THE SLOWLY EXPANDING RANGE OF *PAPILIO DEMOLEUS* LINNAEUS (LEPIDOPTERA: PAPILIONIDAE) IN CUBA

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Abstract – The Old World swallowtail *Papilio demoleus* Linnaeus was first reported in the Dominican Republic in March 2004 and was later discovered in Cuba in June 2007. This conspicuous butterfly has been documented from coastal areas of the eastern-most Cuban provinces of Guantánamo, Holguín, and Santiago de Cuba. The dispersal of the butterfly in Cuba has been relatively slow. In 2014 we found *P. demoleus* at sites further to the west and interior of the coast in Las Tunas and Camagüey provinces. The immature stages are attacked by predators and parasitoids in Cuba and other islands of the West Indies and *P. demoleus* does not appear to be much of a threat to citrus production or native citrus-feeding swallowtails.

Key words: *P. demoleus*, Biogeography, immature stages, larval host plants, butterflies, biology, West Indies, Greater Antilles, *Heraclides andraemon*

Resumen – La mariposa cola de golondrina del Viejo Mundo *Papilio demoleus* Linnaeus fue registrada por primera vez en República Dominicana en marzo del 2004 y posteriormente en Cuba en junio del 2007. Esta mariposa ha sido documentada en las áreas costeras de las provincias más orientales de Cuba, como Guantánamo, Holguín y Santiago de Cuba. Su dispersión en Cuba ha sido relativamente lenta. En el 2014 se encontró en localidades más hacia el oeste y el interior de la Isla en las provincias Las Tunas y Camagüey. Sus estadios inmaduros son atacados por depredadores y parasitoides en Cuba y en otras islas del Caribe y *P. demoleus* no parece constituir un peligro para la producción de cítricos ni para los papiliónidos nativos que utilizan estas plantas como hospederos larvales.

Palabras clave: *P. demoleus,* Biogeografía, estadios inmaduros, plantas hospederas, mariposas, Caribe, Antillas Mayores, *Heraclides andraemon*

INTRODUCTION

The Lime Swallowtail (*Papilio demoleus* L., 1758) occurs throughout tropical and subtropical regions of the Old World from the Middle East across southern Asia to Japan and Taiwan and southward through Malaysia, Philippines, Indonesia, and New Guinea into Australia (Zakharov *et al*. 2004, Eastwood *et al*. 2006, Smith & Vane-Wright 2008, Mérit *et al*. 2009, Morgun & Wiemers 2012). *Papilio demoleus* was documented for the first time in the West Indies by Guerrero *et al*. (2004), who collected two adult males at Hoyo Azul, Higuey Province, in eastern Dominican Republic on March 29, 2004. In March 2005 the Lime Swallowtail was found in Puerto Rico at Rincon (Wehling *et al*. 2006) and on March 4, 2006 at Guánica (Homziak & Homziak 2006). In Jamaica it was discovered in October 2006 in St. Catherine Parish (Garraway *et al*. 2009). Jacqueline Y. Miller may have observed a Lime Swallowtail on North Andros Island, Bahamas in June 2006 (Wehling *et al*. 2006), but its occurrence in the Bahamas remains unconfirmed. The Lime Swallowtail has also been observed in the Cayman Islands. It was first documented there from a photo taken by Dora Valdez of an adult visiting flowers in her garden in West Bay, Grand Cayman, May 29, 2011 and then by a worn specimen collected on February 18, 2014 in Captain George Dixon Park on Grand Cayman (see posting at http://caymannature.blogspot.com/2014/02/how-did-papilio-demoleus-get-to-cayman.html).

OBSERVATIONS IN CUBA

The first report of the Lime Swallowtail in Cuba was by Núñez (2007), who collected an adult female on June 3, 2007 about 4 km southeast of Baracoa city, Guantánamo Province on the northeastern coast of the island. From November 20 to December 2, 2010, Lauranzón *et al*. (2011) recorded 46 individuals of *P. demoleus* at two localities on the southeastern coast in Santiago de Cuba Province. Bermúdez (2011) collected an adult male on January 12, 2011 at Los Hoyos, on the coast north of Gibara city, in Holguín Province and observed two other adults on February 9 and 11, 2011 about 3 km from the former locality. Barro *et al*. (2011) stated that *P. demoleus* was found in far eastern Cuba and was spreading along both coasts. Matthews *et al*. (2012) reported a single male collected on January 23, 2012 from the U.S. Guantánamo Bay Naval Base on the southern coast, Guantánamo Province. All of these records are from coastal areas of the eastern-most provinces of Cuba.

While working on conservation projects supported by the Florida Keys Tropical Research Ecological Exchange (T.R.E.E.) Institute, Key West, Florida, we observed *P. demoleus* in eastern Cuba as well as in new provinces further west and inland. We have looked for, but not found, *P. demoleus* in Cienfuegos, Matanzas, La Habana, Artemisa, and Pinar del Río provinces in 2013 and 2014. Following is a summary of our observations.

Guantánamo Province

On February 5, 2013 we observed, but did not collect, a female Lime Swallowtail attempting to oviposit on the wilted leaves of a cut citrus branch lying along a roadside at Maguana on the northeastern coast, about 10 miles (16 km) northwest of Baracoa. After several minutes, the female flew away without laying any eggs.

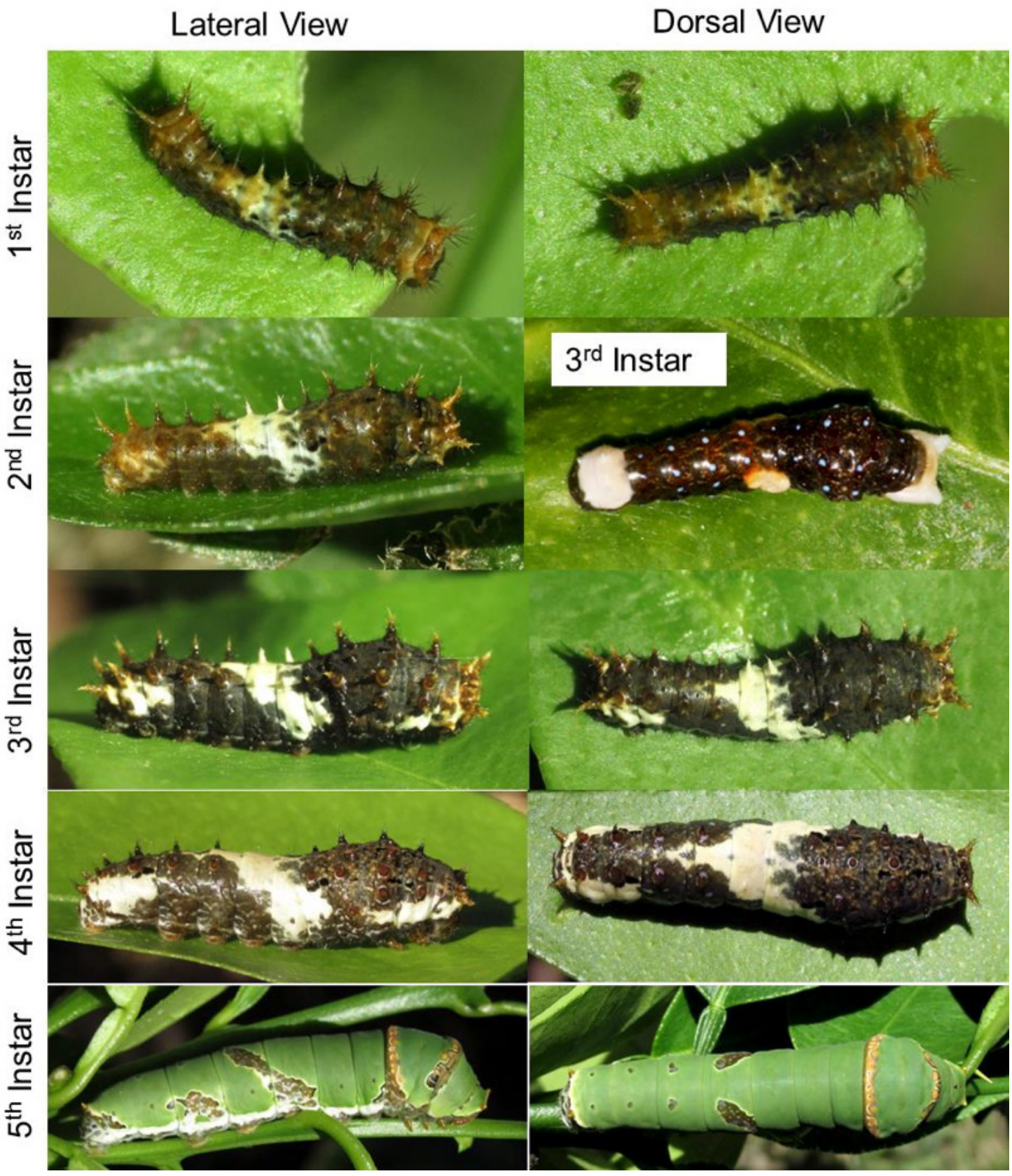

Fig. 1. Larval stages of *Papilio demoleus* from Cuba, Camagüey Province, near the Sierra del Chorrillo Preserve and a third instar larva of *Heraclides a. andraemon* (right column, second from top) from Matanzas Province.

Santiago de Cuba Province

According to María del Carmen Fagilde (pers. comm.) with the Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), the Lime Swallowtail was not uncommon in Santiago de Cuba before Hurricane Sandy, which caused much damage to buildings and forests there in October 2012. On February 1, 2013 we saw a probable Lime Swallowtail flying around flowering bougainvillea at the Santiago de Cuba harbor. Later that day we photographed and collected a male of *P. demoleus* that was sipping water from wet soil near a place where trash had been burned at Jardín de Helechos (Fig. 3). The Garden is located a few kilometers northeast of Santiago de Cuba city on Carretera de El Caney. From these observations, the Lime Swallowtail was still present in urban areas of Santiago de Cuba in February 2013, but it was not an abundant butterfly at that time.

Las Tunas Province

On November 21, 2013 we observed an adult of the Lime Swallowtail flying in a small grove of citrus trees at Las Tunas Botanical Garden, which is located inland about 30 miles (48 km) from the coast. There was also an adult (probably a different individual) in rapid flight near the main buildings of the Garden. This appears to be the first record of the Lime Swallowtail from this province. We collected several swallowtail eggs and first instar larvae on young shoots of citrus trees, but all of these turned out to be *Heraclides a. andraemon* Hübner. We visited the Las Tunas Botanical Garden again on June 2, 2014, but did not find any *P. demoleus*.

Camagüey Province

All of the following locations for the Lime Swallowtail in Camagüey Province are well inland from the coast. The first record of *P. demoleus* in Camagüey was by Douglas M. Fernández, who has lived in this city all of his life and has observed butterflies throughout the province. On August 2, 2013 he saw at least four individuals of *P. demoleus* at Jayamá on the outskirts of the city of Camagüey. One of these, probably a male, circled around a strip of trees that included a small citrus tree for several minutes. In 2014, Fernández observed more adults of *P. demoleus* in the vicinity of Camagüey, including five in the Jayamá area (August 5, 2014), one flying along a roadside at La Vallita, Florida municipality (September 18, 2014), an adult female attempting to oviposit on leaves of a *Citrus x limon* (L.) Osbeck tree in a backyard in the northwestern part of the city on September 22 and another at the same tree on October 2, 2014, and an adult flying fast in the serpentine savanna habitat at Albaiza (October 24, 2014).

On November 20, 2013, we observed a female Lime Swallowtail laying eggs on a small citrus tree in a yard adjacent to the entrance of the Protected Area "La Belén", Sierra del Chorrillo, near Najasa, located about 26 miles (42 km) southeast of Camagüey. We also saw an adult flying in a small grove of citrus trees in otherwise open fields in a western section of the preserve. According to Mr. Camilo Lora (pers. comm.), a nature guide at Sierra del Chorrillo, the Lime Swallowtail had only recently been seen at the preserve.

BIOLOGY

We collected nine swallowtail eggs from the citrus tree near the entrance to Sierra del Chorrillo mentioned above. *Heraclides a. andraemon* and *Heraclides androgeus epidaurus* (Godman & Salvin) also occur at this preserve and use citrus as a larval host, so we are not sure if all of the eggs were *P. demoleus*. Nearby there was a small hedge of Limeberry or *Triphasia trifolia* (Burm. f.) P. Wilson, another *P. demoleus* host plant, but we did not find eggs or larvae of any swallowtails on these plants. Only two larvae eclosed from the eggs we collected. The other eggs were parasitized by a tiny undetermined wasp. One of the first instar larvae soon died of unknown causes.

The surviving larva was fed young leaves of Lemon (*Citrus x limon*) and went through five larval instars. After 12 days of pupation an adult female emerged. Duration of the larval instars was as follows: instar one (2 days), instar two (2 days), instar three (4 days), instar four (2 days), and instar five (5 days). The mature larva also spent about one day preparing for pupation. Thus, the observed development time from egg hatch to adult under ambient conditions was about 28 days. Similarly, in Puerto Rico, Segarra-Carmona *et al*. (2010) found the *P. demoleus* life cycle to take about 30 days for females and 26.5 days for males. They also found that each of the first to fourth instars lasted about three days (sometimes two days), the fifth instar lasted about five days, and the duration of the pupal stage was about 12 days.

The early instar larvae of *P. demoleus*, like other *Citrus*-feeding swallowtails, have a 'bird dropping' color pattern. In contrast, the last instar caterpillar is green with a distinctive pattern quite unlike any other swallowtail in Cuba (Figs. 1, 2). Photos of immature stages of *P. demoleus* from West Indies populations are also shown in Wehling *et al*. (2006), Lewis (2009), Lauranzón *et al*. (2011), and Bastardo (2012). However, the instars are misidentified in Lewis (2009) and also in Wehling *et al*. (2006) because only the last instar is green. In addition, the larva on page 2 Fig. 4 of Lewis (2009) identified as a first instar *P. demoleus* is a second or third instar *Heraclides andraemon* and the larva on page 33 of Wehling *et al*. (2006) identified as a second instar *P. demoleus* is actually a fifth instar *Heraclides androgeus epidaurus* (see photos of life stages in Sourakov 2009).

The brown pupa of *P. demoleus* is remarkably similar to that of *Heraclides andraemon* in shape, color, and pattern (Figs. 2, 3). However, *P. demoleus* also has green with yellow and pinkish-brown color forms of the pupa (Lewis 2009), which are very different from *H. andraemon*.

The only hosts so far identified in Cuba and other islands in the West Indies are cultivated shrubs and trees from the Old World. In the Dominican Republic, Bastardo (2012) reported finding larvae on *Citrus x aurantiifolia* (Christm.) Swingle and *Citrus sinensis* (L.) Osbeck (considered to be a synonym of the former by some botanists http://florida.plantatlas.usf.edu/Plant.aspx?id=1987#synonym). Carmelo Núñez also observed

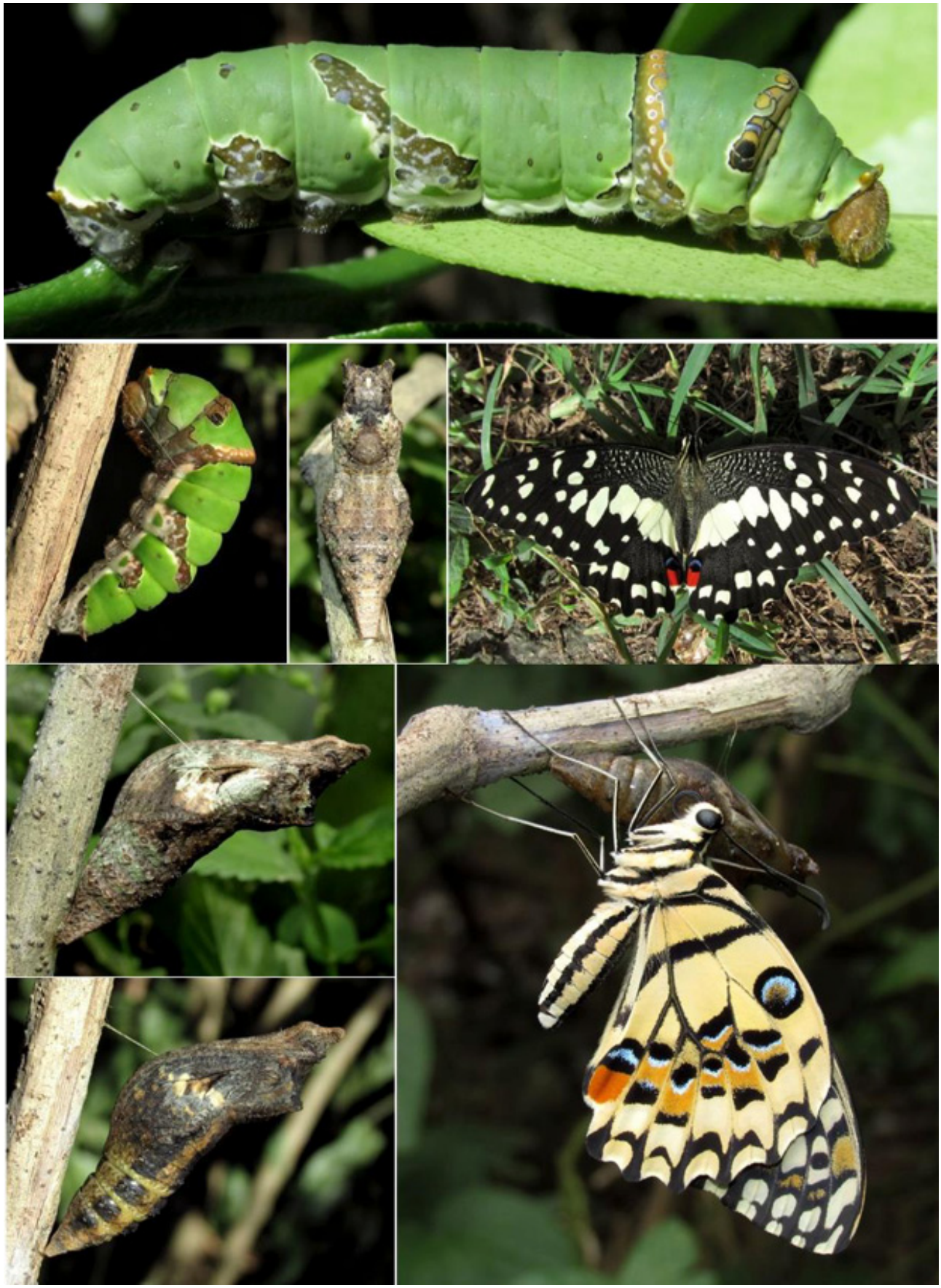

Fig. 2. Life stages of *Papilio demoleus* from Cuba, Camagüey Province, near the Sierra del Chorrillo Preserve: 5th instar larva, larva ready for pupation, pupa in dorsal view, pupa in lateral view at 6 days, pupa just prior to adult eclosion at 12 days, and the newly eclosed adult female.

Fig. 3. *Papilio demoleus* pupa (top left) and *Heraclides andraemon* pupa (top right) and 5th instar larva (bottom right). Adult male *P. demoleus* puddling at Jardín de Helechos near the city of Santiago de Cuba.

Triphasia trifolia to be a well-used host plant in Dominican Republic (Wehling *et al*. 2006). In Puerto Rico, Segarra-Carmona *et al*. (2010) collected several hundred eggs and larvae for study from *Citrus x aurantiifolia*. In Cuba, Lauranzón *et al*. (2013) reported oviposition on *Citrus x limon*.

DISCUSSION

While it is likely that *P. demoleus* will eventually spread throughout much of Cuba, the rate of colonization has been very slow compared to its dispersal on Hispaniola. Since first documented by Rayner Núñez in 2007, only the eastern provinces of Cuba appear to have been colonized by 2014. However, on Hispaniola, *P. demoleus* was first discovered in eastern Dominican Republic on March 29, 2004 (Guerrero *et al*. 2004) and was found in coastal southwestern Haiti in February 2006 (Bastardo 2012).

The actual time and place of *P. demoleus* colonization events in the West Indies is not known. Only the haphazard discoveries by observers on the various islands have been documented. The seemingly rapid spread throughout the Greater Antilles in less than four years may be artifactual if the butterfly had been present but undetected for years. However, if we accept the discovery times as at least approximate times of introduction, it does not seem possible for this butterfly to have colonized so many islands over such a wide area in so little time via natural dispersal. The butterfly has hardly had time to fully colonize a single island, let alone strike out many kilometers over the open ocean to faraway places. Morgun & Wiemers (2012) cite the rapid spread of a tiny moth (*Phyllocnistis citrella* Stainton) as evidence that a citrus pest can spread quickly and widely in new areas. However, it could be easier for small moths that are attracted to lights to move widely via ships, planes, and other means. Accidental transport would not be so easy for a very large and conspicuous adult butterfly. Although butterflies do stray between islands of the West Indies and southern Florida from time to time, it is apparently not of frequent occurrence. Possibly, the dispersal of *P. demoleus* in the West Indies has been facilitated by tropical storms or hurricanes, or by people purposefully spreading the butterfly. Research on the dispersal behavior of West Indian *P. demoleus* is needed to help understand the colonization puzzle.

While most publications on *P. demoleus* emphasize its pest status, to our knowledge there have not been reports of harm to citrus production in the West Indies from this butterfly. We do not believe that the Lime Swallowtail will cause any real harm, but may sometimes cause minor local defoliation, especially in nurseries or newly planted groves. However, the Lime Swallowtail and citrus have likely evolved together, and the fact that the branches and stems of citrus are green and able to photosynthesize may be an adaptation to survive defoliation by swallowtail caterpillars. *Heraclides cresphontes* Cramer is similarly considered to be a pest of citrus in Florida, but is not really a threat because of control by natural enemies. Rather than a pest, we believe that the Lime Swallowtail will become just another interesting butterfly of the West Indian fauna.

How native swallowtail species in the West Indies will be affected by competition from the Lime Swallowtail does not seem to be much of a concern either. *Papilio demoleus* prefers urban and agricultural landscapes to natural areas and its larvae mostly feed on non-native plants. Of the native swallowtails in Cuba, only *Heraclides a. andraemon* commonly feeds on citrus and uses anthropogenic as well as natural habitats. *Heraclides a. andraemon* is not considered to be an important pest in Cuba (Alayo y Hernández 1987, Hernández 2004) because its numbers are well controlled by ants, wasps, flies, etc., and pathogens. We found a parasitoid wasp attacking *P. demoleus* eggs in Cuba, and Lewis (2009) mentions an encyrtid egg parasitoid and a chalcidoid wasp attacking *P. demoleus* in Jamaica. In the Dominican Republic, Wehling *et al*. (2006) documented predation by a *Polistes* sp. and Bastardo (2012) observed the spider *Cyrtophora citricola* (Forskål) feeding on *P. demoleus* larvae. The risk of native swallowtails being harmed by the invasive exotic *P. demoleus* thus appears to be very low.

ACKNOWLEDGEMENTS

We thank Carolann Sharkey and Richard Keefe of the Florida Keys T.R.E.E. Institute for providing travel to and within Cuba and for support of our conservation efforts. Andrei Sourakov and an anonymous reviewer kindly reviewed the manuscript and provided helpful comments.

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