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BUTTERFLIES DIVERSITY OF AGRICULTURAL FIELDS OF HOWRAH DISTRICT, WEST BENGAL, INDIA WITH SPECIAL REFERENCE TO THEIR HOST PLANTS IN AGROECOSYSTEM

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ABSTRACT
A systematic survey was carried out on butterflies of agricultural field, Howrah, West Bengal, India because it is now clear that agricultural fields are unique ecosystems that provide some butterflies to complete their life cycle. This side of agricultural fields is less highlighted so the main aim of this study to show how these fields serve butterflies and list of that butterflies which use these fields in their various purposes. On the other hand these fields are also decreasing gradually by the rapid growth of brick industries and other anthropogenic activities. So, the butterflies of these fields are also under risk. We present a list of 29 butterfly species from agricultural fields of this district. These fields contain 29 species belonging to the 5 families. The most dominant family is Nymphalidae (11 species) followed by Lycaenidae (9 species), Pieridae (4 species) and Hesperiidae (3 species). Papilionidae represent by only 2 species. Larval food plants of three families are found in agro ecosystems of this district. Presence of other supportive plants like adult food plants, basking and mating platforms also found in good numbers.

KEYWORDS: Butterfly, agricultural field, list, anthropogenic, risk, food plants, basking, agroecosystem.

INTRODUCTION

Butterflies are one of the most popular and easily recognized groups of insects. They are extremely important components of the bioindicators of the world (Chakaravarthy *et al*., 1997; Jana *et al*., 2009). Butterflies are potentially useful ecological indicators of urbanization because sensitive to changes in microclimate, temperature (Thomas *et al*., 1998). Increased urbanization one of the main cause of decreases in butterfly species richness, diversity and abundance (Blair and Launer, 1997; Clark *et al*., 2007; Pocewicz *et al*., 2009).The reduction in amount and quality of natural habitat associate with urban development negatively affect nature biodiversity (Malagrino *et al*., 2008). Butterflies serve as important plant pollinators in the local environment and help to pollinate more than 50 economically important plant crops (Borges *et al*., 2003). Butterflies serve the ecosystem especially by recycling nutrients (N, P, and K) essential for crops (Schmidt and Roland, 2006). Their larvae release faeces while feeding on the agrestals and provide required nutrients to the crops (Marchiori and Romanowski, 2006). Inspite of having a diverse and widespread impact on agricultural ecosystem, butterflies have attained scarcely any significant studies in this area in the tropical countries like India. Certain butterfly species are believed to be necessary to pollination of various wild plants and crops on which human beings depend on for their livelihoods (Boriani *et al*., 2005). The influence of butterflies on agroecosystem is better studied in Europe than in Indian sub continent (Tumuhimbise *et al*., 2001). As such, it becomes difficult to preserve them especially as pollinators of crops. The butterfly distributions are expected to cover with the distribution of their host plants even at small scales and type of vegetation may reflect difference in the composition of butterfly communities among habitats at the generic and family level (Beccaloni, 1997). The butterflies inhabiting natural areas, forests and protected areas are mostly studied in India (Thakur and Mattu, 2010). There is virtually has not been any published research works on agricultural butterflies ecology in India whereas, it is essential to have such data so far as the understanding of the butterfly biodiversity and conservation in agro ecosystem is concerned. Butterflies being important pollinating agents for wild and crop plants around the world, it has become expedient to conserve those (Fitzherbert *et al*., 2006). It is required to make exhaustive studies on their foraging behaviors and temporal and spatial distribution in agricultural landscape (Kuefler *et al*., 2008). It is very clear that agricultural fields are containing several agrestals (Dwari and Mondal, 2011) with main crop which are attracted by butterflies for their various purposes. In the west Bengal of India several works on butterflies done at Kolkata or its eastern part and North Bengal (De Niceville, 1885; Sanders, 1944; Chowdhury and Chowdhury, 2006; Chowdhury and Soren, 2011) but little work done in the district Howrah of West Bengal except diversity of Butterflies in the Indian Botanic Garden, Howrah, West Bengal (Chowdhury and Das, 2007). So, it is necessary to study about the butterflies' diversity of this district especially agricultural fields which decrease rapidly. Main causes are industrialization process which is increase day by day and

urbanization of this district. Rapid growth of brick fields and industries are cause of heavy degradation of agricultural fields of this district (Fig. 2). According to Damodar Valley Corporation (DVC) report agricultural fields of Damodar river basin come down 10 % in 2010 from 50 % of 1990 (Bose, 2002). So, a huge habitat loss occurring in this region. Howrah (Fig.1) is the one of the 15 and last district of Damodar River Basin (DRB) in West Bengal, India. Due to lack of previous record a comprehensive list is necessary to know present status of butterfly fauna.

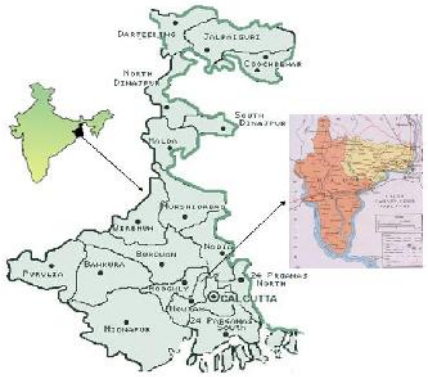


FIGURE1: Howrah district, West Bengal of India (study area).

FIGURE 2: Brick industries in agricultural fields.

MATERIALS & METHODS

Study area

Howrah district is a district of the West Bengal state in Eastern India. The Area of Howrah is 467 km^2. The Howrah district lies between 22°48′ N and 22°12′ N latitudes and between 88°23′ E and 87°50′ E longitudes. Boundaries of the district are naturally determined by Rupnarayan River on west and South-West, and by Bhagirathi-Hooghly River on east and South-East side. On north side, the boundary is an artificial one except for Bally canal on north-east and Damodar River on north-west. Annual normal rainfall is 1461 millimeter per year. Annual maximum temperature varies between 32-39°C, whereas minimum temperature varies between 8-10°C.

Monitoring (Line transect)

Different agricultural fields of this district was surveyed during April 2011 to February 2014 by using line transect method. In this method 5 permanent 300m line transects was setup in each (4) group of the blocks. Through these transects walked once a month in each block to follow Pollard Walk Method (Pollard, 1977; Pollard and Yates, 1993) for recording the butterflies. A slow 180 degree visual sweep was performed during walking. The blocks of entire district were divided into 4 groups on the basis of their geographical similarities. Two groups are agriculturally dominating, one is less agriculturally dominating and last one is industries dominating group. Information on butterfly fauna is based on observation from 07.00 to 11.00 hr and 14.00 to 18.00 hr. Collection of specimen was avoided to the extent possible. Mostly photographic documentation was done. Identification of butterflies was done using the following literature (Evans, 1932; Sabharwal, 2000; Kehimkar, 2008; Dasgupta, 2010). The classification of butterflies followed here is based on (Ackery, 1984).

FIGURE 3: Domestic activity in agricultural fields.

FIGURE 4: Common mormon on *Brassica campestris* L.

FIGURE 5: Lime on *Parthenium hysterophorus* L.

RESULTS & DISCUSSION

The study revealed the presence of 29 species of butterflies belonging to five families from all fields during surveys (Table1). Nymphalidae showed the maximum species richness, comprising of 11 species (37.931%), followed by Lycaenidae (9 species, 31.034%), Pieridae (4 species, 13.793%), Hesperiidae (3 species, 10.344%), Papilionidae (2 species, 6.897%, table 1 & graph 1).

TABLE 1: List of butterfly fauna in agricultural fields of Howrah district (West Bengal, India) during 2011 to 2014

Family	Sl No.	Common name	Scientific name	Occurrence
Papilionidae (Swallowtails and Apollos)	1)	Common mormon	*Papilio polytes* (Linnaeus)	Rf, Mf, Sef,
	2)	Lime butterfly	*Papilio demoleus* (Linnaeus)	Sef
Pieridae (The Whites and Yellows)	3)	Common gull	*Cepora nerissa* (Fabricius)	Sef
	4)	Common grass yellow	*Eurema hecabe* (Linnaeus)	Rf, Sf, Sunf
	5)	Mottled emigrant	*Catopsilia pyranthe* (Linnaeus)	Sf, Sef
	6)	Common jezebel	*Delias eucharis* (Drury)	Sf, Mf
	7)	Quaker	*Neopithecops zalmora* (Butler)	Sef, Vf
	8)	Common Pierrot	*Castalius rosimon* (Fabricius)	Vf, Sf, Sef, Mf, Gnf
	9)	Striped pierrot	*Tarucus nara* (Kollar)	Sef, Jf, Vf
	10)	Dark grass blue	*Zizeeria karsandra* (Moore)	Sef,Jf, Sunf
	11)	Gram Blue	*Euchrysops cnejus* (Fabricius)	Rf, Jf, Lf
	12)	Pale grass blue	*Pseudozizeeria maha* (Kollar)	Gnf
Lycaenidae (The Blues)	13)	Tiny grass blue	*Zizula hylax* (Fabricius)	Sunf, Vf
	14)	Common silverline	*Spindasis vulcanus* (Fabricius)	Sf, Vf
	15)	Forget me not	*Catochrysops strabo* (Fabricius)	Mf, Lf
	16)	Common five ring	*Ypthima baldus* (Fabricius)	Sf, Vf
	17)	Common bush brown	*Mycalesis perseus* (Fabricius)	Sf, Rf
	18)	Brown king crow	*Euploea klugii* (Moore)	Sf
	19)	Tawny coster	*Acraea terpsicore* (Fabricius)	Sf, Sef, Gf
	20)	Grey pansy	*Junonia atlites* (Linnaeus)	Sf, Mf
	21)	Peacock pansy	*Junonia almana* (Linnaeus)	Sf, Rf, Gf, Vf
	22)	Lemon pansy	*Junonia lemonias* (Linnaeus)	Sf, Pf, Sef
	23)	Common evening brown	*Melanitis* leda (Linnaeus)	Rf, Sf,
	24)	Common four ring	*Ypthima huebneri (Kirby)*	Vf
Nymphalidae (Brush-footed Butterflies)	25)	Angled coster	*Ariadne ariadne* (Linnaeus)	Mf,
	26)	Plain Tiger	*Danaus chrysippus* (Linnaeus)	Mf
	27)	Chest nut bob	*Iambrix salsala* (Moore)	Gnf, Vf
Hesperiidae (The Skippers)	28)	Rice swift	*Borbo cinnara* (Wallace)	Rf
	29)	Dark palm dart	*Telicota ancilla* (Herrich-Schaffer)	Sf, Sef

Sf- Sugarcane field, Rf- Rice field, Sef- Sesame field, Mf- Musrtard field, Pf- Potato field, Gnf- Ground nut field, Jf- Jute field, Sunf- Sunflower field, Vf- Vegetable field (Pumpkin, Bitter gourd, Egyptian cucumber, Indian gardening cucumber), Lf- Legume field .

TABLE 2: Butterfly distribution in different agricultural fields of Howrah district (WB, India) during 2011- 2014.

Sl no.	Agricultural fields	Related butterfly species	Number of family	Number of species
1	Rice	Rice swift, Peacock pansy, common evening brown, Gram Blue, brown king cow, peacock pansy, common mormon, common grass yellow	4	8
2	Sugarcane	Grey pansy, Common five ring, common bush brown, brown king crow, tawny coster, grey pansy, peacock pansy, lemon pansy, common evening brown, common pierrot, common silverline, common grass yellow, mottled emigrant, common jejebel, Dark palm dart	4	15
3	Potato	Lemon pansy, Indian Dark palm dart	2	2
4	Mustard	Grey pansy, angled castor, plain tiger, common pierrot, forget me not, common mormon, common jejebel	4	7
5	Sesame	Tawny coster, lemon pansy, quaker, striped pierrot, dark grass blue, lime, common mormon, common gull, mottled emigrant, Dark palm dart	5	10
6	Ground nut	Tawny coster, peacock pansy, common pierrot, pale grass blue, chestnut bob	3	5
7	Jute	Striped pierrot, dark grass blue, gram blue	1	3
8	Sunflower	Dark grass blue, tiny grass blue, common grass yellow	2	3
9	Vegetables	Common five ring, common four ring, peacock pansy, quaker, common pierrot, striped pierrot, gram blue, tiny grass blue, common silverline, chestnut bob	3	10

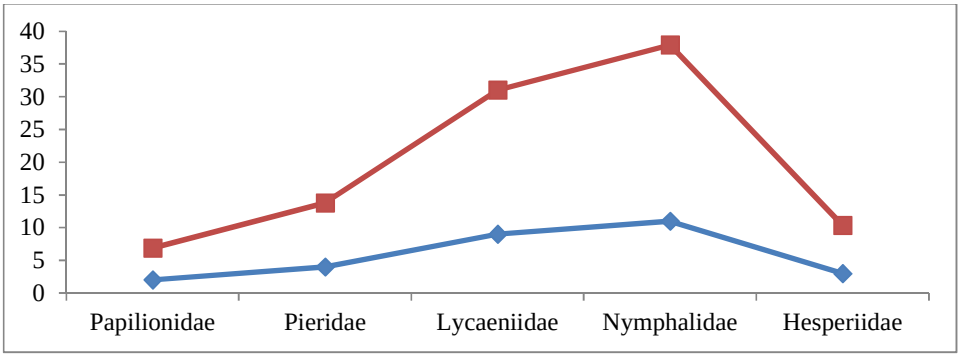
The most common species found during the study was grey pansy, peacock pansy, Quaker Butterfly, Common Grass Yellow, mottled emigrant and rice swift. Some species showed preference for particular fields. These were the grey pansy, dark evening brown in sugarcane field and peacock pansy, rice swift in rice field and plain tiger in mustard field, striped pierrot, dark grass blue, lime, and common gull in sesame field. The structural complexity of habitat and diversity of vegetation forms have been shown to be correlated with animal and insect

species diversity. Successful butterfly habitat must therefore include sufficient larval and adult food resources. In the present study, the maximum number of species and individuals were observed in sugarcane field (Table 2) where availability of diverse plants (agrestals) and access to host plants is greater than other fields. Weeding also occur less in this field than others fields. So, presences of other plants with main crop are more than other fields. Whereas potato and groundnut fields contain less butterflies diversity because less structural complexity, flowering plants, time period and much soily or sandy areas.

TABLE 3: List of butterfly fauna in agricultural fields with their larval food plants (agrestals and main crop) of Howrah district (West Bengal, India) during 2011 to 2014

Family	Sl No.	Common name	Larval food plants	Agricultural fields where larval food plants are found
Pieridae (The Whites and Yellows)	1)	Common gull	*Cleome viscosa* L.	Sef
	2)	Common grass yellow	*Cassia tora* L.	Sf
	3)	Mottled emigrant	*Cassia tora* L.,*Cassis sophera* L.	Sf, Sunf
	4)	Common five ring	*Cynodon dactylon* (L) Pers	Sf, Pf, Vf
	5)	Common bush brown	*Oryza sativa* L. , *Cyperus rotundus* L.	Rf
	6)	Brown king crow	*Ageratum conizoides* L.	Sf
Nymphalidae (Brush-footed Butterflies)	7)	Grey pansy	*Asteracantha longifolia* (L.) Nees	Rf
	8)	Peacock pansy	*Asteracantha longifolia* (L.) Nees, *Phyla nodiflora* (L.) Greene	Rif, Sf
	9)	Lemon pansy	*Asteracantha longifolia* (L.) Nees, *Corchorus capsularis* L., *Sida rhombifolia* L.	Rf, Jf
	10)	Common evening brown	*Oryza sativa* L., Eleusine indica (L.) Garten., *Panicum repens* L., *Oplismenus composites* (L.) P Beauv.	Rf
	11)	Common four ring	*Cynodon dactylon* (L) Pers	Sf, Pf, Vf
	12)	Angled coster	*Tragia involucrata* L.	Mf
	13)	Dark grass blue	*Oxalis corniculata* L., *Amaranthus spinosus* L., *Polygonum plebeium* R. Br.	Rf, Sef, Vf, Sunf
	14)	Gram Blue	*Pisum sativum* L.	Lf
	15)	Pale grass blue	*Oxalis corniculata* L.	Mf, Pf, Sef, Vf
	16)	Tiny grass blue	*Oxalis corniculata* L.	Mf, Pf, Sef
	17)	Forget me not	*Pisum sativum* L.	Lf
	18)	Rice swift	*Oryza sativa* L., *Eragrostis tenella* (L.) P Beavu, *Chrysopogon aciculatus* (Retz.) Trin	Rf, Sf
Hesperiidae (The Skippers)	19)	Dark palm dart	*Oryza sativa* L.	Sf, Sef

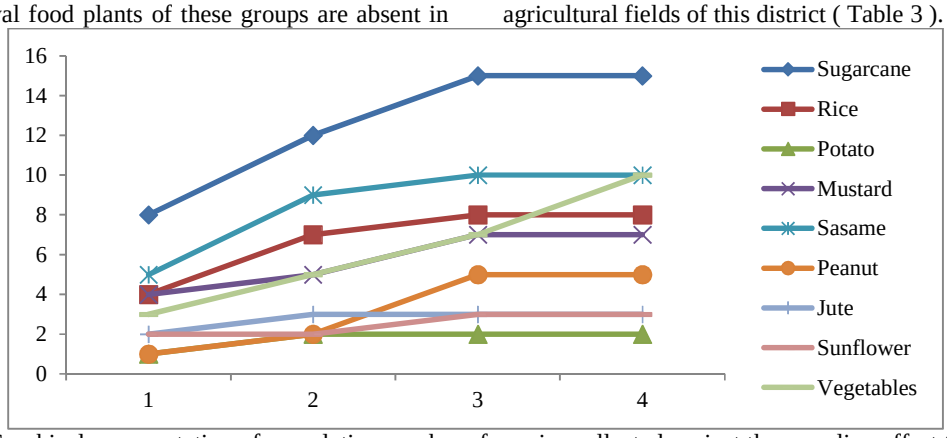
Sf- Sugarcane field, Rf- Rice field, Sef- Sesame field, Mf- Musrtard field, Pf- Potato field, Gnf- Ground nut field, Jf- Jute field, Sunf- Sunflower field, Vf- Vegetable field (Pumpkin, Bitter gourd, Egyptian cucumber, Indian gardening cucumber), Lf- Legume field .



GRAPH 1: Graphical representation of total number of butterfly species belonging to five families

Flowering plants promoted the butterfly richness and density. Most of these plants provide rich nectar sources to adult butterflies. Comparatively the other fields have lesser density of agrestals and their time period also less than sugarcane field due to could also account for lower butterfly colonization. Each habitat has a specific set of micro environment suitable for a species. Papilionidae only found in three fields but Nymphalidae found in more or less all fields. Larval food plants of Nymphalidae, Pieridae and Hesperiidae are found in the agricultural fields but same in case of Papilionidae and Lycaenidae are

not same, larval food plants of these groups are absent in agricultural fields of this district (Table 3).



GRAPH 2: Graphical representation of cumulative number of species collected against the sampling effort (sample unit).

TABLE 4: List of butterfly fauna in agricultural fields with related plants (agrestals and main crop) of Howrah district (West Bengal, India) during 2011 to 2014

Family	Sl No.	Common name	Activity sites like foraging, basking and mating	Occurrence of these plants
Papilionidae (Swallowtails and Apollos)	1)	Common mormon	*Mikania cordata* L.,, *Sesamum indicum* L., *Brassica campestris* L., *Eupatorium odoratum* L.,	Sf, Sef, Mf
	2)	Lime butterfly	*Parthenium hysterophorus* L., *Sesamum indicum* L., *Eupatorium odoratum* L., *Lippia alba* (Mill.) N.E.Br. ex Britton & Wilson	Sf, Sef
	3)	Common gull	*Sesamum indicum* L.	Sef
	4)	Common grass yellow	*Alternanthera sessilis* Dc., *Tridax procumbens* L., *Vernonia cinerea* (L.) Less, Wedelia chinensis	Sf, Rf, Vf
Pieridae (The Whites and Yellows)	5)	Mottled emigrant	*Tridax procumbens* L., *Eupatorium odoratum* L.,, *Sesamum indicum* L.	Sf, Rf, Sef
	6)	Common jezebel	*Eupatorium odoratum* L.,, *Brassica campestris* L.	Mf, Sf
Lycaenidae (The Blues)	7)	Quaker	*Mikania cordata* L.	Sf, Sef
	8)	Common Pierrot	*Tridax procumbens* L., *Parthenium hysterophorus* L, *Cynodon dactylon* (L.) Pers, *Urena sinuata* L	Sf, Mf, Vf
	9)	Striped pierrot	*Tridax procumbens* L.	Sf, Mf, Vf
	10)	Dark grass blue	*Corchorus capsularis* L., *Tridax procumbens* L.	Jf, Sf
	11)	Gram Blue	*Oryza sativa* L.,, Cleome viscosa L., *Pisum sativum* L.	Sf, Rf, Sef , Lf
	12)	Pale grass blue	Arachis hypogaea L., *Tridax procumbens* L.	Gnf, Sf
	13)	Tiny grass blue	*Wedelia chinensis* (Osbeck) Merr., *Cyperus rotundas* L.	Sf, Rf
	14)	Common silverline	*Tridax procumbens* L.	Sf, Vf
	15)	Forget me not	*Brassica campestris* L., *Lippia alba* (Mill.) N.E.Br. ex Britton & Wilson	Mf, Sf
Nymphalidae (Brush-footed Butterflies)	16)	Common five ring	*Cynodon dactylon* (L.) Pers, *Commelina banghalensis* L., *Mikania cordata* L., *Raphanus sativus* L.	Sf, Pf, Vf
	17)	Common bush brown	*Commelina banghalensis* L.	Sf, Sef
	18)	Brown king crow	*Ageratum contizoides* L.	Sf
	19)	Tawny coster	*Tridax procumbens* L., *Xanthium strumarium* L., *Amaranthus spinosus* L., *Cyperous rotundus* L., *Sesamum indicum* L.	Sf, Mf, Sef, Vf
	20)	Grey pansy	*Saccharum officinarum* L., *Brassica campestris* L.	Sf, Mf
	21)	Peacock pansy	*Leucas aspera* L., *Croton bonplandianum* Baill., *Oryza sativa* L.	Rf, Vf
	22)	Lemon pansy	*Alternanthera philoxeroides* Griseb, *Urena sinuata* L., cassia tora	Sef, Gnf, Vf
	23)	Common evening brown	*Commelina banghalensis* L., *Oryza sativa* L., *Alternanthera sessilis* Dc.	Sf, Rf, Sef
	24)	Common four ring	Imperata cylindrica *(L.) P. Beauv Cynodon dactylon* (L.) Pers , *Mikania cordata* L.,	Sf, Vf
	25)	Angled coster	*Brassica campestris* L., *Xanthium strumarium* L.	Mf,
	26)	Plain Tiger	*Celosia argentea* L., *Eupatorium odoratum* L., *Brassica campestris* L.	Sf, Sef, Mf
Hesperiidae (The Skippers)	27)	Chest nut bob	*Oplismenus composites* (L.) P Beauv.	Gnf, Vf
	28)	Rice swift	*Oryza sativa* L., *Leucas aspera* L.	Rf
	29)	Dark palm dart	*Mikania cordata* L.	Sf, Sef

Sf- Sugarcane field, Rf- Rice field, Sef- Sesame field, Mf- Musrtard field, Pf- Potato field, Gnf- Ground nut field, Jf- Jute field, Sunf- Sunflower field, Vf- Vegetable field (Pumpkin, Bitter gourd, Egyptian cucumber, Indian gardening cucumber), Lf- Legume

field .

Whereas other supportive plants of like food sources, basking and mating platforms for adult butterflies are profoundly present in these fields (Table 4). So, these fields become unique ecosystem for butterflies. On the other hand butterflies become important part of these agroecosystems.

Species Accumulation Curve

Species accumulation curve is an approach by plotting the cumulative number of species collected against the sampling effort (sample unit). From the year 2011 to 2014 the species accumulation curve (Graph 2) for the four sites sampled individually, increased from first to the fourth sampling though the number of new species added slowly.

Figure-6: Common gull on *Sesamum indicum* L.

Figure-7: Common jejebel on *Brassica campestris* L.

Figure-8: Mottled emigrant on dry Saccharum officionarum L. leaf

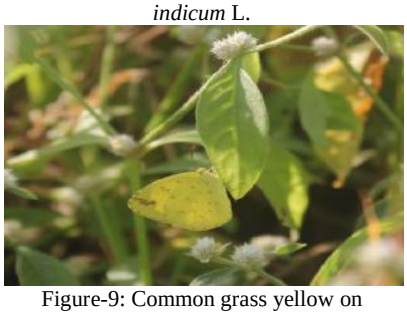


Figure-9: Common grass yellow on *Alternanthera sessilis* Dc.

Figure-10: Common silverline on *Tridax procumbens* L.

Figure-11: Striped pierrot on *Tridax procumbens* L.

Figure-12: Quaker on *Mikania cordata* L.

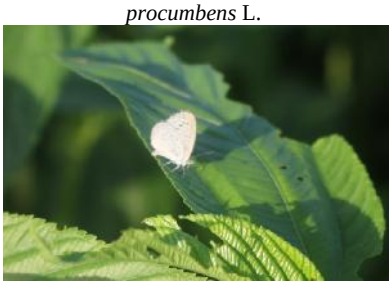


Figure-13: Dark grass blue on *Corchorus capsularis* L.,

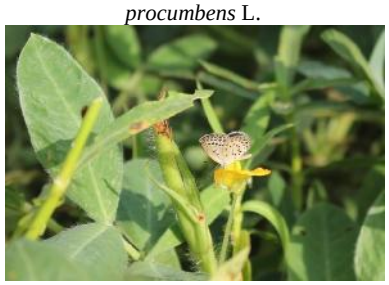


Figure-14: Pale grass blue on Arachis hypogaea L.

Figure-15: Tiny grass blue on *Wedelia chinensis* (Osbeck) Merr

Figure-16: Forget me not on *Brassica campestris* L.

Figure-17: Gram blue on *Phaseolus vulgaris* L

Figure- 18: Common pierrot on *Parthenium hysterophorus* L.

Figure-19: Common five ring on Tinospora cordifolia (Thunb.) Miers

Figure-20: Common four ring on *Dactyloctenium aegypticum* (L.) Willd.


Figure- 21: Lemon pansy on *Alternanthera philoxeroides* Griseb


Figure- 22: Grey pansy on Saccharum officionarum L.

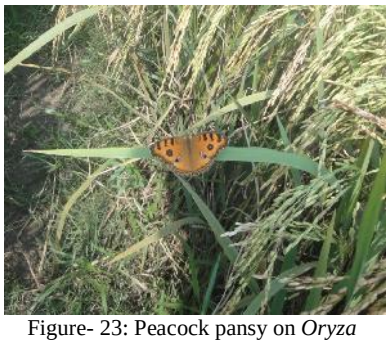


Figure- 23: Peacock pansy on *Oryza sativa* L.


Figure- 24: Brown king crow on *Ageratum houstonianum* Mill.


Figure- 25: Common evening brown *Commelina banghalensis* L.


Figure- 26: Common bush brown on dead Saccharum officionarum L. leaf


Figure- 27: Angled castor on *Brassica campestris* L.


Figure- 28: Tawny coster on *Sesamum indicum* L.


Figure- 29: Plain tiger on *Brassica campestris* L.


Figure- 30: Chest nut bob on *Oplismenus composites* (L.) P. Beauv


Figure- 31: Rice swift on *Leucas aspera* L.


Figure- 32: Dark palm dart on Sesbania cannabina (Retz.) Pers.

CONCLUSION

Butterfly diversity of agroecosystem of this district is very high but cannot compare with past due to lack of previous data. Agricultural fields are unique ecosystem that provides several services to butterflies. So, different butterflies depend on these fields, but now a day due to urbanization these animals are under risk. Their diversity in the fields also signs of good health of agricultural fields. From this study it can be concluded that health of the fields of this district is fair in respect of butterfly diversity because these insects are very good pollution indicators of whole environment. Larval food plants of three families among five found in these fields but in case of foraging and basking plants of all butterflies found in these fields.

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