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Documentation on the visiting profile of Quaker and Lime Blue to their native host plants as pollinating agents

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ABSTRACT

The native host plants bearing wildflowers with overlapping blooming periods provide resource for the butterflies, the significant pollinators next to bees. Few of the behavioural features of these diurnal pollinators are co adapted to the phenology as well as fragrance chemistry or floral morphologies of their host plants establishing an ecological specialization state often maintained by stabilizing selection. Such specialization may lead to the considerable variation among reproductive success rates of the host plants. Thus, species specific pollinating attributes over the seasonal continuum of the pollinators towards their common host plants may provide idea about their pollinating potentiality. Lycaenids, with 443 Indian species, are commonly termed as 'blues'. Two representative species, the Quaker and Lime Blue are selected on the basis of their moderate to high abundance level in the study area. Few of their prominent ecological and ethological features concerned to their host plant visiting patterns are reported. The present study is important for highlighting the role of native pollinators to maintain the regional to landscape level floral diversity. The significance of conservation of such global bioindicators also cannot be neglected.

***Keywords*:** butterflies, pollinators, wildflowers, lycaenids, conservation, bioindicators

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1. INTRODUCTION

The diurnal lepidopterans are essential component of any natural terrestrial ecosystem. They are considered as relevant study group due to availability of existing standard tools. Sufficient information regarding their ecobiology is available. They could be considered as potential bioindicator for assessment of environmental health and hygiene (Pollard and Yates, 1993). Lycaenids are on the wing moderately throughout the year, frequently covering a wide range of habitat distribution.

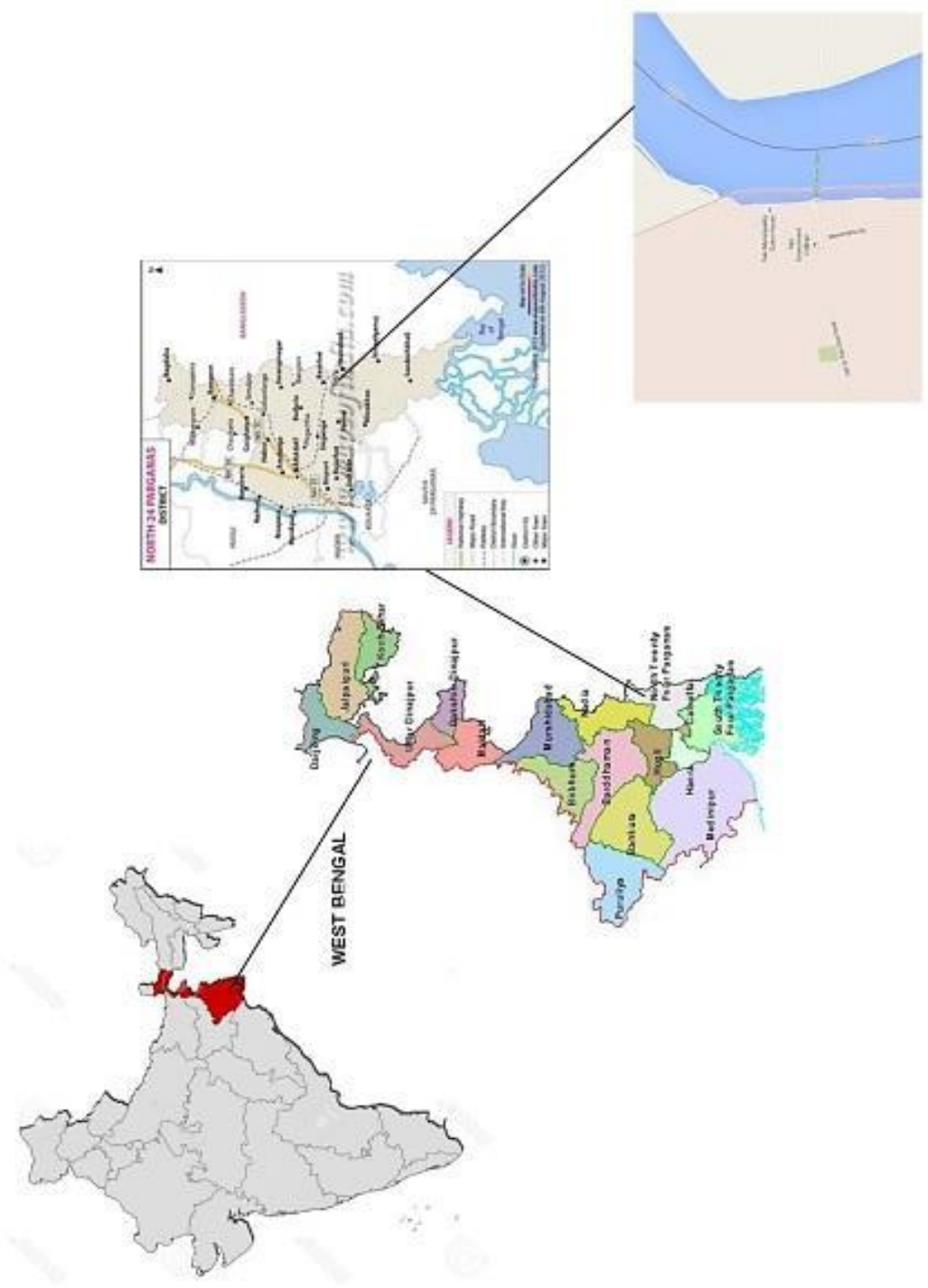
Selection of host plants is based on the criteria of host preference (frequency of visits) and host dependence (on time spent basis). Throughout the study period, few of those plants topped the list with respect to habitat suitability prerequisites for butterflies. Among the climatic parameters, moisture content, rainfall and photoperiodic gradient act as the promoting factor for reproductive fitness. Being ectothermic, microhabitat determinants play crucial role for maintenance of delicate life history phases like oviposition, voltinism, diapauses, eclosion, etc. Latitudinal gradients affect the realized niche shifts on periodic basis to complete the life cycle. Often particular sets of host plants are optimized for different seasons by these poikilotherms, offering a kaleidoscopic assortment over native habitats (Tiple *et al.* 2009). Floral units belonging to different plant families provide nectar pool with a gradient of sugar and other nutrients volume and concentrations.

The nutritional value of consumed nectar promotes adult longevity and reproductive outputs like egg production and egg maturation. Switching of host plants occurs as a result of strong selection pressure to match its phenology with the temporal distribution. Thermal plasticity of host plant resource quality (e.g. Water and nitrogen content etc.) also act as key factor promoting shifting of host plant preference (Dronamraju, 1958; Weiss, 1997). Pollinator-host plant correlation co-evolved as highly diversified as well as unique ecologically sensitive balancing selection measure ensuring their survival. Psychophilic pollinators have established themselves as most effective natural pollinators, just next to the hymenopterans (bees). They are valuable pollinators for wild plants, thus serving key role for natural landscape sustainability (Tiple, 2012). Though the butterflies bear potentiality of playing role as flagship species, recently they are being threatened globally by the risk of habitat isolation, modification, fragmentation or habitat loss mainly due to the natural integrity deteriorating anthropogenic factors like industrialization, urbanisation or overexploiting agrobiological activities. Being extremely sensitive to subtle environmental changes they can act as efficient global bioindicator and the efficient value indicator of biotope quality (van Strien *et al.* 2009). Still a huge ratio of Indian species yet to be described with respect to their detailed ecological and behavioural functionality (Haribal, 1992).

So, the present study is an observation based documentation on the visiting profile of the two commonly found local Lycaenids, Quaker and Lime Blue to their native host plants. The later, interestingly, reported to attain the pest status during their developmental phases to their commonest local host plant, the lime plants. Various behavioural aspects concerned to their resource utilization pattern have been reported as a measure of qualitative description of environmental hygiene. Present study site, Taki, North 24 Parganas, comprising of multiple land use patterns, is presently threatened with huge anthropogenic interventions, particularly the tourism load. Scope exists there for assessing the role of ecological and anthropogenic parameters influencing habitat exploration abilities of native butterfly communities which may become significant from the conservation approaches in turn.

2. MATERIALS AND METHODS

Study area: Taki, 22.59°N and 88. 92°E. Taki-a municipality under Hasnabad P.S. of Basirhaat Subdivision in North 24 Pgs., West Bengal. Global Positioning System (GPS; GPSMAP 76Cx, Garmin, Olathe, Kansas, USA) was used to record the geographic coordinates (Map 1).



Map 1. Study area

Average elevation - 5 meters (16ft) at the bank of Ichhamati river

Climate: Subtropical with hot summer, from late March to Early June (avg. temp. range 25-40 °C). Monsoon dates from Mid-June to late August, receiving an average rainfall of 150 mm. A cool, dry winter ranges formulate Nov to early Feb (average temperature range 12-25 °C.

Duration of Study: April 2014 to March 2015

Survey Period: Monthly once; for thrice in a day: 9 am-11 am, 12 noon to 2 pm, 3 pm to 5 pm.

Division of seasons (summer, monsoon, post monsoon and winter) based on the variation of rate of precipitation and temperature.

Sampling Techniques: Seasonal availability is reported by presence-absence scoring method. Four randomized transect walks performed for 12 minutes during each survey period through the study areas following "Pollard Walk" method with necessary modifications. Fixed transect routes (250 m long and 5m wide) followed for a particular habitat patch. Approximately a uniform pace was maintained at each study site. Prominent host plant trails are selected on the basis of >70% of visiting frequencies of the respective butterflies. Nectar and non-nectar host plants randomly selected from the same transect. 5-10 numbers of each host plant species, depending on availability were focussed. Stationary observation time fixed for 15 minutes per survey period at three suitable locations to watch host plant based interactions. Minimum distance for minute observation was constantly maintained to be 1.5 metres between the observer and the host plant. For assuming the visiting profile by butterfly to host plant, 10 frequently encountered and easily observable landing sites, including the floral units and other suitable units were selected for individual host plants. The number of butterflies encountering each host plant and their behavioural specificity were temporarily scanned and reported; duration of specific behaviours noted with the help of a stopwatch. Microhabitat details like canopy layers, foliage surfaces, substratum profiles are also noted. Encountered butterflies were identified using suitable keys (Kehimkar, 2008; Varshney and Smetacek2015). Specific host plants were identified and recorded (Mukherjee, 1981).

Study sites:






3. RESULTS

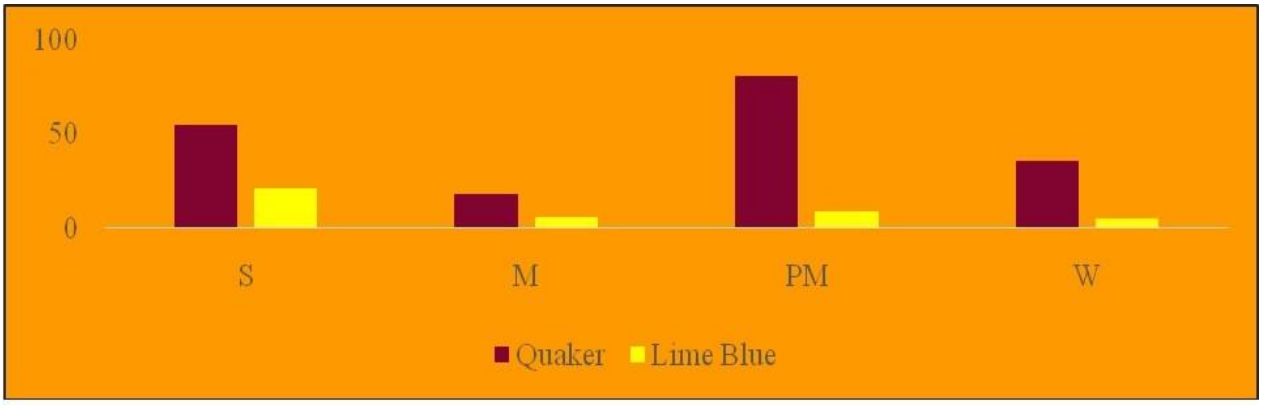


Fig. 1. Seasonal Abundance of the butterfly species

Table 1. Host Plant Profile

A. Quaker (*Neopithecops zalmora*, Butler)

Host plants	Type	Family	Habit and Habitat	Avg. height from ground level (m)	Blooming period	Description of the floral unit
Glycosmis pentaphylla (Ash - Sheora)	non nectar food plant; larval host plant	Rutaceae	wild evergreen Shrub; railway track, river bank, road side vegetation patches	1 -1.5	S, M, PM, W	Small, white flowers; compound inflorescence, racemose, 5 petals
Lantana camara (putush)	nectar plant	Verbenaceae	invasive evergreen shrub; railway tracks, river bank, uncultivated lands, roadside vegetation patches	2-2.5	S, M, PM, W	small white to yellow, orange to red, pink to violet; tubular, 4 petals
Tagetes erecta (taar gaanda)	nectar plant	Asteraceae	both wild and plantation variety; annual herb; garden, cultivated land	1	W	Yellow, orange flower; clustered, both ray and disc florets

B. Lime Blue (*Chilades lajus*, Stoll)

Host plants	Type	Family	Habit and Habitat	Avg. height from ground level (m)	Blooming period	Description of the floral unit
Murraya paniculata (kamini)	nectar plant,food plant, yearlong blooming	Rutaceae	evergreen; garden as well as wild flora	3-5	S, M, PM, W	White
Citrus limon (patilebu)	nectar plant,food plant, larval host plant, seasonal blooming	Rutaceae	evergreen; kitchen garden	upto 6	W, S	White

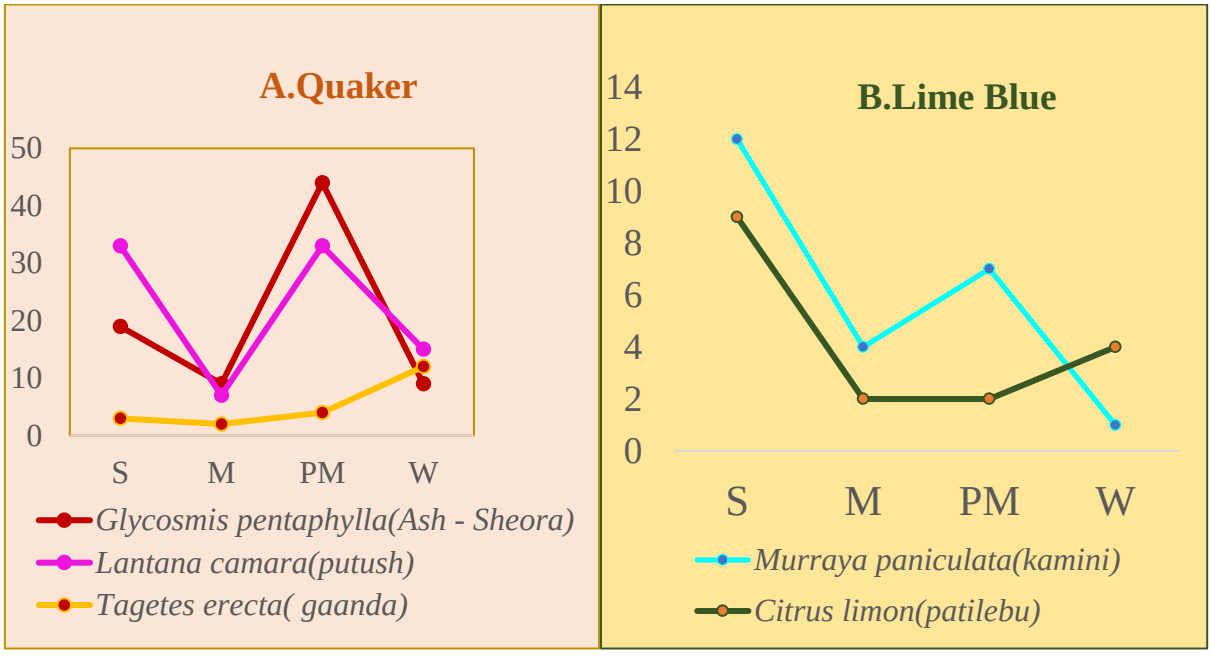


Fig. 2. Host plant based seasonal abundance pattern

Table 2. Seasonal profile of landing quotient on host plants

Landing on host plant includes both contacts and stoppages. Landing platforms provided by the floral units (blooming seasons) or other suitable parts (stem, leaves, fruits) **landing quotient** is estimated as the number of pollinator landings /per avg. no of available landing sites on each plant/hour. It is considered as a qualitative assessment indicator for host preference.

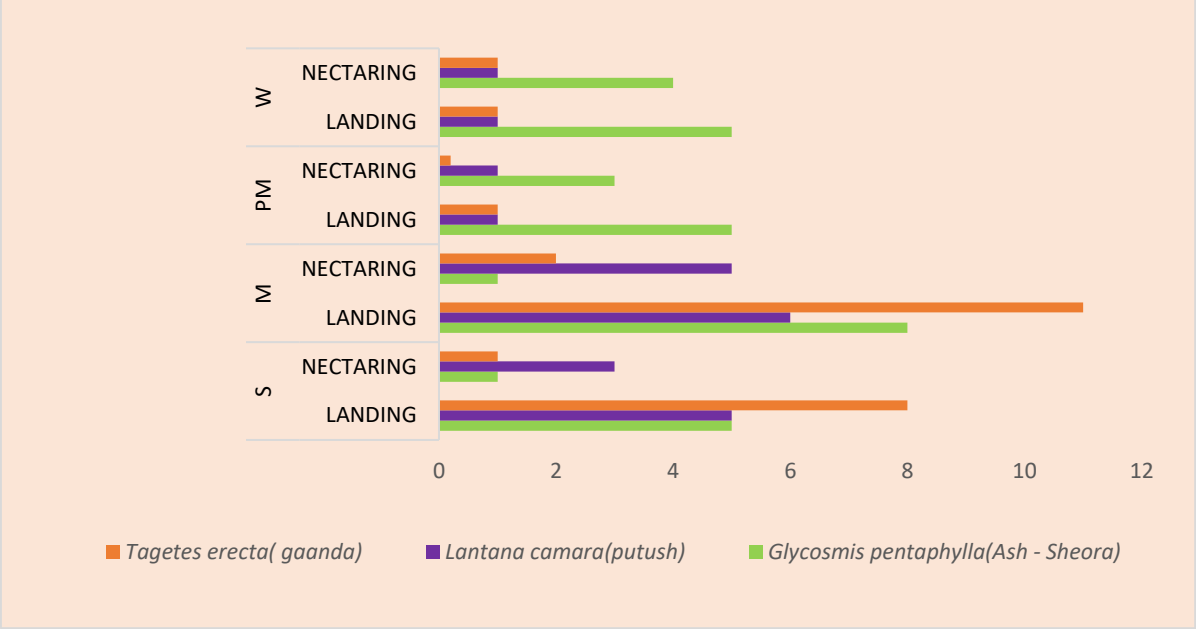
A. Quaker

Host plants	Landing quotient (no. of pollinator landings/available sites)			
	S	**M**	**PM**	**W**
Glycosmis pentaphylla (Ash - Sheora)	0.7	0.7	0.8	0.4
Lantana camara (Putush)	1.2	0.7	1	0.8
Tagetes erecta (Gaanda)	1.1	0.2	0.2	1.5

B. Lime Blue

Host Plants	Landing quotient (no. of pollinator landings/available sites)			
	S	**M**	**PM**	**W**
Murraya paniculata (kamini)	0.27	0.32	0.25	0.21
Citrus limon (patilebu)	0.5	0.4	1.1	0.43

A. Quaker



B. Lime Blue

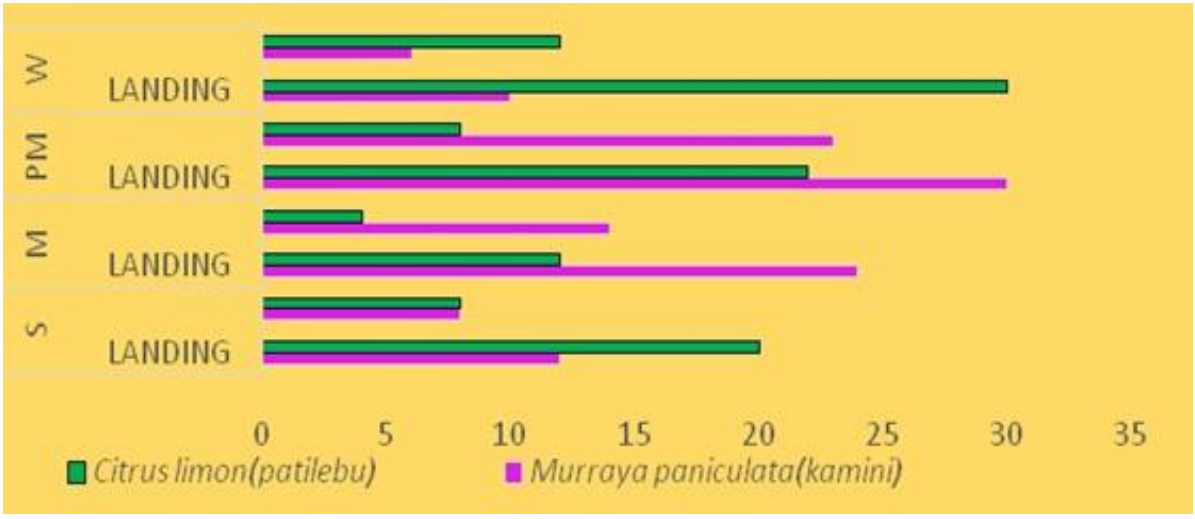
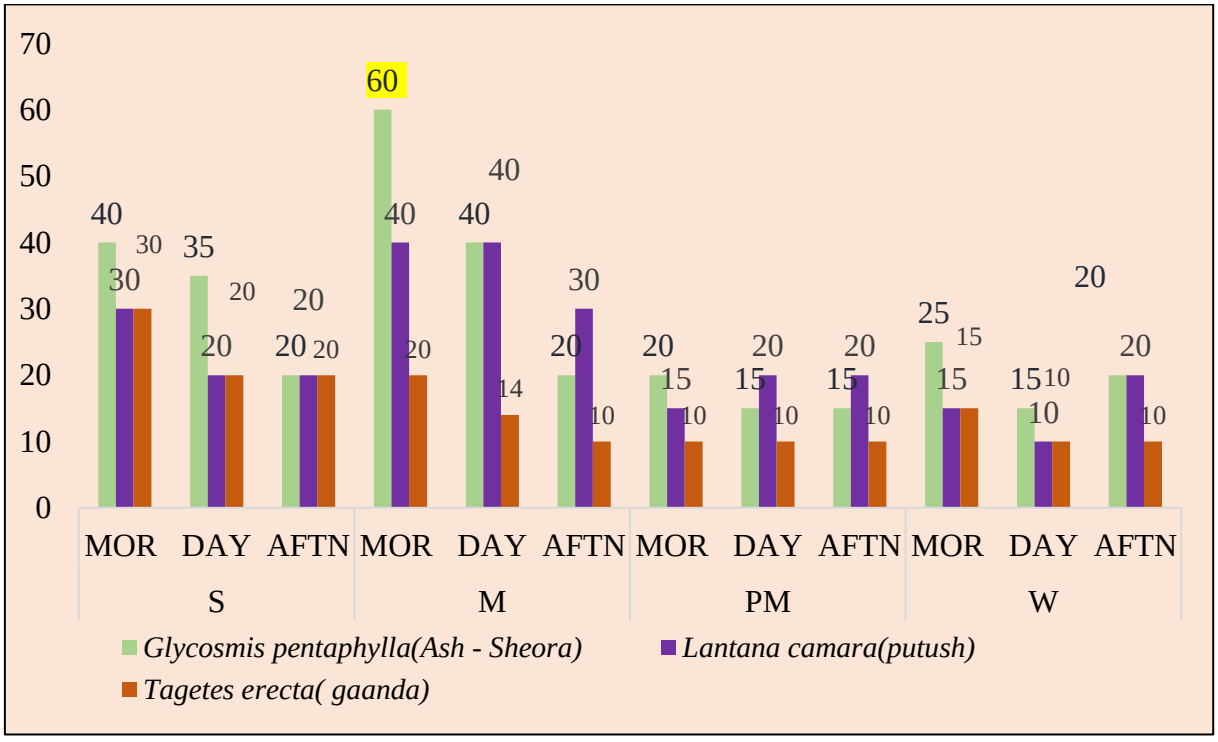


Fig. 3. Landing vs. nectaring profile: (addresses the overall tendency of host dependence for nutrient and other resources)

A. Quaker



B. Lime Blue

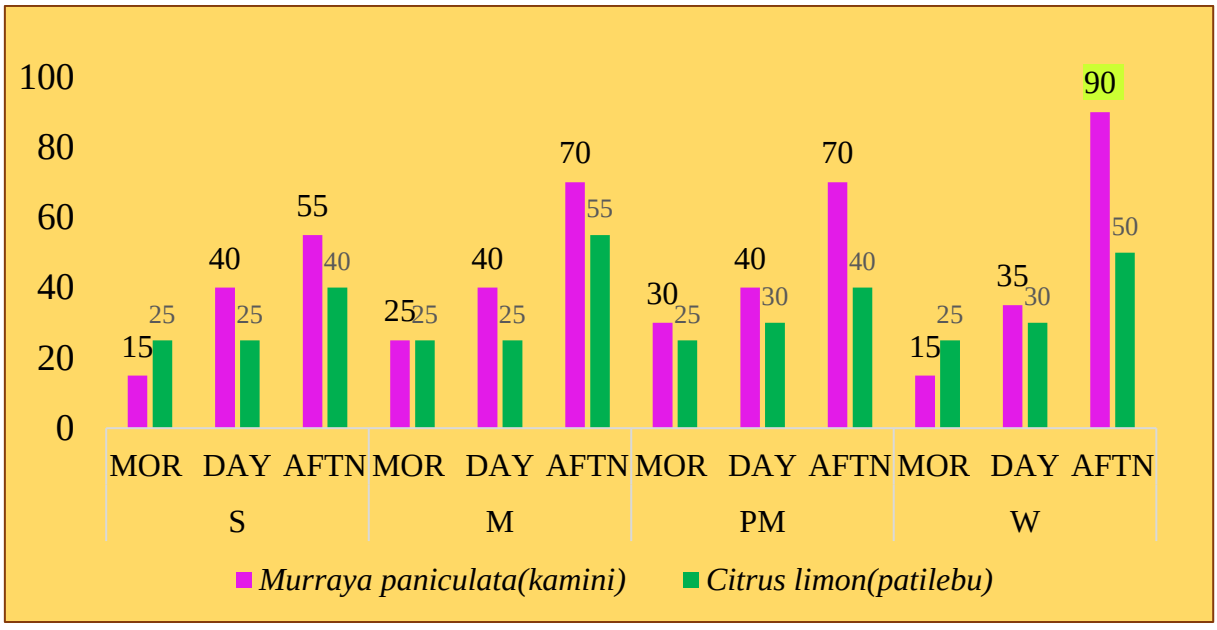
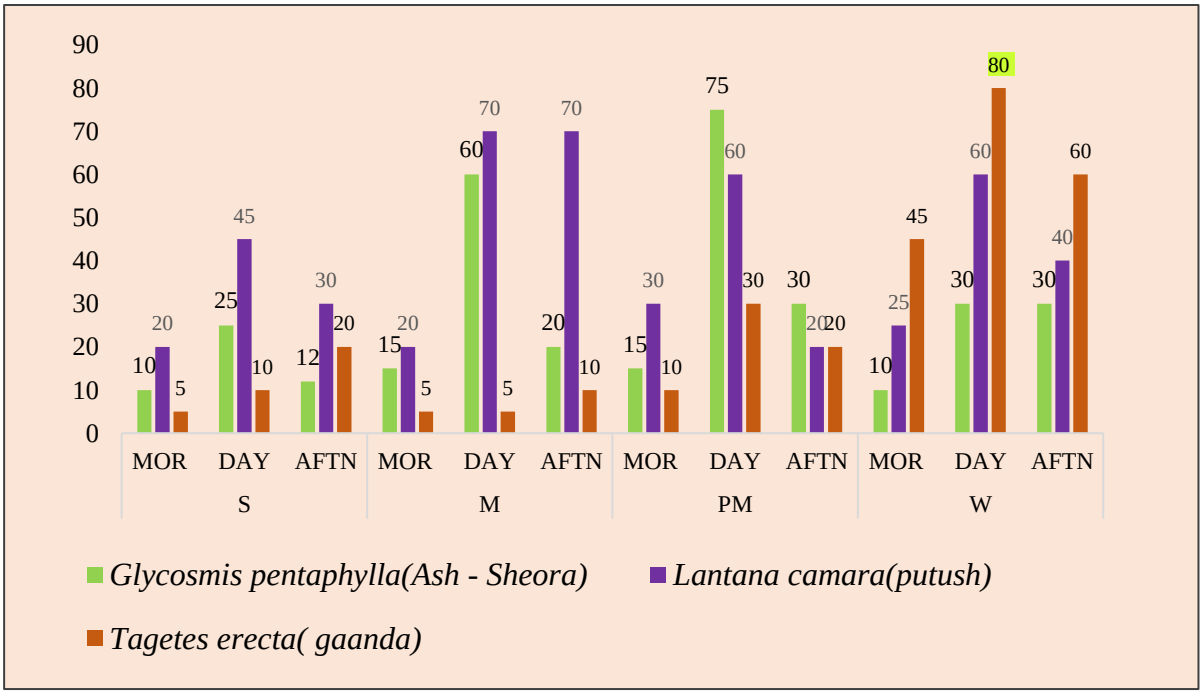


Fig. 4a. Foraging (a. perching b. nectaring) duration (secs);
Perching: sitting folded wing on floral unit or other plant parts to standardize the resource availability; [Avg. perching time /single visit to a single landing site (sec) recorded]

A. Quaker



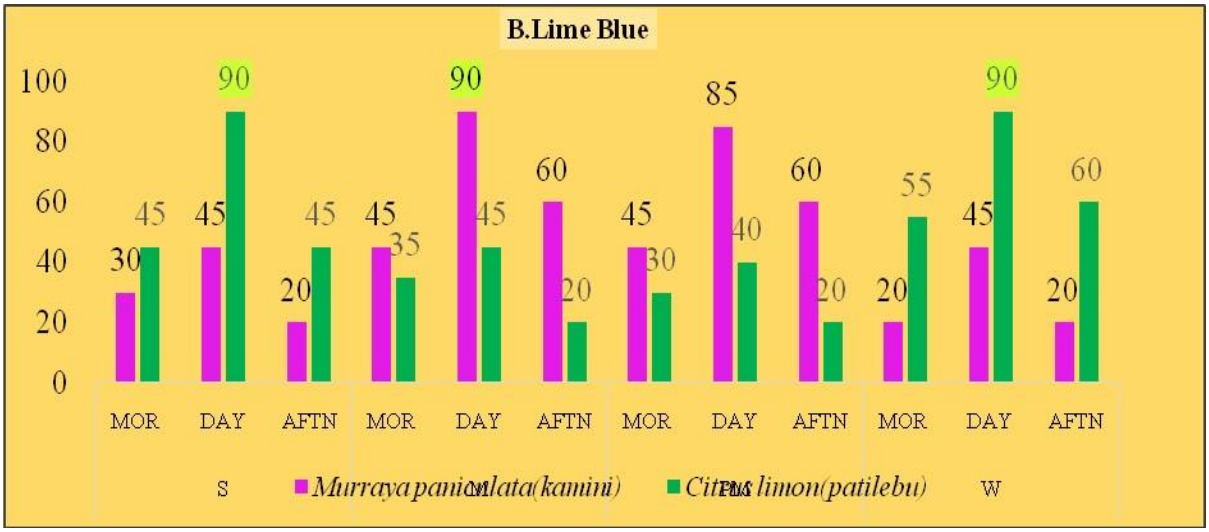
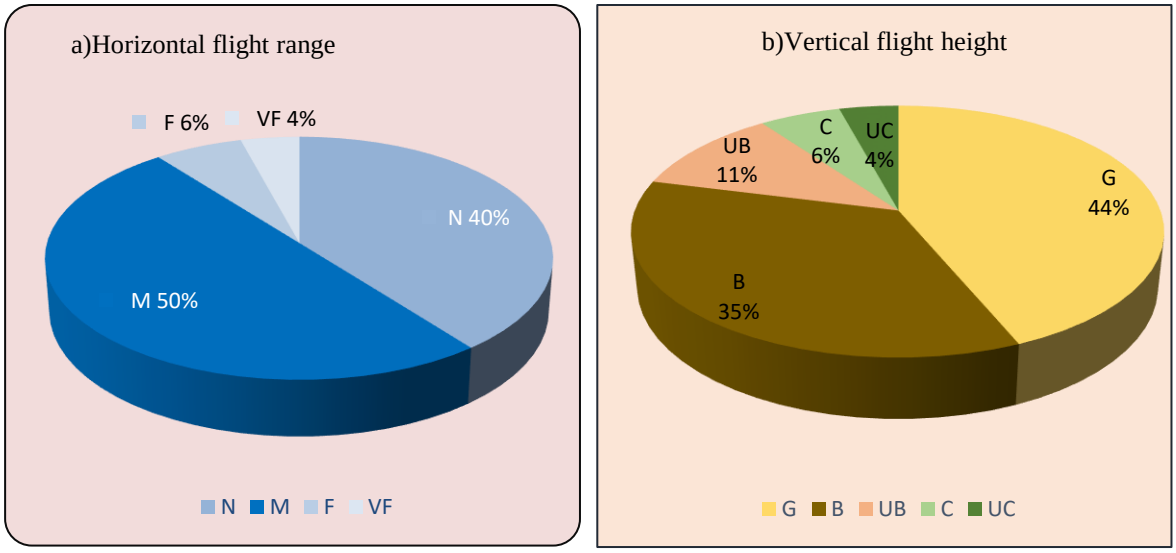


Fig. 4b. Nectaring; Nectaring duration recorded from the moment of dipping butterfly proboscis in the flower corolla till the moment of its withdrawal
[Avg. nectaring duration/single floral unit (secs)

A) Quaker



B) Lime Blue

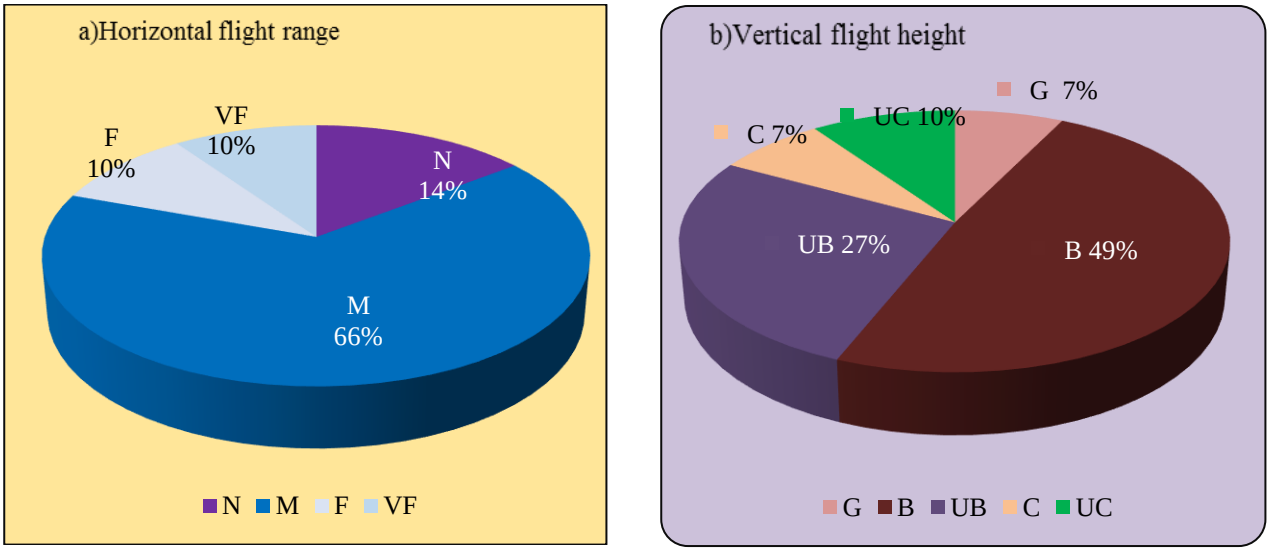


Fig. 5a. Horizontal flight range
Flight range; N- 1.5 m from observation point; M-4.5 m from observation point;
F-7.5 m from observation point- >7.5 m from observation point
b) Vertical flight height
Flight -height – Ground (Ground – 1.5m); B-Bush level (Ground-3. 5m);
UB-Upper Bush level (Ground – 5m); C-Canopy level (Ground to 7.5m);
UC-Upper Canopy level (Ground to >7.5 m)

3. DISCUSSION & CONCLUSIONS

Quaker and Lime Blue both are common visitors to the habitats near human colonisations like railway trackside, urban roadsides, river bank and also in open meadow patches. Lime Blues are likely to visit lime plants in kitchen gardens, orchards and in wild, particularly in summer months. Their larvae being fruitborer they sometimes attain pest level due to higher infestation rates to the fruits. The instars feed on the fruit pulp. Fig. 2 shows the graphical representation of the overlapping blooming period of the host plants and the annual abundance ratios of the butterflies. It also reflects the temporal correlation between host plant flowering and butterfly oviposition. They are on the wing mostly during summer and post monsoon, followed by that in winter. In Table 2, the landing quotients are listed as the qualitative indicator for host preference varying on seasonal basis. Highest (1.5) is for *Tagetes*, during winter by Quaker and lowest (0.2) is for the same plant during monsoon and post monsoon, which is the blooming period for other two nectar source options *i.e. Lantana* and *Glycosmis* .For Lime Blue ,it is highest (1.1)for *Citrus* during post monsoon and lowest (0.21) for *Murraya* during winter. The host plant switching tendency is also reflected from this table. In Fig. 3, landing vs. nectaring ratios are displayed to address the overall tendency of host plant dependence for nutrient and other resources. For individual host plants, it can act as a measure of exclusive resource provision ability. In Fig. 4, an idea about foraging profile with respect to perching (4a)

and nectaring proper (4b) is outlined. Perching is considered to be a behavioural strategy for standardizing resource availability. Sometimes the perching span equivalents to the average temporal spacing between the consecutive visits over a single floral unit.For Quaker, it is of maximum duration (60 secs) at monsoon morning on *Glycosmis pentaphylla*. Highest perching period for Lime Blue, (90 secs) is reported at winter afternoon on its wild host plant *Murraya paniculata*. Maximum nectaring duration (80 secs) for Quaker is reported at daytime in winter on blooming *Tagetes.* Significant nectaring span (85-90 secs) is reported for Lime Blue, mostly during the daytime throughout the year on both the host plants.

Lepidopteran flight may be categorized according to different functional aspects like: searching flight to locate the nutritional resources or appropriate egg laying site, patrolling flights with the scanning purpose, chasing flights, often displayed by males to maintain territory and last but not the least, the courtship(including the contesting) flights. Our study concentrates on the horizontal and vertical level flight patterns observed during regular foraging on host plants. Specific vertical flight patterns observed during foraging, territory maintainace (chasing) etc. Lack of any specific defensive measures against their enemies, such type of aerial displays sometimes make them highly vulnerable to predation. As per the horizontal flight range is considered, Quaker found to avail mostly the near (40%) to moderate (50%) ranges whereas Lime Blue avails the moderate range most frequently (66%). Considering the vertical flight height distribution, Quaker commonly occurs G (44%) to B (35%) levels, whereas Lime Blue frequents mostly the B (49%) level.

On the basis of findings from the present study, it can be concluded that, presence of series of host plant species flowering over all seasons may turn favourable for native butterfly species. Retention of wild floral den with at least few blooming all times provides sites for foraging, nesting, basking, resting and hiding purposes. These suitable conditions, if fulfilled, a spatio temporal mosaic of pollinator assemblage may generate. Presence of mud patches as water source and maintenance of suitable soil salinity level also the role of essential survival factors. Damaging anthropogenic activities like grazing, pesticidal over- exposure, excessive tourism load must be restricted to maintain the undisturbed ecological functioning of these insect pollinators (Dover and Settele, 2009).

Ecological outcomes of host-specificity and habitat association of these native pollinating agents encompass the local dispersion to metapopulational expansion. Often the species with narrow dietary breadth show higher larval advancement rates. Mechanical type of floral isolation, maintenance of allopatric speciation mechanisms and prevention of interbreeding between sympatric populations have been made possible by such type of coevolved host-pollinator interactions (Dronamraju, 1958).

Psychophyly helps framing of a pollination network by the polyphagous species in nature. Their ecological functionality could be justified for selecting them as focal indicator for climatic change and urbanization (Clark, Reed and Chew, 2007).

Pre-requisites for their conservation should cover their protection both at the levels of adult and developmental phases**.** Awareness about adult and larval habitat and mode of optimisation of the natural resources by the individuals over a spatial and temporal scale should be created. Conservation both at habitat and landscape level are equally important. Restoration approaches to be adopted keeping in mind that the habitat specialist species are vulnerable to habitat area isolation whereas generalists are more sensitive to landscape values. Sustainable microhabitat management is essential. Finally, minute and detailed information regarding species autecology would be of major help to improvise their conservation scheme.

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