

Dry season strategies of two Panamanian butterfly species, *Anartia fatima* (Nymphalinae) and *Pierella luna luna* (Satyrinae)  
(Lepidoptera: Nymphalidae)

ANNETTE AIELLO

## INTRODUCTION

Tropical Lepidoptera of seasonally dry forest are faced with the challenge of surviving a dry period each year, when larval food plants may die back, and adult food sources and water may be in short supply. These Lepidoptera must rely on various physiological and/or behavioural strategies to persist until the onset of the wet season. In Panama, a number of species, of several families (e.g. Megalopygidae, Limacodidae, Hesperidae, Noctuidae), prepare a pupal cocoon in which they may diapause as final instar larvae (personal observation) and then pupate the following wet season. Others, such as certain giant silk moths (Saturniidae: Hemileucinae), may pass the dry season as pupae and emerge as adults during the initial rains of a future wet season (Janzen 1982). Certain butterflies, such as *Celaenorrhinus fritzgaertneri* (Hesperidae) (DeVries 1987) and *Eurema daira* (Pieridae) (Opler, in DeVries 1987), pass the dry season as adults in reproductive diapause. In Australia, *E. herla* and *E. laeta* also enter reproductive diapause, while three other *Eurema* species breed continuously, expanding and contracting their geographical distributions as larval food plant availability fluctuates (Jones and Rienks 1987).

The present paper examines the dry season strategies of two Panamanian nymphalid butterflies, one of which passes the dry season in pupal diapause and the other of which persists in humid areas (dry season refugia), until the onset of the rains makes range re-expansion possible once more. The two nymphalid butterflies, *Anartia fatima* (Fab., 1793) (Nymphalinae) (Fig. 37.1, top) of disturbed areas, and *Pierella luna luna* (Fab., 1793) (Satyrinae) (Fig. 37.1, bottom), a forest floor inhabitant, are both common on Barro Colorado Island (BCI), Panama. Each is discussed separately, including methods and results, followed by a brief, general discussion, including comments on fluctuations of lepidopteran parasitoids.



Fig. 37.1 Dorsal views of *Anartia fatima* male (top), and *Pierella luna luna* female (bottom). (Photograph by Carl Hansen).

## PIERELLA LUNA LUNA

*Pierella luna luna* males can be found resting on leaves, roots, rocks, and other objects along forest trails, both man-made and game trails. When disturbed, a male flies along the trail for a distance but soon returns to or near to his original perch. All perches that I observed were along level, shady portions of man-made trails, and the same spots were used by successive generations of butterflies. Individuals are long-lived, and several numbered males returned to the same perches for 3–4 months.

Females were encountered rarely in my surveys. The few seen showed no apparent orientation to trails. Very probably females spend much of their time searching for larval food plants (*Calathaea* spp., Marantaceae), and have no reason to concern themselves with trails. Males, on the other hand, apparently use trails to patrol in search of passing females. Both males and females fly close to the ground, rarely rising more than several feet above it.

On BCI, individuals of *P. luna luna* were captured, sequentially numbered, and released. Resightings were made and new individuals marked on a more-or-less weekly basis from 10 November 1982 through 29 June 1983 along Wheeler (200–700 metre markers) and Snyder–Molino (0–600 metre markers) Trails. Dry season that year began the final week of November, 5 weeks earlier than the median date of onset for previous years on record.

The frequency of survey, the time of year chosen, and the study area itself were remarkably similar to those parameters of a study conducted 14 years earlier by Emmel and Leck (1969). In their study, forest butterflies (all available species including *P. luna luna*) were censused weekly from 14 October 1968 through 28 March 1969, along the clearing end of Barbour-Lathrop trail, and along Wheeler, Miller, and Snyder-Molino Trails. In 1968 the dry season started the third week of December.

The results of the two studies were similar (Table 37.1); population sizes were similar and fluctuated in what appeared to be a monthly cycle. In the late dry season of 1983, many trees lost leaves and as the perches became sunny, fewer *P. luna luna* could be found. The final butterfly was seen on 7 March and from then until the beginning of the wet season in early May, none were perched in my study area. A few individuals, including several that had moved from Snyder-Molino Trail, were sighted along the still shady T. Barbour Trail (not formally included in either study) until 13 April but not thereafter. In 1969, Emmel and Leck saw four individuals of *P. luna luna* on their final census day of 28 March. The persistence of their population through a later calendar date might be explained by the fact that when *P. luna luna* disappeared in 1983, nearly 17 weeks of dry season had elapsed, whereas when the 1969 study ended only 13 dry weeks had passed.

The first rain (5 cm) of the 1983 season occurred on 27 April and on the next census day (4 May) I saw at least ten *P. luna luna*, six of which were in my study area, along trail segments

Table 37.1 Consuses of *Pierella luna luna* on Barro Colorado Island, Panama.

		Emmel & Leck 1968–9	Aiello 1982–3
OCT	14	0	
NOV	1	5	
	9	7	
	10		5
	16	3	
	17		5
	25		2
	28	4	
DEC	2		7
	5	4	
	16	1	5
	22		4
	29		4
	30	0	
JAN	5		6
	7	2	
	12		3
	14	1	
	19		3
	21	0	
	26		2
	27	2	
FEB	2	3	5
	8	2	
	10		1
	16	1	2
	22	2	
	23		2
MAR	1	4	
	7		1
	8	0	
	15	1	
	16		0
	22	1	
	28	4	
	30		0
APR	6		0

that had regained their shade. All were freshly emerged individuals. The simplest explanation for their sudden reappearance is that this butterfly species, reared examples of which spent 16 or 17 days in pupation, is able to persist through extended dry periods in pupal diapause.

## ANARTIA FATIMA

*Anartia fatima* is not encountered in forests. It is a butterfly of open areas and large clearings, where its larval food plant (*Blechnum brownei*, Acanthaceae) also lives. The life cycle, from egg to adult eclosion, requires about 31 days. Most adults live 1–2 weeks, some as many as five weeks (Silberglied *et al.*, 1980). Having reared several thousand *A. fatima* and never

having observed diapause of any kind, it is probably safe to say that diapause does not occur at any life stage in this species, and that if no adults have been seen in an isolated area for 5 weeks or more, the population has probably gone extinct.

Population data of varying quality were collected for *A. fatima* during several dry seasons on BCI, by Emmel and Leck (1969), by Silberglie and Aiello (unpublished data for the years 1976, 1977, 1978, 1980), and Aiello (unpublished data for 1983).

Emmel and Leck censused 92 butterfly species, including *A. fatima*, in the BCI Laboratory clearing on 114 days during October 1968 through February 1969. Species were recorded as present or absent and no data on population size were collected; *A. fatima* was present on every census day. Their data end just past the middle of that year's 17-week dry season and it is not known whether the BCI population of *A. fatima* reached extinction that year.

Silberglie and Aiello conducted mark-recapture studies of *A. fatima* from 14 March–18 August 1976, 18 March–12 August 1978, and 8 March–4 June 1980. No formal censuses were made in 1977 and 1983, but presence or absence of *A. fatima* was recorded each week. In general, adults were present throughout the year, except towards the end of extended dry seasons.

*Anartia fatima* adults were present throughout the dry season of 1975–6 (13 weeks), 1977–8 (12 weeks), and 1979–80 (10 weeks), although their numbers decreased during the final dry weeks.

By the ends of the dry seasons of 1976–7 (21 weeks, with only small amounts of rain from time to time) and 1982–3 (21 weeks), *A. fatima* adults could not be found on BCI, and their reappearance did not take place immediately following initial rains, but only after some delay.

In 1977, no adults were seen on BCI during April or May, and they were also absent from most of the Canal Area. We encountered the species in the town of Achiote on the moist Atlantic side of the Isthmus, and there it was abundant. The first big rains on BCI took place on 17 and 18 May, and on 25 May we saw an old female, presumably a colonizer, in the Laboratory clearing. Fresh individuals appeared about 1 month later, the normal development time (egg to adult eclosion) for the species.

In 1983 on BCI, I saw two *A. fatima* on 6 April, then none until 25 May at which time four adults appeared. Either a colonizing female had arrived just after the first big rain on 27 April, or a very old female remained undetected and laid eggs in late April. That the four adults represented a wave of immigration from the mainland is unlikely, as they were freshly emerged and were flying together in a small area of the clearing.

It appears that *A. fatima* depends upon a few humid refugia to survive through extended dry seasons and then re-expands its populations across the isthmus during wet periods.

A similar situation was observed in the region of Cali, Colombia where the closely related *Anartia amathea* (L.) is a common butterfly. During the dry season of 1977 we located *A. amathea* in three small damp areas: Buena Ventura, Cordoba,

and Los Farallones. It was not seen in the surrounding areas, including Cali, where usually it is abundant. As with *A. fatima*, we never observed diapause of any kind in *A. amathea* although we reared thousands of them.

## DISCUSSION

The exceptionally dry and long dry-seasons of 1976–7 and 1982–3 resulted in the temporary extinction of *A. fatima* on BCI, a phenomenon not observed in average years, and in early 1983, numbers of *P. luna luna* fell dramatically. Although these species employed different strategies to cope with the extended rainless period, both made rapid recoveries following the initial rains. *Anartia fatima* persisted in Atlantic-side refugia and recolonized the rest of the isthmus when humid conditions returned, and *P. luna luna* remained on BCI but apparently entered pupal diapause until the first big rains.

Butterflies in general were in short supply during that severe 1982–3 dry season. However, after the initial rains, caterpillar numbers increased and by late May many species had become so plentiful that even pupae were easy to find. Adults were so abundant during June and July that at least five butterfly species (*Adelpha iphicles*, *Anartia fatima*, *Colobura dirce*, *Heliconius erato*, and *Phoebis sennae*) were commonly seen in Panama City itself. A decrease in adult numbers began in late July and continued through August, and during that time most of the eggs, caterpillars, and pupae, of the various species that I collected, produced parasitoid wasps and flies.

Apparently as a result of the steep decline in butterfly numbers during the severe dry season, parasitoids were sharply reduced as well, so that when humid conditions returned, the now temporarily parasitoid-free butterfly populations were allowed to increase dramatically. By late July, the parasitoids, finding themselves in the midst of plenty, also increased and rapidly became abundant. The lag time between the recoveries of hosts and parasitoids made the temporary explosion of butterfly populations possible.

## LITERATURE CITED

- Emmel, T.C. and Leck, C.F. (1969). Seasonal changes in organization of tropical rain forest butterfly populations in Panama. *J. Res. Lepidopt.*, 8 (4): 133–52.
- DeVries, P.J. (1987). *The butterflies of Costa Rica and their natural history: Papilionidae, Pieridae, Nymphalidae*. Princeton University Press. Princeton, NJ.
- Janzen, D.H. (1982). Guía para la identificación de mariposas nocturnas de la familia Saturniidae de Parque Nacional Santa Rosa, Guanacaste, Costa Rica. *Brenesia*, 19/20: 255–99.
- Jones, R.E. and Rienks, J. (1987). Reproductive seasonality in the tropical genus *Eurema* (Lepidoptera: Pieridae). *Biotropica*, 19: 7–16.
- Silberglie, R.E., Aiello, A., and Windsor, D.M. (1980). Disruptive coloration in butterflies: lack of support in *Anartia fatima*. *Science*, 209: 617–19.