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The Japanese beetle *Popillia japonica* Newman, 1838 (Coleoptera: Scarabaeidae) in the Azores islands

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Abstract: *Popillia japonica* Newman, 1838 (Coleoptera: Scarabaeidae) is recorded for the first time from Flores island of the Azores archipelago. Occasional introductions are made into other islands such as Terceira, Faial, Pico, and São Miguel, when the adult beetles or larvae are shipped in commerce. The original population was detected in Terceira in early 1970's through Lajes, a North America Air Force Base. It has become one of the most important and destructive insect pest of agricultural and ornamental plants. This note emphasizes some advances in understanding the beetle's dispersion and the approaches may provide more options for integrated management. Despite ongoing regulatory efforts, the Japanese beetle remains a threat as an invasive species in Azores.
Key words: Coleoptera, Scarabaeidae, *Popillia japonica,* Japanese beetle*,* Azores islands.

The Azores is a volcanic archipelago located in the Atlantic Ocean (39º 40' - 43' N / 31º 5' - 8' W) at approximately 1.500 km of the western coast of Portugal, Europe. The archipelago is composed of nine inhabited islands, which are divided in three groups: the western group of Corvo and Flores; the central group of Faial, Pico, Graciosa, São Jorge and Terceira; and the eastern group of São Miguel and Santa Maria. The largest island is São Miguel (745 km^2) and the smallest is Corvo (17 km^2). Santa Maria is the southern- and easternmost island (37° N, 25° W), Flores is the westernmost (31° W) and Corvo (39.7° N) is the northernmost island.

The Azores islands enjoy a distinctly oceanic climate. Mild temperatures, ranging from 13.9ºC (February) to 22ºC (August), an insignificant variation in the seasonal temperature and high humidity (above 74%) and precipitation (over 50 mm in driest month, August), provide an ideal environment for the establishment and quick dispersion of the agricultural pest species, such as the Japanese beetle *Popillia japonica*.

Different factors (e.g. climatic conditions, long distance to the mainland continents, and more than 500 years of human settlement) are expected to influence the abundance of beetles (Coleoptera) species and their habitats. According Borges *et al*. (2005), of the 2209 species and subspecies of terrestrial animals (Arthropoda) known to inhabit this archipelago 267 are endemics. Approximately 58% of the arthropods found in the Azores are exotic, being many of them invasive. The Coleoptera checklist of Azores include 528 species, 66 (12.5%) of which are endemics, whose presence in each island was published by Borges (2005).

In particular, the Japanese beetle *Popillia japonica* Newman, 1838 (Coleoptera: Scarabaeidae), named "Escaravelho Japonês" in portuguese, was introduced in Terceira island in early 1970's through Lajes, a North America Air Force Base (Guimarães, 1972; Martins *et al*., 1988; Lopes *et al*., 2001). *P. japonica* is a monovoltine species, native of the Japan islands, and it is widely distributed in China, Russia, Canada and the USA (CABI, 2004). In Macaronesian archipelagos, is only in the checklist of Azores, and had been recorded from Terceira, Faial (in 14.IX.1996, the first specimen was detected at Monte da Guia), Pico (in 10.VI.2007, at São Roque do Pico), São Miguel (in 19.IX.2006, at airport of Ponta Delgada) (Lopes *et al*., 2001; Borges, 2005; Anónimo, 2006; Lopes, 2007).

The present paper deals with Japanese beetle records obtained during a short visit to islands of Flores, Corvo (18-23.VII.07), and Graciosa (30.VIII-01.IX.07).

In the port of Lajes (39º 22' N, 31º 10' W, Flores island) some males of *P. japonica* were captured alive in a Yellow Ellisco® trap, which were accidentally transported by a ferry boat, departing from São Miguel in the first week of July 2007.

A ferry Express Santorini also connects the islands of São Miguel and Flores between May and October, while Faial, Pico and São Jorge have ferry during all year. The ferry usually stops in the Horta's port (Faial) for spend the night, and in the next day arrive to Flores. Curiously, various specimens of *P. japonica* were captured, identified, and photographied, during the trip Faial - Flores, in 17.VII.07 (R. Resendes, pers. communication).

In the front of Baleia's Restaurant (39º 27' N, 31º 07' W, Santa Cruz, Flores), two males of Japanese beetle were observed alive in the 49th Yellow Ellisco® trap, in 18.VII.07. They were also identified, photographied and then released into the trap by myself.

The widespread and destructive pest it is not found by me in Corvo and Graciosa islands during July and August 2007, respectively.

The adult's flight period extends from late May throughout early November, with peak numbers caught during the last half of July and the first half of August, obtaining in this period accounts for 82% of the total number of beetles captured (Martins *et al*., 1988; Lopes *et al*., 2001).

The beetle is slowly spreading across the different islands after being accidentally introduced. In fact, initially the infestation was restricted to the areas or fields surrounding the airports (Terceira, São Miguel) and the ports (Faial, Pico, and now Flores).

Japanese beetle larvae feed on the roots in the pasture grasses which cover most of the Azorean islands, wile the adults feed on the leaves and floral parts of some hundred different species of agricultural and ornamental plants. Odor and location in direct sun seem to be very important factors in plant selection. The beetles usually feed in groups, starting at the top of a plant and working downward. The following are some of the better-known hosts: *Medicago sativa* (alfalfa)*, Acer* (maples), *Phaseolus vulgaris* (pea), *Populus* spp. (poplar), *Asparagus officinalis* (asparagus), *Glycine max* (soybean), *Malus* spp. (ornamental species apple), *Prunus* spp. (stone fruit including plums, peaches, etc.), *Rosa* spp. (roses), *Rubus* spp. (blackberry, raspberry), *Tilia* spp. (limes), *Quercus* spp. (oak), *Ulmus procera* (English elm), *Vitis* spp. (grapes), *Zea mays* (maize) (see also Martins & Simões, 1988).

Since this pest is important in agriculture and commerce, considerable effort has been placed on developing control options. The eradication measures were undertaken in Terceira (chlordane spraying plus traps baited with female sex pheromone japonilure added with food attractants), but those methods proved to be insufficient to prevent the dispersion of this pest (Martins *et al*., 1988). More recently, soil sampling is being carried out to study the development of the immature stages.

The integrated pest management involve both chemical and biological insecticides acting on larvae and adults. *P. japonica* can be infected by some parasitoids, bacteria, nematodes, and fungi (Martins & Simões, 1988). According Martins & Simões (1988) and Lopes *et al*. (2001) extensive field sampling and experiments under semi-natural conditions show that some larvae, pupae and adults could be controlled by the green muscardine fungus *Metarhizium anisopliae* (Metsch.) Sorok; the milky disease bacteria *Bacillus popilliae* Dutky; the insect parasitic nematodes, Steinernematidae (*Neoaplectana* spp.) and preparations containing Heterorhabditidae (*Heterorhabditis* spp.); the white muscardine fungus *Beauveria bassiana* (Bals.) Vuill.; and the adaptation to local conditions of the parasitic exotic wasps (*Istocheta aldrichi* Mesnil and *Tiphia vernalis* Rohwer) can be helpfully an biological control program in near future.

However, all the Azorean islands are connected daily by plane. Regular flights link some islands to Lisbon (Faial, Pico, Santa Maria, Terceira, São Miguel), Boston or Toronto (Terceira, São Miguel). A ferry boat also connects the islands between May and October, while Faial, Pico and São Jorge have ferry during all year. In other hand, for example, Faial and São Miguel have a port of call for a ship that carries passengers and cargo between Portugal mainland and the islands.

Popillia japonica is known from Terceira, Faial (Borges, 2005), Pico, São Miguel (Lopes, 2007), and now Flores. More specific fieldwork will be needed to determine whether a population exists in these islands, and how its introduction and dispersion can be prevented in other Azorean islands, Macaronesia, and Europe or Africa.

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Primera cita de *Phoracantha recurva* Newman, 1880 (Coleoptera, Cerambycidae) en Extremadura

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Muchas especies animales se valen de sus plantas nutricias para colonizar nuevos territorios. Los insectos, por ejemplo, ya sea en su forma adulta, de pupa, larva o huevo utilizan esta vía para establecerse como especies invasoras en regiones muy lejanas, incluso, de su área natural de distribución generando, en la mayoría de los casos, importantes impactos ecológicos y económicos en los ecosistemas receptores. De ese modo, se estima que al menos 16 especies de insectos se han dispersado por todo el mundo utilizando a los eucaliptos como vectores (Lawson, 2007).

El eucalipto (*Eucalyptus globulus* Labill. y *E. camaldulensis* Dehnh. son los más abundantes en la Península Ibérica) es una planta invasora originaria de Australia y de la región Indomalaya (Withers, 2001), que fue introducida en España en 1846 debido su interés comercial, ya sea ornamental o industrial (Hodkinson, 1999; Pujade-Villar & Riba-Flinch, 2004). En la Península Ibérica se han detectado unas pocas de especies australianas de insectos asociadas a los eucaliptales (Rupérez & Cadahía, 1973; Cadahía, 1980; Mansilla, 1992; Cordero-Ribera & Santolamazza-Carbone, 2003; Sánchez, 2003; Pujade-Villar & Riba-Flinch, 2004).

En 1981 (Gil & Mansilla, 1983) se detecta el cerambícido perforador de la madera *Phoracantha semipunctata* (Fabricius, 1775) (Fig. 1a), que produjo graves daños en el sudoeste de la Península Ibérica (Cordero-Ribera & Santolamazza-Carbone, 2003) y que en la actualidad se encuentra ampliamente distribuido en la Península Ibérica (Vives, 2000). Su especie hermana, *Phoracantha recurva* Newman, 1840 (Fig. 1b), es localizada, primero, en Ceuta (Ruiz & Barranco, 1998) y, posteriormente, en el interior peninsular (Bercedo & Bahillo, 1998). También ha sido detectada en Cádiz, Córdoba, Jaén, Sevilla (Verdugo, 2004) y Huelva (López-Pérez, 2007). Según (Vives, 2000), esta última parece tener una aclimatación irregular en la Península Ibérica. La diferenciación de estas especies se puede realizar a nivel larvario (Morelli *et al*., 2002) o de los adultos (Wang, 1995).

Recientemente García Villanueva *et al.* (2007) han publicado el catálogo de los cerambícidos extremeños, donde se cita la presencia de 95 especies, entre ellas *P. semipunctata*.

El 18 de julio de 2007 fue localizado un ejemplar macho (Fig. 1a) de *P. recurva* en los eucaliptales que se localizan alrededor del embalse de Piedra Aguda (términos municipales de Valverde de Leganés y Olivenza, Badajoz, Extremadura, España, UTM: 29SPC8271). El ejemplar fue detectado al atardecer, en su hábitat típico y alimentándose de la sabia que brotaba de un árbol con daños evidentes. En esta zona existen ya citas de *P. semipunctata*.

Estas especies pueden provocan importantísimos perjuicios en plantaciones de eucalipto y en las trozas (Dourojeanni, 1967), pudiendo además, atacar a otras especies de la familia Myrtaceae (Ely & Krüger, 2004). En los eucaliptales del embalse de Piedra Aguda no se han detectado hasta la fecha daños evidentes producidos por *Phoracantha*. El gran éxito como especies invasoras de *P. recurva* y *P. semipunctata* se debe a su habilidad para pasar desapercibida y a su capacidad para sobrevivir en madera de eucalipto muy seca, por lo que las explotaciones madereras de la zona podrían actuar, a su vez, como foco de reinvasiones (Lawson, 2007).

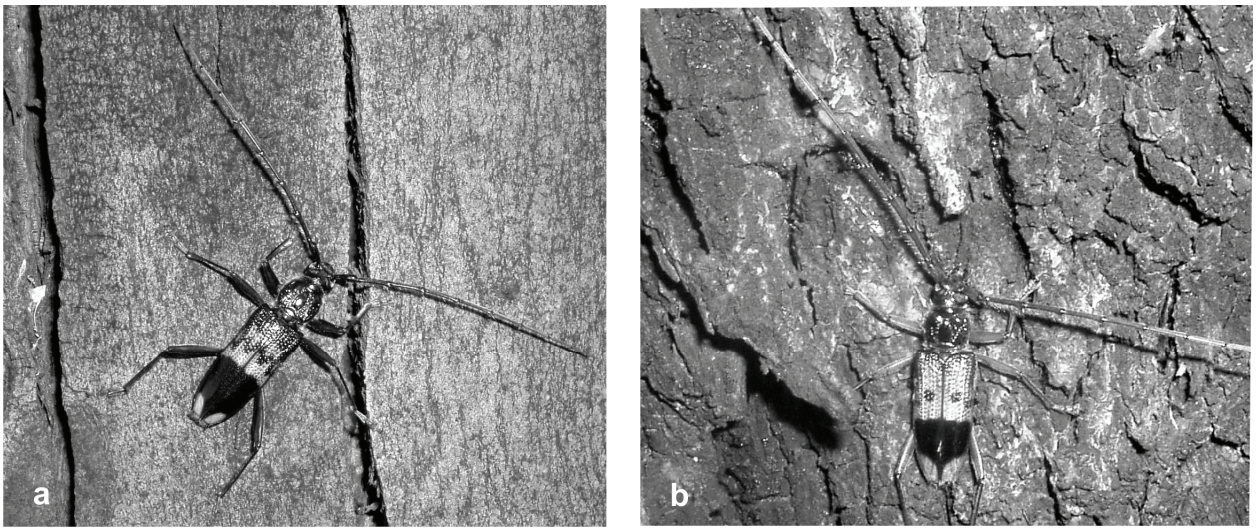

Fig. 1. *P. recurva* (**a**) y *P. semipunctata* (**b**).

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