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GEOGRAPHIC RANGE EXPANSION OF *BOREIOGLYCASPIS MELALEUCAE* (HEMIPTERA: PSYLLIDAE) TO PUERTO RICO

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The Australian tree *Melaleuca quinquenervia* (Cav.) S.T. Blake (Myrtaceae) was introduced into South Florida (U.S.) by horticulturists during the late 1800s (Dray 2003). Nearly 100 years later, *M. quinquenervia* was widely recognized as a pernicious invader of wetland systems in the Florida Everglades (Browder & Schroeder 1981; Woodall 1981, 1982), due in part to the tree's competitive superiority over most native vegetation (Turner et al. 1998). Current estimates of geographic distribution suggest that the invasive tree now occupies approximately 200,000 ha of graminoid/herbaceous wetlands, including portions of the Everglades National Park (Turner et al. 1998).

A classical weed biological control program targeting *M. quinquenervia* was initiated in 1986, with expectations that introduced herbivores would limit invasion and complement conventional control tactics (Balciunas et al. 1994). The curculionid weevil *Oxyops vitiosa* Pascoe (Coleoptera: Curculionidae) was the first candidate selected for quarantine-based host specificity testing (Purcell & Balciunas 1994) and, once deemed environmentally safe, was released in South Florida during 1997 (Center et al. 2000; Pratt et al. 2003).

The second herbivore introduced for biological control of *M. quinquenervia* in Florida was the melaleuca psyllid, *Boreioglycaspis melaleucae* Moore. Host range studies demonstrated that the insect completes its development only on a small group of species in the *Melaleuca* genus (Wineriter et al. 2003), of which there are no native representatives in the New World. Based on this narrow host range, the psyllid was permitted for release in South Florida during the spring of 2002 (Pratt et al. 2004). Both adults and nymphs feed on expanding buds and leaves but nymphs also exploit mature, fully expanded leaves as competition for preferred feeding sites increases. Initial field data indicate that feeding by psyllids induces leaf senescence, eventually resulting in mortality of coppicing stumps and seedlings (Morath et al. 2006; Franks et al. 2006). Psyllids also rapidly disperse from release points, spreading on average 4.7 km/yr but ranging as high as 10 km/yr (P. D. Pratt, unpublished data). Following establishment, common garden experiments confirmed that feeding and development by the melaleuca psyllid was restricted to *Melaleuca* species, as predicted in quarantine-based host range testing, and so it posed no threat to native or economically important species (P. D. Pratt unpublished data). In response to observed impacts of the psyllid, federal, state, and county agencies initiated a redistribution campaign for *B. melaleucae* in 2003. Over 1 million individuals have been redistributed to nearly 100 locations in South Florida since 2002.

In addition to its occurrence in Florida, *M. quinquenervia* has been planted throughout much of the Caribbean (Serbesoff-King 2003). In Puerto Rico, for instance, it was planted islandwide in public parks, promenades, and along certain highway medians and green areas from the 1970-90s (Angleró 1960; Pratt et al. 2005). Not surprisingly, the extensive use of *M. quinquenervia* as an ornamental in Puerto Rico enabled it to naturalize in ecologically sensitive wetlands, including the Tortuguero Lagoon Natural Reserve (Pratt et al. 2005). The implementation of chemical controls for invasive populations of the tree on the island is currently underway. The use of biological controls, which have been very effective in Florida, were considered less suitable for Puerto Rico due to the small size of the infested areas and possible conflicts of interest. Conservationists in Puerto Rico are interested in halting continued invasion of the tree in wetlands, although public policy as to how to address ornamentally planted trees has yet to be determined. More importantly, the biological control agents approved for introduction into Florida have not been evaluated as to their propensity to oviposit and develop on Caribbean species of Myrtaceae. Liogier (1994) cites 30 species in the family Myrtaceae that are native to the island of Puerto Rico and these were not included in initial host testing for the biological control agents described above. Pratt et al. (2005) indicated that additional representatives from the Puerto Rican Myrtaceae and closely related economically important flora must be tested as possible hosts prior to introducing the natural enemies.

In Jan 2006, however, the psyllid *B. melaleucae* was observed on leaves of *M. quinquenervia* trees growing near the San Juan Airport, Puerto Rico. A survey of the island was conducted in Apr 2006 to determine the geographical distribution of *B. melaleucae* on the island. This was accomplished by traveling E, W, and S on primary roads while stopping every 10-20 km to search for

M. quinquenervia trees. Once encountered, trees were examined by 3 observers for 15 min each to detect psyllid presence and estimate feeding damage and proportion of trees infested. Feeding damage was assessed on a 5-point scale based on a visual estimation of percentage of the suitable foliage destroyed by psyllid feeding as follows: 0 = no damage; 1 = <25% destroyed; 2 = 26 to 50%; 3 = 51 to 75%; 4 = 76 to 100% destroyed.

Identification of *B. melaleucae* was confirmed by Susan Halbert (Florida Department of Agriculture and Consumer Services) and voucher specimens were deposited in the Florida State Collection of Arthropods (E2006-2142-201). Surveys indicated that *B. melaleucae* was distributed widely on the island, except for the west coast where no psyllids were found on *M. quinquenervia* trees near Aguadilla and Cabo Rojo (Fig. 1). Damage was greatest (level 3) near the San Juan Airport and Rio Piedras but decreased with increasing distance from the greater San Juan area (ANOVA $df = 3, 14$; $F = 3.71$; $P = 0.0460$). The proportion of trees infested exhibited a similar trend, with fewer trees per site harboring psyllids as the distance from San Juan increased (linear regression $df = 1, 14$; $F = 1.94$; $P = 0.0742$).

The discovery of *B. melaleucae* in Puerto Rico raises several questions regarding pathways of introduction. First, where was the point of introduction on the island? If we assume that increased damage and infestation levels are positively correlated with time, then *B. melaleucae* was likely established in the greater San Juan area prior to other locations. The subsequent dispersal and its current distribution underscores the long range host-finding abilities of *B. melaleucae* under highly fragmented populations of its host. The psyllid had successfully located isolated *M. quinquenervia* trees, for instance, <30 m from the ocean (Arecibo) as well as within canopies of 3 trees growing at 800 m elevation.

Florida, as compared to Australia, is the most logical origin of the Puerto Rican psyllid population based on proximity and frequency of transportation. On-going genetic analyses may help elucidate the country of origin for the Puerto Rican populations. Considering the widespread occurrence of *M. quinquenervia* among the Caribbean islands, one introduction pathway may include unassisted inter-island dispersal from Florida, through the Bahamas or Greater Antilles to Puerto Rico. Hurricanes may facilitate the long range dispersal of insects through the Caribbean (Drake & Farrow 1988). This line of reasoning, however, is not supported by recent surveys of *M. quinquenervia* in the northern Bahamian islands (Grand Bahama, New Providence, and Andros) where *M. quinquenervia* is abundant but where *B. melaleucae* was not detected despite a recent hurricane (Hurricane Wilma, Oct. 2005) that crossed South Florida prior to making landfall on Grand Bahama (Pratt unpublished data). San Juan lies approximately 1660 km southeast of Miami whereas New Providence is about 300 km east and Grand Bahama is only about 130 km northeast. Thus, if the psyllid were dispersing on its own or through the agency of hurricanes, it should reach the more proximate Bahama Islands first. A more probable explanation is that *B. melaleucae* was introduced, either accidentally or intentionally, to Puerto Rico. Human activities play an important role in accidental insect invasions, with the most common introduction pathways including international transportation of airplane luggage and cargo (Kiritani & Yamamura 2003). Considering the frequent transport of tourists and cargo between South Florida and Puerto Rico, the premise that *B. melaleuca* was inadvertently carried or "hitchhiked" to the island remains a plausible explanation. Of greater concern, however, is the possibility that the *B. melaleucae* may have been intentionally smug-

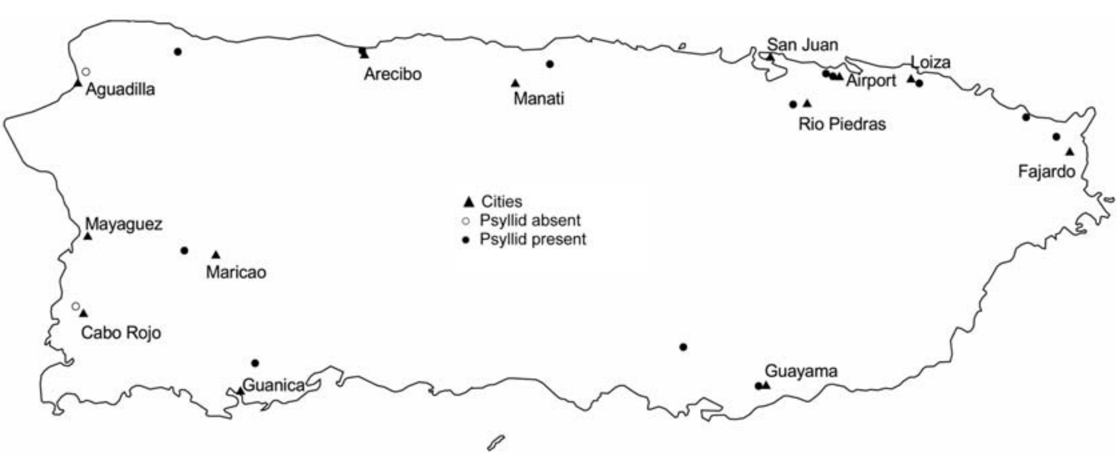

Fig. 1. Geographical distribution of *B. melaleucae* in Puerto Rico.

gled into Puerto Rico to aid in control efforts of *M. quinquenervia*. While the invasion pathway of *B. melaleucae* remains uncertain, the occurrence of the melaleuca psyllid in Puerto Rico draws attention to the potential for movement of biological control agents far beyond their intended range. For this reason, biological control programs must consider risks to the flora of neighboring regions, especially if these regions harbor populations of the target.

Both host range testing and post release field studies indicate that development of *B. melaleuca* is restricted to *M. quinquenervia* and closely related congeners, and is therefore unlikely to pose a threat to the flora of Puerto Rico. However, host specificity studies were based on the flora and particularly Myrtaceae of Florida, which is less diverse than that of Puerto Rico. Seven genera in the family Myrtaceae, for instance, were not tested as possible hosts during quarantine testing. Additional laboratory and field monitoring of *Gomidesia*, *Marlierea*, *Myrcia*, *Myrciaria*, *Myrtus*, and *Siphoneugenia* would provide additional information as to the potential host range in Puerto Rico.

Summary

The Australian psyllid *Boreioglycaspis melaleucae* is a specialized herbivore of *Melaleuca quinquenervia* and other closely related congeners. *Boreioglycaspis melaleucae* was discovered in Puerto Rico feeding on naturalized and ornamentally planted *M. quinquenervia* trees. The psyllid is widely distributed on the island except for the western coast. It is unlikely to harm native plant species but will impact ornamental landscape plantings of *M. quinquenervia*.

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