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Biodiversity and conservation status of Butterflies in Western Himalaya, India: An appraisal

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Abstract

In India, the Himalayan ranges extending from Jammu & Kashmir, Himachal Pradesh up to Uttarakhand is known as Western Himalaya. In the present study, 493 butterfly species are recognized from the Western Himalaya, constituting approximately 30 % of the total Indian butterfly fauna. Threatened butterflies have narrower niches, more restricted distributions of the larval host plants, poorer dispersal abilities and shorter flight periods. The objective of this study is to distinguish the actual threatened taxa in the highly fragile ecosystem of Western Himalaya, for which the published data and recent field observations (from 2013 to 2016) have been utilized to create a dataset of various ecological characteristics (distribution, local status and habitat utilization) for different butterfly species. Many of the narrowly endemic taxa, which are currently not protected, were highlighted and were termed as 'priority species' which should be included in Wildlife (Protection) Act 1972 list. Study showed that status of most of the butterfly taxa was not assessed under IUCN 2016. Besides, taxa with no recent records from Northern Himalaya were also highlighted to emphasize the severity of the habitat degradation and loss of biodiversity.

Keywords: Conservation, endemic, hypsobionts, pseudo rare, Western Himalaya.

1. Introduction

Himalayan ecosystems face mounting threats to biodiversity from anthropogenic disturbances^[1]. Assessing potential impacts requires information on the presence or absence of listed species at affected sites^[2]. The extinction of species is a major concern in ecological conservation^[3]. A large body of evidence now demonstrates that many species are not perfectly detectable; there is a non-negligible probability that the target species will remain undetected during a survey, even when it occupies the site^[2]. As the Himalayan forests are under large threats of habitat degradation and forest fragmentation, there is an urgent need to perform such studies on butterflies, especially for species which are endemic to the Himalayan region and subregions^[1]. In temperate areas, there is strong evidence of recent local and regional extinction of several butterfly species as the result of habitat fragmentation and global climate change^[4].

Butterflies promise to be a good model for rapid assessment and habitat monitoring studies because they are widespread, conspicuous, and easily recognizable and they are effective indicators of forest health^[1]. There seem to be no data available in peer-reviewed literature describing the conservation importance of Indian butterfly species and subspecies^[5]. The reality is that our foresight is limited, especially when dealing with the conservation of insects^[6]. Assessing the status of taxa by assigning conservation values based on multiple species attributes has been a prevailing trend in Western Ghats^[7, 8, 5]. This methodology can be used to objectively assess conservation values of other animals and their inclusion in the WPA^[5]. Similar method, with slight modification has been adopted to evaluate conservation status of butterflies in Northern Himalaya at the species level.

The species traits/multiple species attributes considered in the present study are (1) Geographical distribution (2) Habitat utilization (3) Rarity. As part of the same study, the purpose of this report is to provide a hierarchical categorization of the endangered endemic^[9] species to set the most suitable future conservation priorities for the taxa with higher extinction proneness. Our study illustrates the utility of available taxon-specific data in a localized area for estimating the extinction proneness of species on a regional scale^[10]. The main objective of this study is to distinguish the actually threatened butterfly taxa in Western Himalaya so that appropriate conservation measures could be devised.

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2. Materials and Methods

2.1 Study area

Himalaya is the tri-junction of three realms - Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. The Himalaya, along the northern border of the Indian Subcontinent, extends 2500 km from Pamir Knot in the west to Arunachal Pradesh. Ecologically, the defile of river Sutlej differentiates the North-western Himalaya from Western Himalaya [11]. But in

the present context, the north-western Himalaya is considered as a part of Western Himalaya itself (Fig 1). The timberline and the snowline in the Western Himalaya lie at 3000m and 5200m respectively, whereas in the Eastern Himalaya the former rises to 3600m and latter sinks down to 4500 m. The western half of the Himalayan range has arid, more temperate climate with greater Palearctic affinities [12] and butterflies [13, 14]. The western end of the Himalaya is not as densely forested as eastern Himalaya.

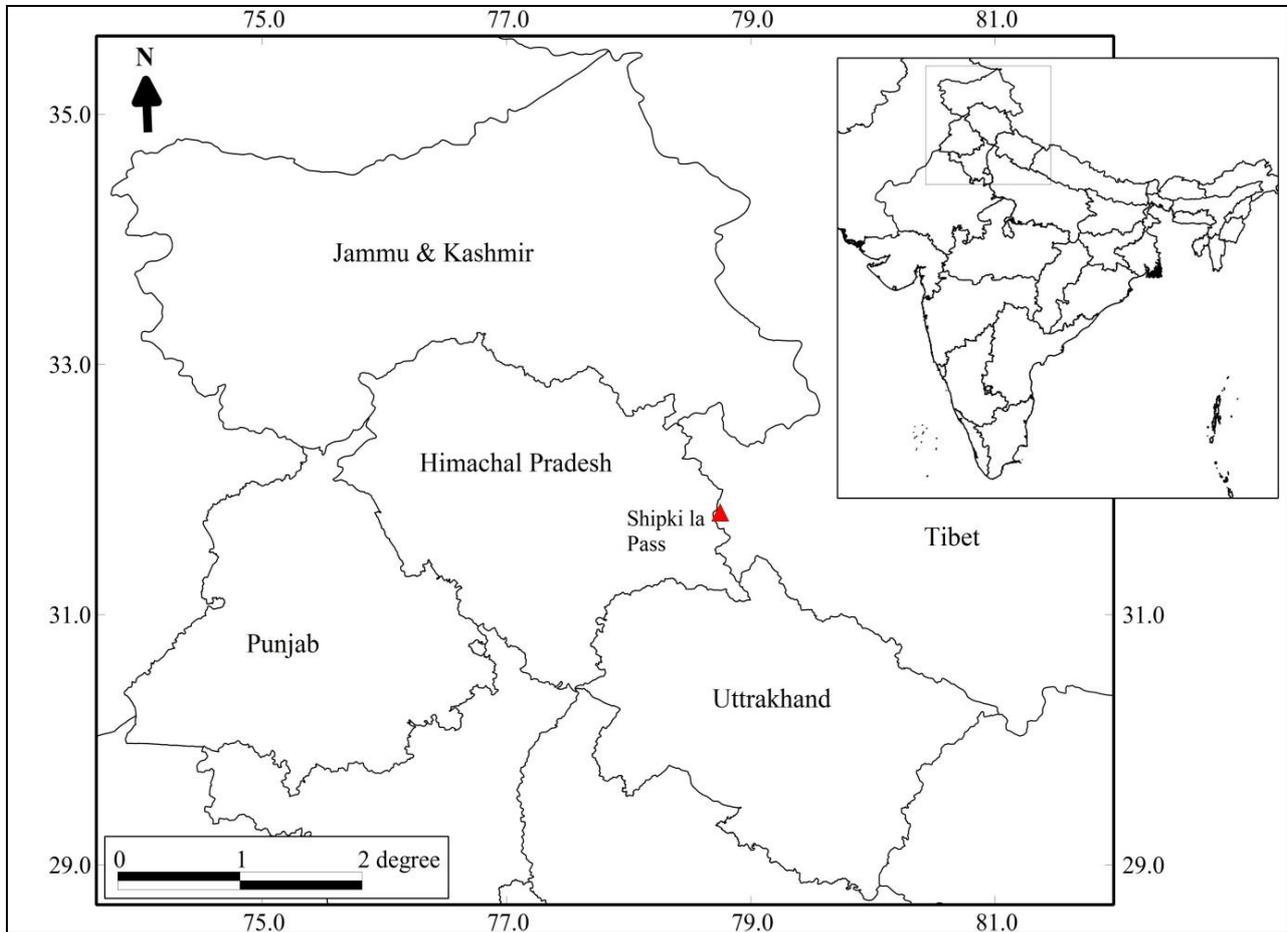


Fig 1: Map of Western Himalaya. Shipki la Pass (red triangle) marks the defile of river Sutlej which enters into the Western Himalaya from Tibet. The Himalaya on the west of this pass is called North-western Himalaya.

Data on the butterflies found in Western Himalaya was gathered from Mackinnon & De Niceville [15], Bingham [16], Evans [13], Talbot [17, 18], Wynter-Blyth [19], Mani [20], D'Abrera [21-23].

A data on multiple species attributes (global distribution, local distribution, habitat and local status) for each butterfly species was documented. The combination of these multiple species attributes obtained the significant results for distinguishing the taxa with high local extinction proneness. The statistical analysis was performed using Microsoft excel 2010.

2.2 Distribution

Global distributions were assigned to species in terms of zoogeographic regions following Kunte [5].

Local distribution (within western Himalaya): As stated earlier, the North-western part (Punjab-Kashmir Himalaya) of the Western Himalaya, differentiated at the defile of river Sutlej is considered the major bio geographical division from where, the ecological transition is strikingly clear. Data on the local distribution of species was obtained from various published data (Lang [24], Moore [25], Doherty [26], Mackinnon & De Niceville [15], Bingham [16], Hannington [27], Ollenbach

[28]; Evans [13]; Talbot [17, 18]; Sanders [29]; Wynter-Blyth [30, 31, 19]; Sakai [32]; Varshney [33-40]; Smith [41]; Singh [42, 43]; Singh & Bhandari [44]; Uniyal [45] [46]; Arora *et al.* [47]; Singh & Bhandari [48]; Kittur *et al.* [49]; Smith *et al.* [50]; Smetacek [14, 51-53]; Sidhu [54-55]; Bhardwaj *et al.* [1]; Sidhu *et al.* [56]; Qureshi [57]; Singh & Sondhi [58]) and from various biodiversity websites [59-60].

2.3 Habitats

Different types of habitats found in Western Himalaya classified according to Champion & Seth [61] are enlisted below:

- Montane subtropical forests (<1500 m above mean sea level) mainly located in the shivalik range of the Himalaya form the highly unstable and degraded habitats. Shivalik range is one of the most fragile ecosystems due to its topographic features. It is also highly degraded due to anthropogenic activities. Ecologically, this region is a transition zone between the plains of the North India and high mountains of Himalaya, which accounts for its high-ranking in terms of biological diversity.
- Himalayan Moist Temperate Forests (altitudinal range

from 1500 - 3300 m above mean sea level) extends between the subtropical pine forests and the subalpine zone with a rainfall between 1000 to 2500 mm annually.

- Moist Temperate Deciduous Forests: It is indeed a subtype of Himalayan moist temperate forests. It is commonly found from 1,800-2750 m.
- Himalayan Dry Temperate Forests: This forest type is found on the inner dry and arid valleys between the ranges 2500 – 4500m above mean sea level. Species inhabiting this type of habitat and the next are true hypsobionts.
- Subalpine and Alpine zone: This zone stretches from 3000m and above. The species belonging to this region needs protection as only specialist species occupy such zones and they typical high altitude species, which rarely wander out of their range. Many of them are narrowly endemic to North-western Himalaya.
- Moist forests: Shivalik Sal forests, moist tarai sal forests and moist gangetic mixed deciduous forests fall under this habitat.
- Low and mid elevation grassland and savannah used for grazing etc.
- Montane ecotones and degraded habitats are polluted areas
- Diverse.

Data for the habitat utilization for different butterfly species was obtained from Mackinnon & De Niceville [15], Bingham [16], Evans [13], Talbot [17, 18], Wynter-Blyth [19], Mani [20].

2.4 Status

Status, i.e. frequency of occurrence and patchiness of geographical distribution, was assigned to butterfly species [5] in the Western Himalaya based on the literature surveys and personal observation.

3. Results

A total of 493 butterfly species referable to 219 genera were reported from Western Himalaya, out of which, 89 species (60 species are narrowly endemic) i.e. 18% were found to be endemic (Table 1).

Table 1: Family-wise breakdown of butterfly diversity and endemism in the Western Himalaya. NENWH (Narrowly endemic to North-western Himalaya); EWH (Endemic to Western Himalaya).

Family	Genera	Species	NENWH	EWH	Total Endemics
Hesperiidae	46	78	3	0	3
Papilionidae	7	38	3	2	5
Pieridae	19	49	5	3	8
Nymphalidae	75	178	25	13	38
Lycaenidae	72	150	24	11	35
Total	219	493	60	29	89

Highest number of endemic taxa belonged to family Nymphalidae, followed by Lycaenidae. However, as stated by Kunte [5], endemism alone is not a good correlate of overall conservation values. Hence the status of each species within the Western Himalaya was assessed. Of the total 493 butterflies in Western Himalaya, 205 butterfly species fell under the combination of rare and patchy (i.e. 41% species). And out of these 205 rare and patchily distributed species, 65 species were endemic (51 butterfly species are narrowly endemic), to the Western Himalaya and 20 were endemic to Himalaya (i.e. found in western, Central and Eastern

Himalaya). Hence, out of the 89 species (Narrowly endemic and endemic butterfly species), 65 species (i.e. 73%) were found to be rare and patchily distributed in the Western Himalaya (Fig 2).

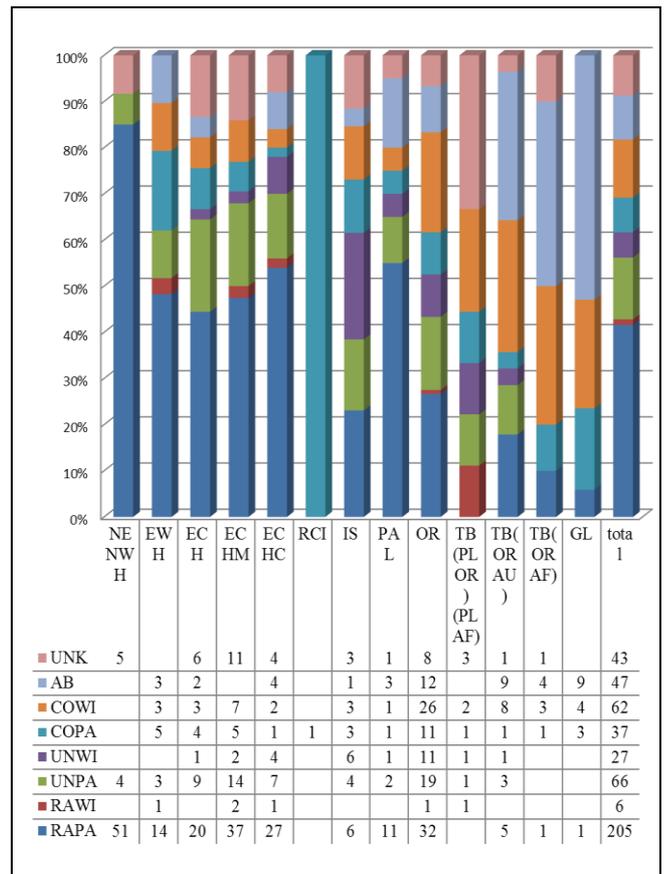


Fig 2: Local status of Western Himalayan butterflies. Status within the Western Himalayan – RA (Rare); UN (Uncommon); CO (Common); AB (Abundant); PA (Patchily distributed); WI (Widely distributed). Global distribution – NENWH (Narrowly endemic to North-western Himalaya); EWH (Endemic to Western Himalaya); ECH (Endemic to Himalaya); ECHM (Endemic to Himalaya extending up to Malaysia); ECHC (Endemic to Himalaya and extending into Chinese provinces); RCI (Restricted between Western Himalaya to Central India); IS (Indian Subcontinent); PAL (Palearctic); OR (Oriental); TB (Two Biogeographic Zones); PLOR (Palearctic + Oriental); PLAF (Palearctic + African); ORAU (Oriental + Australian); ORAF (Oriental + African); GL (Distributed over three or more zoogeographic regions).

A breakdown of species according to their global distribution and habitat preferences [5] within the Western Himalaya was done. Habitat specialization was the most important determinant of butterfly extinction probability [10]. A large proportion of Western Himalayan butterflies seemed to occupy Montane subtropical forests (180 species, i.e. 37%), diverse habitat (78 species; 16%) followed by Subalpine and alpine habitats (73 species; 15%). A remarkable fraction of the narrowly endemic species inhabited the highly endangered habitats: subalpine and alpine zone (47/60 species; 78%) and highly specialized habitats like Himalayan montane temperate forests and moist forest (6/60 species; 10%) (Fig 3).

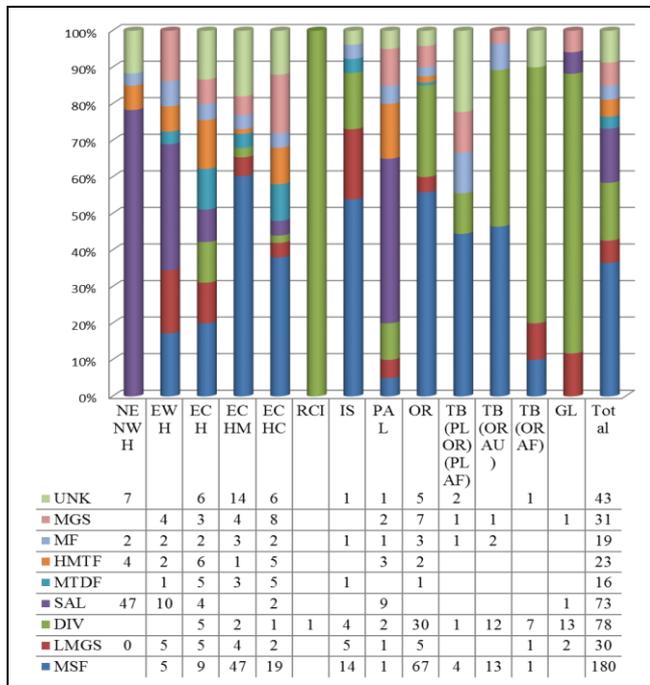


Fig 3: Habitat utilization of Western Himalayan butterflies. MSF (Montane sub-tropical forest); SAL (sub-alpine and alpine pastures); HMTF (Himalayan moist temperate forests); MTDF (Montane temperate deciduous forests); MF (moist forests); LMGS (Low and mid elevation grassland and savannah); MGS (Montane grasslands, ecotones and degraded habitats); DIV (Diverse).

An analysis of Western Himalayan butterfly species included in Wildlife (Protection) Act, 1972 and IUCN was also done. Only 104 species and subspecies (21% species) of the total 493 Western Himalayan butterflies were found to fall under WPA 1972 (Table 2).

Table 2: Western Himalayan butterflies included under various schedules of Wildlife (Protection) Act, 1972.

Family	Schedule I	Schedule II	Schedule IV	Total Species	Total Species in WPA
Hesperiidae	0	1	5	6	12
Papilionidae	3	4	0	7	35
Pieridae	3	8	1	12	31
Nymphalidae	7	35	1	43	211
Lycaenidae	6	30	0	36	161
Total Species	19	78	7	104	450

A total of 450 butterflies are included in the WPA (1972), out of which the family wise percentage of Western Himalayan species is given in Fig 4.

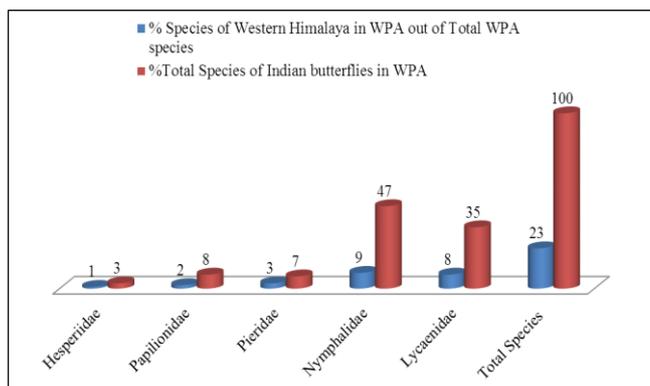


Fig 4: Comparison of the percentage of the protected butterflies of each family in Western Himalaya with the total species of WPA 1972.

Only four species (viz., *Eurema brigitta*, *Dodona eugenes*, *Euploea core*, *Junonia almana*) out of 493 Western Himalayan butterflies were enlisted under the IUCN list, whereas rest of the species were with unassisted status. We suspect this to be a problem due to paucity of quantitative biodiversity studies in the region rather than a true indication of the conservation status [10] of Western Himalayan butterflies.

4. Discussion

A review of the conservation status of Western Himalayan butterflies with the help of multiple species attributes has been presented here. Results of the present study were in accordance with those presented by Kunte [5] i.e. WPA does not protect many endemic and non-endemic species with high conservation values.

There are actually fewer species and fewer individuals of species in the western end of the Himalayan forests than in the eastern end [20]. In the Himalaya, butterfly distribution shifts with season (dry and wet seasons) and with change in climatic condition (e.g. snowfall, temperature fluctuation, forest fire, etc.) [1, 20]. Western elements especially true hypsobionts exhibit high endemism and often have no more than a single annual brood which further enhances the extinction risks manifolds. For example, species under genus *Parnassius* show high endemism, and all the species and subspecies under this genus ought to be enlisted under WPA. To name a few, following are the butterfly species and subspecies that were found to be narrowly endemic to Western Himalayan with high conservation values, yet are currently not included in WPA: *Actinor radians*, *Pyrgus alpinus*, *Pyrgus cashmirensis*, *Mesapia peloria*, *Baltia shawii*, *Polyommatus sarta gooraisica*, *Polyommatus fraterluci*, *Polyommatus ariana*, *Polyommatus stoliczkana*, *Polyommatus pseuderos*, *Polyommatus dux*, *Albulina omphisa*, *Lycaena baralacha*, *Lycaena kasyapa*, *Polyommatus solskyi*, *Esakiozephyrus mandara*, *Chrysozephyrus triloka*, *Rapala extensa*, *Rapala tara*, *Oreolyce vardhana*, *Lasiommata menava maeroides*, *Melitaea arcesia balbita*, *Callerebia shallada*, *Hyponephele pulchella*, *Hyponephele pulchra*, *Hipparchia parisatis*, *Karanasa astorica*, *Karanasa huebneri*, *Karanasa rohtanga*, *Pseudochazara mmiszecchii*, *Paroenis pumilus*, *Boloria sipora*, *Limenitis trivena*, *Aglaia ladakensis*.

Some true hypsobiont species viz., *Parnassius stoliczkanus*, *Parnassius jacquemontii*, *Parnassius epaphus*, *Parnassius charltonius*, *Pieris deota*, *Baltia butleri*, *Aporia nabellica*, *Colias eogene* are included in the WPA. Out of these, *Parnassius stoliczkanus*, *P. jacquemontii*, *P. charltonius*, *A. nabellica*, *C. eogene* are endemic to Western Himalaya, nevertheless, have no recent records from Gharwal region/ Uttarakhand [58], indicating the incompetent conservation strategies offered by WPA. Regional conservation actions are usually formulated within national or administrative boundaries that have little regard for, or relationship to, the boundaries of natural habitats and biomes [62]. Species like these should be shifted to Schedule I. Moreover, the conservation practices should have primary focus on habitat protection as these species are highly habitat specific. Indeed, there are species which are centred in Palearctic and/or Mediterranean regions but only their peripheral populations occupy the narrow adjacent boundaries of Western Himalaya. For example: *Satyrus actaea* and *Hyponephele davendra brevistigma* may be termed 'pseudo rare' [63]. These marginal populations are more prone to local extirpation (as they often occupy highly fragile habitats like

sub-alpine and alpine zone) and require appropriate conservation strategies. Populations at the geographic margins of their ranges may be important for the long-term survival and evolution of species [64].

Conservation strategies for the species which are widely distributed throughout Eastern Himalaya/Indian subcontinent, but are 'sporadic' in Western Himalaya (*Pedesta masuriensis*, *Sovia grahami*, *Carterocephalus avanti*, *Papilio alcmenor*, *Atrophaneura aidoneus*, *Gonepteryx mahaguru*, *Delias acalis*, *Dodona ouida*, *Arhopala single*, *Arhopala paraganesa*, *Arhopala centaurus*, *Elymnias patna*, *Lethe nicetas*, *Mycalesis nicotia*, *Ypthima avanta*, *Nymphalis xanthomelas*, *Chersonesia risa*, *Neptis cartica*, *Tanaecia lepidea*, *Dichorragia nesimachus*, *Mimathyma ambica*, *Polyura agraria*, *Polyura dolon*) should be planned accordingly. Extirpation of these marginal/peripheral populations leads to the range contraction of the species.

If a species' presence has been overlooked, an important locale for that species may not receive protection or proper management, and local extinction could occur [65]. Although failure to detect specimens at a site does not necessarily equate to their absence [65], but having a species not reported for 50 years or more is a major concern. There are many species which have no recent reports/or are extirpated from their particular habitat or from entire Western Himalaya. It should be noted that 51 species have no recent records (some since 1899, others since mid-20th century) from Garhwal and/or Uttarakhand [58], out of which many are endemic to Western Himalaya (viz., *Parnassius stoliczkanus* (Sch I), *P. jacquemontii* (Sch II), *P. charltonius* (Sch II), *Aporia nabellica* (Sch II), *Callerebia shallada*, *Colias eogene* (Sch II)). We consider these species locally extinct [4] from Gharwal. Range contraction can ultimately result in the extinction of a number of species due to total habitat loss [9] [66] [67]. In fact many Eastern Himalayan species extending sporadically into western Himalaya (viz., *Bibasis vasutana*, *Celaenorrhinus ratna daphne*, *Darpa hanria*, *Esakiozephyrus mandara*, *Delias sanaca* (Sch I), *Arhopala singla*, *Catapaecilma major*, *Strymonidias assanides*, *Tajuria yajna*, *Tajuria illurgis* (Sch II), *Creon cleobis*, *Sinthus nasaka* (Sch II), *Calinaga buddha* (Sch. I), *Speyeria clara* (Sch II), *Dichorragia nesimachus*, *Hestina nicevillei*) have no recent records from Gharwal and further west.

5. Conclusion

The Himalayan butterflies have two major ecological groups: the forest species (confined to densely wooded slopes of the outer Himalayan ranges and valleys) and the hypsobionts (true high altitude forms which never occur below timberline). The western elements exhibit high endemism, particularly at higher altitude accounting for the ecological as well as geographical isolation. A major challenge in conservation biology is to identify the extinction-prone species. From the above discussion it is evident that, Western Himalaya harbours many endemic/non-endemic butterfly species to be top listed for conservation. Generally, the threatened species have narrower habitat ranges at the local scale. It is thus of the utmost importance to protect species on a regional basis, or else the provisions of the Wildlife (Protection) Act [69] and IUCN [70] will be meaningless. The method proposed in this paper is a relational approach where the relative conservation importance of a species is derived from distribution [62], rarity and habitat preference. When intensive field studies are not forthcoming, especially in regions suffering from rapid biodiversity loss, similar

approaches could be used to estimate extinction threats for other taxonomic group [5]. With this kind of approach it is easier to identify the taxa which require higher prioritization in terms of conservation.

The attributes such as host plant and habitat specialization, taxonomic distinctiveness, attributes of the larval stages, migratory patterns and congenor density etc. could be utilized for the future study.

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