

First record of *Platyscapa quadraticeps* (Hymenoptera: Chalcidoidea: Agaoninae) in Colombia: A warning sign?

Primer registro de *Platyscapa quadraticeps* (Hymenoptera: Chalcidoidea: Agaoninae) para Colombia:
¿Una señal de advertencia?

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Abstract: The first occurrence record of *Platyscapa quadraticeps* in Colombia is reported. This wasp is the pollinator of *Ficus religiosa*, a tree species introduced mainly for ornamental use. The obligate mutualistic relationship between them could result in the naturalization of both species, with possible negative consequences.

Keywords: Fig wasp, pollinator, *Ficus religiosa*, introduced species, naturalization.

Resumen: Se presenta el primer registro de ocurrencia de *Platyscapa quadraticeps*, para Colombia. Esta avispa es la polinizadora de *Ficus religiosa*, una especie vegetal introducida principalmente para uso ornamental. La relación mutualista obligada entre estas especies podría resultar en la naturalización de ambas, con posibles consecuencias negativas.

Palabras clave: Avispa de los *Ficus*, polinizador, *Ficus religiosa*, especies introducidas, naturalización.

Introduction

The genus *Ficus* exhibits enclosed inflorescences (syconium) containing tiny flowers pollinated by wasps from the family Agaonidae. This relationship between fig trees and fig wasps is an obligate mutualism because fig-pollinating wasps also use some flowers to lay their eggs and produce offspring (Cook and Rasplus 2003). The development of seeds and wasps occurs through a five-phase cycle highly synchronized between both mutualistic species (Galil and Eisikowitch 1968; Weiblen 2002). In phase A, the fruit starts its development; in phase B, the female flowers become receptive and female wasps enter to pollinate the flowers and lay their eggs in some of it. In phase C starts the development of larvae and seeds. In phase D, the male flowers become mature and male wasps leave the galls where they developed, open the galls where females are, fertilize them and then dig tunnels in the fruit wall so that the females – loaded with pollen, can leave it in search for receptive trees with fruits in phase B. Finally, after females have abandoned the fruits, phase E starts, in which fruits are mature and are consumed by different frugivorous animal species that can disperse the seeds (Galil and Eisikowitch 1968).

The genus *Ficus* comprises approximately 750 species distributed into six subgenera and 19 sections. It is widely distributed in the tropics and subtropics around the world with approximately 140 species reported for the Americas, belonging to the subgenera *Urostigma*, section *Americana* and to the subgenera and section *Pharmacosycea* (Berg 1989). In the Neotropics, the *Ficus* of the section *Americana* are pollinated by wasp species of the genus *Pegoscapus* and those of the section *Pharmacosycea* by species of *Tetrapus* (Wiebes 1995).

Since A. Dugand, six decades ago, the knowledge on the genus *Ficus* in Colombia has had no significant advances. One of his last studies published on the subject, the author reported 53 species for this country (Dugand 1955). However, this list should be updated due to several changes that had occurred with the advances in the knowledge of the species within the genus. For example, in the section *Pharmacosycea* Dugand (1955) had listed 21 species, then DeWolf (1965) reviewed the section and reduced this number to seven. Recently, Cardoso *et al.* (2017) did a taxonomic synopsis of this particular section for Colombia and reported 21 species. The section *Urostigma* is the most diverse in the Neotropics

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and there is no recent review or listing. Nor is there a official listing of the species that have been introduced in Colombia, but in some urban areas it is possible to observe species as *Ficus benjamina* L., *Ficus elastica* Roxb. ex Hornem., *Ficus lyrata* Warb., *Ficus pumila* L., *Ficus carica* L., *Ficus microcarpa* L. and *Ficus religiosa* L., being the first two the most common. These species have been introduced mainly for ornamental purpose and most of the cases they cannot reproduce by themselves because they were not introduced along with their pollinators.

Platyscapa quadraticeps (Mayr, 1885) (Hymenoptera: Chalcidoidea: Agaoninae) is the fig pollinating wasps of *F. religiosa*, a native *Ficus* species from southern Asia (Galil 1984). This fig tree has a cultural and religious relevance as well as some medicinal uses, being very appreciated for ornamental use and is commonly found in parks and green areas of cities around the world. The origin of the species scientific name is related to an individual of *F. religiosa* and its descendants, known as the Bodhi tree, a sacred fig tree venerated by Buddhists (Sitaraman *et al.* 2009, Singh *et al.* 2011). Thus, the commerce of *F. religiosa* around the world has been going on for decades.

This high abundance and broad distribution of *F. religiosa* worldwide increases the probability of colonization and establishment of *P. quadraticeps* populations in places with the proper ecological conditions to survive. Despite the small size of pollinating fig wasp, *P. quadraticeps* has reached many places around the world, colonizing four of the five continents (Asia, Africa, Oceania and America) (Joseph 1982; Galil 1984; Nadel *et al.* 1992; Evenhuis and Eldredge 2008; van Noort and Rasplus 2010; Chaudhary *et al.* 2012; van Noort *et al.* 2013; Vianna-Filho *et al.* 2017) (Fig. 1). Accidental or intentional transport of *P. quadraticeps* individuals may have occurred during the trading of *F. religiosa*, increasing the invasive potential of this fig tree. The naturalization of both species have been occurred in some countries as a result of the pollinator's arrival and, consequently, the reproductive success of the fig tree with possible negative consequences (Galil 1984; Nadel *et al.* 1992; Vianna-Filho *et al.* 2017). Some of the possible risks are the displacement of native species due to the hemi-epiphytic nature of the fig trees, which also can affect buildings and other urban structures such as bridges (Nadel *et al.* 1992; Sitaraman *et al.* 2009). Although the

impacts of the naturalization of these species are uncertain, monitoring and management plans are necessary to avoid possible negative consequences.

Materials and methods

Material examined: *Platyscapa quadraticeps*. 125♀, 43♂. **COLOMBIA.** Valle del Cauca, Cali. Universidad del Valle, Campus Meléndez. 30°22'30.74"N, 76°32'12.27"W. 985 m. Manual in figs of *F. religiosa*. Mar - 2016. Cardona, W. [UDVC].

The wasps were collected from one tree of *F. religiosa* at the Universidad del Valle campus, Cali, Colombia This is the only adult individual observed in the University and nearby places. Cali is located in a valley in the Andean region of Colombia, within the Tropical Dry Forest life zone (Espinal 1967). It has a annual average temperature of 23,9 °C, 72 % of average relative humidity and average annual rainfall of 1483.4 mm (IDEAM 2019).

The presence of wasps developing inside the fruits of *F. religiosa* was detected through casual and routine observation. Two fruits were collected when they made the transition to the male phase, that is, when male have emerged from the galls in which they developed but wasps have not

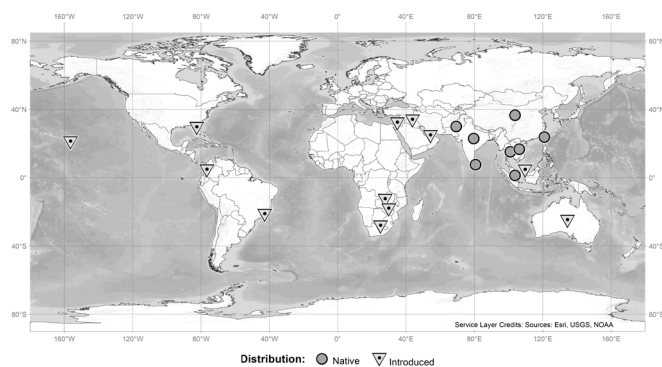


Figure 1. Distribution of *Platyscapa quadraticeps* in its native (China, India, Pakistan, Singapore, Sri Lanka, Taiwan, Thailand and Vietnam) and introduced (Iraq, Israel, United Arab Emirates, Malaysia, Zambia, Zimbabwe, South Africa, Australia, Hawaii, USA, Brazil and Colombia) range.



Figure 2. *Platyscapa quadraticeps* collected at the Universidad del Valle campus, Cali, Colombia.

yet abandoned the fruit. Then, the fruits were taken to the laboratory and put into glass vials until the emergence of the wasps. After 48 hours, some of the wasps were preserved in 80 % ethanol. For the dry mounting, we used the acetone drying procedure (van Noort 1995). The photographs were taken with a stereomicroscope Nikon SMZ 1500 equipped with a Nikon DS-Ri1 camera. Later, they were edited with the NIS Elements Br software.

Knowing that the *F. religiosa* pollinator in its native habitat is *P. quadraticeps*, the individuals were compared with reports of that species found in literature (van Noort and Rasplus 2010; van Noort *et al.* 2013; Vianna-Filho *et al.* 2017). The specimens are deposited in the Universidad del Valle Entomological Museum (MUSENUV).

Results

In one of the collected fruits, 57 females and seven male wasps developed. From the other fruit, 68 females and 36 male wasps emerged. All individuals belonged to one species with apterous males and winged females (Fig. 2). Five females and five males were dry mounted, photographed and identified. The wasps matched with the description of *P. quadraticeps* recorded in other places in the world (van Noort and Rasplus 2010; van Noort *et al.* 2013; Vianna-Filho *et al.* 2017). Additionally, Dr. Stephen Compton from Leeds University (UK) confirmed the identification, thus we assure it is the first report of the species for Colombia.

Mayr (1885) described *P. quadraticeps* over a century ago. The major characteristics of females are the following: average size approximately 1.1 mm, dark brown in the posterior part of the head and in the back. Light yellow in the base of antennas and legs. Ovipositor approximately the same size as the body. Semi-squared head in dorsal view, approximately the same width as length. Mandibles with two

basal setae and seven ventral lamellae. Mandible appendices with eight lamellae. Antennas with ten segments, semi-oval scape and rectangular pedicel both covered with disperse setae. The last four segments of the flagellum form a clava. Sensillas present in the last seven flagellar segments. Anterior and posterior tibia with an external three-cusp tooth. Wings with a short marginal vein and a very short post-marginal vein, i.e., 1/3 of the marginal; stigma vein forming a almost straight angle with the marginal vein.

In Cali (Colombia) predominates introduced *Ficus* species and the most common are *F. benjamina* and *F. elastica*, conversely *F. religiosa* is one of the least common. The Administrative Department of Environmental Management of the city of Cali (DAGMA, pers. comm.) together with the Valle del Cauca Regional Autonomous Corporation (CVC) and the Universidad Autónoma de Occidente recently conducted a tree census and only reported 36 individuals of *F. religiosa* in approximately 121 km² covering the urban area of Cali. According to this information, the density of the species in the city is less than one individual per km² or an individual every 3.36 km². The tree from which the wasps were collected produce fruits regularly and all of them exhibited exit orifices for wasps when they ripe. In addition, in the surrounding area of the studied tree, several small and medium-sized seedlings can be found growing on other plant species or freely (Fig. 3).

Discussion

The dispersal success of *P. quadraticeps* is conditional to the presence of *F. religiosa*, a tree that has been introduced in multiple places around the world (Galil 1984; Sitaraman *et al.* 2009; Singh *et al.* 2011). The use of this fig tree as ornamental has facilitated the wasp dispersal, probably by accidental transport of the larva inside the figs. Although *P.*



Figure 3. *Ficus religiosa* specimens growing in different kind of substrates in the Universidad del Valle and nearby places.

quadraticeps has been reported as an introduced species in several countries, until very recently it had been restricted to Asia, Africa and Oceania continents (Joseph 1982; Evenhuis and Eldredge 2008; van Noort and Rasplus 2010; van Noort *et al.* 2013). Besides, there is evidence of the *P. quadraticeps* in the American continent (Florida, USA) due to the observation of some seedlings, however these occurrences were considered isolated and non-persistent events (Nadel *et al.* 1992). Conversely, only recently the presence of *P. quadraticeps* was confirmed in Rio de Janeiro, Brazil (Vianna-Filho *et al.* 2017). Therefore, the current record of this species in Colombia extended its distribution in the American continent and helped to fill a geographic gap between the records from USA and Brazil, suggesting that *P. quadraticeps* may also be occurring in other nearby countries, where *F. religiosa* has been introduced.

The presence of *P. quadraticeps* may be a result of periodic and constant introductions of *F. religiosa* individuals in Cali. However, this introduction is unlikely due to the low density of trees and its absence in commercial nurseries. In contrast, the wasps dispersal probably occurred by the colonization from nearby populations of *P. quadraticeps* because these fig pollinating wasps have a high dispersal ability (Harrison 2003). Besides that ability, this is only the second record of the species in South America, with a long geographic distance between them (approximately 4,650 km). If the natural dispersal occurred, this required the existence of naturalized populations of both species in areas not too far from Cali. However, there are no reports of *P. quadraticeps* and *F. religiosa* in nearby places. Thus, a regional assessment of this mutualistic relationship would be required to clarify this unique situation.

Additionally, the presence of *P. quadraticeps* in southwest Colombia indicates the beginning of the reproductive success of *F. religiosa* in the country. Currently, seedlings and young individuals of this fig tree can be found in different places of Cali, exhibiting freestanding or hemi-epiphytic growing habit (Fig. 3). Individuals are found in urban structures such as bridges, where they grow in crevices and among concrete blocks, therefore the possible impacts of this probable naturalization need to be assessed.

F. religiosa tolerates a wide range of climatic conditions and soil types (Galil 1984; Singh *et al.* 2011). The germination is the critical phase of its establishment because the seeds require constant humidity (Galil 1984). Seed germination may be observed in Cali, despite the tropical dry climate of the city. Even under these conditions, both fig tree and pollinating fig wasp could become naturalized in this region of Colombia. Similar situation was found in Israel, according to previous studies *F. religiosa* have been recorded growing in the warmest areas of the country for more than 70 years (Galil 1984). Besides germination, there is a need to assess the ability of establishment of the new individuals in the region. In addition, the impact of this naturalization on the ecosystem or on some particular species should be addressed. *F. religiosa* seems to grow more frequently on small-leaved tree species, where light is abundant and in crevices where humidity accumulates. Therefore, an assessment of a possible threat the species pose to the stability or permanence of urban structures is also relevant because some individuals have been recorded growing in crevices of vehicular bridges in the major highways of the city.

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