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GEOGRAPHIC RANGE EXPANSION OF *OXYOPS VITIOSA* (COLEOPTERA: CURCULIONIDAE) TO THE BAHAMIAN ARCHIPELAGO

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The Australian tree *Melaleuca quinquenervia* (Cav.) Blake was internationally disseminated over the last century for ornamental and agroforestry purposes (Dray et al. 2006). Although introduced into California, Texas, and Louisiana, it has not been reported as an invasive pest in those areas. In contrast, it has proven to be a superior competitor to most native vegetation in wetlands of Florida, Puerto Rico, Cuba, and the Bahamas (Pratt et al. 2005b; Pratt et al. 2007; Turner et al. 1998).

A biological control program in Florida targeting *M. quinquenervia* was initiated in 1986 (Balciunas et al. 1994). The weevil *Oxyops vitiosa* Pascoe and the psyllid *Boreioglycaspis melaleucae* Moore were among the first natural enemies selected for pre-release risk assessments (Purcell & Balciunas 1994). Host range testing indicated that both herbivores only completed development on a small group of species in the *Melaleuca* genus, of which there are no native representatives in the New World. The weevil and psyllid were permitted for release in south Florida during the spring of 1997 and 2002, respectively. Both species established in *M. quinquenervia* dominated habitats (Pratt et al. 2003; Center et al. 2007).

Herbivory from introduced biological control agents resulted in significant reductions in *M. quinquenervia* growth, reproduction, and survivorship (Pratt et al. 2005a; Franks et al. 2006; Morath et al. 2006; Center et al. 2007; Tipping et al. 2008). These impacts collectively limited the competitive superiority of *M. quinquenervia* and led to increases in native species diversity in habitats once dominated by it. In response, federal, state, and county agencies initiated a redistribution campaign for *O. vitiosa* and *B. melaleucae*. To date, >3 million individuals have been redistributed to nearly 407 locations in southern Florida.

Biotic exchange between the Florida mainland and neighboring island systems is an increasingly common occurrence (Dobbs & Brodel 2004). We questioned whether *O. vitiosa* and/or *B. melaleucae* had dispersed to the neighboring West Indies. To address this question we surveyed *M. quinquenervia* dominated wetlands of Puerto Rico and discovered the presence of *B. melaleucae* in 2006 (Pratt et al. 2007). The occurrence of the psyllid in Puerto Rico, some 1300 km from the originating population in Florida, led us to hypothesize that the Australian herbivores may have dispersed to *M. quinquenervia* stands on the nearby islands of the Bahamian archipelago.

Recent aerial and ground vegetation assessments quantified the geographic distribution of several exotic plant species, including *M. quinquenervia,* on Grand Bahama, New Providence, and Andros islands of the Bahamas (Fig. 1; Pratt et al. 2007). Using coordinates from these assessments, we surveyed all known *M. quinquenervia* populations or individuals for the Australian herbivores during Dec 2005 and Mar 2007. Trees were examined by 3 observers for 15 min each to detect presence, estimate feeding damage, and determine the proportion of trees infested. Feeding damage was assessed on a 5-point scale based on visual estimation of percentage of suitable foliage destroyed by feeding: 0 = no damage; 1 = <25% destroyed; 2 = 26 to 50%; 3 = 51 to 75%; 4 = 76 to 100% destroyed. The proportion of damaged trees within a given site was estimated and averaged within site.

Eight sites on Andros, 22 on Grand Bahama, and 20 on New Providence containing *M. quinquenervia* were surveyed (Fig. 1). No evidence of either insect was observed in the 2005. Similarly, *B. melaleucae* was absent in the 2007 survey but *O. vitiosa* was observed at 6 locations on New Providence (Fig. 1). Identification of *O. vitiosa* was confirmed by Mike Thomas (Florida Department of Agriculture and Consumer Services, Gainesville, FL) and voucher specimens were deposited in the Florida State Collection of Arthropods.

Geographic distribution of *O. vitiosa* was limited to the southern half of New Providence (Fig. 1). Herbivory was greatest at site 1, with *M. quinquenervia* trees experiencing 25-50% damage, and having the highest proportion of trees attacked by the weevil (60%). Less than 10% of trees were damaged at the 5 other sites. If we assume that damage levels and the proportion of trees attacked correlate with time since establishment, these data suggest a point of introduction for *O. vitiosa* at or near the village of Adelaide and adults spread from these trees to surrounding *M. quinquenervia* stands.

Discovery of *O. vitiosa* in the Bahamas raises questions regarding pathways of introduction. How might *O. vitiosa* disperse from Florida to New Providence? Proximity and widespread occurrence of *M. quinquenervia* among the Bahamian islands may have allowed unassisted dispersal from Florida. It is possible that hurricanes facilitate dispersal of insects through the Caribbean (Drake & Farrow 1988). Hurricane Wilma in Oct 2005 crossed southern Florida and made landfall in the Bahamas. New Providence lies ap-

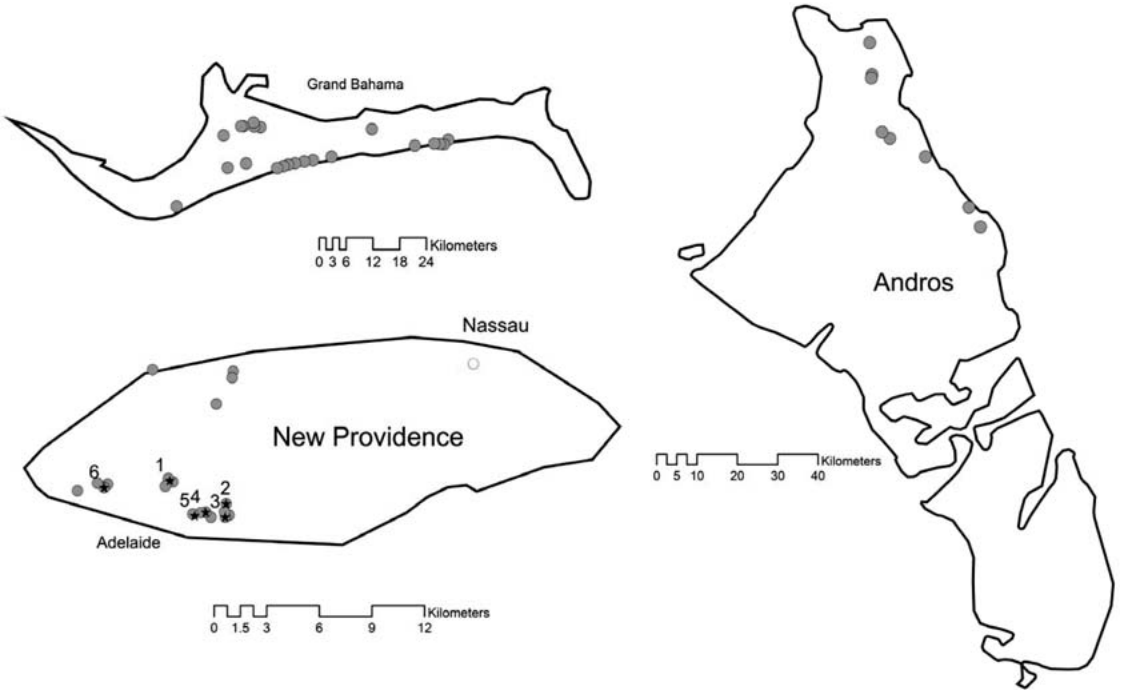

Fig. 1. Geographical distribution of the invasive tree *M. quinquenervia* (grey points) and the Australian weevil *O. vitiosa* (numbered stars) in the Bahamas.

proximately 300 km east of Miami but Grand Bahama and Andros are 130 and 230 km, respectively, from the mainland, suggesting that under natural dispersal scenarios it is more likely that *O. vitiosa* would reach one of the near islands first.

Frequency of trade and tourism may have aided weevil establishment. Human activities play an important role in accidental insect invasions, particularly with international transportation of airplane luggage and cargo (Kiritani & Yamamura 2003). Nearly 32,000 flights departed Florida for the Bahamas in 2006, and nearly 22,900 of these arrived on the 3 islands studied herein (US Department of Transportation 2008). Within the Bahamas, the number of annual flights to New Providence was markedly greater (16,576) than those destined for Grand Bahama (5,688) or Andros (600). The frequent transport of tourists and cargo between southern Florida and New Providence makes the premise that *O. vitiosa* was inadvertently carried or "hitchhiked" to the island a plausible explanation. Of greater concern is the possibility that *O. vitiosa* may have been intentionally smuggled into the Bahamas to facilitate control efforts of *M. quinquenervia*.

While the invasion pathway of *O. vitiosa* remains uncertain, occurrence of the weevil in the Bahamas draws attention to potential movement of biological control agents beyond their intended range. Thus, biological control programs must consider risks to the flora of neighboring regions, especially if those regions harbor populations of the target host. Host range testing and post release field studies indicate that development of *O. vitiosa* is restricted to *M. quinquenervia* and closely related congeners, and is therefore unlikely to pose a threat to flora of the Bahamas. Host range testing of *O. vitiosa* addressed the biogeographic overlap of *M. quinquenervia* with Florida's neighboring regions by including genera that represented much of the Caribbean myrtaceous diversity. Ten of the 11 native Bahamian myrtaceous species were included in the *O. vitiosa* host range studies and all were non-hosts (Correll & Correll 1982).

Summary

The Australian weevil *Oxyops vitiosa* is a specialized herbivore of *Melaleuca quinquenervia* and closely related congeners. The weevil was intentionally introduced into Florida, USA in 1997 and was recently discovered on the Bahamian island of New Providence, some 300 km east, feeding on naturalized *M. quinquenervia* trees. The weevil has colonized *M. quinquenervia* stands in the southern part of the island and is expected to spread to all invaded habitats. *Oxyops vitiosa* is unlikely to harm native plant species but will affect ornamental landscape plantings of *M. quinquenervia*.

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