ISSN 1996-3351

Asian Journal of Biological Sciences

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Asian Journal of Biological Sciences 4 (7): 563-569, 2011
ISSN 1996-3351 / DOI: 10.3923/ajbs.2011.563.569
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Community Organization and Distribution of Lepidoptera in the Rice Fields of Kashmir (J and K) India

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ABSTRACT

Present paper attempts to investigate the community structure and distribution of lepidopteran fauna in the representative rice fields of Kashmir. The main objective was to provide an overview of the diversity and distribution of lepidopteran fauna harbouring the rice ecosystems of Kashmir valley. The investigation commenced through two successive crop cycles. A total of 24 species belonging to 8 families including 16 taxa of butterflies and 8 taxa of moths were reported from 6 spatially variable representative sites. Maximum number of species were reported from north west Kashmir (Kupwara) as 22 species, whereas, lowest number was registered at Budgam (south west Kashmir) as 17 species. Diversity calculated using Simpsons Index (D), Simpsons Index of Diversity (1-D), Simpsons Reciprocal Index (1/D), Shannon-Wiener Index (H'), Margalef Richness Index (d), Menhinick Index, Evenness Index (J') indicated the significance of rice fields in maintaining the biodiversity of lepidopteran fauna. Calculations obtained from indices suggested south east Kashmir (Anantnag) as the most diverse site and north west Kashmir (Kupwara) as the least diverse site. The need for conserving rice fields as a habitat for lepidopteran fauna was recognized in the study.

Key words: Biodiversity, butterflies, density, moths, paddy field

INTRODUCTION

Rice fields are temporary aquatic and terrestrial habitats that remain flooded for certain period of year and are transformed into terrestrial habitats post-harvest. Scientifically, these ecosystems are defined asagro-economically managed temporary and seasonal aquatic habitats regulated with a variable degree of intensity (Bahaar and Bhat, 2011). In spite of being extensive monoculture systems, the paddy fields harbour numerous plant, animal and microbial species. A wide array of arthropods including odonates, coleopterans, hemipterans and heteropterans use rice fields as their habitats (Kandibane *et al.*, 2007). Insects play various roles in rice field ecosystems acting as herbivores, predators and decomposers (Latif *et al.*, 2009). These ecosystems remain flooded throughout the cultivation period and soon after harvesting they get transformed into terrestrial habitats. Rice is one of the most important crops that provide food for about half of the world population (Sie *et al.*, 2008). The crop production in India has entered the regime of non-sustainability as a consequence of degradation in aerial, edaphic and hydro-environments (Srivani *et al.*, 2007).

In Kashmir the crop cycle begins from April and lasts for about 120-150 days. Cultural operations begin with the sowing of seeds in nursery beds. Rice fields have some peculiarities which make them particularly interesting for ecological studies: Precise, clear boundaries, both physical and ecological; manageable dimensions at the human scale; great variety of changes in a short period of time; strong interactions between biological and geochemical components (Fores and Comin, 1992). The ecology of rice fields is dominated by rapid physical, chemical and biological changes. The organisms inhabiting rice fields can be considered as opportunistic biota which is able to react physiologically and behaviourally to the drastic conditions in these temporary wetlands. However, these ecosystems are shrinking rapidly owing to varied factors like ecosystem transformation and accelerated urbanization. Declines in biodiversity have been reported to be greater in freshwater ecosystems than terrestrial ecosystems (Nowrouzi and Valavi, 2011). Biodiversity is regarded as the key component for sustainable environment (Hossain *et al.*, 2008). The changes in biodiversity cause concern for ethical, economical, ecological and aesthetic reasons (Shameem *et al.*, 2010). The order Lepidoptera (lepis = scale; pteron = wing) includes butterflies and moths which are the only insects with wings covered by tiny colourful structures called scales. Butterflies prefer areas with least degree of disturbance. Such areas where agricultural methods are simpler and many parts are too rugged to be cultivated at all create natural reserves for lepidopterans and their food plants. The main objective of the study was to explore the lepidopteran fauna of the rice fields of Kashmir which at present are facing the threat of ecosystem transformation. The rich assemblage of butterflies and moths recorded from the 6 spatially differentiated study sites represented 8 families including Nymphalidae, Lycaenidae, Pieridae, Noctuidae, Geometridae, Arctiidae, Crambidae and Hesperidae. Diversity indices depicted the significance of rice fields as potential harbours of lepidopteran fauna. The bio-ecological studies on the rice fields of Kashmir are scarce and the present investigation being a maiden one in the region was carried out in the same backdrop.

MATERIALS AND METHODS

The present investigation encompassing two successive crop cycles commenced between April (2005) and December (2006). The specimens were collected from 6 spatially variable representative rice fields including Kupwara (34°02'N; 74°16'E) in north west Kashmir; Bandipora (34°06'N; 74°44'E) located in north Kashmir; Budgam (34.63°N; 76.04°E) lying in south west Kashmir; Srinagar (35°5'N; 74°47'E) in north east Kashmir, Pulwama (33°53'N; 74°55'E) in south Kashmir and Anantnag (33.73°N; 75.15°E) situated towards south east of Kashmir province. Five hundred meter long transects were established at each study site. The monitoring was done between 10:00 and 12:00 h, when the activity of aerial fauna was at its peak. Transects were walked at a steady pace. For counting and identification, three methods were employed:

- Visual identification
- Capture, identification and release and
- Capture and preservation (in case of unidentified specimens) (Panzer, 1988)

The observations were made 5 m ahead of the observer, 5 m to either side and 5 m above the ground (Selby, 1990). The total number of adult individuals was expressed as number per 100 m following Jorge *et al.* (2000). Specimens were collected with the help of standard insects net (40 cm dia). The specimens which could not be identified on the spot were killed in killing jars containing cotton swabs soaked in chloroform. The specimens were stretched using spread boards followed by dry preserving in transparencies (Kunte, 2000). Identification was done according to Mani (1986), Novak and Severa (1990), Kunte (2000) and Balmer (2007). Simpsons Index (D), Simpsons Index of Diversity (1-D) and Reciprocal Index were performed following Simpson (1949); H' was calculated as per Shannon and Wiener (1949); Margalefs' Richness Index was obtained as prescribed by Margalof (1958); Evenness Index was calculated as per Pielou (1966). Correlation analysis was performed employing SPSS program.

RESULTS AND DISCUSSION

Butterflies have been regarded as the symbol of beauty and grace (Khan *et al.*, 2003). These marvellous creatures are found almost in every part of the world except snow bound areas like Antarctica (Rafi *et al.*, 2000). The study unveiled a significant assemblage of Lepidoptera including 6 species from Nymphalidae, 5 species from Pieridae, 4 species belonging to Lycaenidae, 4 species representing Noctuidae, 2 species from Geometridae and 1 species each from Hesperidae, Arctidae and Crambidae. The overall analysis of primary data revealed that Nymphalidae formed the major component contributing significantly as 25%, followed by Pieridae (21%), Lycaenidae (17%) Noctuidae (17%), Geometridae (8%), Arctiidae (4%), Crambidae (4%) and Hesperiidae (4%). Qualitatively and quantitatively, the maximum number of taxa were registered from Kupwara (22) whereas, lowest number of taxa were reported from Budgam (17). Highest densities were recorded during vegetative phase whereas, significant declines were registered in the fallow season drawing support from Uka and Chukwuka (2011). The flight period was generally between April and October. Average density registered maximum values during summer (Fig. 1) thus, exhibiting a significant positive correlation with weed density (r = 0.958) and air temperature (r = 0.934). Nymphalidae was represented by 5 species which showed an irregular distribution. *Aglais urticae* L., *Junonia orithya* L. and *Vanessa cardui* L. were recorded from all study sites despite being registered in lesser numbers (Table 1). *Danaus chrysippus*, *Phalanta phalantha* Drury and *Mesoacidalia aglaja* were distributed unevenly. *Danaus chrysippus* is a unpalatable butterfly which never occurs in large numbers (Kunte, 2000) thus, explaining their low density in the rice fields of Kashmir. Among the Pieridae, *Pieris brassicae* and *P. raphae* were the most common species. The larval host plants of these species usually belong to Brassicaceae, as such these occur

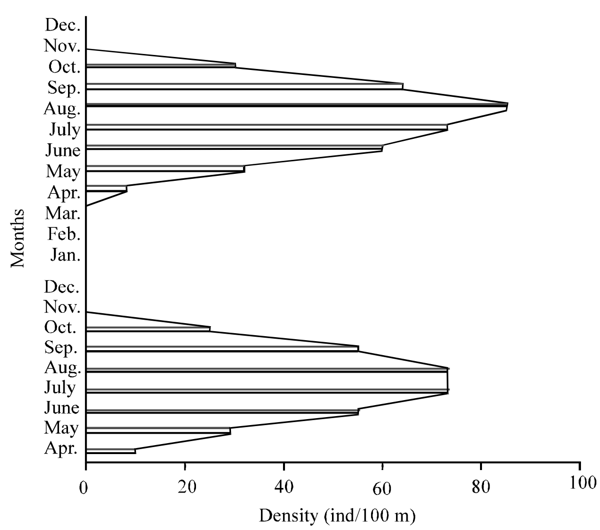

Fig. 1: Average density of Lepidoptera at the representative sites

Table 1: Population density (ind/100 m) of various taxa recorded at the representative sites

Species kupwara	Bandipora	Bandipora	Budgam	Srinagar	Pulwama	Anantnag	Community composition (%)
Nymphalidae							25
Aglais urticae	0-3	0-3	0-7	0-6	0-4	0-3	
Danaus chrysippus	0-2	0-2	-	-	0-2	0-1	
Junonia orithya	0-6	0-6	0-8	0-8	0-4	0-3	
Mesoacidalia aglaja	0-2	-	-	0-3	0-3	0-2	
Phalanta phalantha	0-4	0-3	0-3	0-3	0-3	0-2	
Vanessa cardui	0-4	0-3	0-4	0-4	0-4	0-3	
Pieridae							21
Colias crocea	0-6	0-7	0-6	0-4	-	0-6	
Colias hyale	0-4	0-11	0-8	0-10	0-3	0-4	
Pieris brassicae	0-18	0-20	0-12	0-22	0-12	0-14	
Pieris raphae	0-10	0-16	0-18	0-14	0-12	0-8	
Pontia daplidice	0-6	0-14	0-9	0-10	0-4	0-4	
Lycaenidae							17
Aricia agestis	0-4	0-6	0-6	0-3	0-5	0-3	
Lampidus boeticus	0-2	-	-	0-2	0-2	0-2	
Lycaena phlaeas	0-4	0-16	0-4	0-8	0-6	0-5	
Polyommatus icarus	0-14	0-36	0-6	0-12	0-12	0-16	
Hesperiidae							4
Hesperia comma	0-4	0-4	0-5	0-7	0-7	0-6	
Noctuidae							17
Agrotis exclamationis	0-1	0-2	0-1	0-3	0-2	0-3	
Autographa gamma	0-2	0-2	0-2	0-2	0-2	0-6	
Catocala sponsa	-	-	0-2	0-2	0-1	0-2	
Chalcopasta sp.	-	-	0-2	0-2	0-2	0-1	
Geometridae							8
Durapteryx sp.	0-1	0-1	-	-	-	-	
Unidentified	0-1	-	-	-	-	-	
Arctiidae							4
Spilosoma luteum	0-1	-	-	0-3	0-2	-	
Crambidae							4
Pleuroptya sp.	0-2	0-2	0-2	-	0-2	0-3	

abundantly in the cultivated fields. In addition, the members of Pieridae show a wide spread distribution in the valley which acts as another probable reason for their high density and cosmopolitan distribution in the rice field agro ecosystem. *Pontia daplidice*, *Colias hyale* and *C. crocea* were also reported from all the study sites. Their larval host plants include Papilionaceae among others which may provide evidence for their distribution in the rice fields. Lycaenidae or Blues were represented by 4 species with *Polyommatus icarus* L. as the most abundant species. The other three species included *Lycaena phlaeas*, *Lampidus boeticus* and *Aricia agestis*. The greater abundance of *L. phlaeas* in such open habitats has earlier been reported by Jorge *et al.* (2000). The members of Lycaenidae are common in cultivated fields, damp grasslands, marshes and the banks of slow flowing rivers (Balmer, 2007). These low-flying lepidopterans are among the commonest and widest spread (Goodden, 1977). Hesperidae showed a cosmopolitan distribution, being registered at all the study sites. The moths were represented by 4 families and were recorded only occasionally. An unidentified geometrid probably migrated from the nearby forests was recorded

Table 2: Diversity indices calculated at the representative study sites

Index	Kupwara	Bandipora	Budgam	Srinagar	Pulwama	Anantnag
Simpsons	0.2563	0.1371	0.1289	0.1147	0.1172	0.1057
Dominance	0.7437	0.8629	0.8711	0.8853	0.8828	0.8943
Reciprocal	3.902	7.294	7.756	8.716	8.533	9.463
Shannon-wiener	1.93	2.33	2.35	2.47	2.47	2.54
Margalefs	3.013	2.482	2.528	2.867	3.273	3.142
Menhinick	0.6748	0.5865	0.7177	0.7274	0.9889	0.8712
Equitability	0.625	0.8062	0.8296	0.8246	0.8113	0.8362

at Kupwara only once. Since moths are nocturnal, they were recorded in much less numbers during day time mainly resting among the leaves of plants.

During the entire study period, maximum number of individuals was collected from Kupwarasite (1063 individuals) whereas lowest number was recorded from Pulwama site (451 individuals). The calculations obtained from various biodiversity indices showed that the Simpsons Index (D) was highest at Kupwara site (0.256) and lowest at Anantnag site (0.105) indicating the higher diversity of later over the former site. Simpsons Dominance Index (1-D) showed highest value of 0.894 for Anantnag site whereas, lowest value of 0.743 was registered for Kupwara site, again pointing towards the higher diversity of former over the later site. Similar results were obtained from the Reciprocal Index (1/D) which showed the highest value of 9.436 for Anantnag site and a lowest value of 3.902 for Kupwara site. Shannon-Wiener Diversity index (H') confirmed the findings by depicting maximum value of 2.54 for Anantnag site and minimum value of 1.93 for Kupwara site. Margalefs Richness index exhibited highest value for Pulwama site (3.27) and lowest value for Bandipora site (2.48). Menhinick Index depicted a peak value of 0.98 for Pulwama site where as, lowest value was registered for Bandipora site as 0.58 (Table 2). The Equitability Index (e) showed that the taxocoenosis was more even at Anantnag site (0.83) whereas, maximum disorder was exhibited at Kupwara site (0.62). Irrespective of the minor spatial differences in the diversity, the overall results indicated that the rice fields of Kashmir contribute significantly to the biodiversity of this region thus, pressing the need for recognizing the importance of these transitional ecosystems as potential biodiversity habitats. The significance of rice fields in maintaining biodiversity has earlier been stated by Bambaradeniya *et al.* (2004), Segers and Sanoamuang (2007) and Chittapun *et al.* (2009).

CONCLUSION

In order to study the community organization and distribution of Lepidoptera in the rice fields of Kashmir, 6 study sites were selected in different parts of the valley. The study revealed the presence of 24 species with Nymphalidae as the most dominant group. The overall interpretation of the results indicated towards the significance of rice fields as potential habitats for a diverse array of butterfly and moth fauna that have adapted to the harsh and highly disturbed environment of these shallow ecosystems that remain fallow for almost one-third of the year. The general community composition was fairly similar at all the representative sites which could be a probable consequence of existence of a similar agro-climatic zone. Further, the rice fields are interconnected through continuous corridors which make the taxocoenosis fairly homogenous. Slight variations were evident in the community organizations of different study sites which could be aprobable function of micro-climatic variations.

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