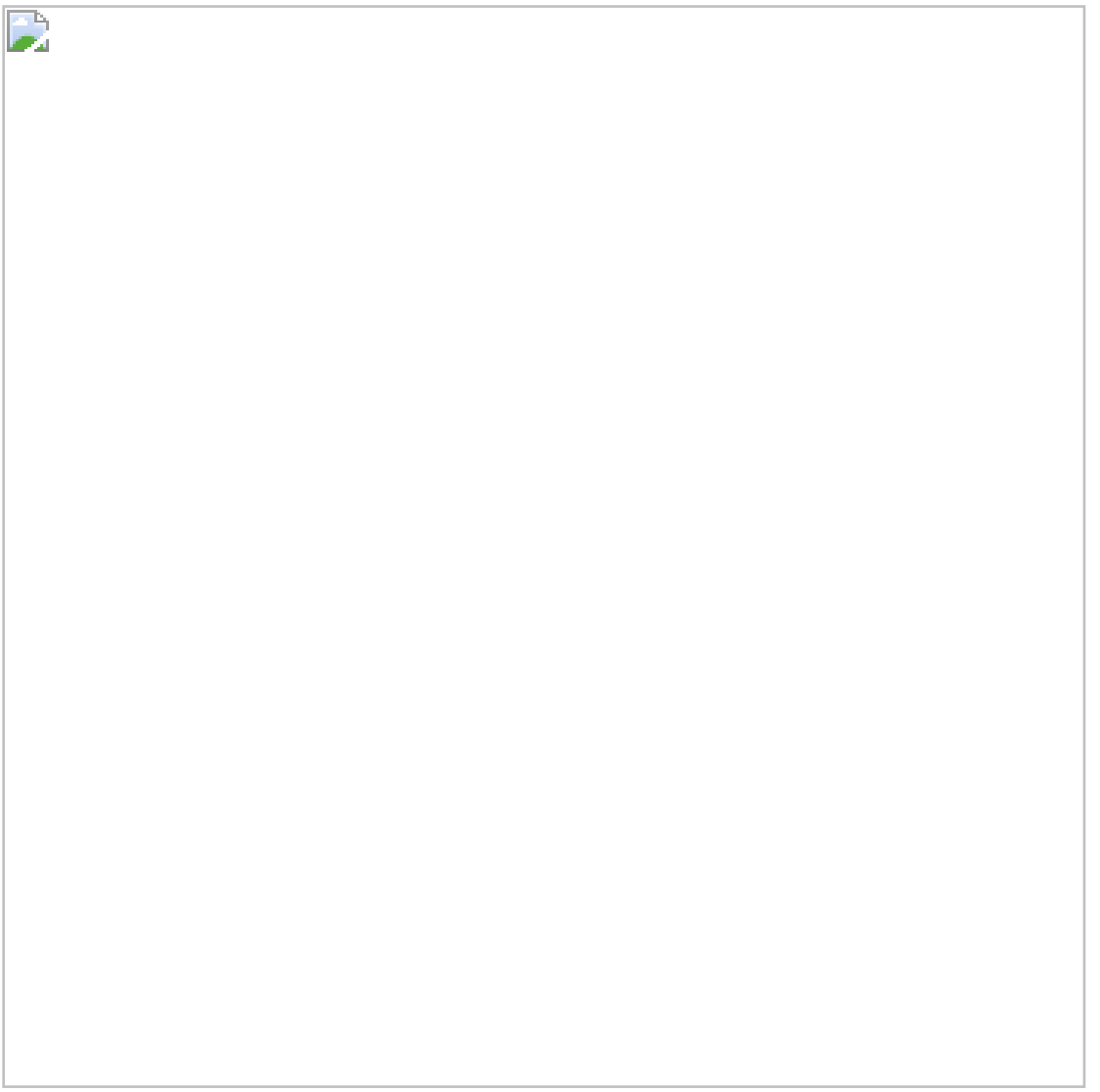

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NOTES ON, AND THE TAXONOMIC SIGNIFICANCE OF, THE IMMATURE STAGES OF *LINTNERIA JUSTICIAE* WALKER (SPHINGIDAE) FROM SOUTHEASTERN BRAZIL

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ABSTRACT. Confirmed aspects of the life history of *Lintneria justiciae* are discussed and illustrated for the first time. Observed larval characters represent a unique synapomorphy that has been shown to correlate with predictable adult forewing patterns. The significance and taxonomic implications of these recent discoveries confirm the placement of several South American taxa, including *L. justiciae*, in the recently reinstated genus *Lintneria*.

Additional key words: *Sphinx, Cryptophion, Microplitis, Hyptis sidifolia*, synapomorphy

In mid-April 2009, one of us (LEV) discovered larvae of an unidentified sphingid on a pungent, sprawling shrub on his fazenda (ranch) near Itanhandu, Minas Gerais, in southeastern Brazil. The site is at an elevation of 1066m in remnant Atlantic Rainforest. The discovery included a 3rd and two 5th instar larvae with very different larval forms.

The larvae were feeding openly during the daytime, and within a few days it became apparent that the larvae were parasitized. Photographs of the resulting parasitoid cocoons suggest they are a *Cryptophion* wasp (Ichneumonidae) and *Microplitis* wasps (Braconidae). Species-specific parasitoid identifications are pending.

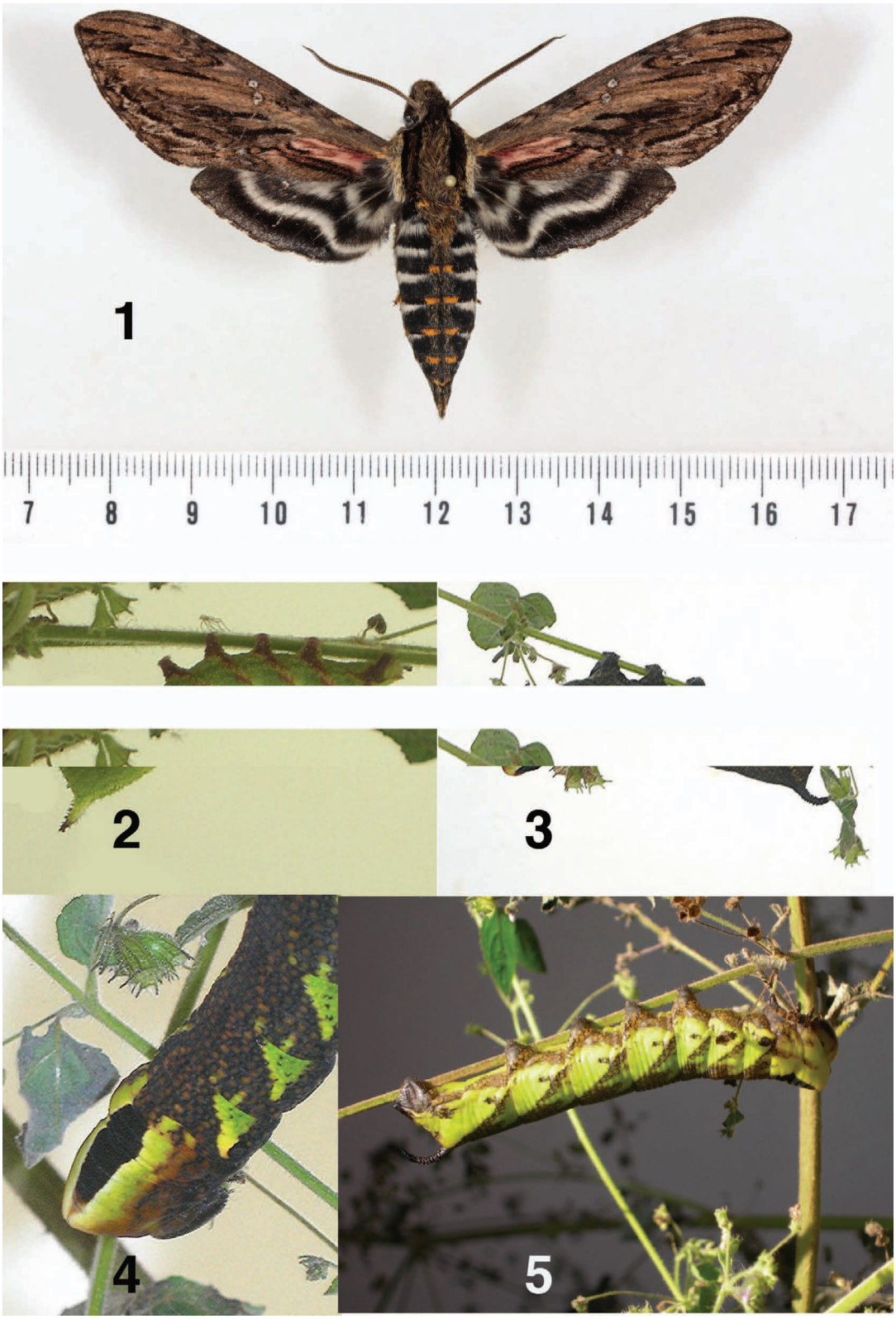
Suspecting that open diurnal feeding was aberrant behavior related to parasitism, Larry and Donna Valentine returned to the same location and once again searched the larval host plants, this time with flashlights at dusk. Donna Valentine found a single fifth instar larva ascending one of the plants to feed. The larva was successfully reared to maturity and a healthy pupa was obtained. The resulting adult emerged on 22 October 2009, and although it failed to fully expand its wings, it was identified as *Lintneria justiciae*. Since that time, additional observations between October and April indicate that there are two annual generations.

L. justiciae is the southeastern most representative of this broadly distributed genus, which extends from extreme southern Canada to southern South America. It is the only member of the genus found in Brazil. The second member of *Lintneria* to be described, *L. eremitus* from North America being the first, *L. justiciae* has never been fully understood (Hübner [1823]; Walker 1856). It is unclear how Walker (1856) arrived at his etymology when he described *Lintneria justiciae* (as *Sphinx justiciae*). However, circumstances suggest that life history information or an unpublished manuscript name based upon life history information may have been available to him that led to the name *justiciae*. Supporting that suspicion is the fact that over 20 years later, Burmeister (1878) erroneously [in retrospect] reported the association of the larva of *L. justiciae* (as *Sphinx justiciae*) with a member of the plant genus *Justicia* (Acanthaceae). The following year, Burmeister (1879) provided an excellent color illustration of a "typical" sphingiform last instar larva purported to be *L. justiciae*. In the subsequent years, the life histories of no other South American members of the genus *Lintneria* were described. Almost 130 years later, Tuttle (2007) pointed out that the Burmeister larval illustration, presented as *L. justiciae*, was actually *Manduca rustica*. As a result, the larval form and biology of the South American *Lintneria* species remain undescribed.

Given the lack of life history information on *Lintneria justiciae*, a description of the available immature stages follows.

Third Instar: The head and ground color are a light lime-green. The larva has a large, mid-dorsal, fleshy, horn-like projection on the second thoracic segment. This structure is extremely rugose and tipped in brown. On the dorsum there are also two pairs of tiny spikes equally spaced between the fleshy horn and the head capsule. The entire larva is heavily stippled with tiny, whitish secondary tubercles giving it a very rough appearance. There are seven pale dorsolateral diagonal stripes beginning at the bottom of each abdominal segment and continuing into the dorsum of the next segment. The exterior of the prolegs is brown and the brownish color extends partially up each dorsolateral diagonal stripe. The true legs are brown [as best can be determined from the single image available]. The spiracle on the first abdominal segment is a light blue, encircled boldly in black, and highlighted by a small yellowish patch. The anal horn is predominantly brown and also extremely rugose. 27mm (n=1)

Fourth Instar: Not recorded.



FIGS. 1-5. *L. justiciae* ♂, Santa Catarina, Brazil (coll. J. Haxaire). FIG. 2. 3rd instar larva of *L. justiciae* from Itanhandu, Brazil. **3,** Brown form 5th instar larva of *L. justiciae* from Itanhandu, Brazil (lateral view). **4,** Brown form 5th instar larva of *L. justiciae* from Itanhandu, Brazil (dorsal view). **5,** Green form 5th instar larva of *L. justiciae* from Itanhandu, Brazil (lateral view).

FIG. 6. Pupa of *L. justiciae* pupa from Itanhandu, Brazil (lateral view).

Fifth Instar (Brown Form): As with all other known *Lintneria* larval histories, there is a dramatic change in general form in the last instar. The mid-dorsal thoracic protuberance is replaced by a large hump with a large black patch on thoracic segments two and three which is encircled in bright lime-green. The ground color of the larva, head, true legs, prolegs, and anal horn are a dark brown and the entire larva is heavily stippled with very faint, light spots. The brown frontal lobes of the head have a pair of green vertical stripes. Each abdominal segment has a bright, lime-green triangular patch, the base of which transects the spiracle horizontally and runs the entire width of the segment. This lime-green patch is heavily stippled with dark brown spots. The black anal horn is stout, extremely rugose, and curves sharply downward. 79–80mm (n=2)

Fifth Instar (Green Form): The morphology is as in the brown form. However, the ground color is green with a slight yellowish hue, as are the head and venter. The seven dorsolateral stripes are bordered dorsally by angular dark brown patches stippled with light brown. These patches merge into the dark brown dorsum. The green frontal lobes of the head have a pair of dark brown vertical stripes. The true legs, outer portion of the prolegs, and the lower portion of the subspiracular region are dark brown; the subspiracular region is heavily stippled with light brown. The anal horn is as in the brown form. 70mm (n=1)

Pupa: The fusiform pupa is a dark purplish brown, smooth, and somewhat glossy. The tongue case is free, fairly short (approximately 10mm), and closely appressed to the thorax. The black cremaster is very broad at the base, hollowed ventrally forming a scoop, and narrows rapidly into a fine bifurcate tip. 50mm (n=1)

Host Plant Identification. Images of various aspects of the larval host plant were sent to the Royal Botanic Gardens at Kew, London, UK. The plant was identified by Dr. Raymond M. Harley as *Hyptis sidifolia* (L'Herit.) Briq. (= *H. umbrosa* Salzm. ex Benth.) (Lamiaceae). *H. sidifolia* is widely distributed across much of South America and northward to southern Central America.

Taxonomic Significance. Although the above description of the larval stages of *L. justiciae* is incomplete, the morphology of the 3rd and 5th instar larva has significant taxonomic implications. Tuttle (2007) reinstated the genus *Lintneria* from long-standing synonymy under the genus *Sphinx*. As long treated, the genus *Sphinx* contained 48 species and a number of subspecies ranging from Europe, across to eastern Asia, North America, Central America, and South America (Kitching & Cadiou 2000). Although all species originally placed in the genus *Sphinx* have a fairly consistent adult morphology, two predominant adult forewing maculation patterns exist. One forewing pattern can be generalized as having minimal maculation and/or orderly linear patterns, whereas the second forewing pattern can be generally described as an intricate mosaic that includes a prominent pair of parallel lines that run from the inner margin into the basal area (except in *L. arthuri* and *L. maura*), and a pair of discal spots of varying sizes.

One of us (JPT), while carrying out investigation into the genus *Sphinx* for "The Hawk Moths of North America", discovered a possible correlation between adult forewing pattern and larval morphology. The species with minimal or orderly linear forewing maculation patterns had a "typical" sphingid larval form throughout all five instars—long and cylindrical. In contrast, the species with intricate mosaic forewing maculation patterns had a larval form with a large, fleshy mid-dorsal protuberance on the second thoracic segment in instars 1–4 (as described in 3rd instar above) which is replaced by a thoracic hump in the last instar (as described in 5th instar above).

FIG. 7. Close-up of larval host plant, *Hyptis sidifolia* (Lamiaceae).

Fortunately, during the time frame of that research, the life histories of additional species long attributed to the genus *Sphinx* from North America and Central America came to JPT's attention. In each case, the correlation between adult forewing maculation and larval morphology held true, thereby confirming the earlier hypothesis. In addition, with one exception (*L. lugens*), all known *Lintneria* larvae are associated with members of the plant family Lamiaceae. As a result, 21 species from the Americas with mosaic forewing maculation patterns, including all of the South American species, were removed from *Sphinx* and reassigned to *Lintneria* (Tuttle 2007). This conclusion has been supported further by phylogenetic analysis of DNA sequence data (Kawahara *et al*. 2009). Tuttle (2007) further proposed that as the immature stages of additional *Lintneria* species became known, they too would exhibit the above-described unique larval synapomorphy.

The discovery of the partial life history of *L. justiciae*, which includes larval morphology and association with the plant family Lamiaceae, clearly confirms its placement within *Lintneria*. Although their life histories remain to be discovered, it also further corroborates the placement of the other South American species *L. arthuri*, *L. aurigutta*, *L. maura*, *L. phalerata*, *L. porioni*, and *L. praelongus* within the genus *Lintneria*.

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