood and Bright 1992; Beaver and Liu 2010). They are probably native in warm and humid regions throughout the Americas and have subsequently spread to the tropics and subtropics of other continents long before human-assisted dispersal (Kirkendall and Jordal 2006; Gohli et al. 2016; Gomez et al. 2018). In Asia, *X. affinis* recorded from India, Cambodia, Laos, Myanmar, Nepal, Taiwan island, Thailand, Vietnam (Maiti and Saha 2004; Beaver and Liu 2010, 2018; Beaver et al. 2014), is much more widely distributed than *X. ferrugineus* which was only reported in India (Maiti and Saha 2004) and Taiwan island (Beaver and Liu 2010). Moreover, it should be noted that, Chang et al. (2014) cited that "*X. affinis* has damaged numerous rubber estates and caused economic losses in Yunnan province, China" is a misquote of Huang and A (2001), which recorded several *Xyleborus* species but did not mention *X. affinis* during the large-scale survey published nearly two decades ago. Interestingly, more than half of the specimens were collected by the light trap indicating *X. affinis* may be nocturnal and exhibiting phototaxis.

Due to the width of the distribution and host ranges, it is difficult to trace the exact pathway of these two ambrosia beetles. Nowadays, China has become the second largest timber importer in the world, with import quotas increasing year by year, from 40.88 million $m^3$ in 2009 to 107.51 million $m^3$ in 2018 (Zhang et al. 2019). Accordingly, *Xyleborus affinis* and *X. ferrugineus,* are both listed as quarantine pests in China (Chen 2009) and frequently intercepted in ports of China during 2011 to 2019, with 10,384 interceptions of *X. affinis* and 3,208 of *X. ferrugineus* (http://info.apqchina.org). Such a high interception rate indicates an increased probability of a recorded incursion (Caley et al. 2015). Therefore, it is possible that these two X*yleborus* species invaded China through international trade of wood and its products. Furthermore, *X. affinis* is established in Laos, Myanmar, and Vietnam which are very close to Yunnan and Guangxi of China. It is feasible that the beetle could naturally expand its range across borders. Conversely, *X. ferrugineus* is not common in the Oriental region which means that the movement of *X. ferrugineus* is unlikely by natural spread for China.

Both *Xyleborus* species carry multiple fungi within mycangia (Kostovcik et al. 2015). In Florida, they can be the vectors of laurel wilt disease, *Raffaelea lauricola,* which is a lethal disease to some Lauraceae plants (Ploetz et al. 2017). Rabaglia et al. (2006) also reported that both *Xyleborus* can cause economic damage in moist, lowland areas of the Neotropics.

In our survey, even though *X. affinis* is not recorded as an aggressive pest, it is still of phytosanitary concern. The reasons are 1) it can bring structural damage to timber which is freshly cut and has not been dried or

chemically treated (Sobel et al. 2018); 2) it is the sporadic vector of plant disease (e.g. *Ceratocystis fimbriata* and *R. lauricola*) (Carrillo et al. 2013; Souza et al. 2013); 3) It is extremely polyphagous with hundreds of recorded hosts (Wood and Bright 1992; Wood 2007). Furthermore, Abreu et al. (2002) found that in the Amazon rainforest *X. affinis* is always presented together with the platypodine *Euplatypus parallelus*, which was also recently recorded in southern China (Li et al. 2018; Lai et al. 2019). These species were responsible for most of the timber damage of 18 tree species in Brazil. These invasive wood borers may act synergistically threatening Chinese plantations.

Wood (2007) considered that *X. ferrugineus* may be one of the most destructive species of harvested timber in South America. It aggressively attacked newly felled logs in the forest or in wood processing and storage areas where the sapwood may be destroyed entirely. The economic importance of *X. ferrugineus* was also manifested in the attack of cocoa (*Theobroma cacao*) (Saunders and Knoke 1967). It was subsequently found to be responsible for the damage on stored yam tubers (*Dioscorea* spp.) in Nigeria (Williams 1988).

Both *Xyleborus* species are difficult to accurately identify (Atkinson et al.2013; Sosa-Castillo et al. 2017). New infestations are rarely detected until widespread damage and symptoms are observed on local host plants (Inward 2019). Our observations indicate that the distribution of these species in mainland China maybe wider than we expected.

Rapid detection of new invasive beetle-fungus pests is critical to forest protection (Inward 2019; Rabaglia et al. 2019). In China, invasive species account for more than $18.9 billion annually (Wan and Yang 2016). However, there are no countrywide surveys in natural forest and plantation. This leads to inaccurate data of new invasive pests. Considering the potential damage of both *Xyleborus* species, more investigation and research should be carried on their distribution, biology, ecology and pathogenicity in China.

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**Supplementary material**

The following supplementary material is available for this article:

**Table S1.** Occurrence of two invasive *Xyleborus* species in China.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2021/Supplements/BIR_2021_Lin_etal_SupplementaryMaterial.xlsx