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1005

Establishment of *Sinoxylon anale* Lesne (Coleoptera: Bostrichidae) in Brazil and its potential implications

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Establishment of *Sinoxylon anale* Lesne (Coleoptera: Bostrichidae) in Brazil and its potential implications

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Abstract. Bostrichidae (Coleoptera) are a family of beetles with specialized xylophagous feeding habits that allow consumption of dry woody plant tissues. Bostrichids are often polyphagous and therefore pose a significant threat to many agricultural and forestry products, particularly in tropical regions. Bostrichids are commonly detected in solid wood packaging material at international ports of entry. Notably, *Sinoxylon anale* Lesne has been intercepted in wood crates and pallets worldwide and has now become established in Brazil. This paper reports the first documented establishment of *S. anale* in Brazil, being found both in domestic wood pallets and within native forest and monoculture. The origin of these populations remains uncertain, but introductions through infested wood packaging at ports of entry is a likely scenario. Similarly, the exact time of establishment is unknown. Given that *S. anale* adults are attracted to light and ethanol, trapping using light or ethanol could be used in monitoring surveys. This species typically infests dead or decaying woody material, and therefore does not pose a direct threat to healthy, live trees. Although more common in tropical regions, *S. anale* has exhibited some adaptability to temperate climates, which may allow it to spread across the tropical and subtropical regions of Brazil and potentially to other parts of South America.

Key words. Auger beetle, exotic species, flight intercept trap, invasive species, pest status, dispersal.

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Introduction

The Bostrichidae (Coleoptera) represent a group of insects that are highly adapted to a xylophagous lifestyle (Lesne 1924), wherein both larvae and adults feed on the woody tissues of plants (Lesne 1911). The vast majority of bostrichids are highly polyphagous (Lesne 1903, 1911; Mayné and Donis 1951; Vrydagh 1960).

Bostrichids are considered pests of both agricultural and forestry products, particularly in the tropics (Lesne 1924; Beaver et al. 2011). They bore mainly into dry, felled or dead and standing trees and bamboo (Lesne 1911; Chararas and Balachowsky 1962), as well as timber used for construction or for industrial purposes (Lesne 1924; Fisher 1950; Sittichaya and Beaver 2009). Sometimes adults bore into live plants for feeding or overwintering, but no offspring are reared in such plants (Lesne 1911; Beeson and Bhatia 1937).

As a result of their polyphaghy and xylophagous habits (Roll et al. 2007), bostrichids are easily transported live to new regions, and they are frequently detected in solid wood packaging materials at ports of entry worldwide (Haack 2006; Beaver et al. 2011). Compounding this problem is that many bostrichids are secondary colonizers of treated wood and thus seldom the target when ISPM 15 measures are initially applied to newly cut wood (Haack et al. 2014). Many reports of bostrichids in wood treated to ISPM 15 standards (Benker 2008; Zahid et al. 2008) likely represent inappropriate treatment or post-treatment colonization (Haack et al. 2014), although some wood-boring insects may have the ability to survive the current heat-treatment schedules used in ISPM-15

(Haack and Petrice 2022). Largely as a result of international trade, there are at least seven bostrichid species that are now cosmopolitan, three in the subfamily Lyctinae and four in subfamily Bostrichinae (Liu and Beaver 2018).

There are 37 native Bostrichidae species reported to occur in Brazil, along with 17 introduced species (Borowski and Węgrzynowicz 2007). These introduced beetles constitute over 30% of the total known Brazilian bostrichid fauna, highlighting the significant role of international trade in the global dissemination of Bostrichidae.

Sinoxylon anale Lesne, a bostrichid auger beetle, which naturally occurs in the Oriental Region (Beeson 1941), was originally described from specimens found in India (Lesne 1897). Even before international trade became common, this species was considered to have a wide distribution (Vrydagh 1962), and today it has a cosmopolitan geographic range (Liu and Beaver 2018).

Sinoxylon anale has been detected in wood packaging material worldwide, and is one of the most commonly intercepted species of Bostrichidae. To give some examples, it corresponded to over 21% of all Bostrichidae interceptions in the USA that were identified to species during the period 1985–2000 (Haack 2006), ca. 20% in New Zealand (Bain 1994) and ca. 30% in Chile (Beéche-Cisternas 2000).

In South America, to the best of our knowledge, *S. anale* has been reported as established only in Venezuela (Joly et al. 1994), Peru (Juárez and González 2016) and Paraguay (Liu et al. 2022). In Brazil, other than interceptions at ports of entry, specimens were found in 2001 in wood pallets from India in Americana, state of São Paulo (Teixeira et al. 2002). This city is located in the interior of the state, and over 160 km from the nearest maritime port of entry, which is the coastal city of Santos. We report here the first evidence for establishment of *S. anale* in Brazil and its potential implications.

Materials and Methods

As a component of an extensive investigation focusing on bark and ambrosia beetles in Brazil, one of the authors (CAHF) has been collecting wood borers (Bostrichidae, Cerambycidae, Curculionidae, including Scolytinae and Platypodinae) across diverse Brazilian environments for over a quarter-century. The primary method of collection involved utilizing flight intercept traps (FIT; modified from Berti Filho and Flechtmann 1986) baited with 96% ethanol. Voucher specimens are deposited in the Museu de Entomologia da FEIS/UNESP, Ilha Solteira, São Paulo, Brazil (MEFEIS). Specimens reported as *S. anale* in the present paper were only recently identified and all were collected as part of the regional surveys mentioned above.

Results and Discussion

We report here evidence of establishment of *S. anale* in Brazil for the first time, based on collections in the states of Espírito Santo, São Paulo, and Paraná (Fig. 1). Specimens of *S. anale* were collected from the following localities:

- ESPIRÍTO SANTO: Cachoeiro de Itapemirim, Madereira Verona, found dead inside pallet heat treatment container, pallet of *Eucalyptus grandis* for granite tile export; [trees] planted ca. 1990, 20°51′6.55″S 41°5′44.32″W, 20-II-2010, M.D.D. Esposti (MEFEIS, 4 specimens).
- PARANÁ: Apucarana, Fazenda Três Bocas, Toona ciliata cv. BV1110 stand planted in November 2020, ethanol-baited FIT [flight intercept traps], 23°32′51.32″S 51°21′36.34″W, 26-VIII-2023, A.A. Souza (MEFEIS, 1 specimen).
- SÃO PAULO: Sete Barras, Fazenda São José, transition semideciduous seasonal forest-cerrado anthropized fragment [forest patch], ethanol-baited FIT [flight intercept traps], 24°20′35.3″S 47°51′8.0″W, 01-VII-2009, J.G.N. Wendt (MEFEIS, 2 specimens).

In all of the above cases, the collection locations indicate established populations. In the case of the *E. grandis* pallets, these pallets were made from trees cut in a eucalyptus stand about 9 km from where the dead beetles were found at the heat-treatment facility, indicating that the beetles colonized the eucalyptus logs or sawn wood soon after cutting in the forest, or at the sawmill during storage or after milling. The sawmill and heat treatment

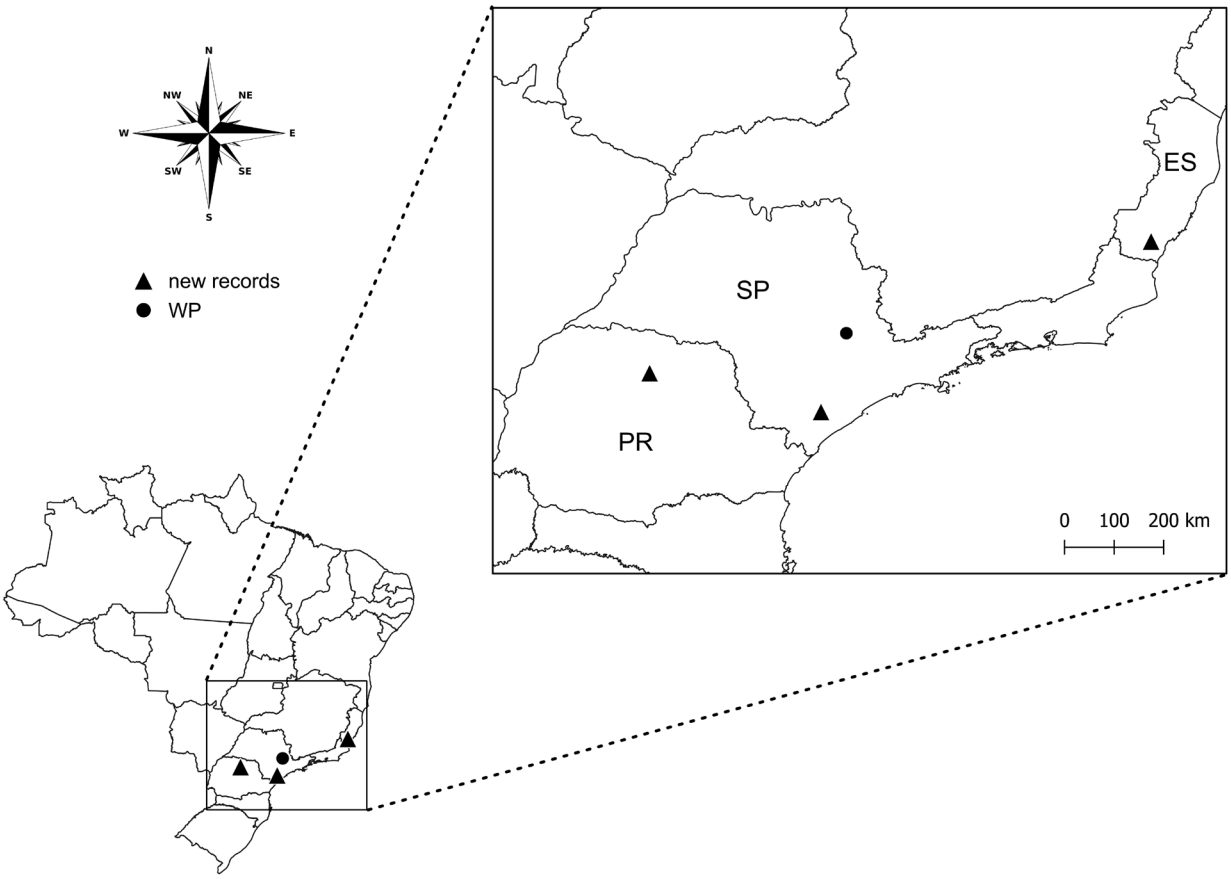

Figure 1. Distribution of *Sinoxylon anale* field collections in Brazil. WP – collection associated with wood pallets from India (Teixeira et al. 2002), ES – collection at pallet heat-treatment facility in the state of Espírito Santo, and PR – collection in a Toona ciliata stand in the state of Paraná, and SP – collection in a natural forest stand in state of São Paulo.

facility are at the same property. In the situation of Sete Barras and Apucarana , the beetles were trapped in a native forest and a monoculture stand of Toona ciliata M. Roem, respectively.

The origin of the *S. anale* population in São Paulo is not known. They could have originated from individuals present in the infested Indian pallets found in Americana in 2001 mentioned above, or possibly from other infested wood packaging material that arrived in the port of Santos, both at similar distances from Sete Barras (ca. 170 km). It is possible that the beetles then spread further south to Apucarana, at a distance of ca. 370 km from Sete Barras (Fig. 1). Similarly, it is possible that the *S. anale* population now in Espírito Santo originated from infested materials arriving at the port of Vitória, a distance of ca. 100 km from Cachoeiro de Itapemirim. Alternatively, infested wood packaging from other sites in Brazil or elsewhere could have been transported over land and initiated infestations of *S. anale* at or near the three collection sites mentioned above.

Similarly, there is no way to ascertain for how long *S. anale* has been established in Brazil. In most cases, it takes several years after the establishment for an exotic species to increase in numbers and be discovered (Roll et al. 2007; Haack and Rabaglia 2013). Given that two of the above collection records are from 2009 and 2010, establishment of *S. anale* in Brazil surely occurred many years earlier. Interestingly, in 25 years of trapping bark- and wood-boring insects with ethanol-baited flight intercept traps in Brazil, including many localities in Espírito Santo and São Paulo, by the third author (CAHF), no *S. anale* were ever trapped, suggesting that populations of *S. anale* in Brazil are still low or their distribution is somewhat restricted or localized, making them difficult to collect.

Natural forest ecosystems (such as Sete Barras, where *S. anale* was collected in traps) are considered as having more stable environmental conditions and being richer in biodiversity, with many natural enemies of plant-eating insects (Grégoire and Gould 2023). In comparison, forest plantations, often established as monocultures (such as Apucarana, where *S. anale* was trapped in a *T. ciliata* stand), and other anthropized forest environments such as agroforestry systems and many parks, have lower environmental stability and biodiversity (Brockerhoff et al. 2017; Salomão et al. 2019; Grégoire and Gould 2023). It is believed that in natural ecosystems, due to the characteristics listed above, establishment of exotic species is more difficult in comparison with anthropized environments (Hooper et al. 2005; Stachowicz and Byrnes 2006 and references therein). Given the above, it is likely that *S. anale* is well established in Brazil, as is the case for three Asian Scolytinae species [*Euwallacea fornicatus* (Eichhoff), *Xyleborinus exiguus* Wood, *Xylosandrus crassiusculus* (Motschulsky)] that were at first rarely collected in Central American natural forests but are now much more widespread in Central America (Kirkendall and Ødegaard 2007).

Bostrichid adults are commonly attracted to light (Liu et al. 2008) as well as to ethanol-baited traps (Flechtmann et al. 1996). More importantly, *S. anale* is known to be attracted to light and ethanol (Lesne 1897; Stebbing 1902; Vrydagh 1961; Amin et al. 1986), and thus these attractants could be used to survey for this beetle, using flight intercept traps, as suggested for Bostrichidae in general (Wylie et al. 2008).

The biology and ecology of *S. anale* have been studied in its region of origin (Stebbing 1902; Lesne 1906; Miller 1934). Like most bostrichids, *S. anale* is highly polyphagous (Stebbing 1914; Beeson and Bhatia 1937), infesting mainly dead trees, logs, firewood, timber and even dry rotting wood material (Stebbing 1914), but it has also been reported in bamboo (Beeson and Bhatia 1937) and even stored grain (Vrydagh 1954). At times, *S. anale* bores galleries and oviposits in dying trees and, when present in high numbers, *S. anale* can attack standing, fungus-diseased but still living trees (Stebbing 1914). In addition, adults occasionally attack young shoots and twigs of living woody plants for maturation feeding (Fisher 1950; Argaman 1987). In general, *S. anale* does not attack green healthy trees, so it generally is not considered as a forest pest (Stebbing 1914; Nahrung and Carnegie 2022).

While *S. anale* is more common in tropical areas, it has been reported from temperate parts of northern China (Lesne 1901) and can survive in parts of India that experience very low winter temperatures (Stebbing 1914). Considering that *S. anale* can survive at this range of temperatures, we predict this species can spread to both tropical and subtropical parts of Brazil, and eventually will cover most of the country, as well as other parts of South America.

Although there have been no reports to date of *S. anale* causing local outbreaks or economic losses in Brazil, more surveys for this insect should be conducted in Brazil to determine its current distribution and where and in what host material it is breeding. For many countries, *S. anale* is considered a quarantine pest, so the occurrence of *S. anale* in Brazil could have trade implications.

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