

SUITABILITY OF FLORIDA RED BAY AND SILK BAY FOR *PAPILIO PALAMEDES* BUTTERFLY LARVAE (LEPIDOPTERA: PAPILIONIDAE)

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ABSTRACT.— The Lauraceae-specialist swallowtail butterfly, *Papilio palamedes* Drury, has never been reported using a prominent tree species like silk bay (*Persea borbonia* var. *humilis*, Lauraceae) in central Florida. This tree grows in the central white, arid, sandy habitats and its dense hairy/pubescent leaves distinguish it from the glabrous hammock-dwelling red bay (*Persea borbonia* var. *borbonia*) and the wetland/swamp-dwelling swamp bay (*Persea palustris*). We examined the suitability of these two plant species for larval survival and growth using split-brood bioassays. No significant differences in survival, pupal weight, overall duration of development or growth rates were observed. Whatever prevents silk bay from being used as a natural host for the *P. palamedes* butterfly is not known.

KEY WORDS: arid sand habitats, defenses, ecological monophagy, habitats, hostplants, Lauraceae, Magnoliaceae, Nearctic, North America, USA, wetlands.

In southern Florida, the Lauraceae-feeding swallowtail butterflies, *Papilio palamedes* Drury and *Papilio troilus* Linnaeus (Papilionidae) are basically confined to red bay (*Persea borbonia* (L.) Spreng. var. *borbonia*) in the hammocks and swamp bay (*Persea palustris* (Ref.) Sarg.) in swamps and wetland habitats where they occur (Scriber *et al.*, 1998; M. Minno, pers. comm.). Further northward in the eastern United States, sassafras (*Sassafras albidum* (Nutt.) Nees) and spicebush (*Lindera benzoin* (L.) Blume) (both Lauraceae) can serve as host plants for *P. troilus* and *P. palamedes*, although the ability to use these northern hosts is poorer for the allopatric *P. palamedes* than the sympatric *P. troilus* (Lederhouse *et al.*, 1992). These two swallowtail species are not known to utilize sassafras or spicebush in Florida (M. Minno, pers. comm.). Even within a single species, it was observed that survival and growth of Florida *P. troilus* populations on red bay were significantly greater than Michigan and Ohio populations on this plant (Nitao *et al.*, 1991). *Papilio troilus* also frequently utilize the exotic but naturalized camphor tree (*Camphora* sp.).

Numerous literature records incorrectly list sweet bay (*Magnolia virginiana* L.) (Magnoliaceae), or just "bay" (which common name can refer to a variety of plants), as putative hosts for *P. palamedes* and *P. troilus* (Scriber, 1984). However larval survival in no-choice bioassays is non-existent and oviposition mistakes onto the Magnoliaceae plant species are minimal (Scriber, 1986; Scriber *et al.*, 1991; Scriber *et al.*, 2001).

It has been shown that neoliginins from the leaves of *Magnolia virginiana* (sweet bay) are toxic to the Magnoliaceae-unadapted *P. troilus* and *P. palamedes* (Nitao *et al.*, 1992), while chemicals in red bay are toxic to the generalist *Papilio glaucus* larvae (Scriber, 1986) and deterrent to the *P. glaucus* ovipositing females (Frankfater and Scriber, 1999a; Frankfater and Scriber, 2003). In contrast, phytochemicals in red bay are attractive for both *P. troilus* and *P. palamedes*.

The existence of a different shrubby lauraceous "bay" species (silk bay, *Persea borbonia* var. *humilis* (Nash) L. E. Kopp) in the desert-like white sand scrub of central Florida (Wunderlin, 1998) raised the question of suitability for the Lauraceae-adapted *P. troilus* and *P. palamedes*. No host records for either *Papilio* species exist for silk bay, and these two swallowtail species are rarely even seen in such white sand scrub habitat (such as found at the Archbold Biological Station in Highlands County, Florida). However, these

plants are common in the scrubs of the Ocala National Forest, in north-central Florida. Silk bay, now treated as a variety of bay (*P. borbonia*) (Wunderlin, 1998), has been viewed previously as a separate species (*P. humilis*) (see Nelson, 1994). We decided to examine the leaves of silk bay (*P. borbonia* var. *humilis*) relative to red bay (*P. borbonia* var. *borbonia*) to see if the distinctive morphological differences of silk bay leaves (densely pubescent and silky on underside; Nelson, 1994) made them differentially suitable for swallowtail butterfly survival and growth. Such thick pubescence might be a significant defensive adaptation against potential herbivores such as *P. palamedes* or primarily just an adaptation for leaf water conservation in their hot, arid habitats compared to the cooler and wet bayheads and hammocks where *Persea borbonia* and *P. palustris* (and *Magnolia virginiana*) exist. Our test was a bioassay of neonate larval survival and growth on the two varieties of red bay.

METHODS

Adult females of *P. palamedes* from Highlands and Levy Counties, Florida, were collected in late March to early April 1999 and set up in revolving multi-choice oviposition arenas in front of incandescent light bulbs (on and off at 2 hr intervals) to obtain eggs (Scriber, 1993; Scriber *et al.*, 2001). Neonate larvae of two families (F37 and F44) were divided equally between two host species to be bioassayed. Groups of 3-8 larvae were carefully placed into petri dishes (2.5cm x 15cm) with leaves on a sprig of either red bay or silk bay inserted in floral aquapics to maintain leaf water and turgor. All dishes were maintained at room temperature in the air conditioned, invertebrate laboratory of the Archbold Biological Station near Lake Placid, Florida. The final few days of the feeding were in our lab at Michigan State University using *Persea* leaves brought back on ice in zip-lock bags. Each larva was transferred to its own individual dish when it reached the pupal stage. Survival on each host was assessed at one to two day intervals as host leaves were changed and dishes cleaned. Total durations to pupation were recorded for survivors. Pupal weights were recorded using a Semi-Macro analytical balance. A follow-up study was conducted at the Archbold Biological Station (28 Mar-2 Apr 2000) with *P. palamedes* and *P. troilus* females collected from Levy County, west of Alachua Co., Florida.

Data are presented as a mean \pm se. Significant differences are indicated ($p = 0.05$). Plant voucher specimens of both Lauraceae

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Table 1. Larval growth performance of two Florida families of *Papilio palamedes* on two red bay (*Persea borbonia*) varieties (Lauraceae). Data presented as a mean (\pm s.e.) (Highlands Co., FL).

Host plant	number of pupae	Pupal mass (g)	Total Duration (d)	Overall Growth Rate (g/d)
var. <i>humilis</i> (silk bay)	10	1.37 $\pm .04$	29.5 ± 0.5	.047 $\pm .001$
var. <i>borbonia</i> (red bay)	12	1.46 $\pm .06$	30.1 ± 1.1	.049 $\pm .001$
T-test*	-	(n.s.) p = .226	(n.s.) p = .664	(n.s.) p = .389

* No significant differences between means on different plants (n.s.; p = 0.23, 0.66, 0.39 respectively t-tests on pupal mass, total durations and growth rate.

species have been deposited in the herbarium research collection of JMS at Michigan State University.

RESULTS

Contrary to our predictions, the overall survival of neonate larvae to pre-pupae in 1999 was basically the same for larvae of *Papilio palamedes* on red bay, *Persea borbonia* var. *borbonia* (70.6%) as on the silk bay, *Persea borbonia* var. *humilis* (61.1%) (Fig. 1). Furthermore, the final pupal weights, total durations and overall growth rates (neonate to pupa) were also virtually identical between split broods (on different *Persea* species) of two families of *P. palamedes* larvae (Table 1). However, in 2000, females of both *P. palamedes* and *P. troilus* showed strong oviposition preference for red bay versus silk bay. All *P. palamedes* (n = 4) preferred red bay (163 total eggs) versus silk bay (15 total eggs). Furthermore, neonate larvae grew poorly on silk bay (only one of 28 survived the 1st instar) and grew well on red bay (35 of 37 survived the 1st instar).

DISCUSSION

The extensive and dense hairiness on leaves of the silk bay (*Persea borbonia* var. *humilis*) and their desert-like white sand shrub habitats of central contrast rather dramatically with the smooth, more glabrous leaves of upland red bay (*Persea borbonia* var. *borbonia*) and swamp bay (*Persea palustris*) which are found in the wettest swamps, forests, and hammocks throughout Florida (Preston, 1976; Nelson, 1994). The Lauraceae-specialized swallowtail butterflies, *Papilio palamedes* and *P. troilus*, have been reported repeatedly on red bay and swamp bay but, to our knowledge, never on silk bay. Our bioassay results from larval feeding studies with *P. palamedes*, suggest that habitat preferences or oviposition preferences of the adult females may account for this lack of host use records for silk bay. We found the suitability for larval survival and growth of *P. palamedes* to be basically identical for red bay and silk bay (Fig. 1) for later instars, but not for neonate 1st instar larvae.

Our results also suggest that the hairiness of the silk bay leaves may be more likely an adaptation for desiccation-prevention rather than as a major defense against the larval stages of insect herbivores. It is possible that the hairy undersides of leaves deters oviposition (e.g., Kumar, 1992) by adult *P. palamedes* (and *P. troilus*), which generally prefer to oviposit on the undersides of

leaves of Lauraceae host species (Scriber, 1996a). Preliminary results from 2000 suggest that this may at least partially explain the lack of any field host records of eggs or larvae on silk bay.

The chemical suitability of tree leaves for larval survival and growth is a function of leaf water, nitrogen, allelochemicals, minerals, and their interactions (Scriber, 1977, 1984; Mattson and Scriber, 1987). The physical texture, toughness, hairiness, spines, and trichomes are also of fundamental importance for the host plant suitability (Scriber and Slansky, 1981; Finke and Scriber, 1988). Despite the fundamental chemical constraints upon the evolution of host plant preferences and usage patterns (Feeny, 1995), other biotic factors such as natural enemies (Bernays and Graham, 1988; Scriber, 1998; Redman and Scriber, 2000) and abiotic factors such as seasonal thermal unit (growing degree day) constraints (Scriber and Lederhouse, 1992; Scriber, 1996b; Nylin and Janz, 1999) can affect local host specificity. While we don't know why silk bay is apparently not used as a host for either *P. troilus* or *P. palamedes* butterflies, we do know that for the latter it is not due to physiological unsuitability for larvae.

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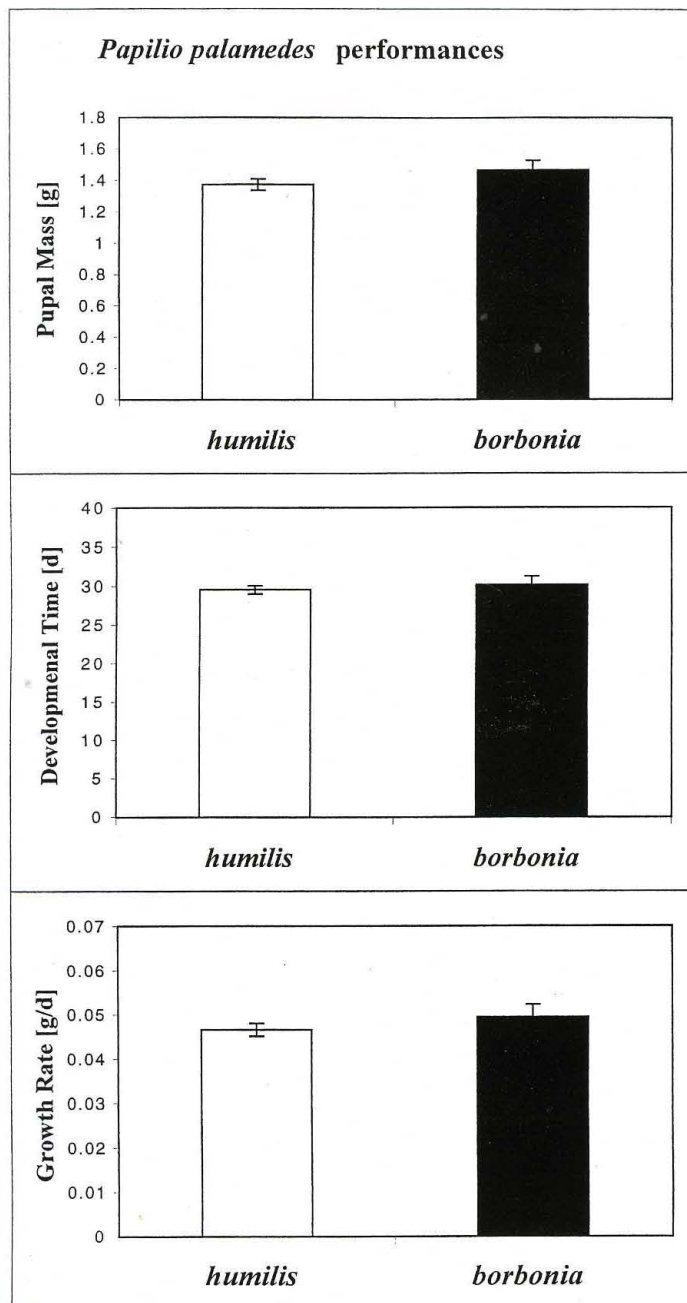


Fig. 1. *Papilio palamedes* larval development, neonates to pupae (1999) on *Persea borbonia*: var. *humilis* and var. *borbonia*.

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