Khulna University Studies **Volume 16(1 & 2): 19-32 : 2019**

LIFE SCIENCE

A CHECKLIST OF BUTTERFLIES (LEPIDOPTERA: RHOPALOCERA) OF KHULNA DISTRICT, BANGLADESH

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KUS:19/03: 190219

Manuscript received: February 19, 2019 Accepted: September 04, 2019

Abstract: A survey was conducted to annotate the butterflies (Lepidoptera: Rhopalocera) of Khulna for the duration of August 2015 to August 2018. A total of 53 species belonging to 44 genera and 6 families were listed. Nymphalidae was recorded as the most dominant family with 14 genera and 19 species followed by Lycaenidae (13 species), Hesperiidae (8 species), Pieridae (7 species), Papilionidae (5 species) and a Riodinidae species. Among ten administrative upazilas Khulna sadar has the highest species richness with 41 species, followed by Phultala (36), Paikgacha (34), Dacope (31), Koyra (31), Rupsha (30), Terokhada (30), Digholia (29), Batiaghata (29) and Dumuria (28), respectively.

Keywords: Checklist, Butterflies, Lepidoptera, Rhopalocera, Khulna, Bangladesh.

Introduction

Butterflies are one of the most fascinating insect community and significant member of the order Lepidoptera. They play vital role in ecosystem functioning as pollinators. Those are also a convenient indicator for understanding the condition of both natural and modified ecosystems (Oostermeijer and Swaay, 1998; Bashar *et al.*, 2005; Fleishman and Murphy, 2009; Rákosy and Schmitt, 2011; Islam *et al.*, 2013. Species richness of butterflies varies in different ecological niches. Tropics and sub-tropics are the most diversified region (Devries and Walla, 2001). According to Heppner (1998), the species count of butterflies could cross 19,238 species whereas Landing (1984) listed 16,823 species and Shields (1989) mentioned 17,280 species globally.

Larsen (2004) recorded 236 species from different regions of Bangladesh whereas, Ahmad *et al.* (2009) annotated 148 species from Bangladesh. In recent years a few species were first time recorded from different regions of Bangladesh (Khan, 2014; Khan *et al.*, 2014; Rahman *et al.*, 2016; Neogi *et al.*, 2016) and at present 378 species are known in Bangladesh (Shihan, 2016). In addition to that Bashar (2014, 2015) listed 325 species of butterflies from the country. Till to date, several regional studies were conducted to annotate the regional diversity of butterflies. Alamand Ullah, (1995) recorded 22 species from the Chittagong University campus which is later updated to 142 species by Haider *et al.* (2017). A total of 49 species were also recorded from Tangail District by Khan and Islam, (2001) while 121 species were recorded from the eastern border by Chowdhury and Mohiuddin (2003). Also, 51 species were recorded from Jahangirnagar University campus by Hossain *et al.* (2003) and 160 species were recorded from the Lawachara Natinal Park, Moulavibazar by Khandokar *et al.* (2014). Furthermore, 37 species from the Sundarbans by Hossain (2014), 71 species from Dinajpur by Chowdhury *et al.* (2014), 49 species from Chuadanga by Shihan (2014), 74 species from the Rema-Kalenga Wildlife Sanctuary, Habiganj by Shihan and Mohammed (2014) and 19

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DOI: https://doi.org/10.53808.KUS.2019.16.1and2.1903-L

species of Nymphalidae from deciduous forest of Kaliakayer, Gazipur by Islam *et al.* (2015) were recorded by some studies in different region of Bangladesh. The Khulna region located in the southwestern region of Bangladesh are known for rich insect diversity (Tuhin and Khan, 2018; Biswas*et al.*, 1980). However, until now very few studies were conducted to annotate the butterflies of Khulna. The current study is an initiative to document the current butterfly diversity of Khulna region.

Materials and Methods

Study site: The present study was conducted throughout the administrative district of Khulna from August 2015 to August 2018. Khulna district lies between 22.871N to 22.968° N and 89.245° to 89.338° E with an area of 4,389.11 km² (Fig 1). The Khulna region have a vast coastal areas experiencing tidal inundations regularly and rich with cultivated land, canals and ponds, wetlands, planted and natural vegetation including herbs, shrubs and trees which serve as host plants for butterflies. The area experiences a mild winter from October to March, hot and humid summer from March to June and humid, warm rainy monsoon from June to October. The average temperature varies from 12-15℃ (minimum) to 41-45^{0}C (maximum) and the average annual precipitation varies from 368 mm to 393mm (BBS, 2014).

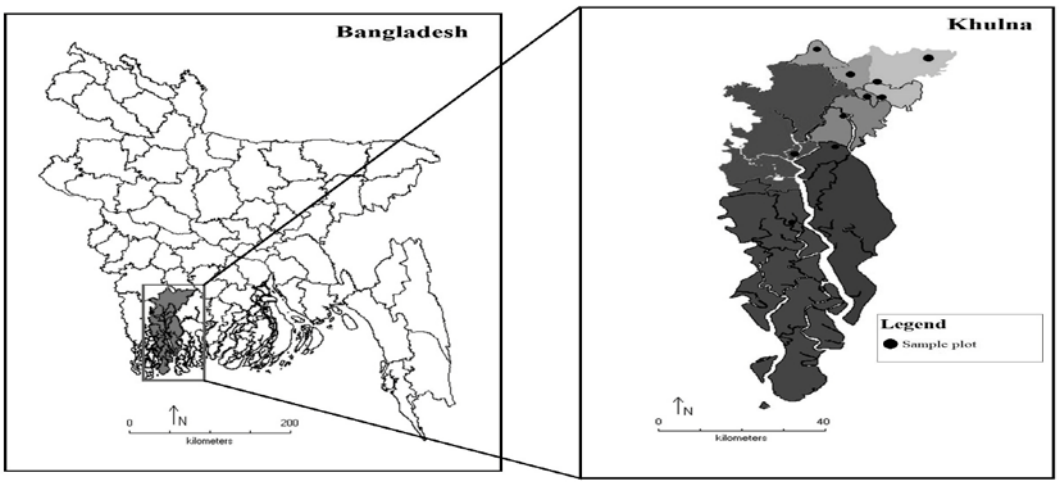


Fig. 01:Map of Khulna district marked with surveyed sites.

Sampling design: Field visits were conducted throughout different localities of Khulna by covering all upazilas and thanas such as Khulna sadar, Phultala, Paikgacha, Dacope, Koyra, Rupsha, Terokhada, Digholia, Batiaghata and Dumuria from August 2015 to August 2018 (table 1). Weekly, monthly and bi-monthly visits with visual observation and opportunistic survey were done by walking through all possible habitats such as river bank, forest patches, mangroves, pond side, open fields, agricultural croplands, urban areas and semi-urban areas to annotate butterflies of the study site (Larsen, 2004; Khan and Neogi, 2014). The butterflies were photographed for various morphological features with Nikon-3200D camera with Nikkor 18-55mm AF-S DX, Nikkor 55-300mm AF-S DX and Micro-Nikkor 105 mm FX AF lenses. To minimize the killing of butterflies and accurate identification, only visually unidentifiable specimens were collected with an insect sweeping net. Species identification were done with the help of taxonomic keys provided by Marshal and de Nicéville (1882); Moore (1874, 1890–1992, 1893–1896, 1896–1899, 1899–1900, 1901–1903, 1903–

1905); Evans (1932); Wynter-Blyth (1957); Arora *et al.* (1986); Bingham (1905); Kunte (2000); Kehimkar (2008); Singh (2010); Kunte *et al.* (2012) and Bashar (2014, 2015). A species was considered very common (VC) by listed over 75% of the total observation days; common (C) with 50-74% observation days, 25-49% were counted uncommon (UC) and rare (R) ware counted less than 25%observation days.

Table 01:A list of locations in Khulna District of Bangladesh surveyed during the study period. (UR= Urban, MG= Mangroves, FP= Forest Patches, RS= River Side, WL= Wet Lands, NH= Natural Herbs, CF= Crop Field)

Plot no	Location	Latitude	Longitude	No. of species	Habitat	Date Visited
1.	Khulna City	22.801 °N	89.533 °E	41	UR, CF	Weekly
2.	Phultala	22.952 °N	89.474 °E	36	NH, UR, FP	Bi-monthly
3.	Digholia	22.899 °N	89.547 °E	29	RS, NH, CF	Bi-monthly
4.	Rupsha	22.773 °N	89.587 °E	30	MG, CF	Monthly
5.	Padmabil, Terokhada	22.973 °N	89.711 °E	26	NH, WL	2.ix.2016, 6.vi.2016, 18.xi.2017, 9.v. 2018
6.	Aichgati, Terokhada	22.835 °N	89.607 °E	28	UR, FP, RS	7.ix.2016, 11.v.2016, 19.vi.2017, 27.i.18
7.	Batiaghata	22.726 °N	89.502 °E	29	RS, MG, NH	Monthly
8.	Dumuria	22.866 °N	89.405 °E	28	NH, WL, FP	Monthly
9.	Paikgacha	22.590 °N	89.324 °E	34	RS, MG, UR	9.vii.2017, 31.xi. 2017
10.	Dacope	22.601 °N	89.512 °E	31	RS, FP, MG	17.ix.2017, 15.ii.2018
11.	Koyra	22.351 °N	89.284 °E	31	RS, FP, MG	30.ii.2018, 17.v.2018

Results

A total of 53 species belonging to 44 genera and six families were recorded from the study area. Nymphalidae was the most dominant family with 14 genera and 19 species followed by Lycaenidae (12 genera, 13 species), Hesperiidae (8 genera, 8 species), Pieridae (6 genera, 7 species), Papilionidae (3 genera, 5 species) and Riodinidae (only one species) (table 2). Among the genera, Junonia was the most dominant genus with 4 species followed by Papilio (3), Catopsilia (2), Danaus (2), Tarucus (2) and Ypthima (2) (table 2; fig. 2). Only a single species was recorded from 38 genera (table 2; fig. 3).

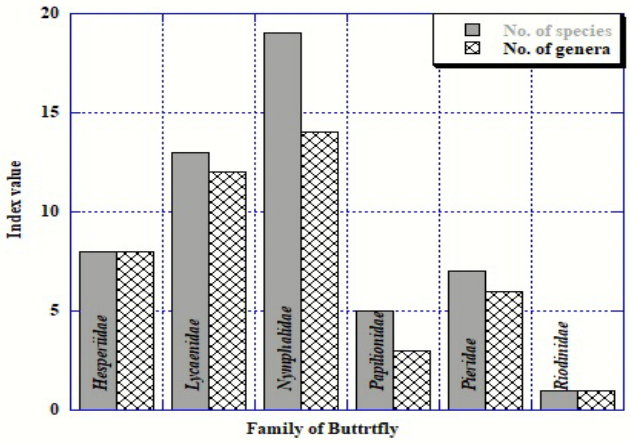


Fig. 02: Species richness of the butterfly families recorded from different areas of Khulna district

A maximum of 41 species of butterflies were recorded from Khulna sadar upazila followed by Phultala (36), Paikgacha (34), Dacope (31), Koyra (31), Rupsha (30), Terokhada (30), Digholia (29), Batiaghata (29) and Dumuria (28) (table 2; fig. 3). Among 53 species, 17 was very common (VC), 9 was common (C), 15 was uncommon (UC) and 9 was rare (R). *Erionota torus*, *Matapa aria*, *Leptotesplinius* and *Tarucusananda* was extremely rare (ER) and cited only once during the study period.

Table 2: A list of butterflies distributed in different upazilas of Khulna. (RA= Relative Abundance, KSU= Khulna Sadar Upazila; TRU= Terokhada Upazila, BAU= Batiaghata Upazila, PHU= Phultala Upazila, RSU= Rupsha Upazila, DIU= Digholia Upazila, DMU= Dumuria Upazila, PKU= Paikgacha Upazila, KOU= Koyra Upazila, DAU= Dacope Upazila)

SL	Species	RA	KSU	TRU	BAU	PHU	RSU	DIU	DMU	PKU	KOU	DAU	Distribution in Bangladesh
Family: Papilionidae													
	Graphiumagame mnon (Linnaeus, 1758)	UC	✓	✓	✓				✓	✓			JU Campus, Lawachara NP, Nizampur
	Pachlioptaaristolo chiae (Fabricius, 1775)	C	✓		✓	✓		✓		✓	✓	✓	JU Campus, Lawachara NP, Sitakunda, Rangamati, Sundarban, Bandarban, Nizampur
	Papiliodemoleus (Linnaeus, 1758)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Papilionephelus (Boisduval, 1836)	R	✓										CU Campus, Lawachara NP, Sitakunda, Rangamati, Nizampur
	Papiliopolytes (Cramer, 1775)	C	✓	✓		✓	✓	✓		✓			Widely Distributed
Family: Pieridae													
	Appiasolferna (Swinhoe, 1890)	UC	✓			✓				✓	✓		Chittagong Hill tract, Chuadanga, JU Campus
	Catopsiliapomona (Fabricius, 1775)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Catopsiliapyranth e (Linnaeus, 1758)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Ceporanerissa (Fabricius, 1775)	R	✓					✓		✓			Widely Distributed

SL	Species	RA	KSU	TRU	BAU	PHU	RSU	DIU	DMU	PKU	KOU	DAU	Distribution in Bangladesh
	Delias eucharis (Drury, 1773)	UC	✓		✓			✓		✓	✓	✓	Chittagong Hill tract, Sylhet, Sundarban, JU Campus.
	Euremahecabe (Linnaeus, 1758)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Leptosianina (Fabricius, 1793)	R	✓			✓				✓			Widely Distributed
Family: Nymphalidae													
	Acraeaviolae (Fabricius, 1775)	R	✓						✓	✓			Eastern region, Central East, South East
	Ariadne merione (Cramer, 1777)	UC		✓	✓	✓		✓	✓	`			Widely Distributed
	Athymaperius (Linnaeus, 1758)	R	✓										JU Campus, Chittagong Hill tract, Lawachara NP, Nizampur
	Danauschrysippus (Linnaeus, 1758)	VC	✓	✓	✓	✓	✓	✓	✓		✓	✓	Widely Distributed
	Danausgenutia (Cramer, 1779)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Elymniashypermn estra (Linnaeus, 1763)	UC	✓				✓	✓	✓				Widely Distributed
	Euploea core (Cramer, 1780)	VC	✓	✓	✓	✓	✓	✓		✓	✓	✓	Widely Distributed
	Euthaliaaconthea (Cramer, 1779)	UC	✓			✓			✓	✓	✓	✓	JU Campus, Dhaka, Sitakundo, Chittagong Hill tract
	Hypolimnasbolina (Linnaeus, 1758)	UC	✓			✓		✓		✓	✓	✓	Sundarban, Chittagong Hill tract, Lawachara NP, JU Campus
	Junoniaalmana (Linnaeus, 1758)	VC	✓	✓	✓		✓	✓	✓	✓	✓	✓	Widely Distributed
	Junoniaatlites (Linnaeus, 1763)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Junoniahierta (Fabricius, 1798)	R								✓	✓	✓	Widely Distributed

SL	Species	RA	KSU	TRU	BAU	PHU	RSU	DIU	DMU	PKU	KOU	DAU	Distribution in Bangladesh
	Junonialemonias (Linnaeus, 1758)	UC		✓			✓	✓		✓			Widely Distributed
	Lebadeamartha (Fabricius, 1787)	C	✓			✓	✓	✓	✓		✓	✓	Chittagong Hill tract, Chuadanga, Lawachara NP
	Melanitisleda (Linnaeus, 1758)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Mycalesisperseus (Fabricius, 1793)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Tirumalalimniace (Cramer, 1775)	C	✓			✓	✓				✓	✓	Widely Distributed
	Ypthimaasterope (Klug, 1832)	R				✓				✓			Chittagong Hill tract, Chuadanga, Lawachara NP, Dhaka
	Ypthimabaldus (Fabricius, 1775)	UC			✓	✓	✓			✓	✓	✓	Widely Distributed
Family: Riodinidae													
	Zemerosflegyas (Cramer, 1780)	R	✓										Chittagong Hill tract, Dolhazra, Lawachara NP, Madhabkundo, Inani, Teliapara, Sitakunda
Family: Lycaenidae													
	Castaliusrosimon (Fabricius, 1775)	C	✓	✓	✓	✓	✓	✓	✓				JU Campus, National Botanical Garden, Sundarban, Lawachara NP
	Chiladeslajus (Stoll, 1780)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Curetisthetis (Drury, 1773)	C	✓		✓	✓	✓	✓	✓	✓		✓	Widely Distributed
	Euchrysopscnejus (Fabricius, 1798)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Leptotesplinius (Fabricius, 1793)	R				✓				✓			Lawachara NP, Rangpur, Chuadanga

SL	Species	RA	KSU	TRU	BAU	PHU	RSU	DIU	DMU	PKU	KOU	DAU	Distribution in Bangladesh
	Loxuraatymnus (Cramer, 1780)	C	✓	✓	✓						✓	✓	Widely Distributed
	Neopithecopszalmora (Butler, 1870)	C	✓		✓	✓	✓			✓	✓	✓	Widely Distributed
	Prosotasdubiosa (Semper, 1879)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
	Spalgisepeus (Westwood, 1851)	UC		✓		✓				✓	✓	✓	JU Campus, Sundarban, Chuadanga
	Tarucusananda (de Nicéville, 1884)	R				✓							South Eastern region
	Tarucusnara (Kollar 1848)	C	✓	✓	✓		✓	✓		✓			Widely Distributed
	Zizeeriakarsandra (Moore, 1865)	VC	✓	✓	✓	✓	✓	✓	✓		✓	✓	Widely Distributed
	Zizulahylax (Fabricius, 1775)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Widely Distributed
Family: Hesperiidae													
	Erionota torus (Evans, 1941)	UC	✓	✓	✓		✓		✓				South East, North East, Central
	Halpeporus (Mabille, 1877)	UC		✓	✓	✓							Chittagong Hill tract
	Iambrixsalsala (Moore, 1866)	UC	✓	✓			✓		✓	✓		✓	Chittagong Hill tract
	Matapa aria (Moore, 1866)	UC		✓					✓		✓		JU Campus, Chuadanga
	Oriensgola (Moore, 1877)	VC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Kaptai, JU Campus, Lawachara NP, Dhaka
	Pelopidas agna (Moore, 1866)	R				✓							Chuadanga, JU Campus
	Tagiadesjapetus (Fruhstorfer, 1910)	C		✓		✓	✓		✓	✓	✓	✓	Chittagong Hill tract, Lawachara NP, Dhaka, Chuadanga
	Udaspesfolus (Cramer, 1775)	R	✓										Chittagong Hill tract, Lawachara NP, Bhawal NP, Dhaka, JU Campus

* JU= Jahangirnagar University; NP= National Park; CU= Chittagong University

Discussion

Checklist of southwestern butterflies became updated with this study which recorded 53 species which covers 14% of the total butterfly fauna of Bangladesh. Previous studies from this region recorded Nymphalidae as the dominant butterfly family with 17 species (Hossain, 2014; Shihan, 2014). The present study also depicts Nymphalidae as the dominant family with 19 species. Nymphalidae was also dominant family in other regional checklists e.g. Islam *et al.* (2011); Hossain, (2014); Chowdhury *et al.* (2014) and Haidar*et al.* (2017). Two rare species (Shihan, 2016) of Bangladesh, *Tarucusananda* and *Tarucusnara,* were recorded during current study.

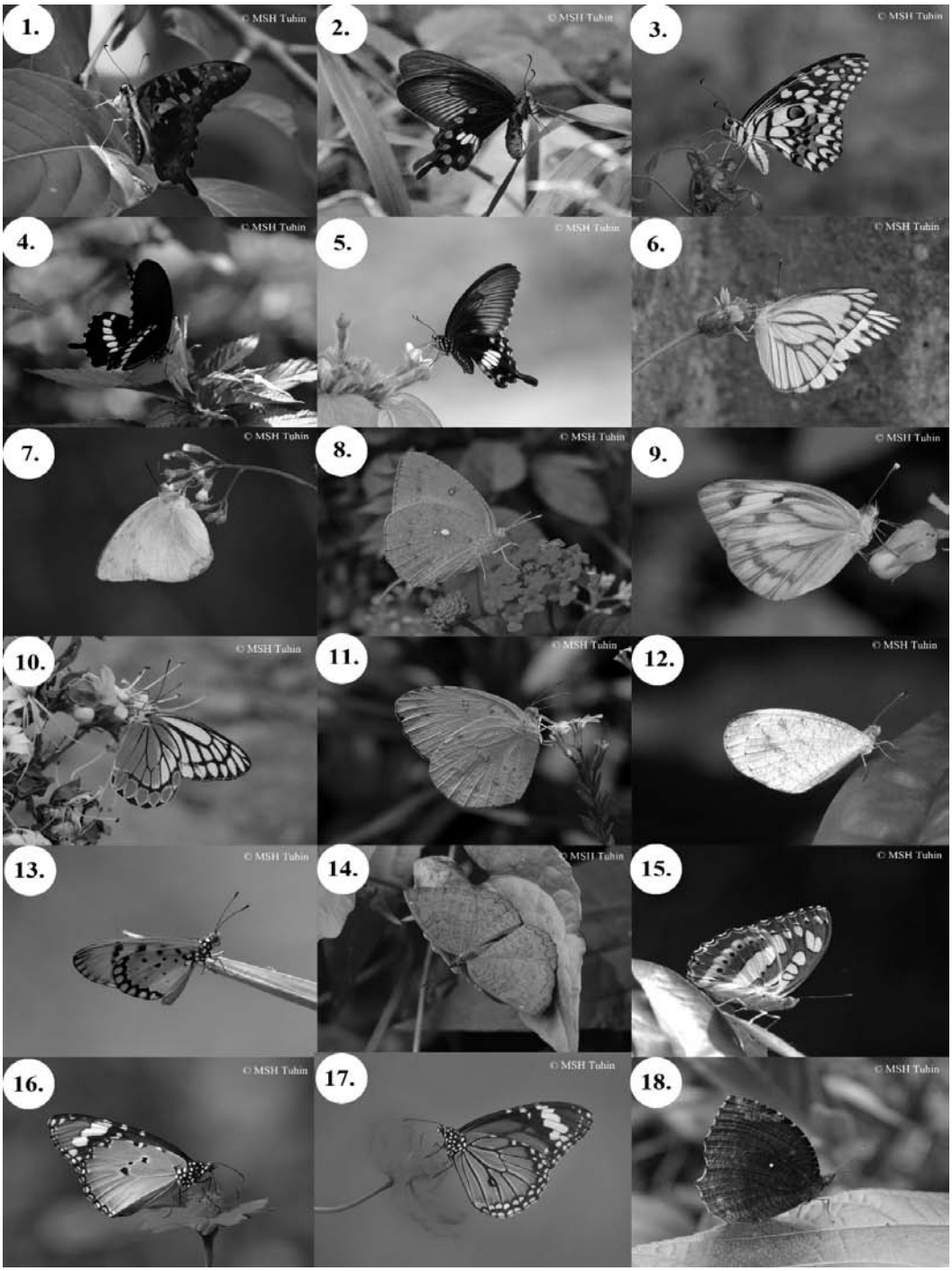
Among six recorded families Riodinidae comprise only a single species. Riodinidae is not an abundant family in Bangladesh and only four species recorded from the country (Larsen 2004). Papilionidae (5), Pieridae (7) and Hesperiidae (8) families also revealed low species richness and correlates with country's total of 35, 31 and 88 respectively (Larsen, 2004; Shihan, 2016). Nymphalidae (19) and Lycaenidae (13) were found as the two most dominant families in the present study. These two families are also listed as two major butterfly families in Bangladesh which possesses 14% and 9% of total Bangladeshi butterflies with 142 species and 133 species respectively (Larsen 2004; Bashar, 2014, 2015).

With 41 species, Khulna sadar was the most diverse site and sampling intensity were the highest as well. With Urban habitat and croplands, Phultala (36) and Paikgacha (34) showed higher species richness than other habitat types. Whereas, mangroves and wetlands found poor in species richness among others eg. Padmabil (26), Dumuria (28) and Dacope (31)(table 1).

Listed species have shown heterogeneity with habitat association and plant community e.g. *Castaliusrosimon*, *Euremahecabe*, *Euchrysopscnejus*, *Leptosianina* and *Spalgisepeus* were observed at grasslands. Whereas, *Junonia spp*. have been cited from all possible habitats of the study area. *Tirumala spp*. (tiger) and *Junonia spp*. (pansy) were also found very common throughout the study area except *Junoniahierta* (yellow pansy). *Junoniahierta* has found very rare and cited twice only at *Tridaxprocumbens* flower. *Spalgisepeus* and *Elymniashypermn estra* found at the close canopy of the vegetation with low light intensity areas. *Acraeaviolae* found only at *Turneraulmifolia* plant.

Except *Leptotesplinius* and *Tarucusananda*, all of the Lycaenidae species were more visible and equally distributed throughout the study area. Whereas, Hesperiidae found less than others and most of them were uncommon or rare except *Oriensgola.* Eight species found most dominant and found in all possible habitats of the study area. Meanwhile, *Papilionephelus*, *Zemerosflegyas* and *Tarucusananda* were rarest than all and cited from only one sample site (table 2).

A few of the study sites have some salinity and similar vegetation composition like the Sundarbans. At present study, we have found 20species from Khulna matches the checklist of Sundarbans (Hossain, 2014). A total of 33 species found new in comparison to the Sundarbans and a 24 species were newly discovered from the Khulna division in comparison of the checklist of Chuadanga by Shihan (2014). The present study showed the Khulna region is rich in butterfly diversity and invertebrate conservation should be carried out to maintain this diversity.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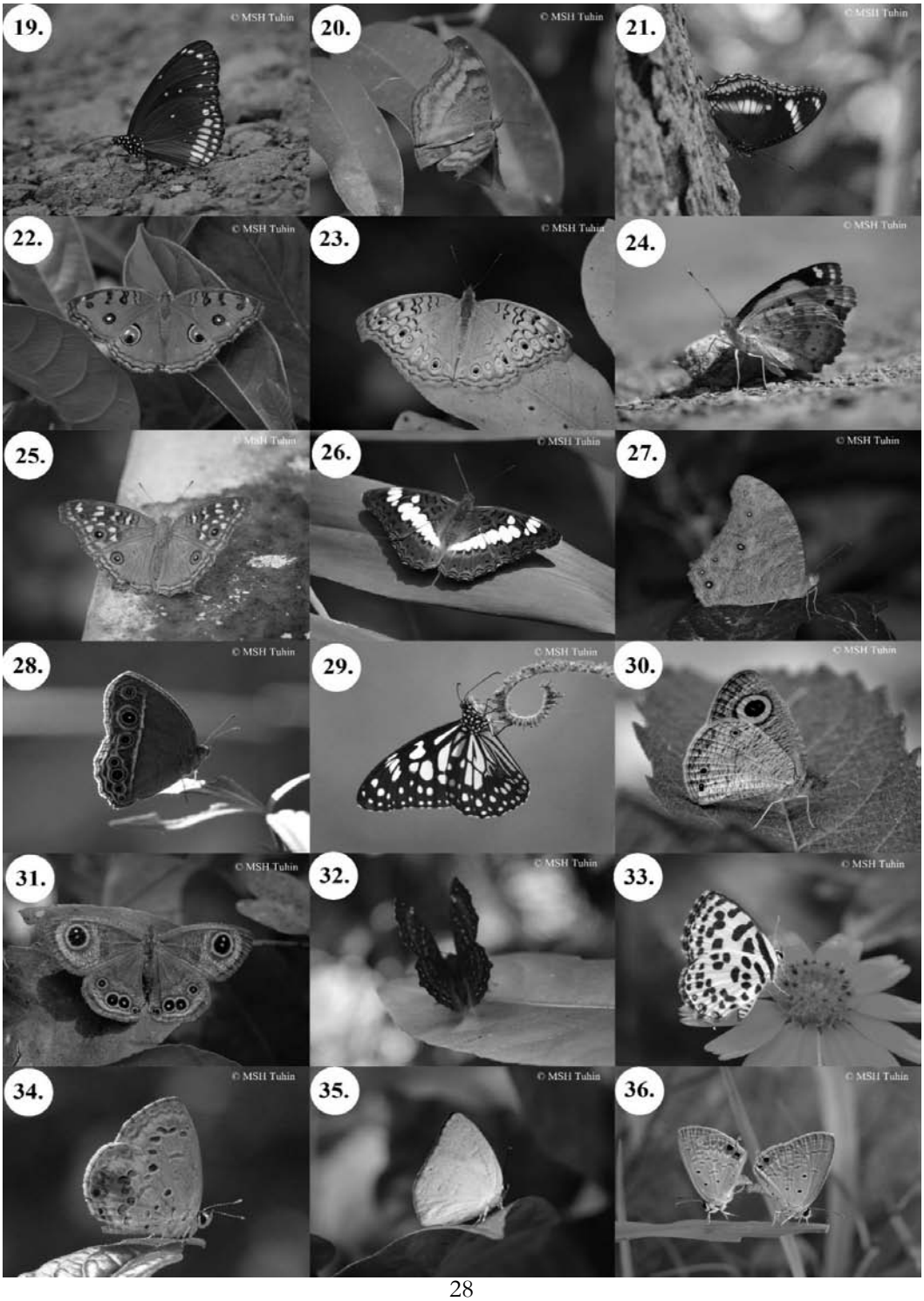
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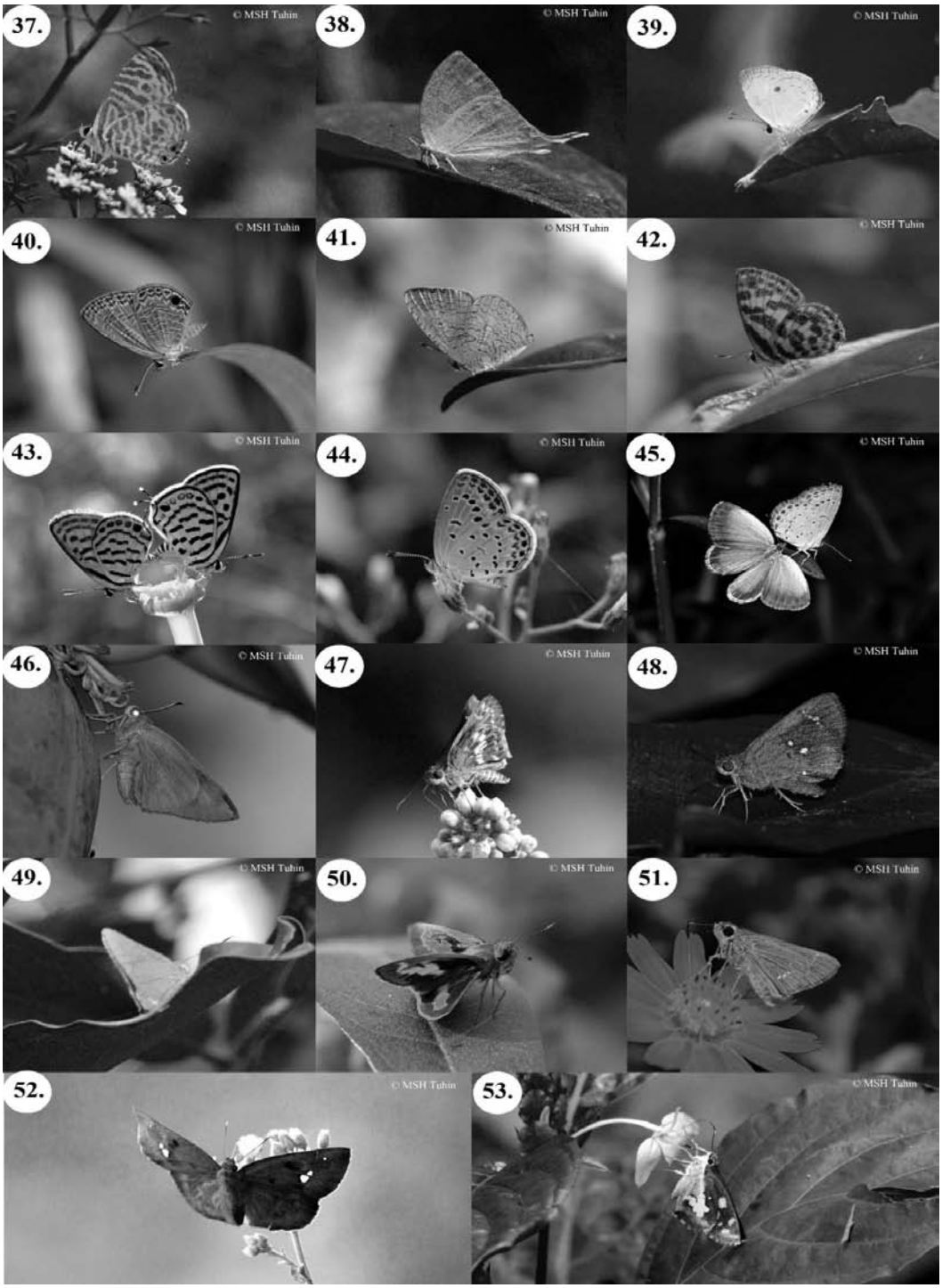

Fig.03: Image of the butterflies listed from Khulna district. (See Table 2 for corresponding names).

Acknowledgements: Authors are grateful to Md. Kawsar Khan, Department of Biochemistry and Molecular Biology, Shahjalal University of Science and Technology, for initial review and valuable comments.

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