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The exotic wasp *Megastigmus transvaalensis* (Hymenoptera: Torymidae): first record and damage on the Brazilian peppertree, *Schinus terebinthifolius* drupes, in São Paulo, Brazil

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ABSTRACT

This paper records the first report of *Megastigmus transvaalensis* Hussey (Hymenoptera: Torymidae) in Brazilian peppertree, *Schinus terebinthifolius* Raddi (Anacardiaceae) drupes in Sorocaba, state of São Paulo, Brazil. This wasp is an invasive species and was found damaging *S. terebinthifolius* drupes in urban areas (35.0±15.8%), natural forests (21.5±10.2%) and restoration areas (15.8±8.4%). The bioecology and damage caused by *M. transvaalensis* in the *S. terebinthifolius* drupes warrants further study focused upon the management of this phytophagous wasp. *Megastigmus transvaalensis* has a potential to be disseminated throughout Brazil and is posing a threat to the natural regeneration of *S. terebinthifolius* in the native forests and restoration areas and ecological regions of this country.

Key words: Anacardiaceae, biological control, forest pest, monitoring, restoration.

INTRODUCTION

Brazilian peppertree, *Schinus terebinthifolius* Raddi (Anacardiaceae), native to Brazil, Paraguay and Argentina (Ewel et al. 1982), is a pioneer plant (Lenzi and Orth 2004a) of tropical and subtropical regions (McKay et al. 2009). This species has been introduced in more than 20 countries (Morton 1978, Mytinger and Williamson 1987) and is considered

invasive in USA (Ewel 1986, Habeck 1995). In Brazil, *S. terebinthifolius* occurs from the coast to inland areas at altitudes up to 2000 feet in the state of Pernambuco and in southern Brazil (Joly 1979, Lenzi and Orth 2004a). This dioecious plant, pollinated by Diptera and Hymenoptera (Lenzi and Orth 2004b), can adapt to different areas reaching up to 5-6 meters in height (Lenzi and Orth 2004a) in the sandy and clayey soils of the Atlantic Forest. Furthermore, it grows in the sandbank soils (Cesário and Gaglianone 2008, Lenzi and

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Orth 2004b) and regenerating regions, fringes of the forests, cities, swamps and pastures (Ewe and Sternberg 2002, Tassin et al. 2007). *Schinus terebinthifolius* tolerates extreme conditions of humidity, shaded environments and saline conditions (Cuda et al. 2005) with rapid growth and allelopathic compounds (Morgan and Overholt 2005) in locations where other species present less growth (Donnelly et al. 2008). This plant is regarded as invasive in many countries; however, in Brazil it is recommended for land reclamation (José et al. 2005) due to its pioneering behavior, attractiveness to birds (Panetta and McKee 1997, Hight et al. 2002, D'Avila et al. 2010) and good development in less fertile soils (Souza et al. 2001).

A phytophagous wasp was first noted in 2012 damaging the *S. terebinthifolius* drupes in the Sorocaba municipality (23°30'S and 47°25'W) in the state of São Paulo State, Brazil. During the dry season, from July-August 2014, three branches with drupes were collected using pruning shears at the lower third of each one of the 25 trees of this plant in three zones: a native semidecidual seasonal forest, a restored site and an urban forest (Table I), and stored in paper bags. Hundreds of *S. terebinthifolius* drupes were randomly sampled from the three branches per tree and placed in 500 ml transparent plastic containers with lids, and maintained at 25 °C with white light along 16 h to force the hatching of insects. After that, the number of emergence holes on the drupes and the number of adult insects were counted utilizing a stereoscopic microscope with 10 fold magnification (Figs. 1 and 2). A Kruskal-Wallis analysis and Tukey's test ($P \leq 0.05$) were performed to compare drupe damages (DD) among trees and sites.

The phytophagous wasps were identified as *Megastigmus transvaalensis* Hussey 1956 (Hymenoptera: Torymidae) by Dr. Paul Hanson of the University of Costa Rica, University City, School of Biology, San Pedro, Costa Rica.

TABLE I
Number (N°), location of trees (Geog. coord.) and percentage of *Schinus terebinthifolius* drupes damaged (%DD) (mean \pm SD) by *Megastigmus transvaalensis* (Hymenoptera: Torymidae) in the semidecidual seasonal natural forests (Forest), restoration areas (Restoration) and urban areas (Afforestation) in Sorocaba, São Paulo, Brazil.

N°	Geog. coord.	%DD
Forest		
1	23°35.20'S 47°31.12'W	35
2	23°35.21'S 47°31.13'W	28
3	23°35.20'S 47°31.14'W	21
4	23°35.21'S 47°31.15'W	31
5	23°35.14'S 47°30.99'W	23
6	23°35.15'S 47°31.31'W	12
7	23°34.97'S 47°31.31'W	1
8	23°35.12'S 47°31.48'W	29
9	23°34.99'S 47°31.62'W	21
10	23°35.00'S 47°31.61'W	14
Mean \pm SD (%)		21.5 \pm (10.2)
Restoration		
11	23°21.94'S 47°28.65'W	9
12	23°21.95'S 47°28.66'W	12
13	23°21.96'S 47°28.66'W	14
14	23°21.92'S 47°28.56'W	20
15	23°21.90'S 47°28.60'W	5
16	23°21.95'S 47°28.45'W	29
17	23°21.97'S 47°28.42'W	12
18	23°22.14'S 47°27.78'W	13
19	23°22.12'S 47°27.84'W	31
20	23°22.07'S 47°27.99'W	13
Mean \pm SD (%)		15.8 \pm (8.4)
Afforestation		
21	23°31.77'S 47°28.11'W	55
22	23°31.58'S 47°28.16'W	44
23	23°31.48'S 47°28.12'W	36
24	23°31.43'S 47°28.05'W	26
25	23°31.43'S 47°28.03'W	14
Mean \pm SD (%)		35.0 \pm (15.8)
CV%		
Trees		
Mean \pm SD (%)	21.9 \pm (12.6)	57.5
Sites		
Mean \pm SD (%)	24.1 \pm (3.4)	15.6

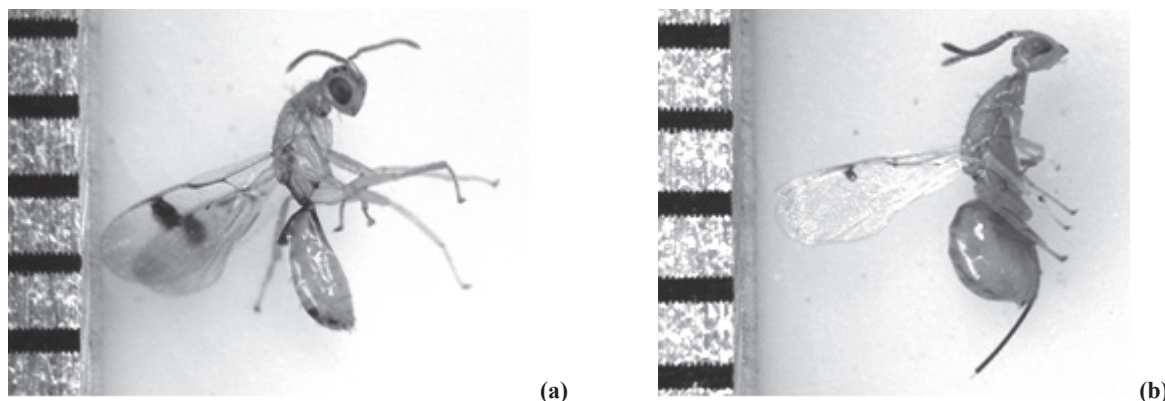


Figure 1 - *Megastigmus transvaalensis* (Hymenoptera: Torymidae) adults emerged from *Schinus terebinthifolius* drupes. Side view of a male (a) and female (b). Scale bars in millimeters.

Although *Schinus* spp. are native South American tree species, the wasp *M. transvaalensis* is presumed to originate from South Africa (Scheffer and Grissell 2003). It was also reported from the Canary Islands (Grissell 1979), Mauritius and USA (Habeck et al. 1989), Argentina (Wheeler et al. 2001), state of Paraná, Brazil (Perioto 1999), Southern Europe (Continental France and Corsica, Portugal and Continental Spain) and North Africa (Morocco) (Roques and Skrzypeczynska 2003). Actually, the seed chalcid is capable of developing and reproducing on plants in the genera *Rhus* and *Schinus*. The host range includes at least three *Rhus* spp. in South Africa of which *Rhus laevigata* L. and *R. angustifolia* L. (Hussey 1956, Grissell 1979, Yoshioka and Markin 1991), and *Schinus molle* L. and *S. terebinthifolius*, which are both native to South America (Hussey 1956, Habeck et al. 1989).

Adults of *Megastigmus transvaalensis* are yellowish-brown in color, with males and females measuring 2.3 to 2.9 mm and 3.1 to 3.4 mm in length, respectively (Fig. 1). Female ovipositor reaches about half of the body length (Hussey 1956). In most *Megastigmus* species, egg incubation period is short, the first-instar larvae hatching after four to five days. The larvae then develop through five successive instars to pupae, which are often capable of prolonged diapause (Milliron 1949). Wasps lay more than one egg per *S. terebinthifolius* drupe but

larvae are cannibalistic and after several months, we observed that only an adult emerges from each *S. terebinthifolius* drupe, leaving a quite circular exit hole (Fig. 2).

Megastigmus transvaalensis damaged 1-55% of *S. terebinthifolius* drupes collected per tree in the state of São Paulo, Brazil with greater variation than that reported in Florida, USA, where 31% and 76% of them were damaged in the winter and spring, respectively (Wheeler et al. 2001) and 80% in Hawaii (Hight et al. 2003). Furthermore, damage largely varied among trees (cv= 57.5%) and sites (cv= 15.6%) (Table I). Drupe damage also differed significantly between zones (Kruskal-Wallis test; $H = 6.927$; $P = 0.031$). Following Tukey test, it appeared that damage did not differ between urban areas ($35.0 \pm 15.8\%$) and natural forests ($21.5 \pm 10.2\%$) but restoration areas ($15.8 \pm 8.4\%$) were significantly less attacked than urban areas (Table I).

The observed number of damaged caused by *M. transvaalensis* to the *S. terebinthifolius* drupes is only an indicator, and the damage may be more important if empty seeds are considered and therefore, requires further study in Brazil. Monitoring of this wasp is necessary for proper population management to lessen the damage it causes to the *S. terebinthifolius* drupes and others Anacardiaceae species.

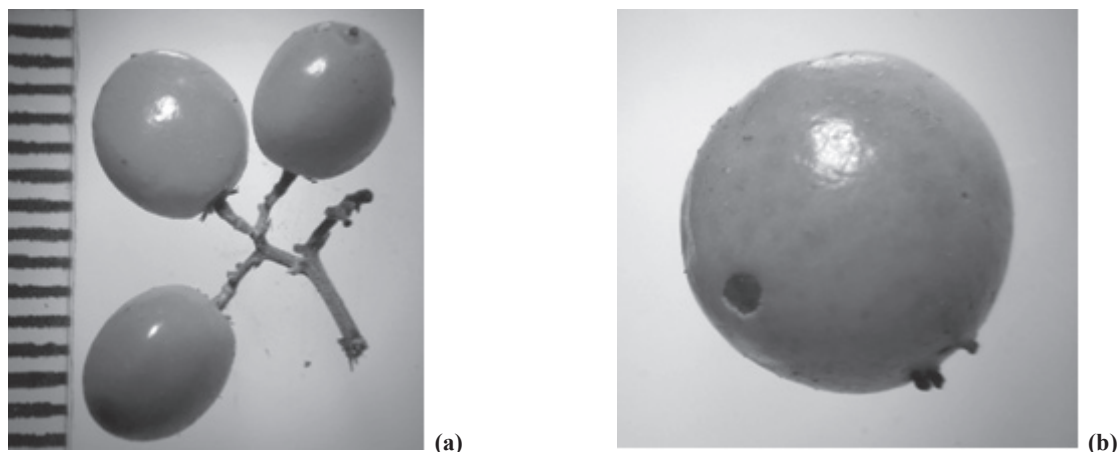


Figure 2 - Undamaged *Schinus terebinthifolius* (Anacardiaceae) drupes (a) and drupe with the circular exit hole (b) of *Megastigmus transvaalensis* (Hymenoptera: Torymidae) adults. Scale bars in millimeters.

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RESUMO

Este trabalho registra o primeiro relato de *Megastigmus transvaalensis* Hussey (Hymenoptera: Torymidae) em drupas de aroeira-vermelha brasileira, *Schinus terebinthifolius* Raddi (Anacardiaceae), em Sorocaba, estado de São Paulo, Brasil. Essa vespa é uma espécie invasora e foi encontrada danificando drupas de *S. terebinthifolius* em áreas urbanas ($35,0 \pm 15,8\%$), florestas nativas ($21,5 \pm 10,2\%$) e áreas de restauração ($15,8 \pm 8,4\%$). A bioecologia e os danos causados por *M. transvaalensis* em drupas de *S. terebinthifolius* justificam mais estudos visando o manejo dessa vespa fitófaga. *Megastigmus transvaalensis* tem um potencial de ser disseminado por todo Brasil e representa uma ameaça para a regeneração natural de *S. terebinthifolius* em

florestas nativas e áreas de recomposição e restauração ecológica do país.

Palavras-chave: Anacardiaceae, controle biológico, praga florestal, monitoramento, restauração.

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