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SEASONAL VARIATION IN THE LITTLE SULPHUR BUTTERFLY, *EUREMA LISA LISA*, IN CENTRAL FLORIDA: HOW IT COMPARES TO OTHER SYMPATRIC *EUREMA* SPECIES (LEPIDOPTERA: PIERIDAE)

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ABSTRACT.– *Eurema lisa lisa* Boisduval & Leconte produces distinct wet and dry season forms in central Florida that, when compared with the other two sympatric, polyphenic *Eurema* species, *Eurema nicippe* (Cramer)and *E. daira* Latreille, shares numerous basic overall trends in wing color and pattern changes. A marked discrepancy in the trend appears, however, if proboscis length and forewing length are examined. The resulting contrarieties are discussed in regard to differences in adult winter activity, mobility and reproductive status.

KEY WORDS: ecology, movement, reproductive diapause, seasonal polyphenism.

The little sulphur butterfly, *Eurema lisa lisa* Boisduval & Leconte, is a permanent resident throughout much of the southeastern United States, Mexico, Central America, Bermuda and the northern Bahamas (Minno and Emmel, 1993). Each year, however, it readily establishes temporary populations as far north as the Canadian border (Opler and Krizek, 1984). It occurs year-round in Florida where it shares its affinity for open sunny locations and disturbed sites with the other two resident congeneric species, *Eurema nicippe* (Cramer) and *E. daira* Latreille (Klots, 1951). All three are sexually dimorphic, display considerable phenotypic variation, and produce distinct seasonal forms (Haskin, 1933; Klots, 1928; Smith *et al.,* 1982). *Eurema lisa lisa, Eurema nicippe* and *Eurema daira* share overall trends in wing color and pattern changes between wet (summer) season and dry (winter) season forms. If additional phenotypic characteristics of forewing length and proboscis length are examined, however, a clear discrepancy appears.

The purpose of this paper is to provide a detailed description of the seasonal forms produced by *Eurema lisa lisa,* illustrate how they compare with the seasonal forms of the related sympatric species, *Eurema nicippe* and *Eurema daira,* and suggest an ecologically-based explanation for the observed differences.

Individuals of *Eurema lisa lisa, E. nicippe* and *E. daira* were collected over a two year period from 1993-95 at a single study site directly adjacent to the east side of US 27, 8 miles south of Sebring, Highlands County, Florida. The site consisted of a network of small interconnecting roads cut through a large parcel of relatively intact oak scrub. The resulting disturbed roadside areas provided excellent habitat for all three *Eurema* species. Dry season forms were sampled once a month during January and February of each year: a total of 46 *E. lisa*, 35 *E. nicippe* and 58 *E. daira* were collected. Wet season forms were sampled once a month during September and October of each year: a total of 22 *E. lisa*, 29 *E. nicippe* and 49 *E. daira* were collected. All individuals were caught as seen using a standard aerial net. Forewing length, proboscis length, proboscis:forewing ratio (P:F), as well as dorsal and ventral wing coloration and pattern, were recorded for each specimen.

EUREMA LISA LISA, DRY SEASON FORM

Description.– MALE (Fig. 3-4): Mean forewing length 17.80mm (±0.26). Mean proboscis length 8.70mm (±0.14). Mean P:F ratio 0.49 (N = 33). *Forewing:* Above ground color yellow to deep yellow with costal margin, apex and outer margin black. Does not vary with seasonal form. Underside ground color yellow occasionally fading to orange-yellow near apex. Costal and outer margin with pink border. Apical spotting pattern between R4-M3 typically pink if present. *Hindwing:* Above ground color yellow to deep yellow and outer margin black. Does not vary with seasonal form. Underside ground color yellow with increased concentration of melanic scales. Outer margin with pink border. Wing fringe pink. Distinct patch at outer angle between RS-M2 deep pink. Remaining components of spotting pattern highly variable, may or may not be more intense or enlarged.

FEMALE (Fig. 1-2): Mean forewing length 18.24mm (±0.42). Mean proboscis length 8.91mm (±0.16). Mean P:F ratio 0.49 (N = 13). *Forewing:* Above ground color pale yellow to yellow with costal margin, apex and outer margin black. Underside ground color yellow occasionally fading to yellow-orange near apex. Costal and outer margin with pink border. Apical spotting pattern between R4-M3 typically pink if present.


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Fig. 17-23. *Eurema nicippe*. **17**. Female dry season form, dorsal surface; **18**. Female dry season form, ventral surface; **19**. Male dry season/wet season form, dorsal surface; **20**. Male dry season form, ventral surface; **21**. Male wet season form, ventral surface; **22**. Female wet season form, dorsal surface; **23**. Female wet season form, ventral surface.

Hindwing: Above ground color pale yellow to yellow. Black outer margin typically reduced to black patch between RS-M2 with small black remnants appearing as dots or inverted triangles at M3, Cu1, Cu2 and 2A. Underside ground color yellow to yellow-orange with increased concentration of melanic scales. Outer margin with pink border. Wing fringe pink. Distinct patch at outer angle between RS-M2 deep pink. Remaining components of spotting pattern highly variable, may or may not be more intense or enlarged.

EUREMA LISA LISA, WET SEASON FORM

Description.– MALE (Fig. 3, 5): Mean forewing length 18.87 mm (±0.37). Mean proboscis length 9.05mm (±0.20). Mean P:F ratio 0.48 (N = 15). *Forewing:* Above ground color yellow with costal margin, apex and outer margin black. Does not vary with seasonal form. Underside pale yellow to yellow. Costal and outer margin same as ground color or with faint orange border. Wing fringe white. Apical spotting pattern between R4-M3 typically black if present. *Hindwing:* Above ground color yellow and outer margin black. Does not vary with seasonal form. Underside ground color pale yellow to yellow. Costal and outer margin same as ground color or with faint orange border. Wing fringe white. Patch at outer angle between Rs-M2 pale orange if present, typically reduced or absent. Remaining components of spotting pattern also highly variable, may or may not be less intense or reduced.

FEMALE (Fig. 6-7): Mean forewing length 18.76mm (±0.53). Mean proboscis length 8.96mm (±0.26). Mean P:F ratio 0.48 (N = 7). *Forewing:* Above ground color cream to pale yellow with costal margin, apex and outer margin black. Underside ground color pale yellow often fading to white or cream toward inner margin. Costal and outer margin same as ground color or with faint orange border. Wing fringe white. Apical spotting pattern between R4-M3 typically black if present. *Hindwing:* Above ground color cream to pale yellow. Outer margin black, typically entire to Cu2, and deeply scalloped. Underside ground color pale yellow to yellow. Outer margin same as ground color or with faint orange border. Wing fringe white. Distinct patch at outer angle between RS-M2 typically pale orange to light pink. Remaining components of spotting pattern highly variable, may or may not be less intense or reduced.

Fig. 1-16. *Eurema lisa lisa*: **1**. Female dry season form, dorsal surface; **2**. Female dry season form, ventral surface; **3**. Male dry season/wet season form, dorsal surface; **4**. Male dry season form, ventral surface; **5**. Male wet season form, ventral surface; **6**. Female wet season form, dorsal surface; **7**. Female wet season form, ventral surface. *Eurema daira*. **8**. Female dry season form, dorsal surface; **9**. Female dry season form, ventral surface; **10**. Male dry season form, dorsal surface; **11**. Male dry season form, ventral surface; **12**. Male wet season form, dorsal surface (yellow hindwing); **13**. Male wet season form, dorsal surface (white hindwing); **14**. Male wet season form, ventral surface; **15**. Female wet season form, dorsal surface; **16**. Female wet season form, ventral surface.

COMPARISONS

Wet season (summer) form and dry season (winter) form specimens of *Eurema lisa lisa, Euremn nicippe* and *Eurema daira* were examined for dorsal forewing ground color, dorsal hindwing ground color, dorsal hindwing costal margin, ventral forewing ground color, ventral hindwing ground color, ventral hindwing markings, wing fringe color, forewing length, proboscis length and proboscis:forewing ratio (Table 1). The overall trends between the three species are identified and specific deviations by *Eurema lisa lisa* reported.

1. Dorsal forewing ground color

Eurema nicippe – MALE: Wet season form deep orange, dry season form deep orange. FEMALE: Wet season form light orange, dry season form deep orange.

Eurema daira – MALE: Wet season form pale yellow to yellow, dry season form yellow to deep yellow. FEMALE: Wet season form cream to pale yellow, dry season form yellow to deep yellow.

Eurema lisa lisa – MALE: Wet season form pale yellow to yellow, dry season form yellow to deep yellow. FEMALE: Wet season form cream to pale yellow, dry season form pale yellow to yellow.

TREND: Relatively unchanged or slight darkening of color in dry season form in males. Considerable deepening of color from wet to dry season form in females.

2. Dorsal hindwing ground color

Eurema nicippe – MALE: Wet season form deep orange, dry season form deep orange. FEMALE: Wet season form light orange, dry season form deep orange.

Eurema daira – MALE: Wet season form pale yellow to yellow, dry season form yellow to deep yellow. FEMALE: Wet season form cream to pale yellow, dry season form yellow to deep yellow.

Eurema lisa lisa – MALE: Wet season form pale yellow to yellow, dry season form yellow to deep yellow. FEMALE: Wet season form cream to pale yellow, dry season form pale yellow to yellow.

TREND: Relatively unchanged or slight darkening of color from wet season to dry season form in males. Considerable deepening of color from wet season to dry season form in females.

3. Dorsal hindwing costal margin

Eurema nicippe – MALE: Wet season form margin entire, dry season form margin entire. FEMALE: Wet season form margin entire, dry season form margin broken with large black patch between Rs and M2 with remnants (if present) appearing as lines at M3, Cu1 and Cu2.

Eurema daira – MALE: Wet season form margin entire, dry season form margin broken with large black patch between Rs and M2 with remnants (if present) appearing as lines or inverted triangles at M3, Cu1 and Cu2. FEMALE: Same as male.

Eurema lisa lisa – MALE: Wet season form margin entire, dry season form margin entire. FEMALE: Wet season form margin entire although deeply scalloped, dry season form margin broken with large black patch between Rs and M2 with remnants (if present) appearing as lines or inverted triangles at M3, Cu1 and Cu2.

TREND: Margin typically remaining entire from wet season to dry season form. *Eurema daira* is an exception in males. Entire margin to broken margin from wet season to dry season form. Broken margin appearing as large black patch between Rs and M2 with remnants (if present) appearing as lines or inverted triangles at M3, Cu 1 and Cu2 in females.

4. Ventral forewing ground color

Eurema nicippe – MALE/FEMALE: Wet season form yellow to deep yellow, dry season form deep orange fading to rust or brown toward apex.

Eurema daira – MALE/FEMALE: Wet season form pale yellow to yellow fading to white toward inner margin, dry season form yellow fading to rust or brown toward apex.

Eurema lisa lisa – MALE/FEMALE: Wet season form pale yellow to yellow fading to white toward inner margin, dry season form yellow fading to orange-yellow toward apex.

TREND: Color typically deepening from wet season to dry season form. Forewing apex considerably darker in color than the rest of wing in dry season form.

5. Ventral hindwing ground color

Eurema nicippe – MALE: Wet season form yellow, dry season form brown to rust. FEMALE: Wet season form yellow, dry season form brown to light rust.

Eurema daira – MALE: Wet season form immaculate, dry season form brown to rust. FEMALE: Wet season form white to gray, dry season form brown to rust.

Eurema lisa lisa – MALE: Wet season form pale yellow, dry season form yellow. FEMALE: Wet season form pale yellow, dry season form yellow-orange.

TREND: Considerable darkening of color from wet season to dry season form in males. Considerable darkening of color from wet season to dry season form in females.

6. Wing fringe color

Eurema nicippe – MALE/FEMALE: Wet season form same as ground color (yellow), dry season form same as ground (brown to rust).

Eurema daira – MALE/FEMALE: Wet season form same as ground (white), dry season form same as ground (brown to rust).

Eurema lisa lisa – MALE/FEMALE: Wet season form same as ground (yellow), dry season form pink.

TREND: Color typically same as ground. Considerable darkening in color from wet season to dry season form.

7. Ventral hindwing markings

Eurema nicippe – MALE: Wet season form highly variable with major components of spotting pattern typically highly reduced or absent, dry season form highly variable with major components of spotting pattern clearly evident. FEMALE: Wet season form highly variable with major components of spotting pattern clearly evident, dry season form highly variable with major components of spotting pattern typically evident but reduced.

Eurema daira – MALE: Wet season form immaculate with major components of spotting pattern absent, dry season form highly

TABLE 1. Comparisons of selected phenotypic characteristics between male and female seasonal forms of *Eurema lisa lisa, E. nicippe* and *E. daira.* Lengths are in mm.

	Eurema nicippe		Eurema daira		Eurema lisa lisa	
Wet season-form	Male	Female	Male	Female	Male	Female
Dorsal forewing ground color	deep orange	light orange	pale yellow to yellow	cream to pale yellow	pale yellow to yellow	cream to pale yellow
Dorsal hindwing ground color	deep orange	light orange	pale yellow to yellow	cream to pale yellow	pale yellow to yellow	cream to pale yellow
Dorsal hindwing costal margin	entire	entire	entire	entire	entire	entire, deeply scalloped
Ventral forewing ground color	yellow to deep yellow	yellow to deep yellow	pale yellow to yelloy fading to white toward inner margin	pale yellow to yellow fading to white toward inner margin	pale yellow to yellow fading to white toward inner margin	pale yellow to yellow fading to white toward inner margin
Ventral hindwing ground color	yellow	yellow	immaculate, pure white	white to gray	pale yellow	pale yellow
Wing fringe color	same as ground color-yellow	same as ground color-yellow	same as ground color-white	same as ground color-white to gray	pink	pink
Ventral hindwing markings	highly variable-major components reduced or absent	highly variable-major components evident	completely absent	completely absent	highly variable-large patch btw. Rs-M2 reduced and light orange. Border reduced and light orange. Remaining components may be reduced	highly variable-large patch btw. Rs-M2 reduced and light orange. Border reduced and light orange. Remaining components may be reduced
Mean forewing length	25.72 ± 0.38 N=16	26.72 ± 0.45 N=13	18.70 ± 0.14 N=33	18.70 ± 0.23 N=16	18.87 ± 0.37 N=15	18.76 ± 0.53 N=7
Mean proboscis length	15.92 ± 0.29 N=16	15.67 ± 0.29 N=13	8.96 ± 0.10 N=33	9.31 ± 0.10 N=16	9.05 ± 0.20 N=15	8.96 ± 0.26 N=7
Mean Proboscis: forewing ratio	0.62, N=16	0.59, N=13	0.48, N=33	0.50, N=16	0.48, N=15	0.48, N=7
Dry season form						
Dorsal forewing ground color	deep orange	deep orange	yellow to deep yellow	yellow to deep yellow	yellow to deep yellow	pale yellow to yellow
Dorsal hindwing ground color	deep orange	deep orange	yellow to deep yellow	yellow to deep yellow	yellow to deep yellow	pale yellow to yellow
Dorsal hindwing costal margin	entire	broken-large patch btw. Rs and M2, remnants as lines at M3, Cu1 and Cu2	broken-large patch btw. Rs and M2, remnants as lines/inverted triangles at M3, Cu1 and Cu2	broken-large patch btw. Rs and M2, remnants as lines/inverted triangles at M3, Cu1 and Cu2	entire	broken-arge patch btw. Rs and M2, remnants as lines/inverted triangles at M3, Cu1 and Cu2
Ventral forewing ground color	deep orange fading to brown/rust toward apex	deep orange fading to brown/ light rust toward apex	yellow fading to rust/brown toward apex	yellow fading to rust/brown toward apex	yellow fading to orange-yellow toward apex	yellow fading to orange-yellow toward apex
Ventral hindwing ground color	brown to rust	brown to light rust	brown to rust	brown to rust	yellow to yellow-orange	yellow-orange
Wing fringe color	brown to rust	brown to light rust	brown to rust	brown to rust	yellow to yellow-orange	yellow to yellow-orange
Mean forewing length	24.65 ± 0.20 N=23	25.28 ± 0.61 N=12	19.10 ± 0.37 N=27	20.17 ± 0.15 N=31	17.80 ± 0.26 N=33	18.24 ± 0.42 N=13
Mean proboscis length	15.55 ± 0.16 N=23	15.59 ± 0.39 N=12	10.64 ± 0.15 N=27	11.12 ± 0.11 N=31	8.70 ± 0.14 N=33	8.91 ± 0.16 N=13
Mean Proboscis: forewing ratio	0.63, N=23	0.62, N=12	0.56, N=27	0.55, N=31	0.49, N=33	0.49, N=13

TABLE 2. Comparisons in mean proboscis length (mm), mean forewing length (mm) and proboscis:forewing ratio between seasonal forms of *Eurema lisa lisa, E. nicippe* and *E. daira.* T-values and significance levels are indicated for student t-test comparisons.

	Eurema nicippe			Eurema daira			Eurema lisa lisa		
	Wet season form	Dry season form	Significance	Wet season form	Dry season form	Significance	Wet season form	Dry season form	Significance
Mean forewing length	26.17 ± 0.30 N=29	24.86 ± 0.25 N=35	T= -3.38, $p < 0.05$	18.68 ± 0.10 N=79	19.79 ± 0.19 N=78	T = 5.91, $p < 0.05$	18.84 ± 0.30 N=22	17.93 ± 0.22 N=46	T=-2.42, $p < 0.05$
Mean proboscis length	15.81± 0.20 N=29	15.56 ± 0.17 N=35	T= -0.94, $p > 0.05$	8.97 ± 0.07 N=79	10.98 ± 0.08 N=78	T = 18.91, $p < 0.05$	9.03 ± 0.16 N=22	8.76 ± 0.11 N=46	T=-1.38, $P > 0.05$
Mean proboscis: forewing ratio	0.60, N=29	0.63, N=35	T=3.19, $p < 0.05$	0.48, N=79	0.56, N=78	T = 13.62, $p < 0.05$	0.48, N=22	0.49, N=46	T= 1.22, $P > 0.05$

variable with major components of spotting pattern clearly evident. FEMALE: Wet season form markings absent, dry season form highly variable with major components of spotting pattern clearly evident.

Eurema lisa lisa – MALE: Wet season form highly variable. Patch between Rs and M2 slightly reduced and pale orange in color. Remaining components of spotting pattern may or may not be reduced. Border typically reduced and very pale orange in color. Dry season form highly variable. Patch between Rs and M2 enlarged and pink in color. Remaining components of spotting pattern may or may not be reduced. Border typically wider and pink in color. FEMALE: Same as male.

TREND: Markings highly variable although typically much more pronounced in dry season form in males and females.

8. Forewing length

Eurema nicippe – MALE: Wet season form mean 25.72mm, dry season form mean 24.65mm. FEMALE: wet season form mean 26.72mm, dry season form mean 25.28mm.

Eurema daira – MALE: Wet season form mean 18.70mm, dry season form mean 19.10mm. FEMALE: wet season form mean 18.70mm, dry season form mean 20.17mm.

Eurema lisa lisa – MALE: Wet season form mean 18.87mm, dry season form mean 17.80mm. FEMALE: Wet season form mean 18.76mm, dry season form mean 18.24mm.

TREND: Dry season forms typical of overwintering species are generally larger in size as *Eurema daira.* The smaller size of dry season *Eurema lisa lisa* and *E. nicippe* are exceptions to this basic trend.

9. Proboscis length

Eurema nicippe – MALE: Wet season form mean 15.92mm, dry season form mean 15.55mm. FEMALE: Wet season form mean 15.67mm, dry season form mean 15.59mm.

Eurema daira – MALE: Wet season form mean 8.96mm, dry season form mean 10.64mm. FEMALE: Wet season form mean 9.31mm, dry season form mean 11.12mm.

Eurema lisa lisa – MALE: wet season form mean 9.05mm, dry season form mean 8.70mm. FEMALE: wet season form mean 8.96mm, dry season form mean 8.91mm.

TREND: due to size variability, generalizations using proboscis length measurements alone are not reliable. Size is normalized by taking the proboscis to forewing ratio.

10. Proboscis to forewing ratio

Eurema nicippe – MALE: Wet season form mean 0.62, dry season form mean 0.63. FEMALE: Wet season form mean 0.59, dry season form mean 0.62.

Eurema daira – MALE: Wet season form mean 0.48, dry season form mean 0.56. FEMALE: Wet season form mean 0.50, dry season form mean 0.55.

Eurema lisa lisa – MALE: Wet season form mean 0.48, dry season form mean 0.49. FEMALE: Wet season form mean 0.48, dry season form mean 0.49.

TREND: Dry season forms typically have longer mean proboscis lengths than wet season individuals. The shorter proboscis length of dry season *Eurema lisa lisa* is an exception.

DISCUSSION

Many subtropical and tropical polyphenic butterfly species share general wing phenotypic character changes between wet and dry season forms (Shapiro, 1976; Brakefield and Larsen, 1984; Brakefield, 1987). This rough conformity, especially in dry season forms, is not surprising owing to the similar adaptive constraints presented by seasonal changes in rainfall, temperature and vegetation. Increased ventral hindwing melanization, the appearance or intensification of ventral hindwing patterns, and an increased variability of such patterns are typical changes that may enhance thermoregulation and/or crypsis for dry season form individuals faced with cooler conditions and distinctly different vegetative landscapes (Brakefield, 1984, 1987; Douglas and Grula, 1978; Tauber *et al.*, 1986).

The similarlty of wing coloration and pattern trends between the seasonal forms of *Eurema nicippe, Eurema daira* and *Eurema lisa lisa* is clearly apparent (Fig. 1-22). The convergence in dorsal wing pattern of dry season form individuals of *Eurema daira* and *Eurema lisa lisa* is particularly striking (Fig. 1, 8). However, seasonal changes in forewing length and proboscis length deviate from this overall uniformity. Dry season form individuals of both *Eurema daira* and *Eurema nicippe* have significantly longer probosces than wet season form individuals. Similarly, Opler (1986) found that dry season *Eurema daira* in Costa Rica have longer mean proboscis lengths compared to wet season forms. He postulated that this greater length enhances survivability of dry season individuals by increasing the range of nectar sources available for utilization. The proboscis:forewing ratio of *Eurema lisa lisa,* on the other hand, does not differ significantly between seasonal forms (Table 2). It should then be expected that dry season *Eurema lisa lisa* would benefit as well from an increased proboscis length, provided the dry season ecology of all three species are comparable. In central Florida, the seasonal polyphenisms of *Eurema daira* and *Eurema nicippe* are associated with distinct behavioral and reproductive repertoires. Wet season forms are reproductively active and produce numerous generations while dry season forms survive the winter in ovarian diapause. *Eurema lisa lisa,* however, remains reproductively active and breeds throughout the winter months (unpublished data). For *Eurema lisa lisa,* the increased investment of a longer proboscis may be unnecessary due to relatively stable nectar resources encountered during the short reproductive adult lifespan. However, dry season *Eurema daira* and *Eurema nicippe* remain in reproductive diapause for many months and therefore experience not only a wide range of flowering plant species with a wide range of corolla lengths but also a highly variable temporal avai]ability of such floral resources. As a result, dry season individuals may need to be particularly opportunistic about acquiring nectar when it is available during the cool winter months when few plants are in flower.

The seasonal polyphenisms of *Eurema lisa lisa, E. nicippe* and *E. daira* are also associated with changes in adult size. Dry season form individuals of *Eurema daira* are significantly larger than wet season forms, whereas both dry season form *Eurema nicippe* and *E. lisa lisa* are significantly smaller than wet season forms (Table 2). Longer wing lengths commonly occur in many butterfly species that undergo reproductive diapause and typically

seem to serve at least two main functions. First, larger adult size in combination with fat-body development increases the individual's ability to survive long-term environmental stress and provides tolerance to temperature extremes (Tauber *et al.*, 1986). Secondly, longer wing length enhances adult mobility such as migration or local, short distance movements during diapause (Tauber *et al.*, 1986). In central Florida, dry season *Eurema daira* commonly form fairly large, loose winter aggregations which often are fairly mobile. Whether migratory or not within the state, dry season forms certainly engage in numerous short distance movements throughout the winter, either in response to passing weather fronts or local nectar abundance. In addition, cold daytime winter conditions and freezing nighttime temperatures can persist for extended periods of time even in central Florida. As a result, dry season adults may be unable to search out nectar sources for several days and therefore must rely on metabolic reserves for energy. Clearly, under these conditions, larger size could be seen as a highly beneficial adaptation. Dry season *Eurema lisa lisa,* however, reproduce *in situ* throughout the winter. Once again, the increased investment of larger size is unnecessary for a short-lived, relatively sedentary reproductive dry season form individual. Cooler larval developmental temperatures and poorer food quality during the winter may also play a role.

The observed difference in forewing length for the seasonal forms of *Eurema nicippe* was unexpected. The smaller size of dry season individuals is not consistent with the expected scenario for an overwintering species in reproductive diapause. One possible explanation may be that the smaller size is hostplant related. Larvae of *Eurema nicippe* feed on various species of *Cassia* (Fabaceae) which deteriorate rapidly with the onset of cool weather in fall. As a consequence, developing dry season larvae may be faced with reduced food supply or food quality and therefore not be able to reach maximum size. There would therefore be a relatively strong environmental component producing a high phenotypic variance in dry season adults. In contrast, larvae developing during the wet season experience optimal developmental conditions and are thus able almost invariably to reach a particular size threshold for metamorphosis. The resulting wet season adults would accordingly have a low phenotypic variance in size, with a high genetic component (Brakefield, 1987). However, the difference in variance between wet and dry season forms is not significant ($F=1.25$, one-tail test: $0.3 > p < 0.25$). If individuals of *Eurema daira* are examined, on the other hand, the variance between seasonal forms is highly significant ($F=3.29$, one-tail test: $p < 0.05$). Such results suggest that some factor other than larval hostplant is most likely responsible for the smaller size of adult dry season *Eurema nicippe*.

Difference in adult diapause behavior may offer an alternative explanation. Relatively little is known about the movements of *Eurema nicippe,* although like *Eurema daira,* dry season adults are found throughout the winter in most locations within the state. The winter activity of dry season adults, however, appears to be somewhat reduced when compared to that of *Eurema daira.* Adults appear to be particularly sedentary and become active to nectar only at very warm daytime temperatures. The smaller adult size in conjunction with reduced winter activity may be an effective adaptive alternative to the increased size and mobility that theoretically affords dry season adults with increased winter survivability.

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