

MORPHOMETRIC VARIATION IN THE SPECIES OF TWO SUBFAMILIES OF LYCAENID BUTTERFLIES (LEPIDOPTERA: LYCAENIDAE) OF BANGLADESH

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Abstract

A laboratory examination was done on the morphometric variation of lycaenid butterflies. Identifying characteristics, *viz.* forewing length (FWL), hind wing length (HWL), body length (BdL) and antennal length (AntL) were used for the analysis. A total of 514 individuals of lycaenid butterflies was identified under two subfamilies Polyommatainae and Theclinae. Among them 265 individuals were placed under 19 species of Polyommatainae and 249 individuals under 25 species of Theclinae. ANOVA tests were conducted to find differences between the butterfly species of the two subfamilies through identifying characters like FWL ($F=10.37$, $P=0.005$), HWL ($F=3.81$, $P=0.067$), BdL ($F=5.78$, $P=0.027$) and AntL ($F=2.77$, $P=0.114$). A linear regression analysis of FWL, HWL, BdL and AntL of the species under the two subfamilies showed significant differences between Polyommatainae and Theclinae. These differences stand among the species of both the subfamilies and produced good results to identify the species more correctly.

Key words: Lycaenidae, butterfly, species, morphometric variation, Polyommatainae, Theclinae.

INTRODUCTION

Morphometrics is the study of any quantitative measurement and analysis of morphological traits affecting on it (Digo *et al.* 2015). Lycaenidae is commonly known as ‘Gossamer-winged butterflies’ comprising a huge number of species– an estimated 6,000 species worldwide, with greatest diversity in the tropics (Ackery and Vane-Wright 1984, Fiedler 1996). They are remarkably uniform considering the number of species and genera (Ehrlich and Raven 1964). All of them are rather small in size, brilliantly coloured, and frequently showing marked sexual dimorphism (Roberts 2001).

The lycaenids under the subfamily Polyommatainae are found in all major bio-geographical areas of the world, with the highest diversity of species reported from North America, Europe and Asia (Eliot 1973). This is a large subfamily. The butterflies of this subfamily are commonly known as “Blues”. Theclinae is the largest diversified subfamily of family Lycaenidae and well-represented in all regions particularly in the tropics. Butterflies of this subfamily are commonly known as “Hairstreaks”.

The wing shape morphology of insects is extensively studied to clarify the relationship between closely related taxa and helps in identifying population within and between species of insects (Baylac *et al.* 2003, De la Riva *et al.* 2001, Villegas *et al.* 2002, Aytakin *et al.* 2007, Tuzun 2009). Wing measure, either wing length or wing span, is the most commonly used measure of body size in Lepidoptera (Miller 1977, 1991). Morphological shape is the most evidential aspect of an organism’s phenotype. It provides a strong linkage between species genotype and its environment (Ricklefs and Miles 1994). ‘Environmental-cause variations’ among individuals of the same species differ and depend on the individual’s ability to defend the problems in the environment (Digo *et al.* 2015). Changes and fluctuations in the environment represent selective pressures upon the population because both the environment and the amount of energy fixation in any given ecosystem are limited (Bashar 2016). Most of the morphological variations in moth and butterflies are due to the effects associated with the environment, whether phenotypic responses or particularly those which act during ontogenetic development (Mutanen *et al.* 2007). The overall pattern or venation is often a diagnostic feature of butterflies (Fres 1989).

An attempt was made in the present study to examine the taxo-morphological characters of lycaenid butterflies of Bangladesh.

MATERIAL AND METHODS

Butterflies are seen almost in all areas of Bangladesh either cultivated or non-cultivated (forest areas) areas because they need such an ecological condition where their required plants are available (Bashar 2015). Lycaenid butterflies were collected from different forest areas of Bangladesh, namely Karerhat, Sitakundo, Mirsarai, Chunati, Fashiakhali, Eidgaon, Tonkabati, Padua of Chittagong division, Anarashbari, Satchari, Chautali, Nurjahan, Laowachara, Phoolbari, Rema-Kalenga of Sylhet division, Madhupur and Bhawal Sal forests of Dhaka division from the years 1999 to 2009. In addition some butterflies were collected from Gojni in Sherpur district, Bangladesh Agriculture University Campus in Mymensingh and Dhaka University area.

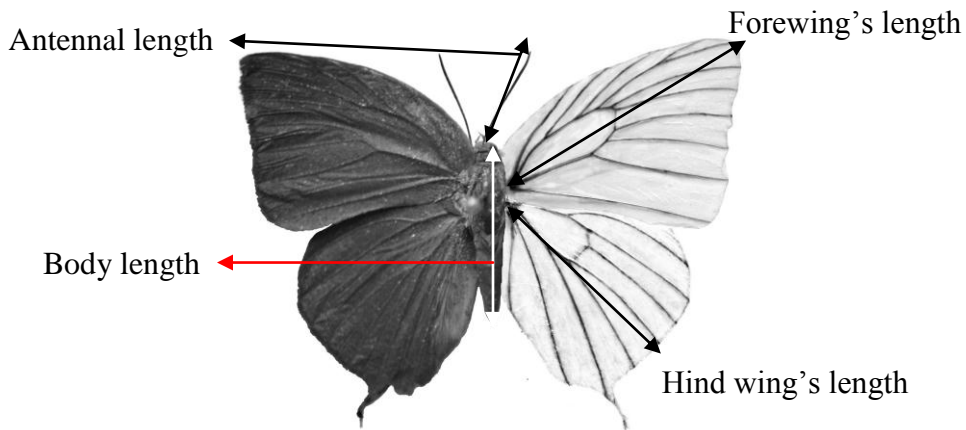


Fig. 1. Morphometric measurement of the identifying characteristics of a typical lycaenid butterfly.

Taxonomic study and identification of dry preserved lycaenid butterflies were made in the Environmental Biology and Biodiversity Laboratory (EBBL), Department of Zoology, University of Dhaka. Identification up to the species level under two subfamilies, namely Polyommatainae and Theclinae of the family Lycaenidae, was followed according to De Nicevelle (1890), Bethune-Baker (1903), Bingham (1907), Evans (1957), Eliot (1973), Pinratana (1981), Hirowatari (1992) and Ek-Amnuay (2006).

A clear transparent measuring scale was used for measuring the identifying variables (Fig. 1). Body length (BdL) was measured from head to tip of abdomen. Forewing's length (FWL) was measured from base to apex of the fore wing. Hind wing length (HWL) was measured from the base to the middle of termen of hind wing. Distance from base to tip of antenna is estimated as antennal length (AntL). Relationships of all the identifying characteristics (*viz.* forewing length, hind wing length, body length and antennal length) examined in the experimental specimens were performed by using Pearson correlation and ANOVA test. All statistical analyses were performed using SPSS software (version 16), ORIGIN software (version 8) and Microsoft Office Excel 2007.

RESULTS AND DISCUSSION

Most of the species of Polyommatainae were purple and iridescent blue with a mixture of violet, bronze and brown in colour depending on whether they are male or females. Kehimkar (2008) reported that the upper sides of males are violet, whereas in females the upper sides are blue or purple or dull bronze or brown in colour. They also have a complex pattern of dark spots and bands on the ventral side.

They have rounded wings which are either tailed or tail-less. The antennae of these butterflies are club shaped and more or less flattened. Most of them are weak fliers, regularly seen on flowers or hovering around the food plants. Their flight is often low, erratic and up and down, and may be difficult to follow (Wauer 2002). Though some occur in dense forests, most of them are seen in open grassy areas and drier deciduous forest (Kehimkar 2008).

Table 1. Morphometric measurements (in cm) of identified species under the two subfamilies of the family Lycaenidae collected from different places of the country from the years 1999 to 2009.

Sub family	Species	N	Forewing length		Hind wing length		Body length		Antennal length	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Polyommatainae	<i>Pseodozizeeria maha</i>	29	12	10-12	9.58	8-10	8.08	6-10	5.06	4-6
	<i>Zizina otis</i>	28	9.92	8-10	7.92	6-8	7.89	6-8	4.76	4-6
	<i>Neopithecops zalmora</i>	5	10.4	10-12	8.8	8-10	8.4	8-10	6	5-7
	<i>Megisba malaya</i>	2	13	12-14	9	8-10	8	-	8	7-9
	<i>Chilades lajus</i>	8	13.75	12-14	10.5	10-12	8.33	8-10	6	6-7
	<i>C. pandava</i>	3	13.33	12-14	11.33	10-12	9.33	8-10	6.66	6-7
	<i>Nacaduba pavana</i>	2	15	14-16	11	10-12	11	10-12	8	7-8
	<i>N. kurava</i>	5	15	14-16	11	10-12	11.33	10-12	8	7-8
	<i>Catochrysops strabo</i>	6	15.66	14-16	11.66	10-12	10.66	10-12	7	7-8
	<i>Tarucus callinara</i>	2	13	12-14	11	10-12	9	8-10	7	6-7
	<i>Castalius rosimon</i>	78	14.65	14-16	10.62	10-12	10.03	8-12	7	6-7
	<i>Discolempa ethion</i>	1	12	-	8	-	10	-	6	-
	<i>Caleta decidia</i>	2	14	-	10	-	10	-	6	-
	<i>Jamides bochus</i>	1	14	-	10	-	10	-	7	-
	<i>J. alecto</i>	9	17	16-18	13	12-14	12.8	12-14	8.5	8-9
	<i>J. celeno</i>	55	16.4	14-18	12.38	10-14	10.81	8-12	7.77	7-9
	<i>Lampides boeticus</i>	6	16	-	12	-	12	-	6	-
	<i>Euchrysops cnejus</i>	6	15.33	14-16	11.33	10-12	11.33	10-12	6	6-7
	<i>Anthene emolus</i>	17	14.62	14-16	10.62	10-12	11.23	10-12	8	8-9
Theclinae	<i>Arhopala amantes</i>	12	24.25	22-28	20.25	18-24	17	14-20	10	10-12
	<i>A. pseudocentaurus</i>	99	27.60	24-30	21.58	18-24	17.54	14-20	10.55	10-12
	<i>A. nicevillei</i>	2	24	22-26	22	20-24	15	14-16	9	8-10
	<i>A. athada</i>	4	21.5	20-24	17.5	16-20	12.5	12-14	8.5	8-10
	<i>A. silhetensis</i>	2	24	22-26	22	20-24	15	14-16	9	8-10
	<i>A. agaba</i>	7	21.42	20-24	17.42	16-20	14.33	12-16	8	8-10
	<i>A. alesia</i>	3	20.66	20-22	16.66	16-18	12.66	12-14	8.66	8-10
	<i>A. eumolphus</i>	5	21.2	22-26	19.6	20-24	14.8	14-16	9	8-10
	<i>Flos fulgida</i>	1	20	-	18	-	14	-	7	-
	<i>Surendra quercetorum</i>	3	20	18-22	18	16-20	14.66	14-16	8.66	8-10
	<i>Loxura atymnus</i>	38	18.02	14-20	14.58	10-16	11.73	8-14	7	6-8
	<i>Ticherra acte</i>	1	16	-	14	-	12	-	7	-
	<i>Iraota timoleon</i>	1	20	-	16	-	18	-	12	-
	<i>Deudorix epijarbas</i>	10	16.4	14-18	12.6	10-14	14.28	12-16	9	8-10
	<i>Rapala manea</i>	6	16	14-18	12	10-14	13	12-14	9.33	8-10
	<i>R. pheretima</i>	6	18.66	18-20	14.66	14-16	12.66	12-14	8.66	8-10
	<i>R. iarbus</i>	4	16.5	14-18	12.5	10-14	13.5	12-14	9	8-10
	<i>R. dienece</i>	2	15	14-16	11	10-12	11	10-12	9	8-10
	<i>Spindasis syama</i>	7	17.14	14-18	13.14	10-14	12	10-14	7.5	6-8
	<i>S. lohita</i>	1	18	-	14	-	14	-	8	-
	<i>S. nipalicus</i>	3	14.66	14-16	10.66	10-12	11.33	10-12	8	-
<i>Dacalana burmana</i>	1	18	-	16	-	12	-	8	-	
<i>Remelana jangala</i>	5	19.2	18-20	15.2	14-16	13.2	10-14	9.5	8-10	
<i>Hypolycaena erylus</i>	23	16.09	14-18	12.38	12-14	11.83	10-14	8	7-8	
<i>Chliaria othona</i>	3	12.66	12-14	10.66	10-12	10.66	10-12	7.33	6-8	

Polyommatainae (Species no = 19, Total individuals, N = 265); Theclinae (Species no = 25, Total specimen, N = 249);

Millimetre (mm) is used as measurement unit.

The colour of the butterflies of Theclinae ranges from iridescent blues and greens to dull browns and grey. Males are usually bright metallic iridescent blue, green or purple on the upper side, while females are mostly brown on the upper side (Kehimkar 2008). Many of them have one or two hair-like tails on the hind wing and most of them have wavy or broken lines on the lighter coloured under surface, likely giving rise to the common name of hairstreak. Often there is a dark spot, called a “thecla spot” above the tails on the ventral surface. The butterflies in this subfamily have the antenna club in cylindrical shape. Most species have a habit of rubbing their hind wings back and forth while feeding. This special behaviour is believed to draw a predator’s attention by the butterfly to its less vulnerable rear end rather than to its head (Wauer 2002). Most members of this subfamily are fast flyers and visit flowers regularly. They are fully forest dwellers and found in the forest that are more stable conditions and undisturbed.

A total number of 514 individuals belonging to two subfamilies, viz. Polyommatae and Theclinae of lycaenid butterflies were examined morphometrically. Among them, 265 and 249 individuals belonging to 19 species of the subfamily Polyommatae and 25 species of the subfamily Theclinae, respectively are shown in Table 1.

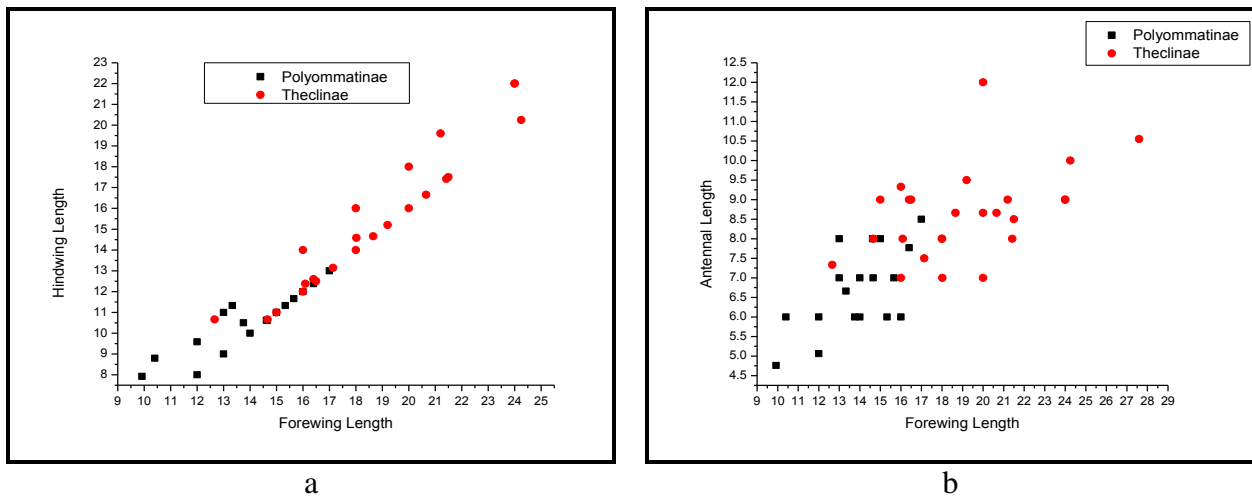


Fig. 2. Relations between forewing-hind wing length and forewing-antennal length among the species examined. a. Forewing-hind wing length (FWL-HWL), b. Forewing-antennal length (FWL-AntL).

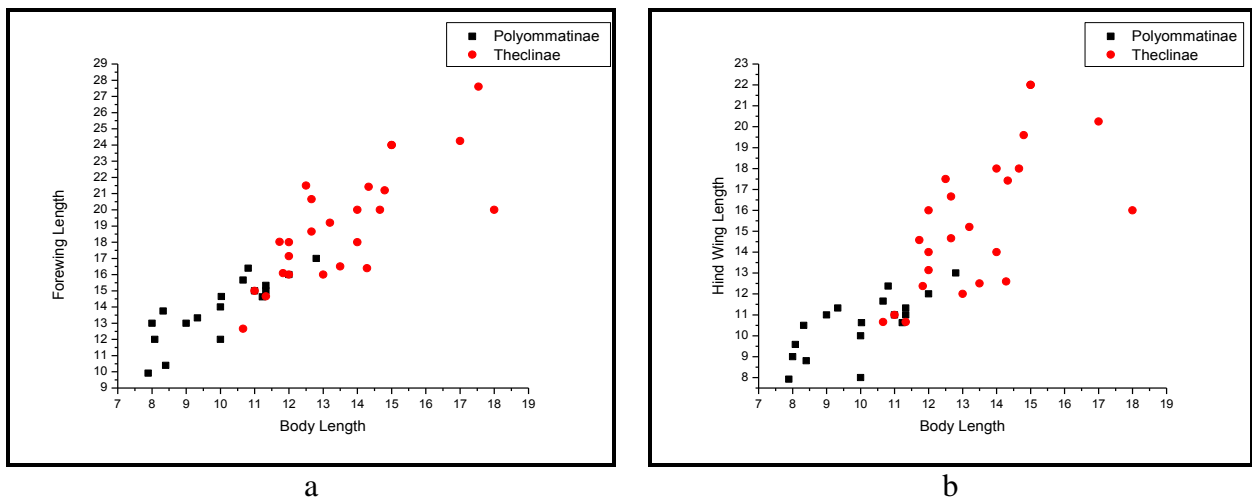


Fig. 3. Relations between body length-forewing length and body length-hind wing length among the species examined. a. Body length-forewing length (BdL-FWL), b. Body length-hind wing length (BdL-HWL).

Morphometric analyses are found useful for species identification and classification. By this experiment, *Jamides alecto* was identified as the largest butterfly having 12-14mm BdL and FWL ranges 16-18mm, whereas *Zizina otis* was the smallest butterfly having 6-8mm BdL and FWL ranges 8-10mm under the subfamily Polyommatainae. On the other hand, *Arhopala pseudocentaurus* was the largest lycaenids having 14-20mm BdL and FWL ranges 24-30mm, whereas *Chliaria othona* having 10-12mm BdL and FWL range 12-14mm was the smallest under the subfamily Theclinae (Table 1).

The relationship of hind wing length and antennal length with forewing length of the species as well as the relationships of forewing length and hind wing length with body length of the species under subfamilies Polyommatainae and Theclinae are plotted in Figs. 2 and 3, respectively. A linear positive relationship was established between the forewing length and hind wing length of the lycaenid butterflies of both subfamilies (Fig. 2a); linearity is also seen between the forewing length and antennal length (Fig. 2b). Between body length and forewing length of the lycaenids, a linear relationship developed in which the forewing length increases linearly with the body length (Fig. 3a), and hind wing length was also linearly increased with the body length (Fig. 3b).

Species of the two subfamilies differ significantly in average size. Mean values with standard deviations for each character are shown in Table 2. FWL, HWL, BdL and AntL between the species of two subfamilies are negatively correlated (Table 2). It has been assessed that differences between Polyommatainae and Theclinae with the identifying characters FWL ($F=10.37$, $P=0.005$), HWL ($F=3.81$, $P=0.067$), BdL ($F=5.78$, $P=0.027$) and AntL ($F=2.77$, $P=0.114$) of the species are highly significant. It was found that species of Polyommatainae are morphologically smaller than that of the species of Theclinae. This study also reveals morphological variations among lycaenid butterflies of each species.

Table 2. Relationship and differences of identifying characters between subfamilies Polyommatainae and Theclinae.

Characters	Polyommatainae		Theclinae		Relations <i>r</i>	Differences	
	Avg.	SD(±)	Avg.	SD(±)		<i>F</i>	<i>P</i>
FWL	13.95	1.91	19.06	3.50	-0.62	10.37	0.005
HWL	10.51	1.39	15.78	3.60	-0.43	3.81	0.067
BL	10.01	1.45	13.56	1.97	-0.50	5.78	0.027
AL	6.77	1.07	8.66	1.14	-0.37	2.77	0.114

Identifying morphological traits were used to test differences between the populations of two subfamilies of lycaenid butterflies and recognize morphometric units within the species. A total number of 44 species under Polyommatainae and Theclinae subfamilies was identified having 19 species of 15 genera under Polyommatainae and 25 species of 13 genera under Theclinae. Morphological differences in identifying criteria have been considered as vital evidences for identification at species level. The results provide a taxonomic working frame. This gives us essential technique for pointing out inter and intra-specific variation in lycaenid butterflies.

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