BCRLIP, ECOLOGICAL INDICATOR (INSECT TAXA)

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Executive Summary:

Insect survey was done in different altitudinal and vegetation zones in Askot Landscape in Western Kumaon, Pithoragarh district, Uttarakhand under Biodiversity Conservation and Rural Livelihood Improvement Project (BCRLIP). Field sampling was done in winter, summer, monsoon and post-monsoon seasons for different taxa and major sampling strategies were transect walk, light trapping and pitfall trapping. Altogether 63 species of butterflies under 5 different families were recorded including some rare and endangered species like Common Red Apollo (*Parnassius epaphus*), Common Blue Apollo (*Parnassius hardwickii*), and Common Yellow Swallowtail (*Papilio machaon*). We recorded and identified 105 species of moths under 19 different families and 7 families of beetles. Five groups of major insect pests were recorded which do a considerable damages to vegetables like cauliflower, cabbage and potato. 16 major pollinator species were recorded in different crops like bottle gourd, brinjal, citrus, maize, cucumber, mustard and red gram. Butterflies have been proposed as suitable biological indicators in the landscape and from existing literature a list of 293 species of butterflies have been compiled which might have potential distribution in the landscape with their altitudinal limit and habitat information. The aim is to establish the group as strong biological indicators with sound field based data and developing monitoring protocol which will involve the local village communities. General threats to the insect taxa and their potential for betterment of human livelihood opportunities in the landscape have been outlined.

Introduction:

The evaluation of sustainability requires the understanding and monitoring of local ecosystem functions before, during and after the use of the forest or its renewable products. Biological diversity is a frequently used surrogate for ecosystem health and function (Schulze and Mooney, 1993). Genetic, specific, and system diversity, and their turnover rates through space and time, can be evaluated through indicator 'focal' taxa of plants and animals (Noss, 1990; Kremen, 1992, 1994; Oliver and Beattie, 1993; Longino, 1994; Kremen et al., 1994). Insect assemblages have been used for conservation monitoring since early suggestions by Pyle et al. (1981). Most authors agree that no single group of organisms can be sufficient for adequate inventory and monitoring (Landres et al., 1988), since each group subtends its own formulae for extrapolation from species–time accumulation curves or genetic diversity measurements to general richness or diversity values (Sober´on and Llorente, 1993). The groups used should be common, biologically and taxonomically well understood, easily observed and identified in any site or season, widespread and comparable across sites, seasons, habitats and human use regimes, faithful and sensitive to given physical and biological factors and processes in their habitat, closely associated with other taxa, resources, and ecosystem characters, and show a predictable early reaction to any unsustainable resource use which could lead to local habitat degradation (Pearson, 1994).

The Askot landscape in the eastern Kumaon of Uttarakhand state lies in the conjunction of the western and eastern Himalayas and contains biodiversity elements of both these regions. The great vertical altitudinal gradients, from 560 m at the banks of the Gori in the township of Jauljibi to over 7000 m at the Panchachuli's summits yield an exceptionally high habitat diversity that ranges from subtropical *shorea robusta*, to alpine meadows and in between fourteen major vegetation types have been identified in the landscape like Pine Mix Forest, Sub-tropical Riverine Forest, Banj Oak Forest, Moru Oak, Kharsu Oak, Alder Forest, Cypress Forest, Temperate Secondary Grasslands, Hemlock or Tansen Forest, Temperate Secondary Scrub including *Berberis*, *Prinsepia*, *Rubus*, Temperate Broadleaf Forest including *Acer*, *Betula*, *Juglans*, *Aesculu*s, Blue Pine, Sub-alpine Forest including Birch-Fir and Birch-Rhododendron

forest, Alpine Scrub consisting Dwarf Rhododendron and Juniper scrub. About 58% of the landscape also falls under alpine conditions that are characterized by moist alpine habitats in the Greater Himalaya and dry alpine habitat in the Trans Himalaya sections of the landscape. In spite of this great diversity in the landscape there have been few intensive studies on the floral and faunal elements in the region except for inventorying plants (2607 species of tracheophytes), birds (265 species) and mammals (37 species). The Askot landscape, encompassing 3326 square kilometers, links the Nanda Devi National Park and the Askot Wildlife Sanctuary and shares international boundaries with the Tibetan Autonomous region in the north and Nepal on the South East; large swathes of wilderness also exist between and in the upper reaches of both the international boundaries. While the landscape shows a predominance of typical west Himalayan forest communities like Chir pine and West Himalayan Oaks, the special location of the landscape in the east to west (longitudinal) transition enables it to also represent the western-most limit for the occurrence of East Himalayan communities such as *Tsuga* and *Macaranga*.

This great variety of habitats and vegetation cover is undoubtedly a major repository of insect diversity in Western Himalayan perspective. But prior to our study, there was minimum focus given to this important group of biodiversity in the landscape. As over 40% of the representative floristic elements present in the landscape are native or Himalayan in origin, richness and relative dominance of native species increase significantly with elevation. The same, may be in slight different magnitude, is expected to be true for hyperdiverse taxa like insects, whose distribution pattern is mainly governed by the association with floral elements owing to herbivory. Diversity and distribution pattern of insect community, which is poorly characterized in this landscape, was very interesting to study in the light of altitudinal gradients in temperature and moisture and natural barriers to dispersal. In regional scale, the mountainous habitats which show relatively distinct elevational zonation of biomes are interesting to study as the area available as habitat become more limited at higher elevations. Mountaintops which resembles oceanic islands in their degree of isolation within a matrix of lower elevation environments and are most vulnerable to climate changes that shift temperature and moisture combinations upward. At landscape scale gradients in climate and

geographic factors interacting with patch scale of disturbances across landscapes produce a shifting mosaic of habitat types that affects the distribution of populations. As local extinction of a patch and subsequent colonization of new habitats are very important for a species to survive, the composition of surrounding patches in a landscape matrix is as important as patch size and isolation in population movement and distribution. Insect populations show considerable spatial variation in densities in response to geographic variation in habitat conditions and resource quality. Variation can occur over relatively small scales because of the small size of insects and their sensitivity to environmental gradients. Now as human presence in a landscape heavily modifies the natural patch dynamics of an area, it also affects spatial distribution of populations in several ways. As climate changes will eventually force many species of insects to shift their geographic ranges or face extinction, it will also favor range expansion of other species, especially the wide-ranging crop-pest species which are more adaptable to varied climatic conditions owing to their ability to survive and population regulation mechanism in resource poor condition.

Objectives & Focus of Current Study:

In the background of above discussion, the primary focus of our study was to creating a roadmap to sensitize both public, in this case the local villagers and conservation managers about insect diversity in the landscape. The objectives and goals in more specific terms were:

- To make a primary inventory of the insect diversity in different orders and families in different altitude and vegetation zones
- From this primary inventorying, coming up with a suitable insect group (an order or suborder) with all the potentials of good indicator taxa, so that in coming years substantial information can be gathered on their diversity and population trend in different parts of the landscape
- Searching or collecting information on different insect assemblages or species which are directly related to human livelihood, like agricultural pollinators or pests
- Finding ways how this highly diverse group of animals can be used for creating new opportunities or improving already existing human livelihood options.

All the sampling locations are shown in Landscape Digital Elevation Map in Figure i.

Methodologies Adapted

Owing to vastness of the landscape and the improbable task of generating information about the most diverse animal group on earth in limited time, opportunistic sampling protocol consisting of multiple strategies focusing different taxa simultaneously would be the best possible option. Beside this some taxa-specific sampling strategies were also adapted like:

Butterfly Inventory

All butterflies of superfamily, Hesperioidea and Papilionoidea (Order: Lepidoptera, Suborder: Rhopalocera) were sampled. A total of five butterfly families (i.e. Hesperiidae, Papilionidae, Pieridae, Lycaenidae, and Nymphalidae) were recorded during current study. Two sampling approaches, direct search and indirect search, were used. Line transects and random forest trail/dirt tracts were walked to sample butterflies. Opportunistic sampling was also conducted in rare habitats to increase species inventory of the area. Butterflies were sampled in areas between the elevations of 600 m - 4000 m in the landscape. All transect lengths were 300 m - 500 m and transects were traversed on foot by single observer. Abundance data were collected when cloud cover was less than 70% and between 0900 - 1700 hrs, the most favorable conditions for butterfly flight. All butterflies seen during the transect walk in an imaginary 5×5×5 (m) box around the observer were recorded. In addition to sweep nets, opportunistic sightings at mud puddles, nectar sources, and other resource rich sites was also used. Butterflies that were too fast or too distant to reliably identify during flight were not counted. Butterflies that could not be readily identified visually were either photographed or captured using a hand held sweep net and were released after identification.

Moth Sampling

Moth assemblages were investigated primarily through light trapping. The 600m belt was sampled using 100 W Tungsten filament bulbs and 50 W Actinic tube run from direct power source. Moths were attracted to light in areas where electricity was not available using two light sources: 15 W white tubes run by solar-powered batteries and 60 W Sodium vapour light run by gas petromax. The light sources were placed in front of a vertically hung white sheet so

that moths arriving at the light traps can rest on the sheet. Sites with very dense vegetation were avoided. Specimens were collected manually using killing jar filled with Benzene vapour. After killing they were spread in standard manner and labeled. Specimens were sorted to morphospecies level and were identified as far as possible using relevant literature.

Beetles Sampling

Coleoptera or beetles sampling procedure involved five methods; Pitfall trapping, Aerial and ground hand collection, Sweep netting, light trap and direct searching along transect. Direct searching involved looking up and down while moving along transect (50 m) and listing possible beetle species encountered. Aerial sampling involved searching leaves, branches, and tree trunks. Ground collection involved searching on hands and knees, exploring the leaf litter logs, rocks, and plants that are between low knee levels. Pitfall trapping was carried out by placing a container dug into the soil in such a manner that the mouth of the container stays at the level of surface. The container was filled with 70% alcohol for preserving specimens whereas detergent was added to reduce the surface tension. Sweep netting was carried out in order to access the foliage dwelling insects. Nocturnal beetles were sampled using light traps.

Information on Pollinators and Pests

During the entire sampling period, pollinators were observed whenever a vegetable garden or cultivated fields around village settlements were encountered. Insect species actively defoliating/damaging crops were also noted. Besides this, several discussions with village farmers and authorities of agriculture departments helped to generate useful information.

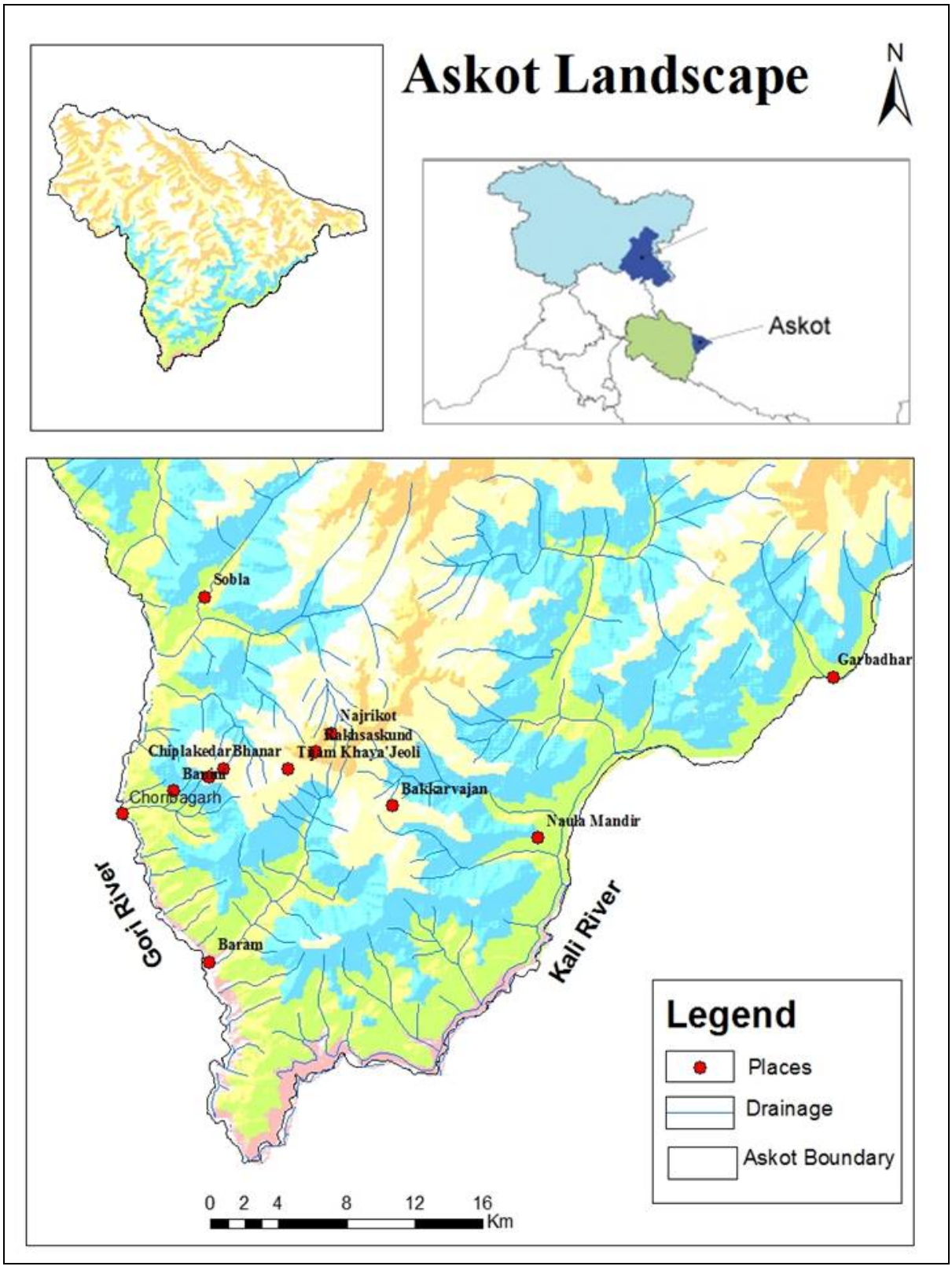


Figure i: The insect sampling locations and trails in the landscape

Description of Diversity: Insect Inventory in Askot Landscape

The initial recordings of the insect diversity in the landscape, which mostly consists of lower altitude records in both Gori and Kali basin, pointed to the fact about potential of the landscape as repository of highly diverse fauna and important from the point of view of insect conservation. In the short time span of the sampling, high diversity in terms of both species composition and taxon richness, came into picture. The following orders of insect taxa were recorded from the landscape:

Lepidoptera: The Lepidoptera, second largest insect order and most important taxon from the point of view of insect indicator group, consists of two suborders: Rhopalocera or butterflies and Heterocera or moths. Following diversity of the order was recorded from the Landscape.

(a) **Butterflies:** Altogether 63 species of butterflies were recorded representing 5 major families: Papilionidae (Swallowtails and Apollos), Pieridae (Whites and Yellows), Lycaenidae (Blues, Coppers and Hairstreaks), Nymphalidae (Brush-footed Butterflies) and Hesperiidae (Skippers). Total 24 transects were laid in seven different habitat class to assess butterfly diversity in the landscape:

Table 2: Butterflies sampled with their relative abundance in different habitats, altitudes in Askot Landscape. Abbreviations: Habitat Code: PF: Pine Mix Forest, OF: Oak Forest, SCF: Scrub Forest, AM: Alpine Meadows, SA: Subalpine Forest, SF: Subtropical Broadleaved Forest, VA: Village Agriculture

S No.	Species	Habitat	Altitude (m)	Relative Abundance
1	Common Banded Awl (*Hasora chromus*)	PF	1800	0.04
2	Common Spotted Flat (*Celaenorhinus leucocera*)	OF	2200	0.12
3	Indian Skipper (*Spialia galba*)	SCF	800	1.23
4	Water Snow Flat (*Tagiades litigiosa*)	PF	1500	0.06
5	Himalayan Dart (*Potanthus dara*)	OF	2400	0.03
6	Chestnut Angle (*Odontoptilum angulata*)	OF	2100	1.56
7	Common Red Apollo (*Parnassius epaphus*)	AM	3400	0.34

8	Common Blue Apollo (*Parnassius hardwickii*)	SA	3200	0.64
9	Glassy Bluebottle (*Graphium cloanthus*)	PF	1600	2.54
10	Common Bluebottle (*Graphium sarpedon*)	SF	900	4.09
11	Spot Swordtail (*Graphium nomius*)	SF	1600	3.66
12	Common Mime (*Chilasa clytia*)	SF	1200	1.47
13	Common Mormon (*Papilio polytes*)	SF	800	6.09
14	Red Helen (*Papilio helenus*)	SF	900	0.92
15	Common Yellow Swallowtail (*Papilio machaon*)	SA	3200	0.02
16	Paris Peacock (*Papilio paris*)	SF	1100	2.87
17	Common Rose (*Atrophaneura aristolochiae*)	SF	700	4.06
18	Common Grass Yellow (*Eurema hecabe*)	SF, PF	700, 1400	11.96
19	Common Brimstone (*Gonepteryx rhamni*)	OF	2200	0.06
20	Common Emigrant (*Catopsilia pomona*)	SF	900	3.87
21	Dark Clouded Yellow (*Colias fieldii*)	SA	3200	0.92
22	Large Cabbage White (*Pieris brassicae*)	SF, VA	700, 1300	4.64
23	Indian Cabbage White (*Pieris canidia*)	PF, VA	1600, 1900	10.54
24	Common Gull (*Cepora nerissa*)	SCF	800	0.08
25	Himalayan Blackvein (*Aporia leucodice*)	OF	2200	0.02
26	Common Jezebel (*Delias eucharis*)	PF	1400	4.03
27	Psyche (*Leptosia nina*)	SCF	800	8.63
28	Pioneer (*Belenois aurota*)	VA	1700	0.67
29	Angled Sunbeam (*Curetis acuta*)	SF	1200	0.75
30	Large Oakblue (*Arhopala amantes*)	OF	1600	1.04
31	Indian Oakblue (*Arhopala atrax*)	SF	1400	0.83
32	Common Acacia Blue (*Acacia quercetorum*)	SF	900	0.05
33	Yamfly (*Loxura atymnus*)	SF	800	0.63
34	Blue Imperial (*Ticherra acte*)	SF	800	0.37
35	Slate Flash (*Rapala manea*)	PF	1600	0.18

36	Common Silverline (*Spindasis vulcanus*)	OF	2400	1.04
37	Common Copper (*Lycaena phlaeas*)	PF, OF	1200,2600	2.87
38	Green Sapphire (*Heliophorus androcles*)	VA	2400	2.05
39	Sorrel Sapphire (*Heliophorus sena*)	PF	1600	1.04
40	Common Pierrot (*Castalius rosimon*)	SCF	900	3.58
41	Common Cerulean (*Jamides celeno*)	PF	1100	1.53
42	Dark Grass Blue (*Zizeeria karsandra*)	OF	2200	6.56
43	Plain Hedge Blue (*Calestrina lavendularis*)	PF	1700	0.73
44	Punchinello (*Zemeros flegyas*)	OF	2200	0.13
45	Common Beak (*Libythea lepita*)	OF	1800	1.04
46	Glassy Tiger (*Parantica aglea*)	VA	1500	0.73
47	Chestnut Tiger (*Parantica sita*)	OF	2400	2.67
48	Common Nawab (*Polyura athamas*)	SF	1700	1.08
49	Common Evening Brown (*Melanitis leda*)	SCF, PF	800, 1700	8.49
50	Common Wall (*Lasiommata schakra*)	SA	2800	1.06
51	Common Satyr (*Aulocera swaha*)	OF	2600	0.06
52	Yellow Argus (*Paralasa mani*)	AM	3100	0.46
53	Queen of Spain Fritillary (*Issoria lathonia*)	SA, AM	2800, 3400	3.96
54	Indian White Admiral (*Limenitis trivena*)	OF	2800	1.72
55	Himalayan Sailer (*Neptis mahendra*)	SF	1600	3.06
56	Yellow Sailer (*Neptis ananta*)	OF	2100	1.57
57	Popinjay (*Stibochiona nicea*)	OF	1800	0.08
58	Indian Tortoiseshell (*Aglais cashmiriensis*)	VA, SA	2100, 3200	11.45
59	Mountain Tortoiseshell (*Aglais urticae*)	AM	3500	2.65
60	Chocolate Pansy (*Junonia iphita*)	SF	1600	4.06
61	Lemon Pansy (*Junonia lemonias*)	SF	1600	5.73
62	Great Eggfly (*Hypolimnas bolina*)	PF	1300	0.53
63	Orange Oakleaf (*Kallima inachus*)	SF	1600	1.24

Although the data is not very exhaustive to comment about any habitat preference or altitudinal preferences of the butterfly species observed, the primary trend shows a wealthy diversity in lower subtropical broadleaved mixed forest and Oak forest. The pine mix forest shows species assemblage of generalist species where the subalpine forest and alpine meadows were characterized by habitat-specific species. Another interesting feature observed from the diversity table is the relative abundance of species was highest in degraded or human-modified habitat like village agriculture patches, where influx of rich resources from human activity might be a causal factor for increased butterfly numbers. In a short span of time, the study was able to record some rare butterfly species like two of the Apollos, Yellow Swallowtail and Red Helen.

Overall, it is evident from the short span of the study, that the landscape holds a unique potential place in Western Himalayan context as a hotspot of butterfly diversity. Wide arrays of habitats are still to be sampled and more seasonal approach to sample as much as microhabitats possible would more clearly reflect the true picture of these very useful insect indicator taxa.

(b) **Moth:** From a very short span of time, the study came up with records of a good number of moth species which were previously unknown. Although, due to lack of time, it was not possible to set up light trap in different habitats in different seasons, we concentrated our focus mainly to lower subtropical broadleaved mix forest and all the major seasons were represented in our sample. Due to the strategic positioning of the light trap station near Jauljivi basecamp, we were also able to target few more habitats nearby like Pine mix forest and Riverine forest patches. Altogether 161 species were recorded representing 14 major families, among which we were able to identify 104 species upto species level. Following is the list of detailed species inventory made during 2012-13 sampling year.

Table 3: Moth diversity under different families recorded during the study period. The season in which each species were recorded is also mentioned. Season Code: W: Winter (December-January), S: Summer (May-June), M: Monsoon (July), PM: Post Monsoon (September)

S No.	Family	Species	Season Recorded
1	**Pyralidae**	*Stegothyris diagonalis*	S
2		*Dichocrocis nigrilinealis*	S,M
3		*Botyodes asialis*	S
4		*Terastia egialealis*	S
5		*Heliothela ophideresana*	S,M,PM
6	**Crambidae**	*Agathodes ostentalis*	M
7		*Agrotera scissalis*	S
8		*Bradina diagonalis*	M
9		*Cirrhochrista brizoalis*	M
10		*Conogethes pluto*	M, S
11		*Cotachena alysoni*	S
12		*Glyphodes actorionalis*	S
13		*Maruca vitrata*	PM
14		*Pagyda quadrilineata*	S
15		*Spoladea recurvalis*	PM
16		*Nausinoe geometralis*	W
17		*Goniorhynchus sp*	PM
18	**Arctiidae**	*Nannoarctia obliquifascia*	PM,S
19		*Nyctemera adversata*	M,PM
20		*Cyana sp*	S
21		*Ceryx sp*	S
22		*Spilosoma multiguttata*	S
23		*Creatonotus transiens*	S,PM
24		*Utethesia lotrix*	PM
25		*Spilarctia obliqua*	S
26		*Olepa ricini*	S
27		*Vamuna remelana*	S,PM
28		*Asura calamaria*	S.M
29		*Miltochrista nubifascia*	M
30	**Saturniidae**	*Actias maenas*	PM
31		*Antherea assmensis*	PM
32		*Loepa katinka*	PM
33	**Lasiocampidae**	*Ganisa plana*	S
34		*Euthrix laeta*	S,M

35	**Limacodidae**	*Phocoderma sp*	S
36	**Lymantridae**	*Lymantria sp1*	S
37		*Lymantria sp2*	S,M
38		*Lymantria mathura*	PM
39		*Lymantria singapura*	W
40		*Toxoproctis sp*	PM
41		*Stigmatophora sp*	S
42		*Euproctis scintillans*	S,PM,M
43		*Euproctis vitellina*	PM
44	**Geometridae**	*Biston suppssaria*	S
45		*Zeheba aureatoides*	S
46		*Scopula pulchellata*	S
47		*Problepsis albidior*	M
48		*Ophthalmitis sp*	PM
49		*Heterostegane sp*	PM
50		*Godonela nora*	PM,S
51		*Fascelina plagiata*	M,S
52		*Eucyclodes divapala*	S
53		*Chlorissa gelida*	S
54		*Chlororithra fea*	M
55		*Agathia hilarata*	M
56		*Aporandria specularia*	M,PM
57		*Thalassodes veraria*	S
58		*Problepsis vulgaris*	S
59		*Organopoda carnearia*	M
60		*Electrophaes aliena*	S
61		*Rhodometra sacraria*	W
62	**Noctuidae**	*Aegocera bimacula*	S
63		*Bastilla crameri*	S
64		*Calyptra ophideroides*	S
65		*Spirama retorta*	S,M
66		*Calesia haemorrhoa*	M
67		*Erebus ephesperis*	M,PM
68		*Asota producta*	PM
69		*Asota ficus*	PM
70		*Eudocima phalonia*	S
71		*Hamodes propitia*	S
72		*Oraesia emarginata*	M
73		*Xanthodes intersepta*	M

74		*Pencillaia sp*	S
75		*Ochropleura flammatra*	S, M
76		*Polytela gloriosae*	S
77		*Acronicta indica*	M
78		*Chasmina candida*	M,PM
79		*Ozarba punctigera*	W
80		*Gabala roseoretis*	S
81		*Agrapha albostriata*	S
82		*Prodenia littoralis*	W
83	**Sphingidae**	*Amplypterus panopus*	S,PM
84		*Clanis stenosema*	S
85		*Acosmeryx anceus*	PM
86		*Elibia dolichus*	M
87		*Rhyncholaba acteus*	M,S
88		*Marumba sp*	S
89		*Psilogramma menephron*	M
90		*Acherontia styx*	S
91		*Theretra clotho*	M
92		*Agrius convolvuli*	PM
93		*Hippotion echeclus*	S
94		*Deilephila elpenor*	S
95	**Notodontidae**	*Tarsolepis sp*	S
96		*Stauropus sp*	PM
97	**Bombycidae**	*Ocinaria sp*	S
98	**Tineidae**	*Opogona sp*	S
99	**Totricidae**	*Totricia sp*	S
100	**Cossidae**	*Xyleutes strix*	PM,
101	**Drepanidae**	*Tridrepana flava*	S
102		*Cyclidia substigmaria*	W
103	**Eupterotidae**	*Eupterote geminata*	S,M
104	**Nolidae**	*Pseudoips prasinanus*	S
105	**Thyrididae**	*Banisia owadai*	S, PM

Coleoptera: Following families of beetles were recorded from the landscape.

Cerambycidae or Long-Horned Beetles: The family is large, with over 20,000 species described. Several are serious pests. The larvae, called roundheaded borers, bore into wood, where they can cause extensive damage to either living trees or untreated lumber (or, occasionally, to

wood in buildings) being a particular problem indoors. We recorded 6 species from the landscape which waits be identified up to species level.

Curculionidae: Commonly known as Weevils or snout beetles, they are one of the most diverse families of Coleptera. They are very host specific and generally a serious pest of stored grains. We recorded 3 species from the landscape.

Lucanidae: Commonly known as Stag beetle, they are generally forest inhabitants and complete their life cycle among the leaf-litters. We recorded 5 species from the landscape.

Cicindelidae: Commonly known as Tiger beetles, they prefer riverine habitats and proven to be good indicator species of their associated habitats. Single species were recorded from the landscape by light trapping.

Carabidae: Commonly known as Ground beetles they are generally nocturnal in nature, as evident from the fact that all the 5 species recorded from the landscape were attracted to light. They generally prefer to live under the bark of fallen or rotten logs and are predaceous in nature. They are also widely used as indicator species worldwide.

Elateridae: Commonly known as Click beetle, the Elaterids occupy diverse habitats and feeding guilds. We recorded 3 species from the landscape.

Scarabidae: Commonly known as Dung beetle, they represent a huge family and most of the species are serious threats for agriculture as pests. We recorded 4 species from the landscape and identified one of the species in its larval form as white grub which make most of the damage to rice and potatoes.

Insect as agricultural pest in the landscape:

Following information were collected on harmful insect species acting as pest in agriculture from local people as well as Agriculture Department for Dharchula Block Development Office:

The main crop pests which are affected or damaged by insect pests are cauliflower, cabbage and potato.

- Leaf Hopper: They belong to the order Hemiptera, Family Cicadellidae. Although the species identification was not possible from the description given by agriculture office, it was certain this group of insects generally attacks potatoes and their feeding results in symptoms called "hopperburn" causing browning and necrosis along the margins of potatoes.

- Leaf Folder: They belong to the order Lepidoptera, Family Crambidae (moths). They generally damage rice by folding leaf blade together and glue it with silk strands and feeds inside the folded leaf creating longitudinal white and transparent streaks on the blade.
- White Grub: These are generally the larval form of Scarabidae beetles and damage crop plants related to nuts like areca nut etc. Grubs feed on roots and the whole trees remain stunted with yellow leaves, tapering stem and sick appearanc.

- Other pests include caterpillar of various moths and butterflies locally called Kurmula, the local name suggesting damaging the crop species in a manner that it becomes dried up, and Dimag, generally referring to Termites. The villagers described how these pests species, particularly the Kurmula are introduced to the crop fields. For manures to be used in the field before seed sowing villagers gather cow dung in which the adult insects come and deposited their eggs. When this cow dung is applied to the field, the eggs get transferred to the field and they hatch out when the crops are mature and juicy enough for the appetite of the larval forms. They come out from their underground hides and start sucking away sap from the crop plants. There are also cases of Locust infestation

which last happened 10-12 years ago, causing major damages to the crop destroying one after another crop field on their way, swarming in millions.

Insects as Pollinators in the Landscape:

The major pollinator dependent crops are fruit and vegetable crops, spices and plantation crops and pulses and oilseed crops. It has been estimated that the total annual economic value of crop pollination worldwide is about € 153 billion (Gallai et al., 2009). Klein et al. (2007) found that 87 of the world's leading food crops depend upon animal pollination, representing 35% of global food production. The area covered by pollinator-dependent crops has increased by more than 300% during the past 50 years (Aizen et al. 2008; Aizen and Harder 2009). Flower-visiting insects provide an important ecosystem function to global crop production through their pollination services. The rapid spread of human habitation is affecting the available natural habitats through urbanization and other land-use practices, putting pressure on ecosystem services delivered by wild pollinators. Plant-pollinator interaction in both wild and cultivated plant species is under threat as a result of indiscriminate pesticide use, habitat fragmentation and intensified cultivation practices.

Askot landscape, being a mosaic of natural forest areas of varying maturity and density, agricultural areas as well as community conserved forested areas locally known as Van-Panchayats, can be an interesting site to study and doing experiments on pollinator diversity and plan-pollinator interaction. Although a very short span of time could be spent to take notes on pollinator diversity, we were able to document some species of insects pollinating flowers in agricultural patches around human habitation. The following table provides the summary of the species of pollinating insects recorded on some cultivated plants around Banini and Gana village in Gori valley and Jauljivi:

Plant/Cultivated Species	Associated Pollinators
Bottlegourd (*Lagenaria siceraria*)	Syrphid fly (*Surphus* sp.)
Brinjal (*Solanum melongena*)	Bumble bee (*Bombus* spp.),
	Golden wasp (*Vespa magnifica*)
	Lemon butterfly (*Papilio machon*)
Maize (*Zea mays*)	European honeybee (*Apis mellifera*)

	Rock bee (*Apis dorsata*)
	Cabbage butterfly (*Pieris brassicae*)
Citrus (*Citrus sp*)	European honeybee (*Apis mellifera*)
	Oriental wasp (*Vespa orientalis*)
Cucumber (*Cucumis sativus*)	Asiatic honeybee (*Apis cerana*)
	Fruit fly (*Dacus cucurbitae*)
	Carpenter bee (*Xylocopa sp*.)
Mustard (*Brassica sp.*)	Ladybird beetle (*Coccinella sp*.)
	Bumble bee (*Bombus sp*)
	Tabanid fly (*Tabanus sp*)
	Yellow banded wasp (*Sphex sp.*)
	Short horned grasshopper (*Oxya sp*)
Red gram (*Cajanus cajan*)	Golden wasp (*Vespa magnifica*)
	Castor butterfly (*Ergolis merione*)
	Rock bee (*Apis dorsata*)

Identification of Indicator Taxa: Initial Approach

Selection Criteria of insect indicator taxa in Askot Landscape:

Lepidoptera have been proposed as surrogate species by several authors. Several features of the butterflies make them good candidates for indicator, umbrella and/or flagship species. They have a wide distribution, are relatively easy to sample and identify, and both as individuals and as species they show important numbers in different ecosystems. They are also strongly influenced by local weather and highly sensitive to environmental changes (Spitzer et al., 1997), besides being charismatic insects that could attract the public attention. Finally, some authors have identified patterns of co-variation between the abundance and/or the richness of Lepidoptera and those of other taxonomic groups (Blair, 1999; Swengel & Swengel, 1999). However, these relationships are highly dependent on the taxa and the spatial scales considered. Butterflies are extremely sensitive to changes in vegetation composition and structure, and different types of vegetation show different butterfly species composition. So, the butterfly assemblages may be used to characterize different habitats (Erhardt, 1985). Plants are the essential source of nourishment of butterflies; some specific plant species provide the trophic resources for caterpillars, while others provide nectar for adults. The vegetation can also play an important role for butterfly survival offering particular structural elements for sun-

basking or mating and determining certain suitable microclimates (Dover et al., 1997). Therefore, it would be expected that butterflies respond more strongly to vegetation gradients than to edaphic gradients (Sawchik et al., 2003).

Probable Butterfly List with altitudinal range: Candidate Indicator Taxa Approach:

As selecting insect indicator taxa in a huge landscape like Askot is a mammoth task and would require a gigantic effort in terms of sampling both in spatial and temporal scale, it would be logical to go for a pre-defined set of indicator group. Henceforth, the candidate indicator taxa approach will be more suitable where a particular set of taxa which has previously been identified as good indicator group elsewhere will be screened and monitored in a long-term basis for serving the purpose. Due to their biological and ecological characteristics mentioned above, the butterflies are regarded as one of the most suitable insect indicator group which has been routinely used in studies relating to habitat fragmentation, invasive or alien species and rapid changes in habitat mosaic all over the world. Above all, their popular image in public mind will also help to motivate village community to do a regular monitoring of butterflies found in and around their household. So, we have prepared a list of butterflies from an extensive literature search, which might have potential distribution in the part of Uttarakhand Western Himalaya which includes the Askot landscape. The list **(Appendix 1)** also mentions their highest altitudinal limit, habitat they are associated with and the time of the year they are active. The idea is to create a handbook kind of thing with the photographs of the butterflies listed, involve local village community and school children to participate in recording species in and around their villages and thus coming up with a list of species which are truly found there. Once the final list is prepared, the task will be to develop a long-term monitoring protocol involving local village community so that the population status of those species which are habitat as well as locality specific can be monitored and a sound database on long-term population trend can be made.

The list prepared is almost exclusive, which means there will be slightest possible chance that any other butterfly not included in the list will be active in the landscape. Although theoretically identification of indicators can only be possible after systematic data collection, this approach

will probably be the best from the perspective of hugeness of the landscape as well as paucity in time and resource to complete the required data collection protocol.

Securing Livelihood Options & Insect Conservation: Global Scenario and Opportunities in Askot Landscape

While conserving biodiversity may be perceived as a goal in itself, rural people inhabiting different villages within Askot landcspae, depend on the goods and services that biodiversity provides. To most people in the world, animals and plants are of no interest unless they have some use, and that very few indeed are actually perceived as useful. However, more recent work emphasises the importance of a wide range of benefits that are derived from insect biodiversity. The marketed as well as non-marketed benefits of insects can be summarized as follows:

Ecosystem Services: Direct Use: Extractive use, e.g. collection of insects for food; Non-extractive Use, e.g. recreation or tourism

Indirect Use: Pest management, Pollination, Soil Decomposition, Food-web components

Individual Organism Services: Direct Use, e.g. Silk, honey, Lac production

Indirect Use, e.g. Ecosystem monitoring (Indicators)

For rural people especially, there may be greater dependence on a broader range of uses, including wild sources of food and medicines, soil fertility, crop protection, as well as commercial production for local and export markets. These all provide important and valuable alternative sources of a wide range of goods and services where access through markets may be severely constrained, as well as a variety of low-cost, income generating opportunities. We may distinguish between two levels of insect use, the first with individual or single species or related groups, and the other with whole communities. For example, pollination of crop plants may be carried out by honey bees specifically (single species) and/or by a myriad of

background, wild pollinating insects (community level). On the other hand, parasitic wasps seeking out pest insects in a biological control program may also incidentally act as pollinators.

Single Beneficial species (Silk Farming, Honey Production): While the majority of the benefits that can be acquired from silk production occur at a national level, the structure of silk production provides low cost opportunities for small farmers. In Kerala, local farmers, as in many other countries, cultivate mulberry bushes to feed the silkworms. An individual farmer can make between Rs 2000 and Rs 6000 per month, depending on the quality of silk produced, by growing the bushes and rearing silkworm cocoons to sell to the State Sericulture Facilities. In this way, local people are able to make a dependable living. From the examples of Bangladesh, where 80% of small scale silk producers are women, it is evident that this kind of livelihood options has a positive impact on the empowerment of women, helping them not only to become financially self-sufficient, but also to become established entrepreneurs. The same kind of rural livelihood options can be generated from honey production. The collection of sweet honey from wild bees is the oldest positive association between insects and humans. The raiding of bee colonies by foragers dates back hundreds of thousands, if not, millions of years. To this day, the culture of the honey bee, *Apis mellifera* (Hymenoptera: Apidae) and its relatives is a rural industry world over. For example, in Mexico, which is the third largest honey exporter of the world, honey is produced by bees that are able to forage on wild flowers, blossoms and other natural vegetation. This clear amber honey called Colima, is nearly twice as expensive as the cheapest sort. This is one example of where conservation of natural habitats in which bees can forage may generate considerably more revenue. In Garwhal Himalaya also, local communities are being encouraged to use their forest resources sustainably through income generating activities including wild silk and honey production. Local bee species (*Apis cerena*) forage for nectar in natural forests and alpine meadows as well as agricultural lands, and new bee hives are deployed around houses. Villagers, especially women, will thus be provided with sustainable revenues and the local biodiversity conserved.

Community Level: Pollination: Hundreds of species of agricultural plants in 40 plant families, including around 400 agricultural crops world-wide, are pollinated at least in part by bees. It is assumed, on a rough scale, that one third of all human food is derived from products pollinated by wild pollinators. So, if this pollination service is removed, the effect on human would be catastrophic. Undoubtedly, modern agricultural practices can have deleterious effects on pollinator populations: within agricultural environments, activities such as land clearance, cultivation, irrigation, pesticide usage, overgrazing and the spread of monocultures have all contributed to a substantial decline in numbers of insect pollination.

Apart from the above-mentioned scopes and benefits acquired from insect diversity in generating and securing rural livelihood options, another major concern for us in the Askot landscape is crop damaged by insect pest. As there is no considerable record of economic loss due to insect pests annually, it is difficult to ascertain the gravity of the situation. Apart from quantifying the economic loss due to insect pest annually, it is also important to keep the following questions in mind:

- Does wild land around crops promote a quantifiable and dependable reduction in crop losses due to pests?
- Do mixtures of distinctly different crops suffer less impact from pests?
- If it is possible to grow crops in mixtures with non-crop (wild/managed) vegetation, does this lead to worthwhile reductions in damage by pests?
- Can reduction in pesticide usage be sustained by the provision of habitat (and thus insect) diversity in and around high intensity crop production?

Threats to the world's insect fauna are often synergistic and repercussionary. Deforestation encourages weedy species, invasive aliens, and pathogens, which in turn further fragment populations, lessening their chances of moving across the landscape to survive climate change. Some principles are emerging from recent research on how we might manage the landscape for

insect conservation. These principles similarly are positively synergistic and interrelated. An ideal management strategy is to maintain reserves and habitat heterogeneity while reducing the adverse impacts of the transformed matrix, setting aside quality stepping-stone habitats across that matrix, and introducing ecological and evolutionary corridors. The outcome of this landscape management package cannot be left to its own devices, but must be adaptively managed to simulate a particular set of conditions that match the ecological conditions at some particular time in the past. This coarse-filter, landscape approach can then be overlaid with the fine-filter, species approach in spot locations to cater for individually threatened species. Such an approach always takes into consideration the importance of the combined positive effects of large patch size, good patch quality, and reduced patch isolation. Combining these management efforts with directly using insect species for generating good livelihood options can serve as an ideal framework for insect conservation in Indian scenario, nonetheless in Askot landscape area.

Conclusion: Way Forward for Using Insect Indicators in Askot Landscape

Although the uses and merits of terrestrial insects as indicators have been extensively discussed in global literature, there is a lack of clear definition, goal directedness and hypothesis testing in studies in the field. The procedures in terrestrial insect bioindicator studies should start with a clear definition of the study objectives and proposed use of the bioindicator, as well as with a consideration of the scale at which the study is to be carried out. Bioindication studies are conducted at a variety of spatial and temporal scales within the context of earth-system processes, but the objectives of the study will largely determine the scale at which it would be optimally conducted. The selection of potential indicator taxa or groups is then based on a priori suitability criteria, the identification of predictive relationships between the indicator and environmental variables and, most importantly, the development and testing of hypotheses according to the correlative patterns found. Finally, recommendations for the use of the indicator in monitoring should be made. Although advocating rigorous, long-term protocols to identify indicators may presently be questionable in the face of the urgency with which conservation decisions have to be made, this approach is critical if bioindicators are to be used

with any measurable degree of confidence. In Askot Landscape, our primary task of screening different taxa has been completed and a consensus have been made to use Lepidoptera as potential indicator to achieve the goal of both biodiversity conservation and livelihood improvement programs. In the coming year our goal will be to establish the group as a strong biological indicator with sound field-based observation on their correlation with suitable environmental as well as anthropogenic disturbance variables and preparing a long-term monitoring protocol to involve both forest managers and village communities for their joint hand-in-hand participation in insect conservation in the landscape.

Some suitable bioindicator insect groups of Askot Landscape

The hyper-diversity and complex ecological relationships have long prevented insects from being used in conservation management practice in Indian scenario. One strategy should therefore be focusing monitoring indicator organisms. Here after a preliminary inventorying of different functional groups, we propose a multi-taxon approach to ensure an adequate range of responses to represent the system being studied as a whole. The study area of interest is Askot Landscape.

The field work was done during May to July, 2014. For a representative inventorying in a short time span we adapted opportunistic sampling protocol consisting of multiple strategies focusing different taxa simultaneously, e.g. Pollard walking, light trapping, pitfall trapping and sweep netting. After having a primary abundance-distribution data, we went through a criteria analysis after McGeoch (1998) for selection of potential taxa. The suit of taxa thus selected was examined then for their abundance fluctuations according to dominant environmental and disturbance gradients.

In the ground layer, indicator set should comprise ants and beetles.

- Ants are potentially good indicators as they are diverse, abundant, easily recorded and present in most habitats. They have been used for monitoring disturbance, fire invasion, habitat management and restoration program. Ants have been divided into different functional groups which may indicate different aspects of ecosystems.

- Many beetle families show close association with particular ecosystems and indicators should be selected from families associated with the ecosystem being studied, such as Cerambycidae in woodland, Carabidae in open habitats and Chrysomelidae in foliage rich environments. Dung beetles or Scarabaeidae are an excellent indicator taxon for landscape diversity studies, as they are ecologically sensitive and dependent on the right combination of dung producing animals being present. They show high species turnover rates along habitat gradients making them sensitive to subtle changes in landscape. Fragmentation and isolation are also important determinants of dung beetle species distribution.

In the riverine ecosystem, indicator set should comprise Odonata (Damselfly & Dragonfly).

- Odonata are a group of insects that have been extensively used as environment indicators of stream health, which ultimately indicators of catchment health. This is an easy to identify environmentally sensitive taxa which have been effectively used to monitor freshwater ecosystem.

In the forested ecosystems, indicators would be Lepidoptera comprising butterflies and moths.

- Of the Lepidoptera, butterflies have been particularly significant indicators owing to their conspicuousness and ease of identification. While butterflies are largely restricted to open habitats, moths include many open and closed habitat taxa. Lepidoptera, especially butterflies have been used to indicate habitat changes, management particularly associated with logging in tropical forest. While Arctiidae moths can be monitored to see the effects of agriculture intensification in a landscape, proportion of Geometridae moths to Noctuidae moths gives an impression about habitat conversion.

  A diverse array of butterfly assemblages were sampled from different habitats, comprising Red Helen, Great Windmill, Golden Birdwing and Popinjay from lower altitude subtropical forest, Orange Oakleaf, Large Oak-blue, Himalayan Fivering from moist oak forest. While abundance of Common Blue Apollo and Yellow Swallowtail can

be monitored in alpine meadows for checking grazing intensity, the abundance of Cabbage White was highest around human settlements up to mid elevation.

By examining more environmental correlates of the distribution of above mentioned taxon-assemblage, this kind of indicator system can be applicable for long-term monitoring purpose. Concluding about the suitability of insects as bioindicators in Askot landscape, it can be said that the use of indicator taxa as surrogates for biodiversity is, in general, unreliable, but nevertheless may be useable within well defined limits of ecosystem and location. In order to produce reliable results, it is important that studies use a suite of taxa to cover different aspects. It has also been assumed that conservation of umbrella species would conserve many other threatened species. However this depends on the distribution of charismatic umbrella species having a close correlation to the distribution of biodiversity rich sites. This assumption remains questionable and the lack of any clear pattern of relationships between species richness in most taxonomic groups suggests that this approach may be unreliable at fine spatial scales. What is for sure is that recent research is suggesting a multi-function, multi-taxon approach to the choice of bioindicators of all types to ensure an adequate range of responses is being included to represent the system or landscape being studied as a whole.

Following is a list of insect groups recorded in Askot Landscape which are either beneficial or detrimental to human interest. Apart from the bioindicator group addressed above, monitoring this set of species can be additionally advantageous for the vast agricultural habitat of Askot Landscape.

Some beneficial & Harmful Insects of Askot Landscape

Integrated pest management (IPM) starts with proper identification and the understanding of what is and is not a pest. This small guide is produced to help people of Askot Landscape realize that not all insects are pests (greater than 95% are not), and that beneficial insects are available naturally or can be introduced into the landscape to manage pest species. Even non-insects, spiders and scorpions, are great predators of common garden pests.

Harmful Insect groups

- **Long-horned Beetle (*Order* Coleoptera: *Family* Cerambycidae)**

  Morphology: This large beetle is 3.5 to 11.5 inches long and shiny black with irregular white spots. Their antennae are black and white striped and longer than their body—nearly twice as long for the male.

  Ecological Role: The Long-horned beetle attacks hardwood tree species including primarily in the genera *Acer* (Sapindaceae), *Populus* (Salicaceae), *Salix* (Salicaceae), Ulmus (Ulmaceae), *Aesculus* (Sapindaceae), *Albizia* (Fabaceae), *Betula* (Betulaceae), *Cercidiphyllum* (Cercidiphyllaceae), *Fraxinus* (Oleaceae), *Prunus* (Rosaceae), and *Sorbus* (Rosaceae) and many that are valued in both urban and forested areas.

  The beetle completes most of its life cycle inside the host tree, with adults emerging in spring. Adult beetles feed on twigs, leaf petioles and primary leaf veins. Eggs are injected under the bark surface where they hatch into larvae. Larvae tunnel under the bark and destroy the tree's vascular system which disrupts sap flow of infested trees. Older larvae tunnel into the heartwood where their feeding slowly destroys the structural integrity of trees. Trees are slowly killed over a 3-5 year period. The species has the potential to ecologically alter the diversity of natural forests.

Distribution in Askot landscape: Recorded from 637m(Jauljivi), 1009m(Chhoribagar), 1445m(Kathtoli), 1794m(Kathtoli), 1866m(Gaila), 2051m(Golfa), 2200m(Gaila).

- **Japanese Beetle (*Order* Coleoptera: *Family Scarabaeidae*)**

Morphology: Less than 0.5 inch long, this introduced beetle has shiny brown wing covers over a metallic green body. Tufts of white hairs rim each side of its body sticking out from under the wings. Small, white grubs have a brown head and a dark tail end. Adults chew flowers, leaves, and fruits of hundreds of ornamental and fruit-producing plants. Their larvae feed on roots of most plants, seriously damaging many.

Ecological Role: It is a widespread and destructive pest of several fruit, garden, and field crops, and has a total host range of more than 300 plant species. They are very flexible with their habitat because of their amazingly wide variety of consumable plants. *Acer* (maples), *Asparagus* officinalis (asparagus), *Glycine* (soybean), *Malus* (ornamental species apple), *Prunus* (stone fruit including plums, peaches etc), *Rheum* (rhubarb), *Rosa* (roses), *Rubus* (blackberry, raspberry), *Ulmus* (elms), *Vitis* (grapes), *Zea mays* (corn) are some of its important primary host.

Distribution in Askot Landscape: 637m(Jauljivi), 1360m(Basaura).

- **White Grubs (*Order* Coleoptera: *Family Scarabaeidae*)**

Morphology: White grubs are the larvae of several large beetles. They are fat, white, C-shaped, and about 1 inch long when mature. They have brown heads and three pairs of legs. They are not an annual, but a cyclic problem.

Ecological Role: White grub is a widespread pest but damage levels are usually low and do not require control measures. In some locations, damage may be highly significant. The larvae live in the soil and gauge broad, shallow cavities in the storage roots. Damage

appears as a yellow to brown mosaic throughout healthy lawns. Grasses are attacked. They may become serious pests of lawns and nursery plantings. Usually only a few percent of roots are damaged, but in heavily infested areas damage may be greater than 50%. White grubs attack a wide range of host plants, and may breed in fallowed land on weeds. The rainy season provides favorable conditions for, grub attack. In case of severe infestation the entire plant stand is destroyed and sometimes the field needs resowing.

Distribution in Askot Landscape: 946m(Baram), 1298m(Basaura), 1320m(Basaura), 1548m(Baram), 1666m(Basaura), 1913m(Buin), 1929m(Bamothi), 2218m(Golfa), 2290m (Gaila)

- **Weevil (*Order* Coleoptera: *Family* Curculionoidea)**

Morphology: Adults are of varied length and color with long, slender snouts almost the length of their bodies. Their Nymphs are similar, but smaller and without wings.

Ecological Role: The adult weevils feed on the tender buds, leaves, vines and storage roots while the larvae, the most destructive stage, feed and tunnel into the mature stems and storage roots. The damage is characterized by small feeding and ovipositional punctures on the surface and larval tunnels filled with frass in the tissues. The damage leads to thickening, drying and cracking of the stems and to secondary infection by bacteria and fungi. There are several species causing damages to apple, pear, peach, cherry, plum fruit, sweet potato, wheat, cotton etc. Large Pine Weevil breeds principally in stumps and roots of felled trees of a wide range of conifer species. The larvae of root weevil actively feed on roots of broadleaf evergreens whenever they are present.

Distribution in Askot Landscape: 637m(Jauljivi), 946m(Chhoribagar), 1360m(Basaura) 1442m(Kathtoli), 1794m(Kathtoli).

- **Red-banded Leaf-roller (*Order* Lepidoptera: *Family* Totricidae)**

Morphology: Adult moths are reddish brown with silver-gray and orange bands. They have a reddish brown band across the forewings. Larvae are small, 1.5 to 3.5 inch long, unmarked, greenish caterpillars.

Ecological Role: Red-banded leaf-rollers feed on a wide variety of plants, injuring foliage and fruit. Larvae feed on the underside of leaves causing them to look skeletonized. They also web leaves together and make shallow cavities in young fruit.

The species feeds on a wide variety of unrelated plants, including tree fruits and small fruits, vegetables, weeds, flowers, and forest or ornamental trees and shrubs. On tree fruits, it is most important on apple, but is also a pest of plum, prune, peach, cherry, especially *Prunus* species. Tortricidae is considered to be the single most important family of insects that feed on apples, both economically and in diversity of feeding found on fruit, buds, leaves and shoots.

Distribution in Askot Landscape: 1320m(Basaura),1510m(Kathtoli), 1548m(Baram).

- **Mealy bug (*Order* Hemiptera: *Family* Pseudococcidae)**

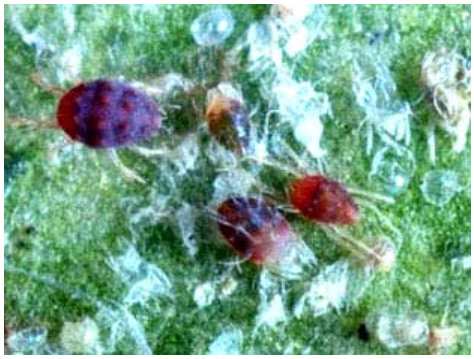
Morphology: Adults are 1.8 inch long, pink, and covered with white, cottony wax, which becomes a large mass as colonies form on plants. Mealy bugs are sexually dimorphic: females appear as nymphs, exhibiting reduced morphology, and lack wings, although unlike many female scale insects, they often retain legs and can move. Males are smaller, gnat-like and have wings.

Ecological Role: They are considered pests as they feed on plant juices of several forest trees and house plants, and also act as a vector for several plant diseases. Mealy bug females feed on plant sap, normally in roots or other crevices, and in a few cases the bottoms of stored fruit. They attach themselves to the plant and secrete a powdery wax layer (hence the name mealy bug) used for protection while they suck the plant juices. There are several species, most serious pests are mealy bugs that feed on citrus; other species damage sugarcane, grapes, pineapple, papaya, mulberry, sunflower and orchids. Mealy bugs only tend to be serious pests in the presence of ants because the ants protect them from predators and parasites. Small infestations by mealy bugs may not inflict significant damage, but in larger amounts though, they can induce leaf drop. There are differences in the amount of damage caused by each species. This is often related to those factors that determine population size (e.g., number of annual generations and female fecundity), preferred feeding locations, and temperature tolerances.

Distribution in Askot Landscape: 637m(Jauljivi), 1009m(Chhoribagar), 1298m(Basaura), 1445m(Kathtoli), 1470m(Kathtoli).

- **Red Mite (*Class* Acari: Superfamily Trombidioidea)**

Morphology: Adults are very tiny, bright red, and have a few long hairs on their backs with white dots at their bases. Bright red, globular eggs are laid on bark or leaves.



Ecological Role: Mites feed by piercing leaf tissue with their mouth parts and sucking out the cellular contents. They feed mainly on the undersides of leaves; moves to upper leaf

surfaces when populations are crowded. They are particularly abundant in high altitudes and cause stippling on the upper surface of leaves. Leaves may bleach and burn at the tips. High populations may cause leaves to turn bronze and drop. It also attacks many crops and ornamental plants but is limited to perennial trees and shrubs.

Distribution in Askot Landscape: 3339m(Sukhdeotal), 4069m(Najrikot), 4364m(Rakhsaskund)

- **Gypsy Moth (*Order* Lepidoptera: *Family* Lymantriidae)**

Morphology: This is an introduced species with males grayish brown and females white with black marks and larger. Egg masses laid on trunks are covered with hair. Young caterpillars are up to 2 inches long, black, and hairy with 11 pairs of blue and red legs.

Ecological Role: The larva or caterpillar is the damaging stage as it eats the leaves of trees and can consume tremendous amounts of leaf material. Gypsy moths defoliate hundreds of species of plants including *Quercus*, *Malus*, *Populus*, *Fagus*, *Salix*, *Betula*, *Aspen*. Successive years of defoliation may kill the plant. During the first three instars, gypsy moths prefer foliage of a limited selection of trees (apple, aspen, birch, larch, oak, willow, alder, hazel, etc), however once larvae gets to approximately 2 cm in size (third instar), it starts to consume foliage of many more trees, such as spruce, pine, chestnut and hemlock. Conifers are more susceptible to death than evergreens because they don't produce another flush of growth once defoliated.

The ecological and economic impact of Gypsy moth is serious concern. Their defoliation can change the complexity of understory growth thus resulting in an increase or

decrease of certain fauna or flora. Gypsy moth defoliation may predispose trees to attack by opportunistic insects or diseases.

Distribution in Askot Landscape: 637m(Jauljivi)

- **Oriental Fruit Moth (*Order* Lepidoptera: *Family* Tortricidae)**

Morphology: The adult moth is small, 1.4 inch long with a 1.2 inch wing span and is charcoal-colored. Its wings are banded light and dark. The long caterpillar is white or pink with a brown head.

Ecological Role: The oriental fruit moth is a cosmopolitan pest that is present in major tree-fruit production areas worldwide. Caterpillars bore into twigs and cause wilting and "flagging" (dried and bent over leaves and stem tips on upper shoots). Feeding patterns vary, an individual larva may attack only one terminal or it may enter several stems or fruit to complete its development. When terminals are killed, lateral shoots are stimulated to develop below the dead area, so heavily infested trees may have a compact, bushy growth habit. Larvae of later generations may feed on terminals or fruits. Fruit feeding increases dramatically as the season progresses, perhaps in response to hardening of terminal growth. Larvae attacking fruit often enter near the stem, leaving little or no external signs of entry. Oriental fruit moth larvae typically exit the fruit through readily visible holes in the sides of fruit, from which considerable gum and dark frass may exude. Infested fruits break down rapidly and are unfit for consumption. After harvest is complete, fruit moth larvae may again develop in the terminals if a late season vegetative growth flush is produced.

Distribution in Askot Landscape: 1388m (Baram).

- **Wood Wasp (*Order* Hymenoptera: *Family* Siricidae)**

Morphology: Wood Wasps are 10 to 12 inches long with a spear-shaped plate on the end of their metallic blue/black abdomen. Females have a long egg ovipositor. Their legs are yellow with black feet. Males have a black hind leg.

Ecological Role: The wood wasps attack Pine trees exclusively. Their tunneling in the trunk disrupts water and nutrient flow. Needles turn yellow, point down, and turn red. Egg laying may cause pitch beads to run down the bark. Adults emerge through round holes in the bark. The most significant ecological feature of the wood wasp is the occurrence of a pulse-like pattern of eruptive population dynamics. Eruptive dynamics are characterized by long time periods during which the populations remain at relatively low densities but may rapidly increase to outbreak levels. It is during these population outbreaks that wood wasp may cause extensive tree mortality, even to healthy and vigorous trees. The wood wasp vectors a fungus, the wasp and fungus together can kill a wide variety of pine trees.

Distribution in Askot Landscape: 2084m(Banini), 2095m(Gaila)

- **Field Cricket (*Order* Orthoptera: F*amily* Gryllidae)**

Morphology: Field crickets of various species are of different colors and size. Their third pair of legs is most robust to assist in long, powerful jump.

Ecological Role: This group of insects is both beneficial and harmful from human point of view. The field cricket is found abundantly in a great variety of habitats and occurs over a wide geographic range. This wide range of habitat selection is reflective of the species' extremely broad tolerance ranges to key environmental factors. They are important agents in the

decomposer communities of many ecosystems. They consume large quantities of often highly resistant, cellulose rich plant materials and produce fecal pellets that are easily decomposed by bacteria and fungi. Their activity, then, greatly accelerates the energy and nutrient flows in an ecosystem and provides plants with a much more abundant reservoir of highly available, essential growth factors. When populations of the field cricket become excessively large, they can cause serious damage to agricultural and garden crops. Symptoms of cricket damage may occur at any time in the growing season on a variety of plants. Crickets cause damage to roots and stems, eat seeds and seedlings, and chew holes in stems of larger plants. Locusts destroy plants on pastures, cropland, and in vegetable gardens. After the food supply is exhausted, they migrate to other areas.

Distribution in Askot Landscape: 637m(Jauljivi), 946m(Baram), 1009m(Chhoribagar), 1298m(Basaura), 1388m(Baram), 1471m(Kathtoli), 1628m(Bamothi), 1818m(Buin), 2002m(Bamothi), 2051m(Golfa), 2194m(Gaila), 2290m(Gaila),4069m(Najrikot).

- **Aphids (*Order* Hemiptera: *Family* Aphididae)**

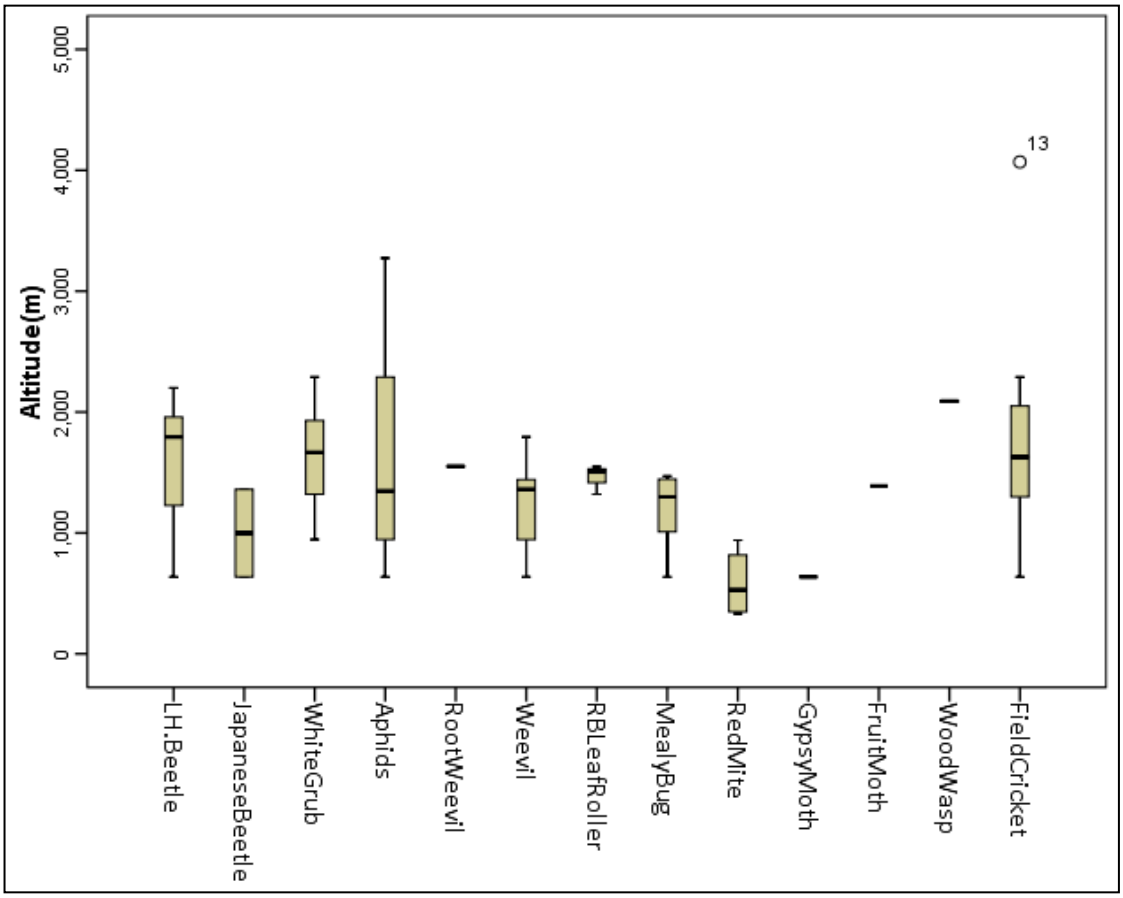
Morphology: Aphids can be of various colors and small, pear-shaped pest with long legs and antennae, and a pair of cornicles (tube like structures) projecting out of the back of its body. Adults may be winged or wingless. Females give birth to live young that begin feeding on plants right away.

Ecological Role: Aphids are among the most destructive insect pests on cultivated plants in temperate regions. Many aphid species are monophagous, others, feed on hundreds of plant species across many families. Plants exhibiting aphid damage can have a variety of symptoms, such as decreased growth rates, mottled leaves, yellowing, stunted growth, curled leaves, browning, wilting, low yields and death. The removal of sap creates a lack of vigour in the plant, and aphid

saliva is toxic to plants. Aphids frequently transmit disease-causing organisms like plant viruses to their hosts. Aphid feeding may cause curled, yellowed, and deformed leaves, as well as stunted shoots. Sticky honeydew may also be secreted attracting ants and turning black with sooty mold fungus. Some aphid species inject a toxin into plants that produces distorted leaves. Many transfer viruses from plant to plant. Aphids contribute significantly to the spread of late blight (*Phytophthora infestans*) among potatoes.

Distribution in Askot Landscape: 637m (Jauljivi), 946m (Baram), 1237m(Baram),1455m(Kathtoli),2290m(Gaila),3273m(Sukhdeotal).

Figure: Altitudinal distribution of harmful insects in Askot Landscape



Beneficial Insect groups

- **Ground Beetle (*Order* Coleoptera: *Family* Carabaidae)**

Morphology: Shapes and colors of ground beetles vary, but they are typically shiny and black or dark reddish. They dwell on the ground, have long legs, and are fast runners. Larvae, which live in soil or litter, are long with large heads and distinct mandibles. Both adults and larvae are predatory.

Ecological Role: Carabid beetles are important biological control agents in agro ecosystems. With their large eyes, spiny powerful legs, and large jaws, ground beetles are formidable predators in the insect world. They feed on wide assortment of soil dwelling insects like armyworms, cutworms, aphids, ants, snails, slugs, root feeding insects and caterpillars, some of which are serious vegetable and field crop pests. Several ground beetles also eat the seeds of troublesome weeds and are considered one of the "many little hammers" that help regulate weed populations. Conserving ground beetles through habitat manipulations and cultural practices can enhance the natural regulation of arthropod pest and weed populations, reducing the need for chemical controls.

Distribution in Askot Landscape: 637m(Jauljivi), 1237m(Baram), 1445m(Kathtoli), 1666m(Basaura), 2095m(Gaila).

- **Ladybird Beetle (*Order* Coleoptera: *Family* Coccinellidae)**

Morphology: Ladybird beetles have several or no black spots on their orange, red, yellow, or black wing covers. Larvae are elongated, somewhat flattened, and covered with spines. Many larvae are dark or black with bright colored spots or bands, while others are cream colored.

Ecological Role: Larvae and adults feed on soft-bodied pests: aphids, scale insects, mealy bugs, and mites. Many farmers rely heavily on ladybug populations to help maintain pest control on their crops. Aphids cause major crop damage and ladybugs keep them in check. Instead on tiny aphids feeding on plant juices and destroying crops, ladybugs feed on aphids. They lay hundreds of eggs in aphid colonies and, when they hatch, the ladybug larvae feed on the aphids immediately. A healthy ladybug population can keep insect pests low and reduce the need for insecticides. Not only are ladybugs important in controlling pests in gardens and crops, they are also valuable predators that eat insects that destroy forests. Many ladybugs are adapted to living in trees and feed on harmful tree-dwelling insects. Ladybug larvae are often found eating twig aphids.

Distribution in Askot Landscape: 637m(Jauljivi), 946m(Baram), 1298m (Basaura), 1360m(Basaura), 1471m(Kathtoli), 1548m(Baram), 1595m(Kathtoli), 1641m(Golfa), 1666m (Basaura), 1864m(Kanar), 1873m(Bamothi), 1909m(Gaila), 2002m(Bamothi), 4069m(Najrikot), 3628m(Bhanar), 3273m(Sukhdeotal), 3339m(Bhanar).

- **Predatory Mite (*Class* Acari: *Family* Phytoseiidae)**

Morphology: They are very small with a pear-shaped body. They are fast moving with orange to bright reddish orange body and long legs. Eggs are oval, and immature stages are of a pale color.

Ecological Role: Predatory mites deserve special mention in an agricultural country like India, where agriculture is always under the threat of constant pest attack. Predatory mites constitute a highly

significant beneficial group on account of their vital role in the maintenance of pest population like phytophagous mites below economic injury level. Another major contribution of the Acari is their normal functioning in ecosystems, especially their roles in the decomposer subsystem. Phytoseid mites have received global attention in the biological and integrated control of crop pests.

Distribution in Askot Landscape: 1470m(Kathtoli), 1510m(Kathtoli).

- **Assassin Bug (*Order* Hemiptera: *Family* Reduviidae)**

Morphology: Assassin bugs are long-legged predators that may be brown, black, or brightly colored. Their heads are long and narrow with a curved, needle-like beak, and their long, slender antennae have four segments. They have sticky pads with thousands of tiny hairs on their front legs that hold their victims.

Ecological Role: Adult assassin bugs feed on pests and beneficial insects, snails, and spiders. They effectively eat caterpillars, nymphs, and other immature insects. Being at top of the food chain they act as important pest control agent.

Distribution in Askot Landscape: 2218m(Buin), 2290m(Gaila).

- **Dragonfly and Damselfly (Order Odonata*: Family* Anisoptera & Zygoptera)**

Morphology: Damselfly and dragonfly adults look similar, though dragonflies are larger and more robust. They have four, large, clear wings and slender, brightly-colored bodies. Their heads are oblong with prominent eyes and short antennae. Immature flies called nymphs are aquatic, have long legs, and three appendages on their tail.

Ecological Role: They are predaceous as nymphs and adults. Nymphs live in water and feed mostly on mosquito and midge larvae. Adults feed on adult mosquitoes and other aquatic insects. Adults prey on mosquitoes, flies, midges, and gnats. They are good

bioindicators of water pollution. Increasingly, dragonflies and damselflies serve as flagship species, used to engage the public and promote conservation efforts for plant and invertebrate communities; Odonate taxa are ideal models for the investigation of the impact of environmental warming and climate change due to their tropical evolutionary history and adaptations to temperate climates. Odonates play crucial role in ecosystem functioning and serve to keep other insects including those harmful to humans under control.

Distribution in Askot Landscape: 637m(Jauljivi), 946m(Baram), 1237m(Baram), 1298m(Basaura), 1288m(Kathtoli), 1442m(Kathtoli), 1595m(Kathtoli), 1680m(Kathtoli), 1794m(Kathtoli), 2081m(Buin), 2158m(Walthi), 3273m(Sukhdeotal), 3339m(Bhanar).

- **Lacewing (*Order* Neuroptera: *Family* Chrysopidae)**

Morphology: Lacewing adults have four, pale green, transparent wings with net-like veins. Their 1.5 inch long, slender bodies are light green to pale yellow. They deposit their eggs at the end of a long, hair-like stalk attached to the underside of leaves. Larvae are flat and tapered at the tail, with distinct legs and long, curved mandibles.

Ecological Role: Adults and larvae are ferocious predators, feeding on other insects, soft-bodied pests (aphids, mealy bugs, and whiteflies) and their eggs. They are found on crops, weeds, and landscape plants. The common green lacewing is a generalist

predator that occurs regularly in many cropping systems and has been used often in augmentative release programs.

*Distribution in Askot Landscape:*637m(Baram), 1237m(Baram).

- **Praying Mantis (*Order* Mantodea: *Family* Mantiidae)**

Morphology: Praying mantises are green, brown, or a mottled color. They have a free-moving, triangular head. Without a larval stage, the young look like miniature adults. Their eggs are deposited in a distinctive pattern on twigs or stems as a frothy mass, which hardens as a protective layer. The females are bigger than males and have a larger abdomen. They have wings, but they usually walk.

Ecological Role: Praying mantises feed on a variety of insects including moths, crickets, grasshoppers, and flies but they do not discriminate between beneficial and harmful insects. They play an important role in the environment and to the ecosystem. They are very important and beneficial to farmers since they feed on pests, hence, controlling the growth of their population and preventing any harm that they can cause on the crops as well as to the plants at garden.

Distribution in Askot Landscape: 637m(Jauljivi), 1388m(Baram), 1641m(Golfa).

- **Syrphid Fly (Order Diptera: Family Syrphiidae)**

Morphology: Syrphid flies may vary greatly in color and size, but most have striped black, brown, and yellow banded abdomens and are about 1.4 to 3.4 inch long, similar to bees and wasps.

Ecological Role: Syrphid flies are a very important group of insects because their services to ecosystems are twofold i.e., their larvae are important natural enemies of herbivorous arthropods and their adults are pollinators of many of the crops and wild

plants. They commonly hover around flower feeding on pollen, nectar, and honeydew. Syrphid fly maggots are predators of aphids, scale insects, and thrips. One maggot can consume 400 to 500 aphids in its lifetime. They have three to seven generations per year. It is estimated that their importance as predator is equal to that of parasitoids, pathogenic fungi, lady birds and lacewings.

Distribution in Askot Landscape: 637m(Jauljivi), 982m(Chhoribagar), 1288m(Kathtoli), 1470m (Kathtoli), 1666m (Basaura), 1794m (Kathtoli), 1882m(Buin), 1895m(Gaila), 1929m(Bamothi), 2002m(Bamothi), 3273m(Sukhdeotal).

- **Predatory Wasp (*Order* Hymenoptera: *Family* Vespiidae)**

Morphology: There are different species of wasps with colorful abdomen generally with banded patterns. Female wasps lay eggs on burrowing larvae in the soil. Larvae penetrate the host and feed until the host is eventually killed.

Ecological Role: The adults feed on nectar, and also are predators of caterpillars which they sting and paralyze. They also prey on other insects such as flies and beetle larvae. Their larvae are parasites to many landscape-damaging insects.

Distribution in Askot Landscape: 2081m(Buin), 2083m(Bamothi).

- **Ants (*Order* Hymenoptera: *Family* Formicidae)**

Morphology: Ants are general predators, being a suitable bioindicators in several studies related to fire invasion. They bore through wood to make nests. Unlike termites, they do not feed on wood and the wood damaged by them will not contain mud-like material.

Ecological Role: Ants are important components of ecosystems not only because they constitute a great part of the animal biomass but also because they act as ecosystem engineers. Their biodiversity is incredibly high and these organisms are highly responsive to human impact, which obviously reduces its richness. Ants are important in below ground processes through the alteration of the physical and chemical environment and through their effects on plants, microorganisms, and other soil organisms. By digging galleries and tunnels, ants help to aerate the soil. They act as decomposers by feeding on organic waste, insects or other dead animals. They help keep the environment clean. Carpenter ants, which make their nests in dead or diseased wood, considerably accelerate the decomposition process of timber. After the ants leave, fungi and bacteria grow in the galleries and break down the lignin and cellulose on large surfaces. Ants are predators of other insects and their eggs. In their natural habitat, they are a source of food for many invertebrates and vertebrates.

Distribution in Askot Landscape: 637m(Jauljivi), 946m(Baram), 1009m(Chhoribagar), 1873m(Bamothi), 1913m(Buin), 1925m(Walthi), 1929m(Bamothi).

- **Bees (*Order* Hymenoptera: *Family* Apidae)**

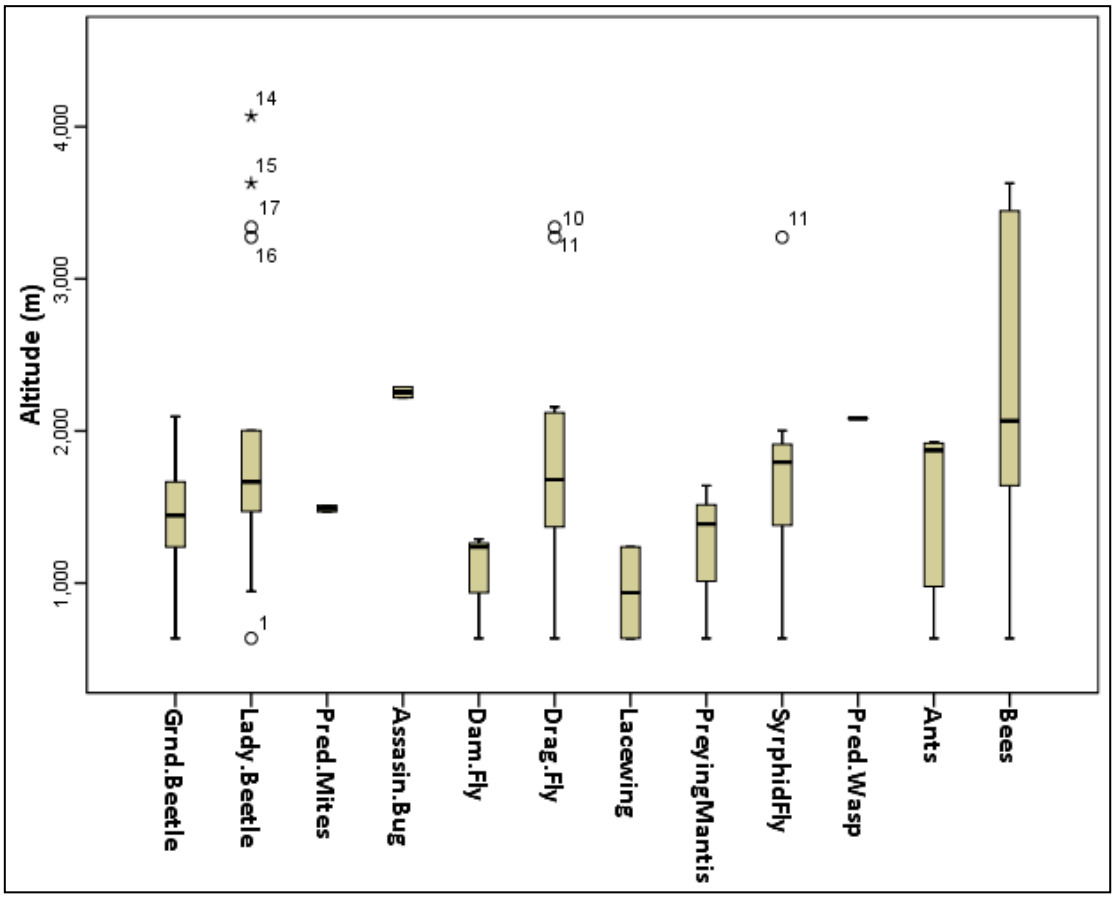
Morphology: There are three species of bees which differ in size. The largest one is *Apis dorsata*; *A. cerana* and *A. mellifera* are smaller.

Ecological Role: Bees are essential pollinators in natural ecosystems, and strongly influence ecological relationships, ecosystem conservation and stability, genetic variation in the plant community, floral diversity, specialization and evolution. In farmed areas, bees are needed for the pollination of many cultivated crops

and for maintaining biodiversity in 'islands' of non-cultivated areas. Seed, fruit, and vegetable producers rely on bee pollinators, and without them yields plummet. Bee-keeping is a popular income-generating hobby for the production of honey as a natural sweetener, royal jelly, beeswax, and propolis.

Distribution in Askot Landscape: 637m(Jauljivi), 1641m(Golfa), 1842m(Walthi), 2290m(Gaila), 3446m(Bhanar).

Figure: Altitudinal distribution of beneficial insects in Askot Landscape



Literature Cited

Aizen MA, Morales CL, Morales JM, 2008. Invasive Mutualists Erode Native Pollination Webs. PLoS Biol 6(2): e31. doi:10.1371/journal.pbio.0060031

Aizen, M.A. and Harder, L.D., 2009. T he Global stock of domesticated honey bees is growing slower than agricultural demand for pollination. Current Biology, 19: 1-4.

Blair, R.B.,1999. Birds and butterflies along an urban gradient : surrogate taxa for assessing biodiversity? Ecol. Appl., 9 : 164-170.

Dover, J.W., T.H. Sparks & J.N. Greatorex-Davies 1997. The importance of shelter for butterflies in open landscapes. J. Insect Conserv., 1 : 89-97.

Erhardt, A,. 1985. Diurnal lepidoptera : sensitive indicators of cultivated and abandoned grasslands. J. Appl. Ecol., 22 : 849-861.

Evans, W.H., 1937. A catalogue of the African Hesperiidae indicating the classification and nomenclature adopted in the British museum (Natural History). London. Annual Magazine of Natural History 12(8), 881-885.

Evans, W.H., 1949. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British museum (Natural History). London. Annual Magazine of Natural History 12(9), 749-752.

Evans, W.H., 1951. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British museum (Natural History). London. Part I: Introduction and group a, Pyrrhopyginae. London.

Evans, W.H., 1952. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British museum (Natural History). London. Part II: Group B, C, D, Pyrginae. Section 1. London.

Evans, W.H., 1953. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British museum (Natural History). London. Part III: Group E, F, G, Pyrginae. Section 2. London.

Evans, W.H., 1954. A revision of the Genus Curetis. Entomologist 87, 190-194; 212-216; 241-247.

Gallai, N., Salles, J.M., Settele, J and Vaissiere, B.E., 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecol. Econ. 68: 810 – 821.

Kehimkar, I., 2008. The book of Indian Butterflies. Bombay Natural History Society, Oxford University Press. Mumbai.

Klein A-M., Vaissière B., Cane J.H., Steffan-Dewenter I., Cunningham S.A., Kremen C., Tscharntke T., 2007. I mportance of pollinators in changing landscapes for world crops, Proceedings of the RoyalSociety B, 274, 303-313

Kremen, C., 1992. Assessing the indicator properties of species assemblages for natural areas monitoring. Ecol. Applications 2, 203–17.

Kremen, C., 1994. Biological inventory using target taxa: a case study of the butterflies of Madagascar. Ecol. Applications 4, 407–22.

Landres, P.B., Verner, J. and Thomas, J.W., 1988. Ecological uses of vertebrate indicator species: a critique. Conserv. Biol. 2, 316–29.

Longino, J.T., 1994. How to measure arthropod diversity in a tropical rainforest. Biology Intern. 28, 3–13.

Noss, R.F., 1990. Indicators for monitoring biodiversity: a hierarchical approach. Conserv. Biol. 4, 355–64.

Oliver, I. and Beattie, A.J., 1993. A possible method for the rapid assessment of biodiversity. Conserv. Biol. 7, 562–8.

Pearson, D.L., 1994. Selecting indicator taxa for the quantitative assessment of biodiversity. Phil. Trans. R. Soc. London B 345, 75–9.

Pyle, R., Bentzien, M. and Opler, P., 1981. Insect Conservation. Annu. Rev. Entomol. 26, 233–58.

Sawchik, J., M. Dufrêne & P. Lebrun, 2003. Estimation of habitat quality based on plant community and effects of isolation in a network of butterfly habitat patches. Acta Oecol., 24 : 25-33.

Schulze, E.-D. and Mooney, H. (eds), 1993. Biodiversity and Ecosystem Function. Ecological Studies no. 99. Heidelberg: Springer-Verlag.

Sober´ on-M., J. and Llorente-B., J., 1993. The use of species accumulation functions for the prediction of species richness. Conserv. Biol. 7, 480–8.

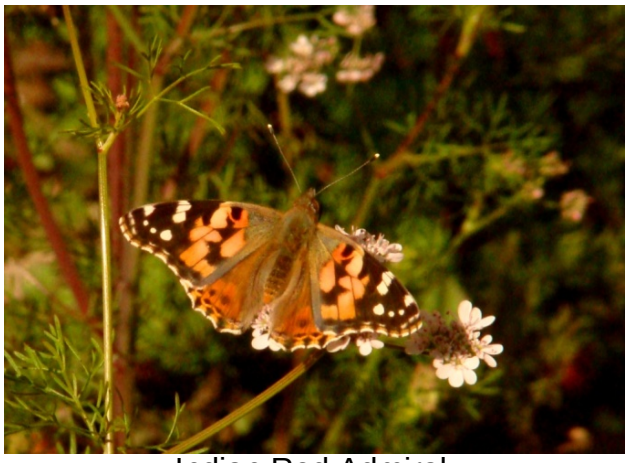
Spitzer, K., J. Jaros, J. Havelka & J. Leps, 1997. Effect of small-scale disturbance on butterfly communities of an Indochinese montane rainforest. Biol. Conserv., 80 : 9-15.

Swengel, S.R. & A.B. Swengel, 1999. Correlations in abundance of grassland songbirds and prairie butterflies. Biol. Conserv., 90 : 1-11.

Talbot, G., 1939. The fauna of British India including Ceylon and Burma Butterflies.1st edition Vol-I. Published by Taylor and Francis, London.

Talbot, G., 1947. The fauna of British India including Ceylon and Burma, Butterfly-Vol-II. Taylor and Francis Ltd., London.

Insect Diversity Recorded in Askot Landscape: Butterfly Diversity



Indian Red Admiral

Red Helen

Chocolate Pansy

Chestnut Tiger

Common Sailor

Striped Blue Crow

Insect Diversity Recorded in Askot Landscape: Butterfly Diversity

Grass Yellow

Common Jester

Indian Tortoiseshell

Common Brimstone

Queen of Spain Fritilary

Lemon Pansy

Insect Diversity Recorded in Askot Landscape: Butterfly Diversity

Common Blue Apollo

Common Grass Dart

Common Red Apollo

Common Redeye

Conjoined Swift

Common Bluebottle

Insect Diversity Recorded in Askot Landscape: Butterfly Diversity

Grass-Demon

Indian Skipper

Sorrel Sapphire

Mountain Tortoiseshell

Orange Awlet

Spotted Angle

Insect Diversity Recorded in Askot Landscape: Butterfly Diversity

Common Small Flat

Tree Flitter

Water Snow Flat

Common Satyr

Indian Oakblue

Orange Oakleaf

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Crambidae)

Agathodes ostentalis

Agrotera scissalis

Bradina diagonalis

Cirrhochrista brizoalis

Conogethes pluto

Cotachena alysoni

Glyphodes actorionalis

Maruca vitrata

Pagyda quadrilineata

Spoladea recurvalis

Goniorhynchus sp

Nausinoe geometralis

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Arctiidae)

Nannoarctia obliquifascia

Nyctemera adversata

Cyana sp

Ceryx sp

Spilosoma multiguttata

Creatonotus transiens

Insect Diversity in Askot Landscape: Family Saturniidae, Lasiocampidae & Limacodidae

Actias maenas

Antherea assmensis

Loepa katinka

Ganisa plana

Euthrix laeta

Phocoderma sp

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Lymantridae)

Lymantria sp

Lymantria sp

Toxoproctis sp

Stigmatophora sp

Lymantria mathura

Lymantria singapura

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Geometridae)

Biston suppssaria

Zeheba aureatoides

Scopula pulchellata

Problepsis albidior

Ophthalmitis sp

Heterostegane sp

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Geometridae)

Godonela nora

Fascelina plagiata

Problepsis vulgaris

Organopoda carnearia

Eucyclodes divapala

Chlorissa gelida

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Noctuidae)

Aegocera bimacula

Bastilla crameri

Calyptra ophideroides

Spirama retorta

Calesia haemorrhoa

Erebus ephesperis

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Noctuidae)

Asota producta

Asota ficus

Ophiusa tirhaca

Erebus sp

Eudocima phalonia

Hamodes propitia

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Noctuidae)

Oraesia emarginata

Xanthodes intersepta

Polytela gloriosae

Pencillaia sp

Gabala roseoretis

Prodenia littoralis

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Sphingidae)

Amplypterus panopus

Clanis stenosema

Acosmeryx anceus

Elibia dolichus

Rhyncholaba acteus

Marumba sp

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Family Sphingidae)

Psilogramma menephron

Hippotion echeclus

Deilephila elpenor

Acherontia styx

Theretra clotho

Agrius convolvuli

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Miscellaneous Families)

Totricia sp(Family Totricidae)

Tarsolepis sp (Family Notodontidae)

Stauropus sp (Family Notodontidae)

(Family Oecophoridae)

Opogona sp (Family Tineidae)

Ocinaria sp (Family Bombycidae)

Insect Diversity Recorded in Askot Landscape: Moth Diversity (Miscellaneous Families)

Xyleutes strix (Cossidae)

Tridrepana flava (Drepanidae)

Cyclidia substigmaria (Drepanidae)

Eupterote geminata (Eupterotidae)

Pseudoips prasinanus (Nolidae)

Banisia owadai (Thyrididae)

Insect Diversity Recorded in Askot Landscape: Beetles (Coleoptera) Diversity

Cerambycidae sp 1

Cerambycidae sp 2

Cerambycidae sp 3

Cerambycidae sp 4

Cerambycidae sp 5

Cerambycidae sp 5

Insect Diversity Recorded in Askot Landscape: Beetles (Coleoptera) Diversity

Cerambycidae sp 6

Curculionidae

Lucanidae

Cicindelidae

Carabidae

Carabidae

Insect Diversity Recorded in Askot Landscape: Beetles (Coleoptera) Diversity

Carabidae

Carabidae

Carabidae

Carabidae

Elateridae

Scarbidae

Insect Diversity Recorded in Askot Landscape: Other Interesting Insects

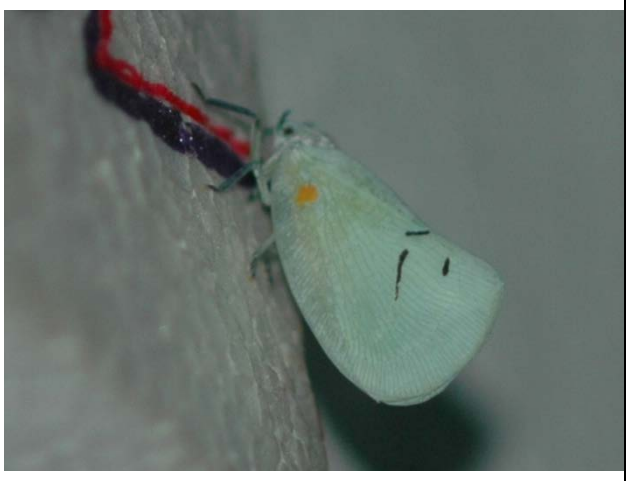
Dobsonfly (Order Megaloptera)

Orthoptera

Stick Insect (Phasmatodea)

Mantodea (Praying Mantis)

Hemipteran Bug



Homopteran Bug

Insect Diversity Recorded in Askot Landscape: Some Important Pollinators

Bumble bee (*Bombus sp.)*

Carpenter Bee (*Xylocopa sp.)*

Golden Wasp (*Vespa sp*.)

Rock Bee (*Apis dorsata*)

Syrphid Fly (Syrphidae)

Tabanid Fly (Tabanidae)

Appendix 1

Table 1: Probable butterfly distribution list with their altitudinal maxima, major habitats recorded from and seasonal activity period compiled from Kehimakar (2008), Waterhouse (1981), Evans (1937, 1949, 1951, 1952, 1953, 1955) and Talbot (1939, 1947). While it has been tried to make the list as exhaustive as possible, any species with doubtful distribution in Uttarakhand, more precisely in Kumaon Himalaya encompassing Askot Landscape, has not been included.

Abbreviations Used: **ATY:** All throughout the year, **DD:** Data Deficient

S No.	Species	Altitudinal Range & Habitat	Activity Season
	Family Hesperiidae		
1	Orange Awlet (*Bibasis jaina*)	up to 1200m, Subtropical Forest	ATY
2	Orange-Tail Awl (*Bibasis sena*)	up to 1400m, Subtropical Forest	February-October
3	Slate Awl (*Hasora anura*)	Up to 900m, Subtropical Forest	December
4	Common Banded Awl (*Hasora chromus*)	up to 2000m, Dense Forest & Open Patches	April-August
5	Brown Awl (*Badamia exclamationis*)	up to 2400m, Dense Forests	August-September
6	Indian Awlking (*Choaspesn benjaminii*)	up to 2400m, Open Patches	March-November
7	Marbled Flat (*Lobocla liliana*)	1400-2000m,	May-September
8	Multispotted Flat (*Celaenorhinus pulomaya*)	2000-3000m, Hill forests	DD
9	Common Spotted Flat (*Celaenorhinus leucocera*)	up to 2400m, Moist Deciduous Forest	March-October
10	Mountain Skipper (*Pyrgus alpina*)	3000-4200m, Alpine Scrub & Meadows	June-August
11	Indian Skipper (*Spialia galba*)	1300-2700m, Damp Forests	March-November
12	Common Small Flat (*Sarangesa dasahara*)	up to 2500m, Open Wet Patches	August-September
13	Spotted Small Flat (*Sarangesa purendra*)	up to 1500m, Dry Habitat	April-September
14	Fulvous Pied Flat (*Pseudocoladenia dan*)	up to 2100m, Wet Hill Forest	March-November
15	Tricoloured Pied Flat (*Coladenia indrani*)	up to 1350m, Subtropical Forest	May-September
16	Dusky Flat (*Gerosis phisara*)	up to 1050m, Foothill Forest	March-June
17	Common Snow Flat (*Tagiades japetus*)	up to 1500m, Mixed Deciduous Forest	DD
18	Water Snow Flat (*Tagiades litigiosa*)	up to 2000m, Moist Forest	March-April, June-October
19	Chestnut Angle (*Odontoptilum angulata*)	up to 2400m, Dampy Habitat	March-October
20	Spotted Angle (*Caprona agama*)	DD	DD

21	Golden Angle (*Caprona ransonnetti*)	DD	July-August
22	Tawny Angle (*Ctenoptilum vasava*)	DD	DD
23	Mountain Hopper (*Carterocephalus avanti*)	3300-4200m,Subalpine & Alpine Patches	April-June
24	Common Grass Dart (*Taractrocera maevius*)	up to 1600m, Hill Forest	March-April, August-October
25	Common Dartlet (*Oriens goloides*)	up to 1600m, Open Patches	March-May, August-November
26	Himalayan Dart (*Potanthus dara*)	above 1800m, Oak Forest	DD
27	Straight Swift (*Parnara guttatus*)	up to 2400m, Open Patches	March-October
28	Great Swift (*Pelopidas assamensis*)	up to 1740m, Forest Habitat	August-November
29	Conjoined Swift (*Pelopidas conjuncta*)	up to 1200m, Moist Forest	August-September
30	Large Branded Swift (*Pelopidas subochracea*)	up to 2400m, Dense Forests	March-April, June-November
31	Yellow Spot Swift (*Polytremis eltola*)	up to 2700m, Forested Hill	March-November
32	Chocolate Demon (*Ancistroides nigrita*)	up to 1200m, Subtropical Forest	July-November
33	Restricted Demon (*Notocrypta curvifascia*)	up to1800m, Disturbed Open Patch	July-September
34	Veined Scrub Hopper (*Aeromachus stigmatus*)	1500-2100m	May-October
	Family Papilionidae		
35	Common Red Apollo (*Parnassius epaphus*)	4300-5400m, Alpine Meadows	June-August
36	Common Blue Apollo (*Parnassius hardwickii*)	3000-3350m, Tree line and Alpine Meadows	May-September
37	Glassy Bluebottle (*Graphium cloanthus*)	up to 2700m, Damp open patch	June-August
38	Common Bluebottle (*Graphium sarpedon*)	up to 2700m, Wet Wooded area	March-October
39	Common Jay (*Graphium doson*)	up to 1200m, Lower elevation forest	March-December
40	Tailed Jay (*Graphium agamemnon*)	up to 1800m, Well-wooded area	March-November
41	Spot Swordtail (*Graphium nomius*)	up to 2000m, Deciduous forest	February-June
42	Great Zebra (*Graphium xenocles*)	up to 1800m, Forested Valley	April-August
43	Sixbar Swordtail (*Graphium eurous*)	1000-2800m, Open forest-adjacent patches	March-May
44	Tawny Mime (*Chilasa agestor*)	1200-2600m, Forest Patches	March-May
45	Common Mime (*Chilasa clytia*)	up to 2500m, Well wooded plain	May-August
46	Common Mormon (*Papilio polytes*)	up to 1850m, Open patches	ATY
47	Red Helen (*Papilio helenus*)	up to 2100m, Subtropical Forests	March-November
48	Yellow Helen (*Papilio nephelus*)	Lower hills, Wooded habitat	February-October
49	Spangle (*Papilio protenor*)	up to 2500m, Wooded hillsides	March-September

50	Redbreast (*Papilio alcmenor*)	up to 1825m, Moist patches	March-September
51	Lime Butterfly (*Papilio demoleus*)	up to 2100m, Open Lightly wooded plain	ATY
52	Common Yellow Swallowtail (*Papilio machaon*)	1800-4200m, Wide habitats	March-September
53	Paris Peacock (*Papilio paris*)	1500-2100m, Moist Evergreen Patch	March-November
54	Blue Peacock (*Papilio acturus*)	up to 2200m, Cold Temperate Forest	June-August
55	Common Peacock (*Papilio polyctor*)	600-2100m, Warm Forested Plain	March-October
56	Rose Windmill (*Atrophaneura latreilei*)	1500-2000m, Hilly Forests	April-July
57	Common Windmill (*Atrophaneura polyeuctes*)	up to 2700m, Oak Forest	March-November
58	Great Windmill (*Atrophaneura dasarada*)	1200-2740m, Forest Habitat	March-October
59	Common Rose (*Atrophaneura aristolochiae*)	up to 900, Cultivated land	ATY
60	Golden Birdwing (*Troides aeacus*)	Foothills to 1100m, Warm Forested Valleys	May-June
	Family Pieridae		
61	Small Grass Yellow (*Eurema brigitta*)	up to 3600m, Degraded habitats	ATY
62	Common Grass Yellow (*Eurema hecabe*)	up to 2500m, all type of habitats	ATY
63	Common Brimstone (*Gonepteryx rhamni*)	1200-2400m, Open Grassy glades	February-October
64	Lesser Brimstone (*Gonepteryx mahaguru*)	above 2100m, Moist Temperate Forest	April-October
65	Common Emigrant (*Catopsilia pomona*)	up to 4000m, Around human habitation	ATY
66	Mottled Emigrant (*Catopsilia pyranthe*)	up to 2700m, Around human habitation	ATY
67	Pale Clouded Yellow (*Colias erate*)	600-3500m, Open Habitat	February-December
68	Dark Clouded Yellow (*Colias fieldii*)	1200-3600m, Himalayan meadows	February-December
69	Small Orange Tip (*Colotis etrida*)	up to 2900m, Dry open habitat	ATY
70	Yellow Orange Tip (*Ixias pyrene*)	up to 2100m, Scrubby habitat	ATY
71	Common Wanderer (*Pareronia valeria*)	at 1500m, Open woodlands	March-November
72	Striped Albatross (*Appias libythea*)	600-700m, Mixed deciduous forest	May, July-October
73	Chocolate Albatross (*Appias lyncida*)	up to 900m, Moist Forest	ATY
74	Spot Puffin (*Appias lalage*)	up to 2000m, Damp patches	ATY
75	Large Cabbage White (*Pieris brassicae*)	900-4000m, Cultivation, light wooded country	ATY
76	Green-veined White (*Pieris napi*)	2100-3600m, Damp, shaded woodland	April-August
77	Indian Cabbage White (*Pieris canidia*)	1500-3600m, around bushes & shrubs	ATY
78	Bath White (*Pontia daplidice*)	1200-2700m, Cultivation land	March-September

79	Peak White (*Pontia callidice*)	2700-4500m, Alpine Habitat	May-September
80	Small Bath White (*Pontia chloridice*)	3600m	March-May, July-August
81	Common Gull (*Cepora nerissa*)	up to 1200m, Dry plains, scrub forest	ATY
82	Spotted Sawtooth (*Prioneris thestylis*)	up to 1200m, well wooded country	April-November
83	Himalayan Blackvein (*Aporia leucodice*)	1200-3000m, Open Wooded Habitat	May-June
84	Great Blackvein (*Aporia agathon*)	1200-3000m, Wet Wooded Habitat	March-July
85	Hill Jezebel (*Delias belladona*)	600-3000m, Open Wooded area	April-July
86	Pale Jezebel (*Delias sanaca*)	1200-3000m	May-July
87	Common Jezebel (*Delias eucharis*)	600-1500m, Urban and Natural forests	ATY
88	Psyche (*Leptosia nina*)	up to 1500m, Scrubby habitat	March-November
89	Pioneer (*Belenois aurota*)	up to 2800m, Open Dry areas	ATY
	Family Lycaenidae		
90	Common Gem (*Poritia hewitsoni*)	up to 1050m, Shrubby area	March-April, August-December
91	Apefly (*Spalgis epius*)	up to 1200m, Forested Area	ATY
92	Bright Sunbeam (*Curetis bulis*)	up to 2100m, Damp patch	March-June, September-November
93	Angled Sunbeam (*Curetis acuta*)	up to 1370m, Damp patch	March-November
94	Silver Hairstreak (*Neozephyrus syla*)	Oak Forest, Riverine patch, 1800-2400m	May-September
95	India Purple Hairstreak (*Esakiozephyrus mandara*)	Temperate Oak Forests, 2100-3500m	May-September
96	White Spotted Hairstreak (*Euaspa milionia*)	Temperate Forest, 1200-2000m	April-July
97	Western Centaur Oakblue (*Arhopala pseudocentaurus*)	up to 2400m, Moist Oak Forest	April-June, August-December
98	Large Oakblue (*Arhopala amantes*)	Dampy Oak Forest, up to 1800m	March-May, July-October
99	Dark Himalayan Oakblue (*Arhopala rama*)	Warm Oak Forest, 900-2700m	May-November
100	Powdered Oakblue (*Arhopala bazalus*)	Banj Oak Forest, 1800m	May & November
101	Tailless Bushblue (*Arhopala ganesa*)	1200-1700m, Pine Forest	July-September
102	Indian Oakblue (*Arhopala atrax*)	up to 1890m, Lower elevation Forest	March-August
103	Pale Himalayan Oakblue (*Arhopala dodonea*)	1500-1800m,Oak Forest	April-July, August-October
104	Common Acacia Blue (*Acacia quercetorum*)	up to 1200m, Lower Hill forest	February-September
105	Silverstreak Blue (*Iraota timoleon*)	up to 2100m, Damp hill forest	March-July, September-December
106	Yamfly (*Loxura atymnus*)	up to 1000m, Wet bamboo forest	April-November

107	Common Onyx (*Horaga onyx*)	up to 2000m, Dense hilly forest	March-May, September-October
108	Blue Imperial (*Ticherra acte*)	600-900m, Subtropical Forest	February-November
109	Common Imperial (*Cheritra freja*)	up to 1050m, Wet hill forest	April-October
110	Dark Blue Royal (*Pratap icetas*)	up to 2700m, Hill Forest	March-May, September
111	Tufted White Royal (*Pratapa deva*)	up to 2130m, Hilly wooded area	March, June-November
112	Broadtail Royal (*Creon cleobis*)	1100-2400m, Lower elevation forest	DD
113	Plains Blue Royal (*Tajuria jehana*)	up to 2130m, Well Foested Area	DD
114	Peacock Royal (*Tajuria cippus*)	up to 1200m, Moist Forest	May-August
115	White Royal (*Tajuria illurgis*)	1520-1860m, Subtropical Forest	March-June
116	Bispot Royal (*Ancema ctesia*)	1400-2100m, forest stream	April-October
117	Blue Tit (*Chliaria kina*)	1000-1800m	March-October
118	Orchid Tit (*Chliaria othona*)	up to 1500m, Wet Forest	February-November
119	Cornelian (*Deudorix epijarbas*)	up to 2500m, Forested Hill	March, July-December
120	Slate Flash (*Rapala manea*)	up to 1980m, Damp patches	July-September
121	Indigo Flash (*Rapala varuna*)	up to 1600m, Hill Forest	February-October
122	Long Banded Silverline (*Spindasis lohita*)	up to 1670m, Thick forested hill	March-July
123	Common Silverline (*Spindasis vulcanus*)	up to 2700m, Light Wooded area	May-June, October
124	Silver-grey Silverline (*Spindasis nipalicus*)	1000-2400m, Open Forest clearings	April-October
125	Scarce shot Silverline (*Spindasis elima*)	up to 2700m, Damp forests	May-June
126	Common Copper (*Lycaena phlaeas*)	300-4300m, Wide range of Habitats	March-October
127	Green Copper (*Lycaena kasyapa*)	1800-3000m, Open habitat	June-September
128	White Breasted Copper (*Lycaena pavana*)	1700-2800m, Open Grassy patches	March-October
129	Golden Sapphire (*Heliophorus brahma*)	1200-2400m, Forest trail	April-October
130	Purple Sapphire (*Heliophorus epicles*)	600-2100m, Forest trails	March-October
131	Powdery Green Sapphire (*Heliophorus tamu*)	1680-2650m, Forest trail	April-October
132	Green Sapphire (*Heliophorus androcles*)	1300-3700m, Forest trail	March-October
133	Sorrel Sapphire (*Heliophorus sena*)	600-2400m, Dry open patch	March-October
134	Angled Pierrot (*Caleta caleta*)	600m, Open Evergreen to Mix Deciduous	July-August
135	Banded Blue Pierrot (*Discolampa ethion*)	up to 1500m, Thick jungle	ATY
136	Common Pierrot (*Castalius rosimon*)	up to 2500m, Open Forest	January-November

137	Common Lineblue (*Prosotas nora*)	up to 2600m, Open and Closed forest	ATY
138	Dark Cerulean (*Jamides bochus*)	up to 1900m, shaded patch	ATY
139	Common Cerulean (*Jamides celeno*)	up to 1600m, Outside forest	ATY
140	Pea Blue (*Lampides boeticus*)	up to 3000m, Agricultural & cultivated area	ATY
141	Rounded Pierrot (*Tarucus nara*)	up to 2130m, Grassy patch	ATY
142	Dark Grass Blue (*Zizeeria karsandra*)	up to 2430m, Grassy patch	ATY
143	Pale Grass Blue (*Pseudozizeeria maha*)	up to 2500m, Open grassy patch	January-November
144	Lesser Grass Blue (*Zizina otis*)	up to 2000m, Grassy patch	ATY
145	Bright Babul Blue (*Azanus ubaldus*)	up to 2400m, Dry grassy patch	March-December
146	Dull Babul Blue (*Azanus uranus*)	up to 1100m, Open dry area	March-December
147	Tailed Cupid (*Everes argiades*)	1500-3000m, Streams in open grassy area	March-October
148	Chapman's Cupid (*Everes argiades*)	1430-2800m, Rocky hillside	February-May, July-October
149	Dusky Hedge Blue (*Oreolyce vardhana*)	2400-2800m, Forest streams	May-October
150	Common Hedge Blue (*Acytolepis puspa*)	Rare record up to 3000m, Moist forest	ATY
151	Pale Hedge Blue (*Udara dilecta*)	600-3900m, Hill forest	January-March, May-December
152	Hill Hedge Blue (*Celastrina argiolus*)	800-3500m, Bushes along stream	March-October
153	Large Hedge Blue (*Celastrina huegelii*)	1450-2900m, Forest edge	March-October
154	Plain Hedge Blue (*Calestrina lavendularis*)	up to 1500m, Both forested & open country	ATY
155	Margined Hedge Blue (*Celatoxia marginata*)	around 700-800m, rarely 3000m	April-October
156	Chequered Blue (*Pseudophilotes vicrama*)	1800-4200m, Dry open & Juniper scrub	May-July
157	Orange Bordered Argus (*Aricia astrarche*)	up to 2900m, Open hilly areas	March-October
158	Plains Cupid (*Chilades pandava*)	up to 2000m, Moist wooded area	DD
159	Lime Blue (*Chilades lajus*)	up to 1980m, Dry open forest	ATY
160	Small Green Underwing (*Albulina metallica*)	2400-3000m, Alpine meadows	ATY
161	Common Meadow Blue (*Polyommatus eros*)	1500-3900m, Rocky alpine areas	May-August
162	Dark Judy (*Abisara fylla*)	550-2000m, Dense Forested region	March-November
163	Plum Judy (*Abisara echerius*)	up to 1190m, Shady areas	ATY
164	Punchinello (*Zemeros flegyas*)	600-2300m, Damp forest streams	February-November
165	Orange Punch (*Dodona egeon*)	900-2700m, Damp patch	February-December
166	Lesser Punch (*Dodona dipoea*)	1800-3000m, Damp patch	DD

167	Tailed Punch (*Dodona eugenes*)	1500-2700m, Along streams in forested valley	February-October
168	Common Punch (*Dodona durga*)	700-2400m, Warm forested valleys	March-October
169	Mixed Punch (*Dodona ouida*)	1200-2400m, Hilltops	April-December
	Family Nymphalidae		
170	Common Beak (*Libythea lepita*)	900-3000m, In forest around streams	March-September
171	Club Beak (*Libythea myrrha*)	900-3000m, Hill Forest	March-October
172	Blue Tiger (*Tirumala limniace*)	up to 2000m, In forested tracks	ATY
173	Dark Blue Tiger (*Tirumala septentrionis*)	up to 2000m, Dense & moist woodland	ATY
174	Striped Tiger (*Danaus genutia*)	up to 2500m, Wet evergreen forest to scrub	ATY
175	Plain Tiger (*Danaus chrysippus*)	up to 2500m, Open country as well as forest	ATY
176	Glassy Tiger (*Parantica aglea*)	up to 2100m, Open Cultivation area	ATY
177	Chestnut Tiger (*Parantica sita*)	up to 3000m, Forested region	April to December
178	Chocolate Tiger (*Parantica melaneus*)	up to 2800m, Hill forests	February-December
179	Striped Blue Crow (*Euploea mulciber*)	up to 2500m, Open forest edge	February-December
180	Blue Spotted Crow (*Euploea midamus*)	600m, Forested plains	February-August
181	Common Crow (*Euploea core*)	up to 2500m, Forest to open country	ATY
182	Common Nawab (*Polyura athamas*)	up to 1900m, Damp Forest patch	March-November
183	Stately Nawab (*Polyura dolon*)	1430-1900m, Damp forest patch	April-August
184	Great Nawab (*Polyura eudamippus*)	up to 1550m, Damp forest patch	April-August
185	Tawny Rajah (*Charaxes bernardus*)	up to 1500m, Damp forest patch	August-September
186	Variegated Rajah (*Charaxes kahruba*)	1250m, Damp patches	May-June
187	Yellow Rajah (*Charaxes marmax*)	up to 1400m, Hill forest	April, November
188	Common Evening Brown (*Melanitis leda*)	up to 2100m, Various habitats	ATY
189	Dark Eveving Brown (*Melanitis phedima*)	up to 2100m, Dense Bamboo forest	April-December
190	Great evening Brown (*Melanitis zitenius*)	up to 1200m, Dense forest	July-November
191	Bamboo Tree Brown (*Lethe europa*)	Low elevation, Bamboo forest	July-August
192	Common Tree Brown (*Lethe rohria*)	up to 3000m, Hill forest & open country	March-November
193	Banded Tree Brown (*Lethe confusa*)	600-1700m, Forest undergrowth	February-November
194	Common Forester (*Lethe mekara*)	up to 2100m, Dense forest undergrowth	June-November
195	Bamboo Forester (*Lethe kansa*)	1200-2000m, Dense bamboo clump	March-July, September-

			November
196	Straight-banded Treebrown (*Lethe verma*)	1200-3000m, Damp forest patch	April-November
197	Common Woodbrown (*Lethe sidonis*)	up to 3100m	May-October
198	Barred Woodbrown (*Lethe maitrya*)	2500-3800m, Forested undergrowth	July-November
199	Yellow Woodbrown (*Lethe nicetas*)	1700-2600m, along forest streams	May-June
200	Veined Labyrinth (*Neope pulaha*)	1500-3050m, Degraded habitat near habitation	April-August
201	Dusky Labyrinth (*Neope yama*)	above 1200m, Shaded forest path	April-September
202	Common Wall (*Lasiommata schakra*)	1830-2700m, Open dry grassy hillside	April-October
203	Scarce Wall (*Lasiommata maerula*)	1500-2400m, Valleys along streams	DD
204	Tiger Brown (*Orinoma damaris*)	1300-2000m, around forest clearings	May-June, October-November
205	Common Palmfly (*Elymnias hypermnestra*)	up to 1500m, Shaded forest & edge	February-December
206	Blue-striped Palmfly (*Elymnias patna*)	Forested hill	DD
207	Common Bushbrown (*Mycalesis perseus*)	up to 1700m, Dry grassy area	ATY
208	Dark-Brand Bushbrown (*Mycalesis mineus*)	up to 1500m, Damp grassy shrub	ATY
209	Long-Brand Bushbrown (*Mycalesis visala*)	600-1300m	October-December
210	Great Satyr (*Aulocera padma*)	above 1200m, Open spaces on rocky ridges	April-October
211	Common Satyr (*Aulocera swaha*)	1800-3000m, Forested areas	May-September
212	Striated Satyr (*Aulocera saraswati*)	1200-1800m, Open grassy meadow	July-October
213	Ringed Argus (*Callerebia ananda*)	1500-2400m, Dry rocky hillside	April-October
214	Common Argus (*Callerebia nirmala*)	1200-2700m, Damp forested areas	May-September
215	Pallid Argus (*Callerebia scanda*)	1200-2800m, Wooded hills	July-September
216	Yellow Argus (*Paralasa mani*)	around 3000m, Open grassy meadow	July-August
217	Mountain Satyr (*Paroeneis pumilus*)	3780-4100m, Open alpine meadow	July-August
218	Common Three-ring (*Ypthima asterope*)	up to 1500m,Open agriculture, mixed deciduous	ATY
219	Jewel Fourring (*Ypthima avanta*)	600-1300m, Open area	January-October
220	Common Fivering (*Ypthima baldus*)	up to 1800m, Damp patch	February-October
221	Large Threering (*Ypthima nareda*)	600-2800m, Sparsely forested areas	March-November
222	Himalayan Fivering (*Ypthima sakra*)	1980-2700m, Light and thick forest	ATY
223	Tawny Coster (*Acraea violae*)	up to 1500m, Forest clearings	ATY
224	Yellow Coster (*Acraea issoria*)	700-2400m, Scrubs at forest edges	March-December

225	Leopard lacewing (*Cethosia cyane*)	Plains up to 4500m, Varied habitats	ATY
226	Western Silverstripe (*Argynnis pandora*)	1500-2400m, Meadow area	August-October
227	Large Silverstripe (*Childrena childreni*)	1200-3000m, Valley and open country	May-November
228	Indian Fritillary (*Argyreus hyperbius*)	500-3000m, Forest glades and open country	January-December
229	Dark Green Fritillary (*Speyeria aglaja*)	2700-4570m, Open grassy slope and meadows	June-August
230	Highbrown Silverspot (*Fabriciana adippe*)	2400-4700m, Meadows and forest clearings	July-August
231	Common Silverstripe (*Fabriciana kamala*)	2000-3500m, Forest edge and open country	May, September
232	Queen of Spain Fritillary (*Issoria lathonia*)	1200-5000m, Hill slopes and alpine meadows	February-October
233	Rustic (*Cupha erymanthis*)	up to 1500m, Shrubs in shady areas	January-November
234	Vagrant (*Vagrans egista*)	2250m, Forested areas with clearings	February-December
235	Indian White Admiral (*Limenitis trivena*)	300-3300m, Forested hilly region	May-September
236	Green Commodore (*Sumalia daraxa*)	600-2100m, Open clearings in hill forest	May-November
237	Commander (*Moduza procris*)	up to 980m, Evergreen, Semi-evergreen forest	February-December
238	Commodor (*Auzakia danava*)	880-1800m, along streams in forest	April-September
239	Common Sergeant (*Athyma perius*)	up to 2200m, Forest edges	February-December
240	Studded Sergeant (*Athyma asura*)	up to 2600m, Forest streams in sheltered valleys	August
241	Himalayan Sergeant (*Athyma opalina*)	1800-2800m, Moist temperate and subtropical	March-November
242	Staff Sergeant (*Athyma selenophora*)	up to 2100m, Forest streams and rivers	February-December
243	Small Staff Sergeant (*Athyma zeroca*)	800-900m, Subtropical forest	March-December
244	Orange Staff Sergeant (*Athyma cama*)	600-1890m, Hilly forest	March-December
245	Common Lascar (*Pantoporia hordonia*)	Moderate elevation, Forest paths and clearings	March-December
246	Yerbury's Lascar (*Neptis yerburyi*)	1200-2000m, along forested streams and ravines	March-October
247	Common Sailer (*Neptis hylas*)	Well watered deciduous forest	August-September
248	Sullied Sailer (*Neptis soma*)	600-2200m, Damp forests	February-July, September
249	Himalayan Sailer (*Neptis mahendra*)	1200-3000m	April-October
250	Broad-banded Sailer (*Neptis sankara*)	800-1600m, Wet forest	April-June, September
251	Pale Green Sailer (*Neptis zaida*)	900-2000m, Moist forested area	April-June
252	Great Yellow Sailer (*Neptis radha*)	1100-2200m, Moist forest	April-May, September-November
253	Broadstick Sailer (*Neptis narayana*)	1200-2900m, along forest streams	March-June, August-October
254	Yellow Sailer (*Neptis ananta*)	970-2300m, along forest streams	March-December

255	Short-banded Sailer (*Phaedyma columella*)	600m, Deciduous forest	March-June, August-December
256	Clipper (*Parthenos sylvia*)	Thick forest	ATY
257	Common Baron (*Euthalia aconthea*)	up to 2400m, variety of habitats, habitations	January-December
258	Gaudy Baron (*Euthalia lubentina*)	up to 3050m, Deciduous & semi-evergreen forest	April-November
259	Baronet (*Euthalia nais*)	not above 900m, dry forested area	February-November
260	Grand Duchess (*Euthalia patala*)	970-2500m, Oak forest	June-August
261	Grey Count (*Tanaecia lepidea*)	up to 2000m, Moist forested region	February-December
262	Common Earl (*Tanaecia julii*)	up to 1030m, Subtropical forest	March-November
263	Common Map (*Cyrestis thyodamas*)	plains to 2700m, Hilly evergreen forest	ATY
264	Common Maplet (*Chersonesia risa*)	up to 1300m, Damp patches	March-December
265	Tabby (*Pseudergolis wedah*)	400-2000m, Streams in hilly areas	April-December
266	Constable (*Dichorrhagia nesimachus*)	Hilly area	August-December
267	Popinjay (*Stibochiona nicea*)	600-1800m, Bushes or damp patches	April-June, August-Dcember
268	Indian Purple Emperor (*Apatura ambica*)	600-2600m, Damp rock and sands	February-November
269	Golden Emperor (*Dilipa morgiana*)	700-2300m, Damp patches	March-August
270	Black Prince (*Rohana parisatis*)	600-1800m, Evergreen hilly forest	April-December
271	Painted Courtesan (*Euripus consimilis*)	300-1400m	March-April, June
272	Circe (*Hestina nama*)	up to 2200m, Open valleys and forest edges	February-December
273	Siren (*Hestina persimilis*)	750-1460m, Subtropical forest	DD
274	Scarce Siren (*Hestina nicevillei*)	1500-2100m, Moist Evergreen Patch	May-June
275	Western Courtier (*Sephira dichroa*)	1500-2700m, Oak forest	March-October
276	Blue-Tail Jester (*Symbrenthia niphanda*)	1000-2600m, along forest stream	March-November
277	Common Jester (*Symbrenthia hippoclus*)	300-1500m, Hilly forest	March-December
278	Himalayan Jester (*Symbrenthia hypselis*)	300-2400m, Shady forest	March-December
279	Indian Red Admiral (*Vanessa indica*)	400-3800m, Around forest clearings	August-September
280	Painted Lady (*Vanessa cardui*)	plain to 4500m, Open grassy plains	ATY
281	Mountain Tortoiseshell (*Aglais urticae*)	2400-4500m, High Rocky valleys	May-August
282	Indian Tortoiseshell (*Aglais cashmiriensis*)	Plains to 5000m, Various habitats except forest	ATY
283	Large Tortoiseshell (*Nymphalis xanthomelas*)	900-3200m, Forest clearings	February-September
284	Eastern Comma (*Polygonia egea*)	2100-4800m, Grassy meadows and open hills	May-September

285	Blue Admiral (*Kaniska canace*)	1000-3000m, Forested hilly regions	March-December
286	Blue Pansy (*Junonia orithiya*)	up to 2100m, Drier open grassy plains	ATY
287	Yellow Pansy (*Junonia hierta*)	up to 1900m, Uncultivated agricultural field	ATY
288	Chocolate Pansy (*Junonia iphita*)	up to 1900m, Wet wooded region	January-December
289	Peacock Pansy (*Junonia almana*)	up to 2100m, On plains around marshes	ATY
290	Lemon Pansy (*Junonia lemonias*)	up to 2000m, Open agricultural areas	ATY
291	Great Eggfly (*Hypolimnas bolina*)	up to 1400m, Wet forest areas	ATY
292	Danaid Eggfly(*Hypolimnas misippus*)	up to 3000m, Open country & forest edges	ATY
293	Orange Oakleaf (*Kallima inachus*)	up to 1800m, Dense hill forest	April-December