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Dry and wet season polymorphism in the butterflies, *Melanitis leda* and *Mycalesis mineus* (Satyridae: Lepidoptera)

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Abstract: A field survey of butterflies was carried out in different areas of deciduous forests at Kaliakyar, Gazipur, during January-December, 2008. Seven species of satyrid butterflies were collected and two species, *Melanitis leda* and *Mycalesis mineus* were found to exhibit dry and wet season polymorphism. The dry season forms (DSFs) and wet season forms (WSFs) of the both species were distinguished by their upperside and underside wing patterns. The DSFs occurred only in the drier period (November to February) when day length was shorter than 12 hrs. at lower temperatures (24.1-20.6°C). Both the species of butterflies of the wetter period (March - October) were predominant of the WSF when day length was longer than 12 hrs. at higher temperatures (26.8-27.6°C). The fluctuations in the number of seasonal forms of *M. leda* and *M. mineus* were higher in DSF than those of WSF. The transition of DSF to WSF and WSF to DSF of *M. leda* was found to occur around the end of April and the early of September, respectively. But the turnover of DSF to WSF occurred around the early March and the turnover of WSF to DSF in October in *M. mineus*.

Key word: Butterflies, seasons, polymorphism, *Melanitis leda* and *Mycalesis mineus*

Introduction

Many animals became extinct because they were unable to adapt to changes in their environment. However, many organisms remain alive under cyclic (daily, monthly and seasonal) changes of environmental conditions to which they show adaptation by decreased physiological activities or by changing their morphology. In tropical and sub-tropical environments with contrasting dry and wet seasons, many insects move into and aggregate in moist refugia during the long and unfavourable dry season (Denlinger 1986, Jones 1987, Scheermeyer 1993). An alternative strategy may occur in some butterflies which become more cryptic during the dry season (Brakefield & Larson 1984, Brakefield & Reitsma 1991, Windig 1992, Jones 1992).

Several tropical satyrid butterflies show striking seasonal polymorphism in the underside wing patterns. The dry season forms (DSF) are usually reproductively inactive or less active and long-lived, aggregate in moist refugia and are characterized by reduced or no ocelli (eye-spots). By contrast, wet season forms (WSF) are reproductively active, generally do not aggregate in refugia, and are characterized by conspicuous eye-spot patterns on the under side of the wing (Corbet & Pendlebury 1978, Kirk 1982, Brakefield & Larsen 1984, Brakefield & Reitsma 1991, Braby, 1994). The incidence of seasonal polymorphism in tropical environments has received little attention (Shapiro 1976, Tauber et al. 1986). But there is no report on the seasonal polymorphism (DSF and WSF) of *Melanitis leda* and *Mycalesis mineus* in Bangladesh. This paper addresses their seasonal changes in the wing phenotype, and fluctuation in the number (WSF and DSF) of both species. It also suggests possible factors inducing phenotypic change of DSF and WSF in *M. leda* and *M. mineus*.

Materials and Methods

Butterflies: The butterflies (*Melanitis leda* and *Mycalesis mineus*) were collected from five different areas in the deciduous forests at Kaliakyar, Gazipur. Field surveys and collections of butterflies were carried out throughout the year

(January to December) in 2008. The 5 research sites were visited on sunny days of every month (2008) and butterflies were collected by using insect nets. Collected butterflies were immediately killed by pressing the thorax carefully for minimizing damages to their external organs (scales, legs and wing veins), put in triangular envelopes of papers and brought to the laboratory. Date, time and place of collection site were recorded for each specimen. Meteorological data of each collection day were recorded and summarized in Table 1.

Seasonal forms identification: Species of butterflies were identified according to the Specimen Books of Butterflies (Islam et al. 2007; Pinratana, 1988). Polymorphic forms (WSF and DSF) were identified according to the characteristics of their wings, such as shapes (angular/regular) and patterns (presence or absence of eye-spots, colour and band pattern). The body portions of butterflies were represented by terms used by Islam et al. 2007.

Photography: Photographs of butterflies (dorsal and ventral sides) were taken by a digital camera (Nikon, COOLPIX 5700, 5.0 mega pixels), uploaded into a personal computer and processed by using imaging software of Adobe Photoshop LE5. Variations of the wing patterns of DSF and WSF adults of *M. leda* and *M. mineus.*

Results and Observation

M. leda and *M. mineus* adults were found in two distinct seasonal morphs, viz. dry season form (DSF) and wet season form (WSF). DSF was found during March to October when day length was longer with high temperature whereas WSF was found during November to February when day length was shorter with low temperature.

Table 1. Monthly temperature, humidity and rainfall data of the butterflies sampling areas in 2008

Month	Temperature (ºC)			Average Relative Humidity (%)	Total Rainfall (mm)
	Maxi	Min	Average		
January	24.4	14.5	19.4	49.9	23
February	26.1	15.2	20.6	36.3	56
March	31.7	23.0	26.8	45.1	45
April	34.5	24.5	29.5	42.9	91
May	34.7	24.9	29.8	52.7	205
June	31.5	26.5	29.0	66.5	577
July	31.7	26.4	29.1	71.8	365
August	32.1	27.3	29.7	69.5	319
September	32.5	26.2	29.4	65.3	279
October	31.4	23.8	27.6	59.2	227
November	29.7	18.4	24.1	40.6	0
December	25.6	17.0	21.2	54.4	0
Mean	30.5	22.3	26.4	54.5	182.3

M. leda:

Dry Season Forms (DSFs): The DSF of *M. leda* has much smaller ocelli (eye-spots), longer tails, larger wings and a variable background.

Upperside: Ground colour brown, the markings, especially the ferruginous lunules inwardly bordering the black sub-apical spots on the fore wing, larger, more extended below and above the black costa. Fore wing strongly angled near the apex. Eye-spots of the fore wing are more prominent and surrounded by orange line. Small tail on the hind wing more pronounced. Sub-marginal dark white-centered fulvous-ringed ocellus (eye-spot) in area 2 absent in the hind wing (Plate 1).

Underside: Eye-spots reduced to minute white dots and the regular irroration of the WSF replaced by a highly variable cryptic pattern ranging in ground colour from a light tan over darker brown and chestnut to almost black. Posterior wing without an eye-spot in area 2, but posteriorly replaced by three or four minute white sub-marginal spots (Plate 1).

Plate 1. Upperside (a) and Underside (b) views of *Melanitis leda* DSF adult

Wet Season Forms (WSFs): The wet season forms of *M. leda* are with large, well differentiated eye-spots, short tails, smaller wings.

Upperside: Ground colour similar to that in the DSF. Apex of fore wing termen sub-acute, termen slightly angulated just below apex, or straight. Fore wing with two large sub-apical black spots, each with a smaller spot outwardly of pure white inwardly bordered, the inner edge of this black patch bordered narrowly with ochraceous, interrupted in area 4, costal margin narrowly pale. Hind wing with a dark, white-centered fulvous-ringed eye-spot sub-terminally in interspace 2 and the apical eye-spot, sometime also other of the eye-spots, on the underside showing through (Plate 2).

Underside: Underside paler and densely striated with dark brown. Fore wing with a discal curved dark brown, narrow band, a post-discal similar oblique band, followed by a series of four eye-spots that in interspace 8 the largest. Hind wing with a series of six eye-spots, the apical and sub-tornal the largest (Plate 2).

Plate 2. Upperside (a) and Underside (b) views of *Melanitis leda* WSF adult.

Seasonal fluctuations of the numbers of WSF and DSF adults of *M. leda*

WSF and DSF adults appeared in April and September, and formed a peak in May and November, respectively. The peak of the DSF was more than 100 times larger as compared to that of the WSF. The transitions of DSF to WSF and WSF to DSF were found to occur around the end of April and the early of September, respectively (Fig. 3).

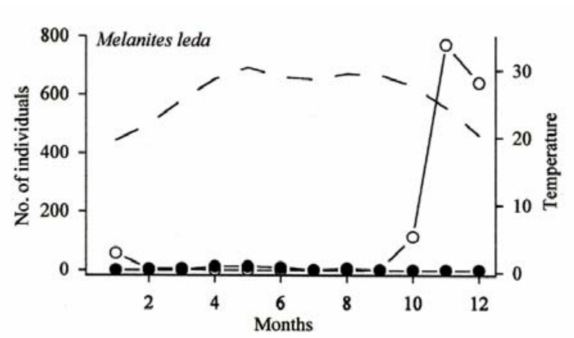

Fig. 3. Seasonal fluctuations in the number of DSF and WSF of *M. leda* adults (○ and ●) and the average temperature (a broken line)

***M. mineus*:**

Dry Season Forms (DSF):

Upperside: Ground colour was dark brown but pale area of the fore wing often very extensive. Fore wings have a large eye-spot with white-centre in space 5. Ventral portion of the hind wing bears a small black spot (Plate 4).

Underside: Underside of the DSF deep chocolate brown to dusky brown of a darker shade. Basal half of the wings conspicuously darker than outer portion, the whole surface irrorated with fine brown striae, sometimes and a distinct dark discal band cross both wings. Eye-spots reduced to minute white dots, the posterior four on the hind wing in a straight line as in the WSF (Plate 4).

Wet Season Forms (WSFs):

Upperside: Ground colour dark brown. Fore and hind wings with slender subterminai and terminal pale lines. Fore wing with a single white-centered, fulvous or dark yellow-ringed, black eye-spot, generally set in a square pale area, in interspace 2, occasionally a similar smaller eye-spot without any pale surroundings area in interspace 5. Hind wing uniform, sometimes with one or two obscure post-median eye-spot (Plate 5).

Plate 4. Upperside (a) and Underside (b) views of *Mycalesis mineus* DSF adult

Underside: Ground colour similar to the upperside. In the fore wing, there are two eye-spots situated only in space 2 and 5. In the hind wing, there is line of eye-spots inwardly bordering by a dusky-yellowish, sometimes purplish-white and they are deeply indented in space 4 and 5. Fore and hind wings crossed by a transverse dusky-white discal band, well-defined inwardly, outwardly diffused, followed by a post-discal series of eye-spots (Plate 5).

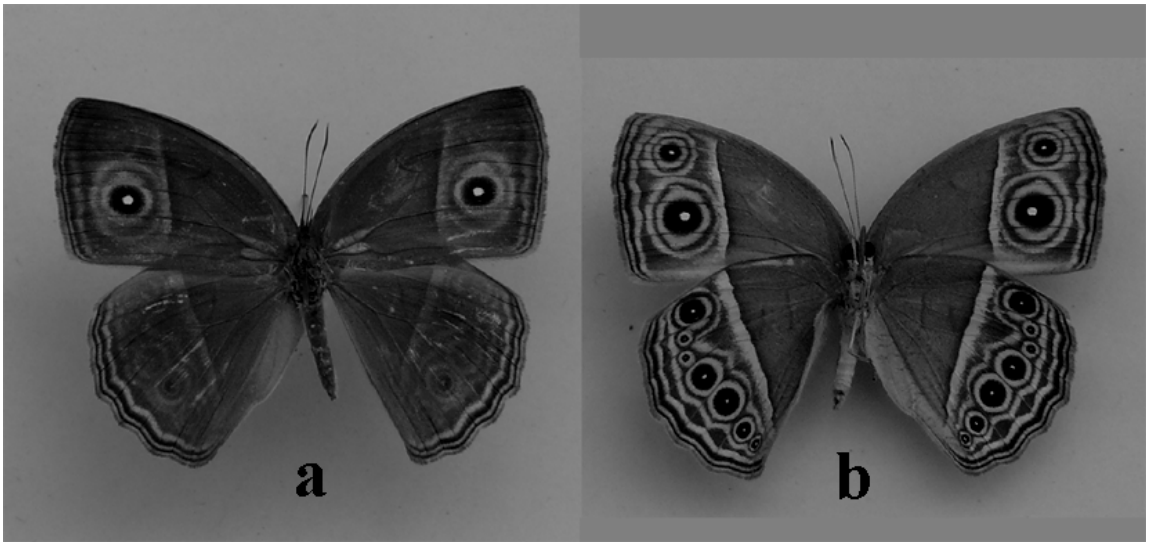

Plate 5. Upperside (a) and Underside (b) views of *Mycalesis mineus* WSF adult

Seasonal fluctuations in the numbers of WSF and DSF adults

WSF and DSF adults appeared in April and October, and formed a peak in May and November, respectively. The peak of the DSF was far higher as compared to that of the WSF. The transitions of DSF to WSF and WSF to DSF were found to occur around the early of March and October, respectively (Plate 6).

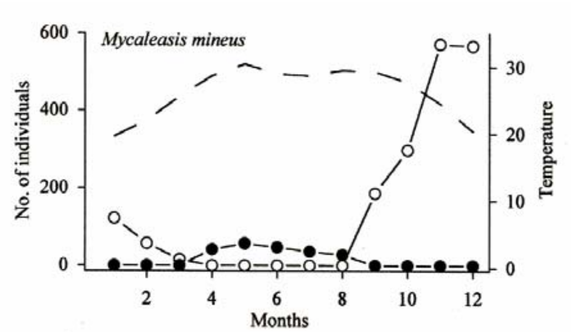

Fig. 6. Seasonal fluctuations in the number of DSF and WSF *M. mineus* adults (○ and ●) and the average temperature (a broken line)

Discussion

Seasonal polymorphism in the tropics and sub-tropics is an important ecological alternative to migration in space or time (diapause). Brakefield & Larsen (1984) described the occurrence of dry and wet season forms in a variety of tropical satyrid butterflies. The WSF and DSF are well separated by the number, shape, size, position and colour composition of eye-spots, tail and wings and the background colour pattern. The WSFs in *M. leda* and *M. mineus* are characterized by a well developed sub-marginal ring of eye-spots on the brown ventral surface of the wings while in the DSF these are greatly reduced or absent.

The development of seasonal morphs is determined by one or more environmental cues changing seasonally. The environmental control of the seasonal morphs is mediated by the hormonal system (Endo & Funatsu, 1985; Endo & Kamata, 1985). The induction of seasonal morphs development in tropical butterflies have been partly established for only a few species (McLeod 1968, 1984; Jones *et al*., 1985; Rienks 1985; Brakefield & Reitsma 1991; Jones 1992; Windig 1992). Janzen (1984) reported that in several Lepidoptera, temperature is of primary importance in regulating wing phenotype. Temperature was found to interact with photoperiod in pierid butterflies in the north of Australia and experiencing a small annual change in day length (Rienks, 1985). MCLeod (1968 & 1984) concluded that temperature was the only factor involved in the control of adult polymorphism in the nymphalid Precis octava in east Africa. Brakefield & Reitsma (1991) and Windig (1992) showed that different temperatures in final instar larvae of Bicyclus safitza induced different seasonal forms. Jones

(1992) also observed that the temperature strongly influenced polyphenism in Eurema spp., although temperature alone could not account for all the variations produced. Rienks (1985) and Jones et al. (1985) have also demonstrated that small changes in photoperiod in conjunction with temperature can affect wing phenotype in two tropical pierids. Brakefield & Larsen (1984), Brakefield (1987) and Brakefield & Reitsma (1991) proposed that the alternative phenotypes (i.e. WSF and DSF) represent responses to seasonal differences in environmental conditions and selective pressures such as the nature of predation. The prominent eye-spot patterns of WSF is thought to rely on anti predator devices which are displayed at rest and function principally in the deflection of attacks from vertebrate predators like lizards. In contrast, DSF butterflies have reduced or lacking of eye-spots and probably relies wholly on crypsis for survival.

In tropical and sub-tropical areas near the equator, photoperiod, the length of which shows a little fluctuation, may not be a suitable indicator for butterflies to determine the seasonal morphs development, such as WSF and DSF. In Satyrinae, the environmental factors regulating the seasonal morph development (WSF and DSF) were not apparent yet. However, we have an interesting report that WSF adult of *M. leda* were developed in the wet season by subjecting larvae to a relatively low humid (60%) condition (Owen, 1971). Roskam & Brakefield (1999) indicated that *M. leda* adults having the wings of DSF are developed by subjecting larvae to a low temperature experienced in the rainy season.

The seasonal fluctuation in the number of *M. leda* and *M. mineus* were more or less similar in the series of above results. The turnover from DSF to WSF coincided with rising temperature when increase in humidity and food plants occur. In contrast, the turnover from WSF to DSF was found at declining temperature, resulting in low humidity and less food plant Brakefield (1987) and Brakefield & Reitsma (1991) reported similar observation. Seasonal polymorphism is linked with seasonal changes in breeding status which in turn is associated with changes in habitat favourably.

The results of our study imply that temperature, photoperiod and humidity play a crucial role in regulating seasonal morphs development in *M. leda* and *M. mineus*.

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