

# MANAGEMENT OF THE LIME SWALLOWTAIL BUTTERFLY, *PAPILIO DEMOLEUS* (LEPIDOPTERA; PAPILIONIDAE) IN JAMAICA

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## ABSTRACT

A quarantine pest, the Lime Swallowtail Butterfly, *Papilio demoleus* L. (Lepidoptera; Papilionidae) was identified in Jamaica in September, 2006 affecting citrus nurseries and young fields in the Bog Walk area of St. Catherine. A management protocol was issued to nurseries quarantined to reduce infestations and risk of spread of *P. demoleus* to uninfested areas. A population dynamics study was carried out at New Hall, Bog Walk (April 2007-February 2008) to identify and determine the role of local natural enemies in the field. Three blocks of citrus were sampled weekly at New Hall, St. Catherine where 75 trees/block were selected using systematic random sampling. The data was collected per tree for all stages of the pest and the damage rated using a scale of 1-5 (1= 0%; 2 =1-25%; 26=50%; 51-75%; 76-100%). An egg parasitoid, *Ooencyrtus* sp. (Hymenoptera; Encyrtidae) and a pupal parasitoid, *Brachymeria* sp. (Hymenoptera; Chalcidae) were discovered. The population of *P. demoleus* larvae remained <1 per tree while damage level remained below two. In a quick survey (February 2008), 25 trees per field at six orchards within three parishes were examined to determine the status of the pest. *Papilio demoleus* was observed to be widespread in major citrus growing areas at very low levels with little or no impact in nurseries or on citrus production. Seventeen months after introduction to Jamaica, *P. demoleus* was relegated to a non-quarantine pest hence, justifiably removing the quarantine status on citrus nurseries in the affected areas.

## INTRODUCTION

In September 2006, an invasive pest species, the Lime Swallowtail, *Papilio demoleus* L. was discovered in Jamaica's major citrus growing area, Bog Walk in the parish of St. Catherine. The specimens were identified by Dr. Eric Garraway, Entomologist and Lecturer at the University of the West Indies, Mona and confirmed by the Caribbean Taxonomic Network of BioNET-INTERNATIONAL (CARINET) from samples submitted by the Plant Protection Unit in the Ministry of Agriculture. This pest was first recorded in the Caribbean from the Dominican Republic in March, 2004 (Guerrero *et al.*, 2004), and Puerto Rico in March, 2006 (Homziak & Homziak, 2006).

Like its Caribbean neighbours, Jamaica has a tropical climate, preferred hosts and the possible lack of effective natural enemies which makes it ideal for the establishment and spread of an invasive pest like *P. demoleus*, thereby posing a great threat to the expanding local citrus industry which has been valued at J\$3.7B or US\$50M (Miller, 2006). *P. demoleus* is an economic pest on citrus in Saudi Arabia, Iran (Badawi, 1981) and India (Agribusiness Information Centre of India, 2005). A single larva can consume 9 leaves through its development (Badawi, 1981) and four to six larvae of *P. demoleus* are able to

defoliate a citrus plant between 1-2 ft tall (Yunus and Munir, 1972). Reports from India record that up to 83% of young grove trees have been defoliated (Narayayanamma *et al.*, 2001) and the larvae are capable of completely defoliating nursery groves (Matsumoto, 1996; Narayayanamma *et al.*, 2001).

Through the Jamaica Citrus Protection Agency and key stakeholders, a Technical Working group was formed to develop and implement an action plan. This plan included the development of a quarantine protocol as a precautionary measure for nurseries in infested areas to reduce infestations and risk of spread of *P. demoleus* to uninfested areas. In the field local natural enemies were detected while *P. demoleus* larval stages were being handpicked as a means of managing the infestation. In order to protect the local natural enemies for this and other citrus pests and to protect the local bee industry no pesticides were applied. Subsequently, research was conducted to identify and determine the role of these and other natural enemies and their impact on *P. demoleus* population in Jamaica in order to guide the developing management programme.

## **MATERIALS AND METHODS**

### **Study Sites**

The studies were located on the farm of the largest citrus farms in Jamaica located at Rade Winds Citrus Ltd., Bog Walk, St. Catherine. The citrus fields contained several varieties including Valencia, Pineapple Sweet, Hamlin and Ortanique. The field is located at New Hall (seven miles outside of Bog Walk town) which is 11.492 ha in size and is located between the coordinates 18° 8'47.11"N/ 76° 58'53.58"W with altitude ranging between 126m and 152m above sea level. The area is characterized by heavy rainfall mainly from April to October annually.

The search for natural enemies was conducted in sections 68 and 69 of the orchard which contained four to five-year-old plants which took place between January to March 2007. A population dynamics study was also done in section 68 which contained two to three-year-old Hamlin scion variety on Cleopatra root stock. Sampling was conducted weekly from April 4, 2007 – November 27, 2007 and fortnightly up to February 11, 2008. No insecticides were applied during the period of the study.

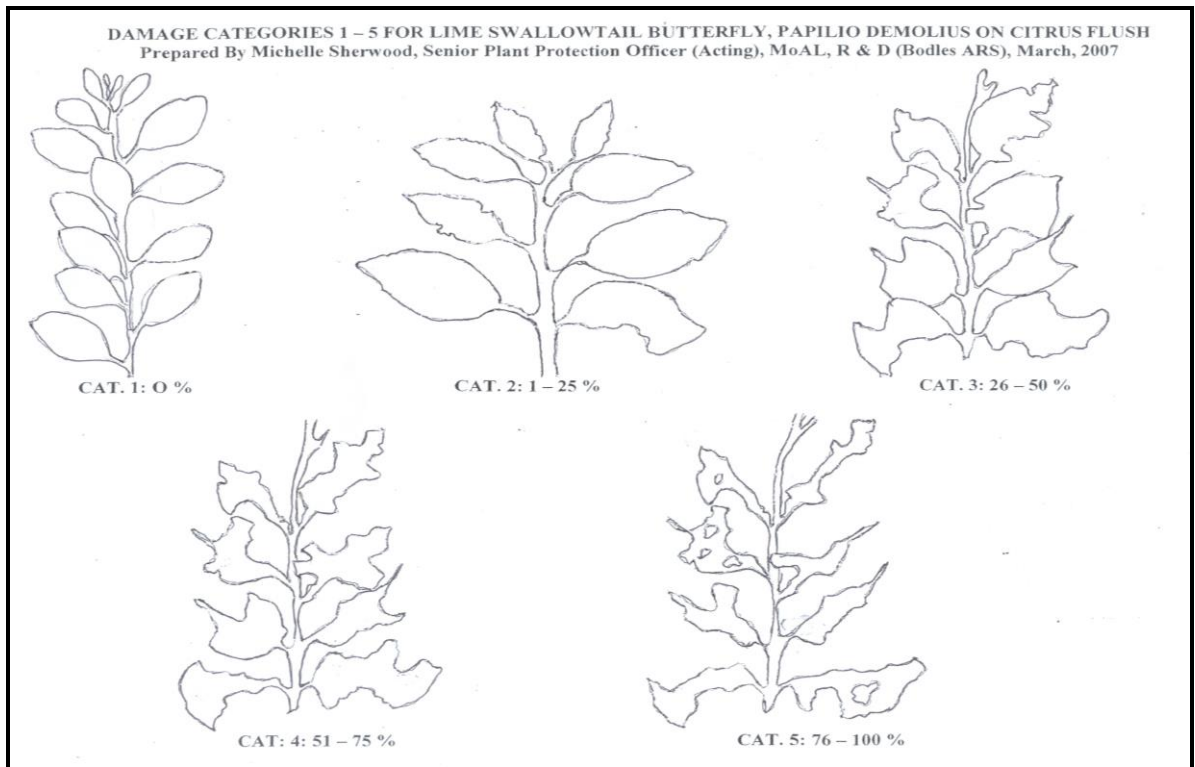
### **Local Natural Enemies**

In January 2007 sections 68 & 69, containing two and four-year-old citrus trees respectively were monitored weekly at New Hall. Twenty five plants were selected from each field using systematic random sampling. Eggs, larval and pupal stages were collected from the field to rear out any natural enemies present. During the search handpicking of older instars and pupae of LSB were carried out by field hands at New Hall which were also collected and used for rearing out natural enemies.

### **Development of a damage index**

A damage index was developed to rate the damage level caused by the larval stage of *P. demoleus*. Young citrus shoots with varying degrees of damage were collected from the field. An outline was made of each shoot on white paper and the area (cm<sup>2</sup>) of the eaten

portion measured using a graph paper copied on plastic transparency and then calculated as a percentage of the total area of each leaf. Five damage categories were then developed which is often used for many lepidopteran pests such as the gypsy moth (*Lymantria dispar*). The categories are (1= 0%; 2 =1 -25%; 26=50%; 51-75%; 76-100%) (Figure 1).



**Figure 1: Citrus shoots showing *P. demoleus* larval damage; categories 1-5**

### **Population Dynamics Study**

Twenty five plants from three blocks of section 68 (2, 3 & 4) containing two-year-old orange trees were monitored weekly using systematic random sampling. The outer trees around each block were used as guard plants from which no samples were taken. The number of eggs, larvae and pupae on the flush of each tree was recorded weekly and the larval damage assessed using a damage index of 1 - 5. Adult moths were counted as they were encountered while monitoring. The presence of any natural enemy and the number of pupae with exit holes were recorded. In block 1 of section 68 located adjacent to the experiment twenty five trees were selected randomly and the number of *P. demoleus* eggs present were collected and reared out for any egg parasitoid.

### **Quick Survey**

Five citrus orchards were visited across three parishes, St. Catherine, St. James and Trelawny in major citrus growing locations. Twenty five trees were chosen using systematic random sampling and data collected for population (egg, larvae, pupae & adult) and damage levels as in population dynamics study.

## Statistical Analysis

The data was subjected to analysis with GenStat Discovery Edition 3 (2000). Regression analyses were performed to determine the relationship between *P. demoleus* populations and rainfall by a stepwise approach for the population dynamics study. For the analyses, mean monthly rainfall during the period April 2007 - February 2008 and the mean monthly population of *P. demoleus* were used.

## RESULTS & DISCUSSION

### Natural enemies

Two species of parasitoid wasps were identified affecting *P. demoleus*, an egg parasitoid *Ooencyrtus* sp. (Hymenoptera; Encyrtidae) and a pupal parasitoid *Brachymeria* sp. (Hymenoptera; Chalcidae) with parasitism levels reaching 11.5 and 9 % respectively. Other natural enemies observed included lacewing larvae and spiders which attack the early instars of *P. demoleus*. In the 1970's two pupal parasitoids *Brachymeria* sp. and a Eulophidae sp. (Hymenoptera) were detected in Java parasitizing the pupal stages of *P. demoleus* (Matsumoto, 1996). *Brachymeria jambolana* and *B. lasus* have been reported as pupal parasitoids on *P. demoleus* while *Ooencyrtus papilionis* has been reported as an egg parasitoid of *P. demoleus* (CPC, 2005). The natural enemies identified may have expanded their host range from other local close relatives such as the endemic *Papilio andraemon* which was first recorded in Jamaica in 1945 (Lewis, 1945).

### Population Dynamics Study

The population of all stages of *P. demoleus* was very low averaging < 1 per tree for most of the study period except the larval stage which was 1.56 per tree for the month of December. The level of damage fluctuated between 1 and 2 for the entire period. The number of larvae and level of damage increased in July/August and peaked in December (Figure 2). This was possibly due to an increase in available flush after a period of heavy rain fall in August after the passage of Hurricane Dean (Figure 3). Even with a high level of rainfall the level of damage remained below the threshold of 2. This finding may explain the reports given by farmers that there was no reduction in citrus production by *P. demoleus*.

The level of *P. demoleus* pupae was very low throughout the study (<1/tree) however, there was a gradual increase from July 2007 to February 2008. The level of pupal parasitism was very low during the period and was only detected in May 2007 and February 2008 which corresponds to the citrus flush cycle. The absence of the pupal parasitoid for most of the study suggests that other natural enemies that are favoured by the rainy period such as entomopathogens may be impacting on the population. The low population of *P. demoleus* suggests that there is a complex of natural enemies in the field keeping the population of *P. demoleus* below economic levels and therefore does not require any further control intervention. This therefore requires further investigation to identify the exact identities of the species involved.

During the period April to November there were low levels of eggs being detected ranging from a mean of 5 – 10 eggs/ 25 trees (Figure 2 & 3) however during that

corresponding period 1 – 2 adult *P. demoleus* were encountered. This period experienced the highest rainfall levels for the year which suggests that *P. demoleus* adults are being hindered from ovipositing though there is available flush. The increased mean *P. demoleus* egg subsequently after November was as a result of a decrease in rainfall levels and corresponded with an increased adult mean possibly due to migration of adult *P. demoleus* into the field (Figures 4 & 5). No natural enemy emerged from the eggs collected for rearing in this study.

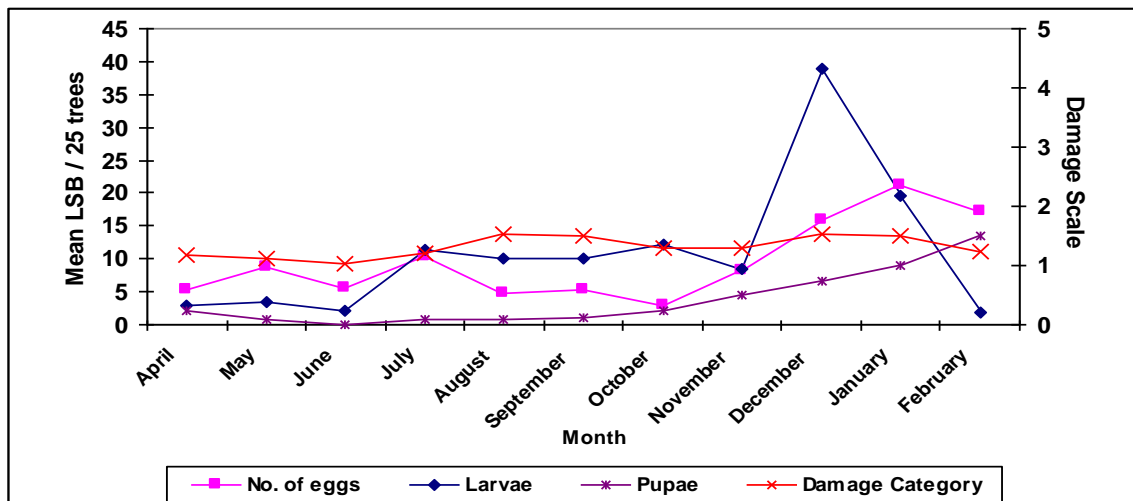


Figure 2: Monthly population of the Lime Swallowtail, *Papilio demoleus* and damage category at New Hall Farm, Bog Walk, St. Catherine April 4, 2007 to February 12, 2008

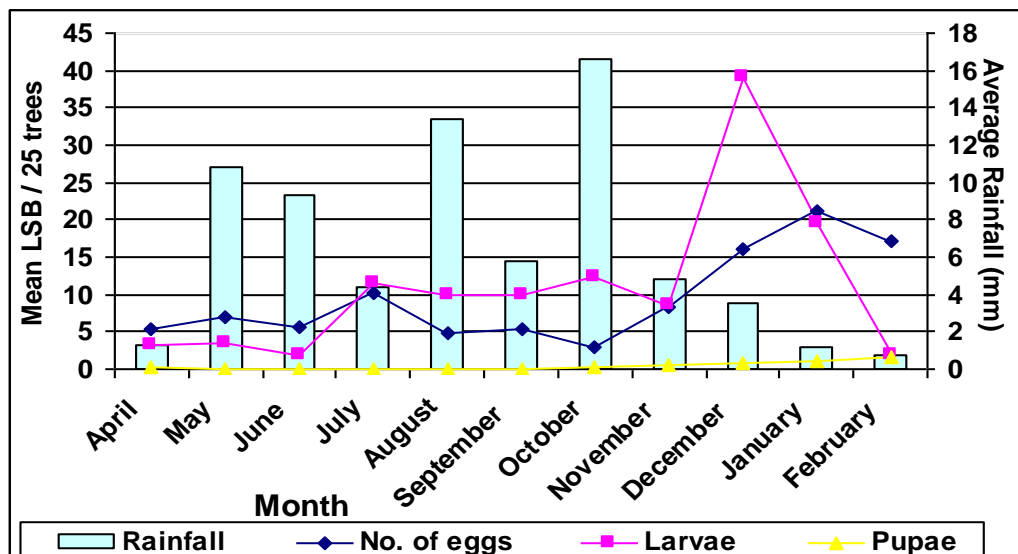


Figure 3: Monthly population of the Lime Swallowtail, *Papilio demoleus* and average monthly rainfall (mm) at New Hall Farm, Bog Walk, St. Catherine April 4, 2007 to February 12, 2008

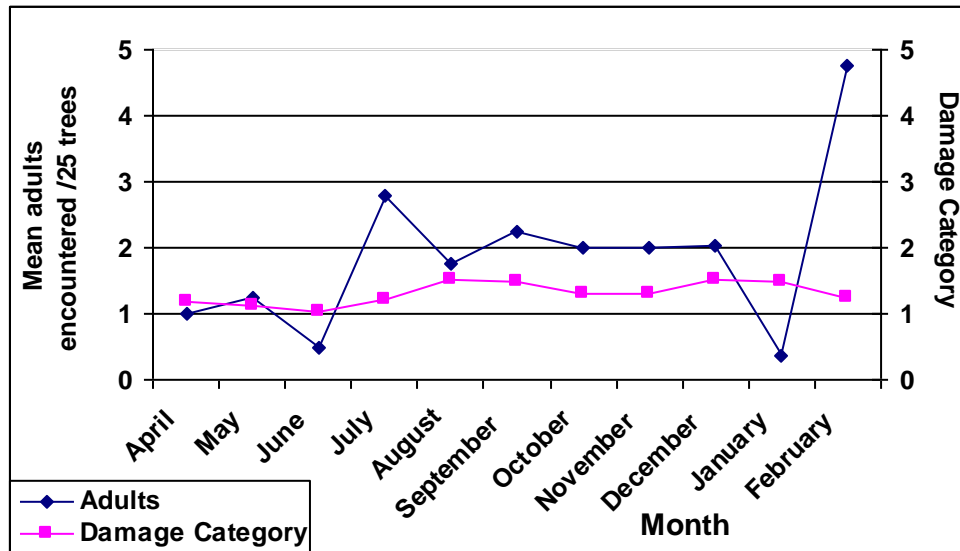


Figure 4: Population of adult Lime Swallowtail, *Papilio demoleus* per field visit and average damage category at New Hall Farm, Bog Walk, St. Catherine April 4, 2007 to February 12, 2008

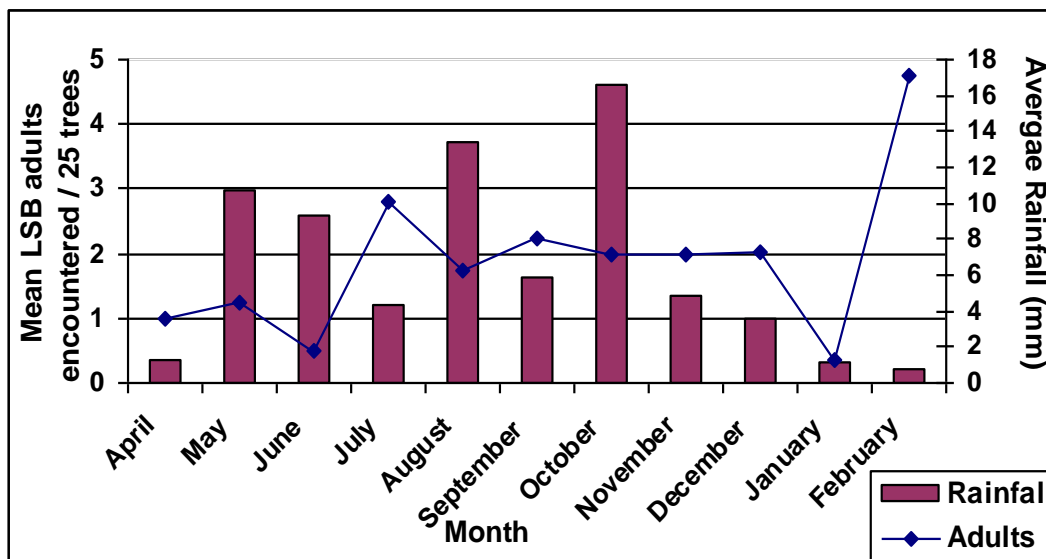
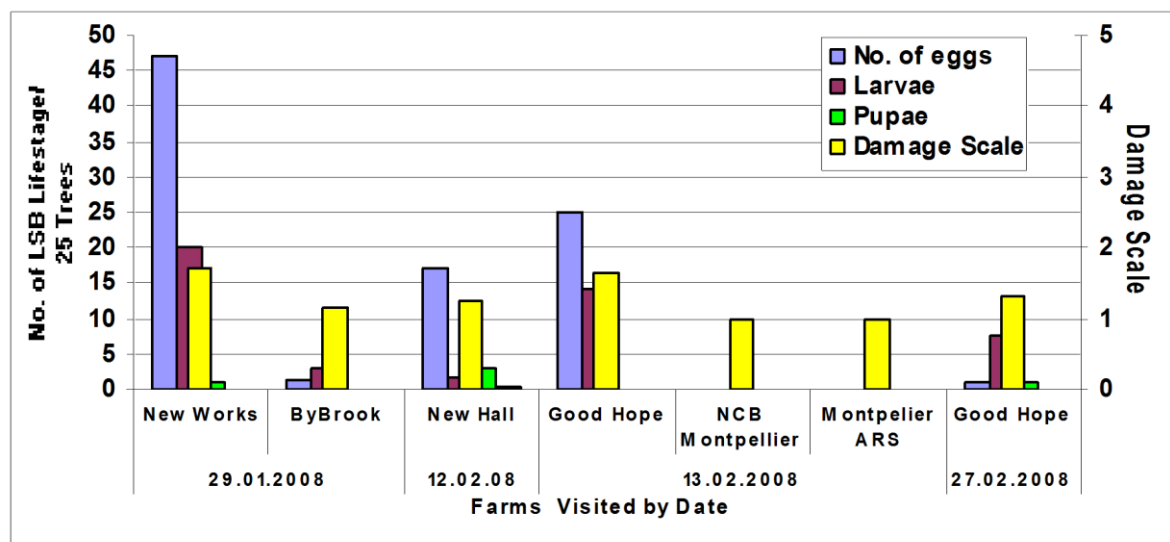


Figure 5: Population of adult Lime Swallowtail, *Papilio demoleus* and average monthly rainfall (mm) at New Hall Farm, Bog Walk, St. Catherine April 4, 2007 to February 12, 2008

### Quick Survey

The population of *P. demoleus* at the five citrus orchards visited is comparable to that examined at New Hall, Bog Walk. Field visits to other citrus orchards within Bog Walk (New Works and Bybrook), NCB Citrus and Montpelier ARS (St. James) and Good Hope (Trelawny) in January and February 2008 revealed that the population of *P. demoleus* larvae remained below one per tree however the number of eggs at New Works and Good Hope was at 1.88 and 1 per tree, respectively. The population of all LSB stages and damage at Good Hope was much lower on a subsequent visit (Figure 6).



**Figure 6: Population of the Lime Swallowtail, *Papilio demoleus* at six citrus orchards visited in January and February 2008**

The quick survey determined that the *P. demoleus* was found to be widespread in major citrus growing areas. This is supported by reports given by extension personnel in the citrus industry who have also observed low or no infestation in eight nurseries inspected across five parishes with little impact on seedling production (Barrett, pers. comm.). Based on the findings of the research and observations in the field *P. demoleus* is no longer of quarantine importance therefore justifying the removal of the quarantine status on citrus nurseries in Jamaica. Any upsurge in population can be managed under an integrated pest management programme.

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