RARITY IN OAK FOREST BUTTERFLIES OF GARHWAL

Arun P. Singh
Ecology & Biodiversity Division, Rain Forest Research Institute (ICFRE), Jorhat, Assam
email : singhap@icfre.org

Butterflies are one of the important components of biodiversity and good indicators of environmental variation (Gilbert, 1980, 1984; Pyle, 1980; Brown, 1982; Murphy *et al.*, 1990; Kremen, 1992) as they are sensitive to any alteration in their habitats, the atmosphere, the local weather, the climate and light levels (Watt *et al*., 1968; Ehrlich *et al*., 1972; Weiss *et al*., 1987; New, 1991). The precise and restricted environmental requirements of particular butterflies make them of considerable value as a group of indicator taxa that indicate the broader effects of environmental changes or reflect a particular suite of ecological conditions (New, 1991). Besides, butterfly diversity also serves as a surrogate for plant diversity because butterflies are directly dependent on plants, often in highly co-evolved situations (Ehrlich and Raven, 1964). A greater number of butterflies usually implies a greater number of vascular plant species on which female butterflies can lay eggs. Butterfly assemblages are affected by habitat loss as native and specialized species decline and species feeding on weeds and those having high reproductive ratios increase (Shapiro and Shapiro, 1973). Butterfly species most representative of the original, pre-development, undisturbed butterfly fauna progressively disappear as sites become more degraded (Blair and Launer, 1997).

The western Himalaya, extending from Kashmir to Kumaon, support more than 417 species of butterfly (Wynter-Blyth, 1957). The area is unique as butterflies from both Oriental and Palaeartic regions mingle here. Ninety-one species among these have been listed as 'rare' or 'very rare', having been placed in schedules I and II of the Indian Wildlife Protection Act of 1972. The prime cause of their depletion in India is destruction of their natural habitats (Smith, 1989; Haribal, 1992).

The west Himalayan oaks *Quercus leucotrichophora, Q. dilatata* and *Q. semicarpifolia* occur in the 'moist temperate forest zone' of the western Himalaya, where they grow gregariously at altitudes between 1,200 and 3,300m, in pure and mixed stands. The Oak forest ecosystem is an important constituent of Himalayan biodiversity as these broad leaved trees provide food, water and habitat for a large number of wildlife species, being the larval food plants of at least six species of butterfly. Many associated trees, shrubs and herbs are hosts of more than 50 species of butterfly in this altitudinal range (Wynter-Blyth, 1957).

However, in Garhwal, these forests have now been extensively exploited and are today increasingly threatened by habitat degradation due to various biotic pressures from local villagers: lopping for fuel wood and fodder (Moench, 1989); grazing and browsing by cattle (Joshi *et al.*, 1996 forest fires (Champion and Seth, 1968; Sharma *et al.*, 1997); illicit felling for charcoal; landslides caused by deforestation and debarking of trees for tanning purposes (Haigh *et al.,* 1995); encroachment of forest land for agriculture; construction of roads and buildings; and other activities. The concomitant changes occurring in the natural Oak forest ecosystem as a consequence of these disturbances affects the structure and composition of the native Himalayan butterfly community present here. However, our knowledge of the native butterfly diversity of the Oak forests in Garhwal and the species occupying various habitat regimes in this ecosystem is negligible. Also, species sensitive to disturbance need to be evaluated for use as the best indicators for monitoring disturbances in these forests.

A 4 year (2006-2010) study was carried out in moist temperate forest areas of the Garhwal Himalaya (Dehradun, Tehri Garhwal, Rudraprayag, Uttarkashi and Chamoli districts of Uttarakhand) under an FRI/ICFRE project to identify the butterflies associated with oak forests and to evaluate species of conservation priority according to their rarity.

ECOLOGICAL CORRELATES OF SENSITIVITY

The community level responses of organisms to land use change are ultimately the consequences of how each species is adapted to its natural environment and how it responds to changes in biotic and abiotic factors following forest modification. Recently, the comparative approach has been used to investigate how traits possessed by species may predispose them to

extinction (McKinney1997; Purvis *et al*., 2000). Such correlative analysis serves two important purposes in the context of land use change. First, it may allow us to identify preemptively species likely to be at risk from forest disturbance, using ecological traits that are easily measured or are readily available. Second, they may generate testable hypotheses as to why different species respond as they do to forest disturbance. Traits that are potentially important for butterflies include the geographic range, forest specialization, micro habitat specialization and larval host specificity (Koh, 2004). The degree of rarity characterizing a species is usually an indicator of extinction risk (Rabinowitz , 1981; Arita *et al.*, 1990; Primack, 1993; Gaston, 1994; Brown, 1995) In general, species characterized by a small geographic range, habitat specialization and low abundance are at higher risk of extinction than those that are widely distributed, that are habitat generalists and that have high abundance. Rare species are the focus of concern for conservation biologists. From a practical standpoint, rare species need to be protected and conserved, or they may become extinct.

SAMPLING METHODS

Four line transects of length 1 km each were chosen for sampling at each site. Each transect was trekked for 1.5 hours for sampling. For sampling butterflies, the standard 'Pollard Walk' methodology (Pollard *et al.*, 1975; Pollard, 1982; Walpole and Sheldon, 1999) was used. All the species that were encountered while trekking along the foot trails between these two sites were recorded daily. Voucher specimens were collected using a butterfly net for only those species that could not be identified in the field. They were also photographed for the same purpose.

A survey of the study area was carried out, and study sites were identified on the basis of the extent of Oak forest cover and the degree of disturbance (measured through the GBH, tree density, prevailing human disturbances, *etc.*). In this study 'rarity' analysis of all the butterflies species sampled in the Oak forests was carried out to identify those species that have a relatively (i) narrow geographical distribution range, (ii) habitat specificity to undisturbed oak forests, i.e sensitivity to disturbance, (iii) low abundance, based on the classification of Rabinowitiz *et al.* (1986).

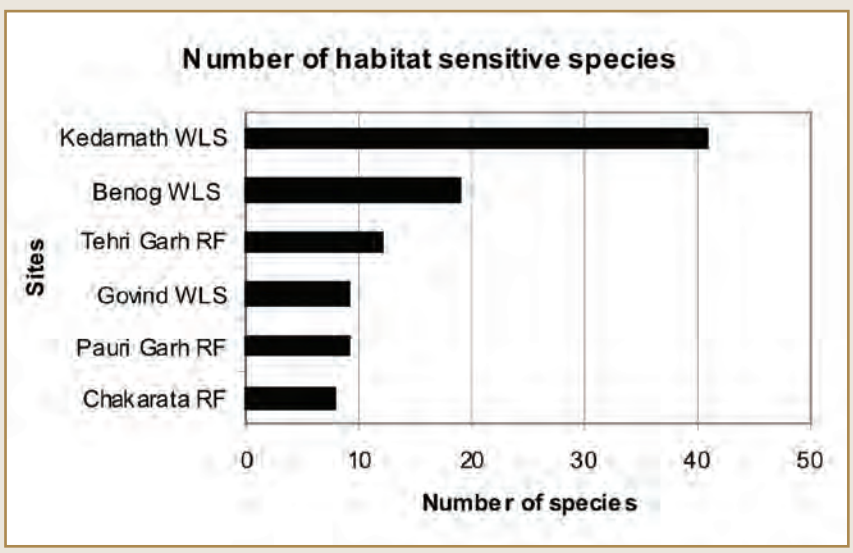
The moist temperate forest area of Garhwal, with three species of Oak, was taken up for this study. Six sites distributed all over Garhwal were studied during the 4 year study period (Fig. 1):

Figure 1.

Map of Garhwal depicting the location of the study sites mentioned in the text

1. Kedarnath Wildlife Sanctuary (Chamoli and Rudraprayag districts)
2. Govind Wildlife Sanctuary (Uttarkashi District)
3. Adwani and Chaurikhal RF (Pauri Garhwal)
4. Binog Wildlife Sanctuary, Mussoorie and surroundings (Dehradun District)
5. Chakrata Forest Division (Dehradun District)
6. Koti Kimoi; Dhanaulty; Nagtibba; and Budha Kedar-Pangarana area (Tehri Garhwal District).

Figure 2.



Distribution of species sensitive to disturbances in different Oak forest sites in Garhwal

RESULTS

Amongst the 211 species sampled, 61 species (Fig. 2) were determined to be sensitive to disturbance as their abundances decreased significantly ($p < 0.05$; Student's t-test)with disturbance in Oak forests.

Amongst these 61 species, 30 species (Table 1) were determined to be both rare (they had relatively restricted geographical distributions and low abundances) and 'sensitive to habitat disturbance' in Oak forests, as compared with the other species found there. These are thus the key butterfly species for conservation in the Oak forests of Garhwal.

Table 1.

Sl. No.	Species	Common Name	Flight Period	Larval Foo Plant	Forest Strata of Food Plants	Habitat Preference
1	*Atrophaneura dasarada ravana Moore*	Great Windmill	April-May	*Aristolochia* spp.	Shrub layer	Mixed forest
2	*Meandrusa sciron Leech*	Brown Gorgon	April-October	*Machilus duthiei*	Canopy	Mixed forest
3	*Aporia agathon caphusa Moore*	Great Black Vein	March-July	*Berberis* spp.	Shrub layer	Pure and mixed
4	*Euaspa milionia Hewitson*	Water Hair-streak	April-July	Data deficient	Middle storey and shrub layer	Pure

5	*Thecla ziha Hewitson*	White-Spotted Hairstreak	May-July	Data deficient	Middle storey and shrub layer	Pure and mixed
6	*Thecla ataxus Doubleday*	Wonderful Hairstreak	May-September	*Rhododendron arboreum*	Shrub and ground layers	Mixed
7	*Esakiozephyrus incana Moore*	Dull Green Hairstreak	May-September	Data deficient	Middle storey and shrub layer	Pure and mixed
8	*Chrysozephyrus syla Kollar*	Silver Hairstreak	May-September	*Quercus leucotrchopho-ra*	Canopy and middle storey	Pure and mixed
9	*Chrysozephyrus birupa Moore*	Fawn Hairstreak	May-October	*Rhododenron arboretum*	Middle storey	Pure
10	*Chaetoprocta odata Hewitson*	Walnut Blue	May-September	*Jugalans regia*	Canopy	Pure
11	*Amblypodia dodonaea Moore*	Pale Himalayan Oak Blue	May-October	*Quercus leucotri-chophora* and *Q. dilatata*	Canopy and middle storey	Pure and mixed
12	*Panchala ganesa ganesa Moore*	Tailless Bush Blue	April-September	Data deficient	Middle storey	Pure
13	*Rapala selira Moore*	Red Himala-yan Flash	April-July	Data deficient	Shrub layer	Mixed
14	*Chliaria kina Hewitson*	Blue Tit	March-October	Data deficient	Shrub layer and middle Storey	Mixed
15	*Lycaenopsis huegelii huegelii Moore*	Large Hedge Blue	April-October	*Prinsepia utilis*	Shrub layer	Mixed
16	*Dodona eugenes eugenes Bates*	Tailed Punch	February-October	*Arundinaria falcata*	Ground layer	Mixed
17	*Lethe verma verma Kollar*	Straight-Banded Tree Brown	April-November	Bamboos (Poaceae)	Ground layer	Pure and mixed
18	*Mycalesis lepcha lepcha Moore*	Lepcha Bush Brown	March-July	Data deficient	Ground layer	Pure and mixed
19	*Lethe baladeva aisa Fruhstorfer*	Treble?] Silverstripe	April-September	*Arundinaria falcata*	Ground layer	Pure and mixed
20	*Zophoessa goalpara nar-kanda Fruhstorfer*	Large Goldenfork	July-September	Data deficient	Middle storey	Mixed
21	*Callerebia hybrida Butler*	Hybrid Argus	April-August	Data deficient	Middle and ground layers	Mixed
22	*Ypthima kedarnathensis sp. nov.*	Garhwal Six Ring	May-October	Grasses (Poaceae)	Ground layer	Mixed
23	*Symbrenthia brabira Moore*	Himalayan Jester	April-November	*Debregeasia* sp.; *Elatostema* sp. (Urticaceae)	Shrub layer	Mixed
24	*Neptis ananta ananta Moore*	Yellow Sailor	April-December	Data deficient	Canopy, middle storey and shrub layer	Pure and mixed

25	*Neptis mahendra Moore*	Himalayan Sailor	April-October	*Flemingia* sp.; *Xylia* sp.; *Triumfetta* sp.; *Grewia* sp.	Middle storey and shrub layer	Mixed
26	*Neptis sankara sankara Kollar*	Broad-Banded Sailor	April-October	Data deficient Schedule II – Part II	Middle storey and shrub layer	Pure and mixed
27	*Neptis narayana naraya-na Moore*	Broadstick Sailor	April-October	Data deficient Schedule II – Part II	Middle storey and shrub layer	Pure and m ixed
28	*Neptis zaida zaida Dou-bleday*	Pale Green Sailor	April-June	Data deficient Schedule II – Part II	Middle storey a nd shrub layer	Pure and mixed
29	*Euthalia patala patala Kollar*	Grand Duchess	May-August	*Quercus leucotri-chophora*	Canopy and middle storey	Pure
30	*Dilipa morgiana West-wood*	Golden Emperor	April-August	Data deficient	Middle storey and ground layer	Mixed

**For species 1,28,29 & 30, images are given in Plate- I*

LONG TERM MANAGEMENT OPTIONS

- The natural regeneration of oaks is adversely affected by lopping as no seed is set. Grazing and trampling by cattle, along with forest fires, destroys the seedlings in the under storey. A check should be imposed on repeated lopping of Oak trees. Since a lack of fodder tree species is one of the major causes of damage to Oak tree in the region, intervention by planting fodder trees and grasses in the fringes of villages may also be considered.
- Also, awareness may be generated amongst the villagers about the damage being caused by lopping to valuable Oak trees, which play a vital role in the Himalayan ecology, including recharging of ground water. Oak nurseries (*Q. leucotrichophora* and *Q. dilatata*) be established, especially in Govind Wildlife Sanctuary, Uttarakashi District, where the Oak stands close to the villages have been extensively exploited and there was practically no regeneration of Quercus leucotrichophora during the study period.
- Protection of selected oak forests stands against biotic interferences, mainly summer fires, felling of green trees and extensive lopping and grazing, .i.e. conservation of native habitat.
- Conservation of the larval food plants of the butterflies listed above.
- Protection of natural resources such as fresh water streams in Oak forests against pollution, mining and drying as a result of diversion as these are important habitats for butterflies in the dry summer.
- Amongst the plants exploited, there were also a large number of larval food plants of butterflies, which directly affect the life cycles of butterflies in Oak forests.
- This study therefore recommends that in order to conserve the Himalayan butterflies found in the Oak forests of Garhwal, managers and planners should aim to maintain the pre-developmental levels of butterfly diversity and check the disturbance in forest stands. Any further development in the moist temperate zone of the Garhwal Himalaya should be concentrated away from the land remaining under Oak forests.

PLATE I

The Grand Duchess, Eutalia patala

Golden Emperor, Dilipa morgiana

Brown Gorgon, Meandrusa sciron

Pale Green Sailor, Neptis zaida zaida Doubleday

REFERENCES

Arita, H.T., Robinsin, J.G. and Redford, K.H. (1990). Rarity in Neotropical forest mammals and its ecological correlates. Conservation Biology 4: 181-192.

Blair, R.B. and Launer, A.E. (1997). Butterfly diversity and human land use: species assemblage along an urban gradient. Biological Conservation 80: 113-125.

Brown, J.H. (1995). Mcroecology. University of Chicago Press.,Chicago, II

Brown, K.S. (1982). Paleoecology and regional patterns of evolution in Neotropical forest butterflies. In Biological Diversification in the Tropics, ed G.T. Prance, Columbia University Press, New York. pp. 255-308.

Champion, H.G. and Seth, S.K. (1968). Forest Types of India. Government of India Publication, Delhi.

Ehrlich, P.R. and Raven, P.H. (1964). Butterflies and plants: a study in co-evolution. Evolution 18: 586-608.

Ehrlich, P.R., Breedlove, D.E., Brussard, P.F. and Sharp, M.A. (1972). Weather and the regulation of sub-alpine populations. Ecology 53: 243-247.

Gaston, K.J. (1994). Rarity. Chapman and Hall, London.

Gilbert, L.E. (1984). The biology of butterfly communities. In R. Vane-Wright and P. Ackery (Eds.). The Biology of Butterflies, XI Symposium of the Royal Entomological Society of London. Academic Press, New York.

Gilbert, L.F. (1980). Food web organization and the conservation of Neotropical diversity. In Conservation Biology: An Evolutionary Ecological Perspective, eds M.E. Soule and B.A. Wilcox, Sinauer Associates, Massachusetts.pp. 11-34.

Haigh, M.J., Rawat, J.S., Rawat, M.S., Bartarya, S.K. and Rai, S.P. (1995). Interaction between forest and landslide activity along new highways in Kumaon Himalaya. Forest Ecology and Management 78: 173-189.

Haribal ,M. (1992). The Butterflies of Sikkim Himalaya and their Natural History. Sikkim Nature Conservation Foundation and Thompson Press (India) Ltd., Faridabad, Haryana, India.

Joshi,M.,Rawat,Y.S.and Singh,S.P.(1996).Plant form selection and dietry overlap of cattle and goats on a continuously grazed rangeland. Journal of Tropical Forest Science. 8:300-309.

Koh, L.P., Sodhi, N.S. and Brook, B.W. (2004). Co-extinctions of tropical butterflies and their host plants. Biotropica 36: 272-274-

Kremen, C. (1992). Assessing the indicator properties of species assemblages for natural area monitoring. Ecological Applications 2: 203-217.

McKinney, M. (1997). Extinction vulnerability and selectivity: combining ecological and paleontological views. Annual Review of Ecology and Systematics 28: 495-516.

Moench, M. (1989). Forest degradation and the structure of biomass utilization in the Himalayan foothill villages. Environmental Conservation 16: 137-146

Murphy, D.D., Freas, K.E. and Weiss, S.B. (1990). An environment-meta population approach to population viability analysis for a threatened invertebrate. Conservation Biology 4: 41-51.

New, T.R. (1991). Butterfly Conservation. Oxford University Press.

Pollard, E. (1982). Monitoring butterfly abundance in relation to the management of a nature reserve. Biological Conservation 24: 317-328.

Pollard, E., Elias, D.O., Skelton, M.J. and Thomas, J.A. (1975). A method for assessing the abundance of butterflies in Monks Wood National Nature Reserve in 1973. Entomologist's Gazette 26: 79-88.

Primack, R. (1993). Essentials of Conservation Biology. Sinauer Assocoates, Sunderland, Massachusetts.

Purvis, A., Agapow, P.M., Gittleman, J.L. and Mace, G.M. (2000). Non random extinction and the loss of evolutionary history. Science 288: 328-330.

Pyle, R.M. (1980). Butterfly eco-geography and biological conservation in Washington. Atala 8: 1-2.

Rabinowitz, D.S., Cairns, S. and Dillon, T. (1986). Seven forms of rarity and their frequency in the flora of the British Isles. In Conservation Biology: The Science of Scarcity and Diversity, ed M.E. Soule. Sinauer, Sunderland, Massachusetts. pp. 182-204.

Rabinowitz, D.S. (1981). Seven forms of rarity. In The Biological Aspects of Rare Plant Conservation, ed H. Synge, Wiley, Chichester, U.K. pp. 205-217.

Shapiro, A.M. and Shapiro, A.R. (1973). The ecological associations of the butterflies of Staten Islands. Journal of Research in Lepidoptera,12,65-128-Staten Islands. Journal of Research in Lepidoptera 12: 65-128.

Sharma, Subart, Rikhari, H.C. and Sharma, S. (1997). Forest fires in the central Himalayas. International Journal of Biometerology 40: 63-70.

Smith, C. (1989). Butterflies of Nepal (Central Himalaya). Craftmen Press, Bangkok.

Walpole, M.L. and Sheldon, I.R. (1999). Sampling butterflies in tropical rainforest: an evaluation of atransect walk method-Biological Conservation 87: 85-91.

Watt, W.B., Chew, F.S., Snyder, L.R.G., Watt, A.G. and Rothchild, D.E. (1968). Population structure of pierid butterflies. I. Numbers and movements of some montane Colias species. Oecologia, Berl. 27: 1-22-

Weiss, S.B., White, R.R., Murphy, D.D. and Ehrlich, P.R. (1987). Growth and dispersal of larvae of the checker spot butterfly, Euphydryas editha. Ecology 50: 161-166.

Wynter-Blyth, M.A. (1957). Butterflies of the Indian Region. Journal of the Bombay Natural History Society, Bombay. 523 pp.