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ORIGINAL PAPER

The population biology and ecology of the Homerus swallowtail, *Papilio (Pterourus) homerus*, in the Cockpit Country, Jamaica

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Abstract The Homerus swallowtail, *Papilio (Pterourus) homerus* (Lepidoptera: Papilionidae), is an endangered species of butterfly endemic to Jamaica. As the largest species of the genus *Papilio* in the world and the largest butterfly in the Western Hemisphere, this rare butterfly once inhabited most of Jamaica but has now dwindled into two tiny populations: an eastern population, found where the Blue Mountains and John Crow Mountains merge, and a western population in the Cockpit Country. The present research focused on the previously unstudied Cockpit Country population of *P. homerus*; most previous information about this species is derived from studies of the eastern population. The purpose was to estimate the size of the remaining population in the Cockpit Country using MRR protocols, while making observations to better understand its ecology. Sampling consisted of carefully netting the butterfly, marking a permanent ink number on the wing (metallic Sharpie® marker), and recording winglength, wing condition, time, and sex. The population was found to be very small, estimated at fewer than 50 flying individuals. Many observations were made about the ecology of the species. These new data suggest a conservation plan is strongly needed, coupled with a breeding program to increase numbers of this extraordinary butterfly.

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Introduction

Ecological review of *P. homerus*

The Homerus swallowtail, *Papilio (Pterourus) homerus* Fabricius 1793 (Lepidoptera: Papilionidae), is the largest butterfly in the Western Hemisphere and is endemic to Jamaica (Emmel 1995; Emmel and Garraway 1990, 1994; Garraway et al. 1993) (Fig.1). *Papilio homerus* is an endangered species and is one of four swallowtail butterflies listed in the IUCN Red Data Book, *Threatened Swallowtail Butterflies of the World* (Collins and Morris 1985). Since 1987, the butterfly has been protected as an Appendix I species by CITES and by the Jamaican Wildlife Act of 1988. Despite this protection, the remaining populations are critically small; a conservation plan and breeding program are needed to save this species from extinction.

Historically, the Homerus swallowtail inhabited seven of Jamaica's 13 parishes (Brown and Heineman 1972; Emmel and Garraway 1990). Today, one population remains in the east at the junction of the John Crow and Blue Mountain ranges and the other in the west in the Cockpit Country (Emmel 1995; Emmel and Garraway 1990, 1994) (Fig.2). Habitat destruction for coffee plantations and farmland has extirpated the other populations of this butterfly once found across the interior of Jamaica.

Of the two remaining populations today, the eastern population has received virtually all of the scientific attention, in part because of the accessibility of prime known habitat for *P. homerus* at the head of the Rio Grande

Valley in Portland Parish. In the eastern population, as many as 200 adults were observed flying between the years 1981 and 1986. The sex ratio in the eastern population was found to be one female for every 3.5 males in the field (n = 27), but was closer to a 1:1 ratio with adults reared in captivity (n = 12) (Garraway et al. 1993).

The eastern population came under severe threat of habitat destruction in the 1980s. FIDCO (Forest Industries Development Company) was formed in 1979 by the Jamaican government to help make Jamaica self-sufficient by 2000 in meeting its needs for fuel wood. Financial help was provided by FAO (Food and Agricultural Organization) and the World Bank. The new policy resulted in an estimated 2,000 hectares of rain forest being cleared per year and then replanted with fast-growing pine (*Pinus caribbea* var. *honduriensis*), devastating the habitat of the area (Emmel 1995). Populations of *P. homerus* dwindled to imperiled numbers. In 1988, Hurricane Gilbert destroyed the pine monoculture, and the forest began to regenerate from source trees in rainforest remnants along the streams (Emmel and Garraway 1990; Emmel 1995). In 1991, John Crow-Blue Mountains National Park was formed to protect the remaining rainforest areas in these eastern mountains and to help preserve this butterfly.

In an intensive study near Millbank conducted by Emmel et al. (1993), adults were seen flying during all months of the year except February and November in 1991 and January in 1992, although larvae were present during these periods. Adults typically soar, beating their wings infrequently and riding the wind, although *P. homerus* is capable of rapid flight. Adults typically fly from 8 a.m. until 4 p.m. at an elevation of 150–500 m, as reported for the eastern population of *P. homerus* in the upper Rio Grande Valley (Garraway et al. 1993). Turner (1991) noted a daily vertical migration that usually occurred between 1 p.m. and 3 p.m. This behavior has not been observed or documented since his report.

There have been few attempts to estimate the population size for *P. homerus*. Previous reports have issued this species' abundance at a dangerously low level. The most successful previous population estimate was attempted in April 1991, where 19 individuals were captured, with only one recapture of an individual originally marked 30 minutes earlier (Garraway et al. 1993).

Morphology and life history of *P. homerus*

The ecology of the larvae has been examined in the eastern population. There has been extensive work with the larval morphology (Panton 1893; Taylor 1894; Swainson 1901; Emmel and Garraway 1990, 1994; Garraway et al. 1993), predation, mortality, and behavior (Garraway et al. 1993). The larvae utilize different host plants in each population. The eastern population feeds on *Hernandia catalpifolia* Britton and Harris (Hernandiaceae), a common plant that grows at elevations of 450–700 m in areas that receive as much as 650 cm of rain annually (Emmel and Garraway 1990). The western population feeds on *Hernandia jamaicensis* Britton and Harris, which grows from 470 to 700 m in elevation on limestone characteristic of western Jamaica (Emmel 1995). There is far less information on the adult biology of the species. Adults display large spatulately tailed wings of black, brightly colored with yellow bands and sporting posterior blue spots on the hindwings.

The western population and the Cockpit Country

The Cockpit Country is located in the western third of Jamaica and occupies approximately 400 square miles. Early settlers said the unique terrain reminded them of the pits used for cock-fighting, hence the name Cockpit Country. The region consists of cone-like hills interspersed by deep pits, underground rivers, numerous caves and sinkholes, and was described by Emmel and Garraway (1990) as an area where there are no flat surfaces or paths that are easy to navigate (Fig. 3). The area is covered by tropical rainforest, interspersed with small farms and remote towns. Average annual rainfall in the Cockpit Country is 590 cm, which is essential to produce the 95% or higher relative humidity required for proper *P. homerus* larval development (Emmel and Garraway 1990).

Although *P. homerus* has periodically been sighted in the Cockpit Country, brief field visits were carried out merely to confirm that the population still existed; there were no thorough studies on this population until this present one. The purpose of this paper is to report the results of an intensive investigation of the western population of *P. homerus*. This is the first in-depth look at the ecology of the western population and is the first successful

Fig. 1 Photograph of individual 006, a specimen from the western population in perfect condition. (Photo © Matthew S. Lehnert)

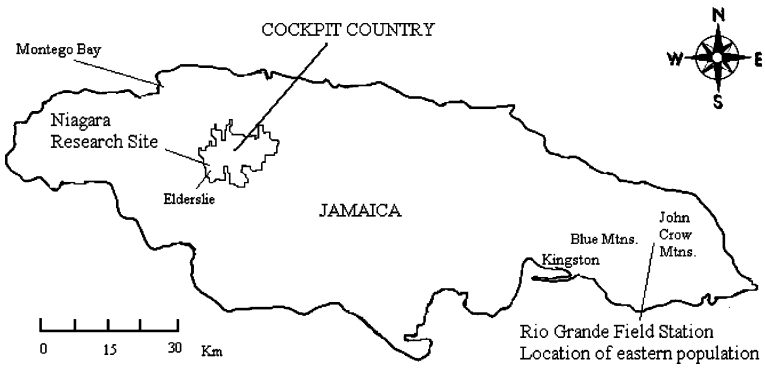

Fig. 2 Map of Jamaica showing the location of the two disjunct populations of *P. homerus*

Fig. 3 Photograph of the terrain of classic Cockpit Country in Niagara, Jamaica (Photo © Matthew S. Lehnert)

attempt at determining the number of remaining *P. homerus* using MRR (mark-release-recapture) methods.

Materials and methods

Field work occurred from 11 July to 14 August, 2004, and again from 19 December, 2004 to 8 January, 2005. Both field periods focused on the same location in the Cockpit Country in Jamaica, although the second trip found no *P. homerus* present despite extensive searching. The investigation took place in a mountain rainforest near the town of Niagara in the southwestern portion of the Cockpit Country along the boundary of St. Elizabeth and St. James parishes (Fig. 4). On the northern border of Niagara, a small path cuts west into the rainforest, which is protected (nominally) as a Forest Reserve. This path was used as the standard transect route for the research and has previously been visited by Garraway, Emmel, and Bailey (personal communication), who discovered *P. homerus* here. At the halfway point of this transect, a 90° right turn west is made along this mountainside joining to another mountainside. This right angle is referred to as "the corner." The distance from the beginning of the transect to the corner is 373 m and gradually declines in elevation from 539 to 482 m. "The corner" is the most open spot along the transect and has a diameter of 9 m and a circumference of 30 m. Here, sunlight covers the ground from 9 a.m. until 4:30 p.m. *Lantana camara* (Verbeniaceae) and other flowers, including flowers in the Hibiscus or Malvaceae family, sparsely line the paths, providing nectar sources for Lepidoptera and other insects.

Sampling in the Cockpit Country

Sampling *P. homerus* consisted of cautiously stalking the butterfly so as not to alarm it, then, when the chance arrived, carefully swinging the butterfly net for the capture. Extreme caution was taken to not harm the butterflies and the bottom of the net was examined for parts of wings that might have come off after every capture. The two nets used were pre-set to 2 m and 7 m in handle length because *P. homerus* generally flies 10–15 m above ground at this area.

Upon capture, an individual was handled with great care. It was delicately removed from the bottom of the net and held so that the wings were kept closed in an upright position to minimize flapping of the wings, which could potentially result in damage to the butterfly. An identification number was then made in the discal cell on the ventral side of the hindwing. For males, the mark was made in the discal cell of the left hindwing; for females, the right hindwing was used. This helped to identify an individual being observed over a long distance through binoculars. The unique number was made in chronological sequence for the order in which specimens were collected (001 for the first, 002 for the second, etc.).

After a mark was made on the wing, the winglength was recorded by using a ruler to measure distance from the base to the apex of the forewing along the costal margin. The sex was recorded along with the condition of the individual. The condition was based on a scale from 1 to 5; the number 5 represented a specimen that was absolutely perfect with excellent wing condition, whereas a butterfly with a condition of 1 would have little wing area remaining (Fig. 5).

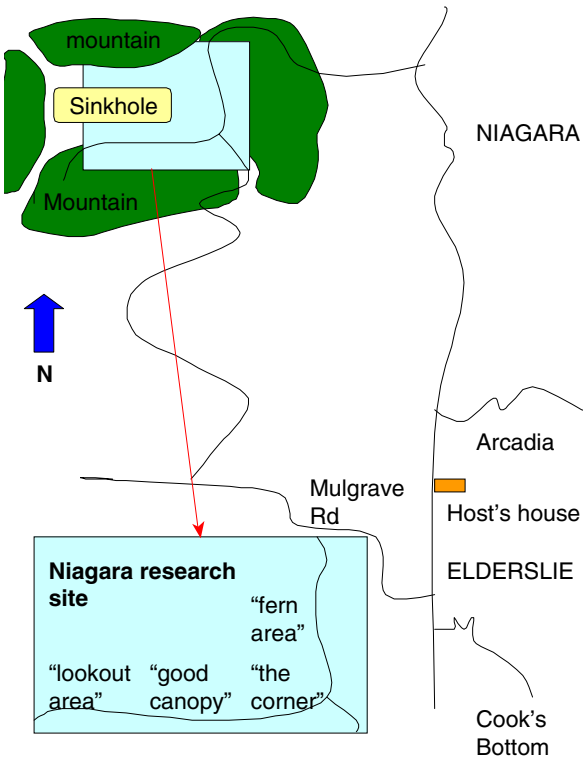

Fig. 4 Map of Niagara research site where the western population of *P. homerus* was sampled

Status as a capture or a recapture was also recorded. A recapture was only considered a recapture if it occurred after an extended period of time from the previous capture (usually one day, unless a special circumstance such as a significant decrease in wing condition occurred within a few hours of previous capture). The time of capture, temperature, relative humidity, and the GPS coordinates were recorded at the capture site. Photographs were then taken of the ventral side of the wing showing the identification number and of the dorsal side with wings spread to document damage on the butterfly. The individual was released within three minutes after time of capture to minimize stress and carefully followed to make further observations on behavior after the marking procedure.

Statistics

Data collected during the study period were analyzed using two different models: the Jolly–Seber Method and the Fisher–Ford Model. Each of these methods has different parameters, but both are appropriate for estimating the size of an open population (Gall 1985).

Results

A total of 18 *P. homerus* were captured during the sampling period. Six of the 18 captured were recaptured, some numerous times giving a total of 17 recaptures. Individual 002 represents 12 of the 17 recaptures, as this specimen made "the corner" his territory throughout a large portion of the sampling period. The majority of captures and recaptures happened before noon (Fig. 6). The sex ratio of females to males of the western population was found to be 1:2.6 (n = 18). The average winglength of *P. homerus* was 74 mm (n = 18) (Table 1).

The Fisher–Ford Model estimated the size of the population at 34 (95% CI: ± 16). The daily survival rate calculated using the Fisher–Ford model is 95%. The Jolly–Seber Model estimated the size of the population at 46 individuals (95% CI: ± 18) (Fig. 7). All the data collected during the sampling period except GPS coordinates are presented in Table 2. GPS coordinates are not provided, to discourage illegal collecting and poaching.

Discussion

Ecology of *Papilio homerus* in the Cockpit Country

The present work yielded a considerable amount of new information about the ecology of the western population of *P. homerus*. The butterfly inhabits rainforest habitat similar to that of the eastern population. Avinoff (1940) noted that *P. homerus* particularly flies in valleys between ridges where surrounding mountains give the feeling of an

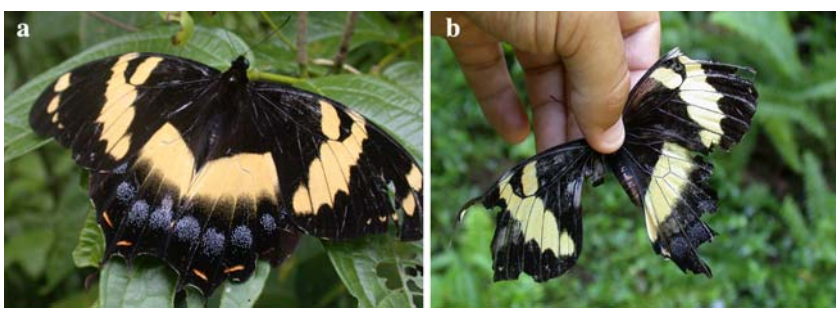

Fig. 5 *P. homerus* individual 002 photographed on (**a**) first day captured (wing condition category 4) and (**b**) last day recaptured (wing condition category 1). (Photos © Matthew S. Lehnert)

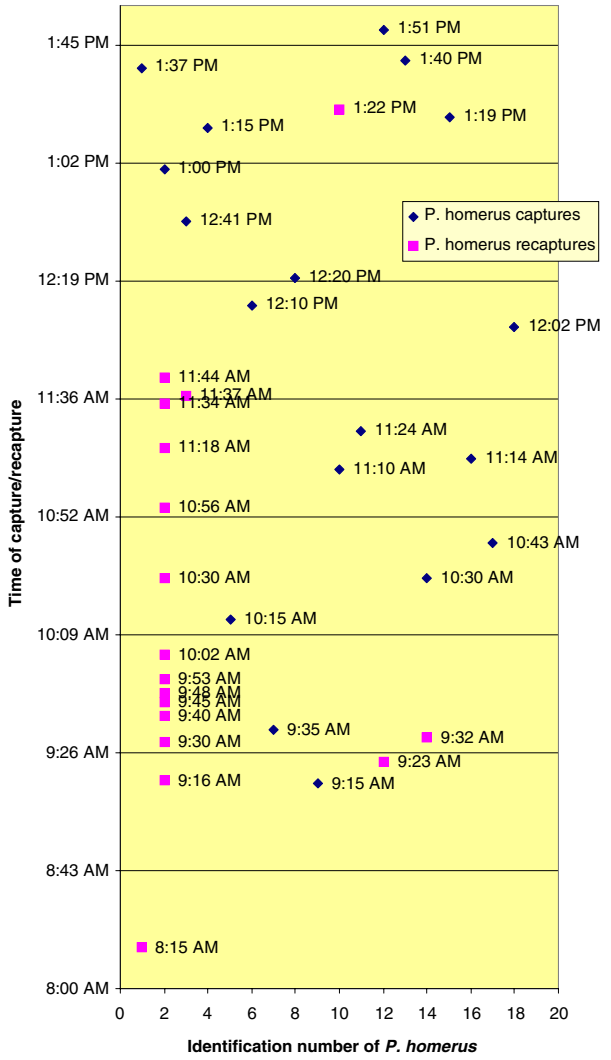

Fig. 6 Time of capture and recaptured *P. homerus*, according to marked individual number

amphitheatre, and this observation was confirmed for the eastern population by Emmel and Garraway (1990). The Niagara research site certainly has this appearance, as the sinkhole is encompassed by mountains.

The average winglength of the population in the Cockpit Country was found to be very similar to that of the eastern population. As noted by Emmel and Garraway (1990), the winglength of the eastern population averaged about 75 mm. According to Table 1, the average winglength of the western population was 74 mm. The difference in average winglengths of males and females corresponds to previous studies: females are larger than males, on average. The overall wing pattern, coloration, and morphology of the western population of *P. homerus* adults did not differ significantly from eastern population individuals.

The sex ratio of females to males in the western population was 1:2.6 (n = 18). However, the behavior of males

Table 1 Winglength of male and female *P. homerus* in the Cockpit Country

Male wing size (n = 13)		Female wing size (n = 5)	
I.D. no.	Winglength (mm)	I.D. No.	Winglength (mm)
2	73	1	80
3	73	5	78
4	75	6	79
8	70	7	78
9	75	16	72
10	74		
11	72		
12	72		
13	71		
14	73		
15	70		
17	72		
18	75		
Mean	72.7		77.4
S.D	1.8		3.1

and females is very different, which may have led to a bias in captures. Males typically patrol open areas in search of females, and may patrol up and down paths in the same sunny area all day, and on subsequent days. Females are much more nomadic and typically wander, most likely in search of host plants. Therefore, this ratio may be skewed because sampling took place in an area that may have been topographically beneficial to males; the sex ratio is probably closer to 1:1.

The wing condition was variable throughout the study. Many of the adults captured had little wing damage; a few were missing large pieces of their wings. Male *P. homerus* displayed territorial behavior, which most likely caused some wing damage. No wing damage occurred due to catching and handling the butterflies.

There was no predation witnessed during the sampling period, although bilateral wing damage was found: likely an unsuccessful attempt by a predator, probably an *Anolis* lizard. In fact, the *P. homerus* males would typically chase after birds as they passed through their territory. Very likely, the majority of mortality due to predation occurs during the immature stages (Garraway et al. 1993).

Papilio homerus could be observed flying from 8 a.m. until 3 p.m., but also later, depending on the weather. At the Niagara research site, *P. homerus* typically did not fly until 9 a.m. In one instance, a *P. homerus* was captured early (recapture of individual 001); both wings were closed and she was resting on top of moisture-covered leaves in the shade, where the sun had not yet reached the area.

The activity level of the area greatly increased just after 9 a.m. when the sun started to warm the research site.

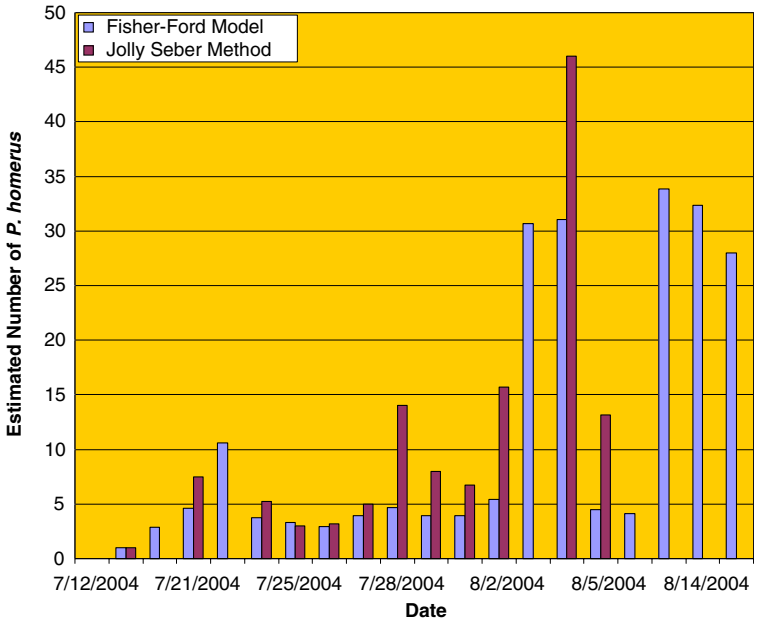

Fig. 7 Estimated population size of *P. homerus* during the 2004 sampling period in the Cockpit Country

Almost at an instant, butterflies of many species began visiting the local flowers, particularly *Lantana camara*. At this time, *P. homerus* would show up, almost out of nowhere. Often, it was individual 002, but other males as well would start to patrol "the corner."

It was also during this time that *P. homerus* butterflies were observed fluttering on flowers, feeding on the nectar. *P. homerus* were observed feeding on *Lantana camara* (Verbeniaceae), and on the small, yellow-flowered tree *Tabernaemontana ochroleuca* Urb (Apocynaceae). This is the first time *P. homerus* has been observed and recorded feeding on the nectar of this latter plant family. *P. homerus* appears to be an opportunistic feeder, taking advantage of what nectar it can find. Other nectar sources recorded for the eastern population are outlined in Garraway et al. (1993) (Table 3).

From this study's observations, *P. homerus* males spend the majority of the morning and early afternoon patrolling selected areas, or territories. The males fly at various elevations, but typically just above the surrounding canopy. "The corner" had trees surrounding the perimeter. These trees were 4–8 m tall, which was the height at which the males flew. While patrolling, males would fly the perimeter of the area, occasionally stopping to rest and bask (which would last 3–4 min) in the sun on the leaves of the trees. Territorial battles also took place.

Butterflies would suddenly become scarce, and their behavior change when the sun was directly overhead and the temperature reached approximately 32°C. The males that were patrolling the area would simply disappear, or at least were no longer flying just over the canopy or circling the area. Leaving the open sunny area, the butterflies find somewhere else to fly or a place to rest for the hot portion of the afternoon. *P. homerus* that were found at this time of day were typically flying low, 1–2 m off the ground, casually flying along the shady areas of the path.

This change in behavior was one of the reasons a trip was made to the sinkhole at the research site in Niagara. Although no *Hernandia* plants were found in the sinkhole, a *P. homerus* was spotted and it turned out to be male 002. He was observed flying, covering a large distance in the sinkhole beneath the canopy. He would occasionally land on the flowers of *T. ochroleuca*, which were abundant. The latest-flying *P. homerus* was at 3 p.m., seen flying over the sinkhole.

Turner (1991) reported a daily vertical migration in the eastern population of *P. homerus*, behavior which has not been observed in intensive fieldwork since 1984 by others (Garraway et al. 1993). Finding individual 002 in the sinkhole at 2 p.m., after it was previously observed the same day at 11 a.m. at "the corner" involved a movement from a higher to a lower elevation over a distance of approximately 57 m, not as drastic as what Turner observed. Since *P. homerus* was rarely observed during afternoon hours, especially on extremely hot days, they may move to a different and cooler elevation during this time period.

It is difficult to conclude what *P. homerus* does when the temperature begins to cool down, as severe thunderstorms typically rake the area in the late afternoon and do not cease until almost dark. It is possible that when these storms cease, courtship and mating occur, but this was

Table 2 Raw data of *P. homerus* individuals collected in the Cockpit Country, Jamaica during July–August 2004 sampling period

Date Sampled	Identification number	Capture/ recapture	Forewing length(mm)	Sex	Wing condition	Time of capture	Temperature (°C)
11 July 2004	1	Capture	80	F	5	1:37 p.m	28
12 July 2004	1	Recapture	–	–	4	8:15 a.m	26
18 July 2004	2	Capture	73	M	4	1:00 p.m	30
19 July 2004	2	Recapture	–	–	4	9:53 p.m	28
	3	Capture	73	M	3.5	12:41 p.m	32
	4	Capture	75	M	4	1:15 p.m	32
21 July 2004	5	Capture	79	F	3	10:15 a.m	26
	6	Capture	78	F	5	12:10 p.m	28
23 July 2004	3	Recapture	–	–	3.5	11:37 a.m	31
	2	Recapture	–	–	3	11:44 a.m	29
24 July 2004	2	Recapture	–	–	2.75	11:18 a.m	28
25 July 2004	2	Recapture	–	–	2.75	9:48 a.m	27
26 July 2004	2	Recapture	–	–	2.75	9:30 a.m	27
	2	Recapture	–	–	2	10:56 a.m	29
27 July 2004	7	Capture	72	F	3.5	9:35 a.m	26
	2	Recapture	–	–	2	9:40 a.m	26
	8	Capture	70	M	4.5	12:20 p.m	33
28 July 2004	9	Capture	75	M	2.5	9:15 a.m	No data
	2	Recapture	–	–	2	9:16 a.m	No data
29 July 2004	2	Recapture	–	–	2	10:02 a.m	28
	10	Capture	74	M	1.75	11:10 a.m.	30
31 July 2004	11	Capture	72	M	5	11:24 a.m	29
	2	Recapture	–	–	2	11:34 a.m	29
	10	Recapture	–	–	1.5	1:22 p.m	33
	12	Capture	72	M	3.75	1:51 p.m	33
2 August 2004	13	Capture	71	M	2.75	1:40 p.m	31
3 August 2004	14	Capture	73	M	3	11:04 p.m	28
4 August 2004	12	Recapture	–	–	3.5	9:23 a.m	No data
	14	Recapture	–	–	3	9:32 a.m	No data
	2	Recapture	–	–	1.75	9:45 a.m	No data
5 August 2004	2	Recapture	–	–	1	10:30 a.m	28
	15	Capture	70	M	4	1:19 p.m	No data
8 August 2004	16	Capture	78	F	3.75	11:14 a.m	No data
10 August 2004	17	Capture	72	M	4.5	10:43 a.m	No data
14 August 2004	18	Capture	75	M	4	12:02 p.m	No data

never observed. The one instance when *P. homerus* was observed during a thunderstorm provided some information as to what these butterflies do during these daily torrential downpours. Individual 006 remained on the upper-side of a leaf sheltered by other leaves throughout the thunderstorm, and basked her wings before flying away once the sun returned.

Adult *P. homerus* were present at the research site throughout the initial July–August 2004 study period. A second trip made to the area during December 2004–January 2005 produced no sightings of *P. homerus*. Although similar methods were employed as before (searching up and down the transect at the Niagara research site, and scouting other similar habitat nearby), no *P. homerus* of any life stage were found despite the rigorous effort. Clearly, the number of adult *P. homerus* dwindles during the winter dry season. No immature stages were found in either season in the western population. Immature stages have been recorded during almost all months in the eastern population (Garraway et al. 1993).

Table 3 Outline of nectar sources used by *Papilio homerus*

Family	Species
Mimosaceae	*Entada gigas* (L.)
Zingiberaceae	*Hedychium coronarium* Koenig
Hernandiaceae	*Hernandia catalaefolia Britton* and Harris
Malvaceae	*Hibiscus rosa-sinensis* L., *Urena lobata* L.
Verbenaceae	*Lantana camara* L.
Acanthaceae	*Pachystachys coccinea* (Aubl.)
Papilionaceae	*Psophocarpus palustris* Desv.
Apocynaceae	*Tabernaemontana ochroleuca* Urb

All nectar sources except for the family Apocynaceae were recorded from the eastern population (Garraway et al. 1993). The nectar sources recorded from the western population are Malvaceae and Apocynaceae

Factors that affect sampling

Various complications made sampling difficult for a rare species in the Cockpit Country of Jamaica. The rocky terrain makes it impossible to run full speed while pursuing a *P. homerus* swallowtail off in the distance. Like many swallowtail species, however, *P. homerus* tend to follow more open paths, such as the transect path used for sampling. This transect allowed the collector to move freely and chase for the capture and mark or recapture. Sometimes, a *P. homerus* would leave the trail while the collector was in pursuit, making the capture difficult. Running through extremely dense vegetation with a butterfly net, over a surface of sharp and wet rocks was not an easy task. Most likely, the Homerus swallowtails were attracted to the research area by the open terrain, host plants and nectar sources.

The attraction of other depressions and open terrain

Many scouting trips were made in the area surrounding Elderslie and Niagara, but the Homerus swallowtails were found in only two other spots. One was found in the Cook's Bottom region once and only briefly as it was moving quickly. *Papilio homerus* were observed on three out of six visits in Arcadia; unfortunately, due to terrain conditions sampling was nearly impossible. The *P. homerus* there flew about 20 m above the ground over a pit filled with fallen trees and openings with large, sharp rocks. On the first visit, 3 were seen and only 1 was seen on the other visits. From these observations, Homerus swallowtails appear to exist in small, sporadic populations.

The Niagara sampling site was ideal *P. homerus* habitat. The Cockpit Country is composed of hundreds of these amphitheatre-like formations. Although this habitat is common in the region, the butterfly is not. Even with thorough investigations throughout the area, no other populations of similar size as the Niagara sampling site were found. The lack of surrounding populations led the author to believe that the sampling area showcased the largest population of *P. homerus* in the Cockpit Country. Due to the distance between these sporadic populations, there may be little mixing of individuals. Since the Homerus swallowtail has not been seen outside of the Elderslie area in the Cockpit Country for at least 40 years, this area most likely represents the largest concentration of Homerus swallowtails in the western population. The estimated population size of less than 50 flying adults at one time is most likely an accurate representation of the number of remaining *P. homerus* in the Cockpit Country.

Conclusion

The numerous observations made during this study will hopefully provide better understanding of the ecology of *P. homerus* in the Cockpit Country. This study focused on the adult population. The study would have been more complete with observations and experiments on the immature stages of the western population of *P. homerus* to see how they differ from the eastern population, especially considering the utilization of different host plants.

The eastern population has faced habitat destruction at an alarming rate. This reduction of wet mountain forest, along with the high mortality of immature life stages, suggests that without human intervention and a conservation plan the size of the population will continue to dwindle. The size of the western population has already reached extremely low numbers. This study shows that there are less than 50 flying adults at a particular time in the study region. Considering that there are hundreds of these valleys throughout the Cockpit Country, it is possible that other small undiscovered populations may exist. Regardless if there are other small populations, this one certainly represented the largest known for the western population. These results imply that the western population of *P. homerus* is in dire need of additional work studying courtship behavior, home range, oviposition preference and host plant availability, and an investigation of the immature stages.

The western population was previously thought to be undisturbed. Though small, there has been relatively little human impact on the species there. This state of affairs has already changed and is no longer true. On his most recent trip to the Cockpit Country (December 2004–January 2005), the author witnessed habitat destruction in the Niagara research site as a result of human activity. Cutting

had occurred in "the corner" and altered the habitat compared to the previous visit. Illegal poaching of this endangered butterfly by commercial collectors is still a problem, and the western population, which was previously untouched by humans, may certainly face this threat in the future.

Local education about the species is absolutely essential. Education has grown in the towns and villages surrounding the eastern population, thereby decreasing the chance for a poacher to collect without notice or alarm. In comparison, the author found the people inhabiting the towns surrounding the Niagara research site, such as the town of Elderslie, were unaware that an endangered species of butterfly lived in their midst. The presence of the author brought awareness to the community, and many of the people there are now educated about the importance of keeping this population safe.

Poaching in the area could still become a problem. The community is relatively poor, and locals could be hired cheaply to acquire these butterflies. The author encountered some locals in the area in December 2004 that were hired to find and capture large, black and yellow butterflies, and would be paid handsomely for them. It was never clear whether this reward was specifically for *P. homerus*, as there are other black and yellow butterflies in the area. These collectors, though, were not actively searching for butterflies, as their crops were far more important.

An immediate conservation plan is crucial if *P. homerus* is to continue to survive. This study confirmed that the size of the remaining populations is extremely small and a genetic bottleneck is possible which could lead to a nearly homozygotic population that would be increasingly vulnerable to disease and other hazardous environmental factors. To remedy this problem, the author suggests that future studies determine if *P. homerus* from both populations could be interbred, increasing the genetic variation within the species. If a successful breeding program is developed (assuming the current limitations on working with a CITES Appendix I species can be lifted), releases into the wild could increase the total population size as well as make both the eastern and western populations more genetically healthy. One caveat to this proposal must be noted: the genetic basis for host plant selection could be deleteriously affected by F1 hybrids, and this factor would have to be studied carefully for several generations in captive propagation to make sure that offspring can still choose and thrive on the species of *Hernandia* present in the proposed release areas.

Thus a plan for a breeding program is essential. The breeding program should have several components:

1. The rearing of disease-free individuals.
2. Determine which plants are capable as serving as a host plant for the F1 hybrids.
3. Mate parental types between the two existing population areas. This may be the most important part of the plan if potential effects of a genetic bottleneck are to be overcome.
4. Determine if the F1 hybrids are fertile and capable of reproduction and can produce fertile offspring with parental specimens from each population and other F1 hybrids.
5. Develop a comprehensive recovery and release plan for the species. This will most likely include transporting healthy pupae, which are nearing eclosion, to specified areas that contains host plants that will support larvae.
6. Conduct periodic surveys in these release sites, include additional releases, and start a population-size estimate program using MMR methods.

With these guidelines, a conservation program involving captive propagation should prove successful in reestablishing this magnificent butterfly. Hopefully, these data will contribute to the growing knowledge of the species' ecology and therefore stimulate development and implementation of a much-needed plan for its conservation.

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