Butterflies (Lepidoptera: Papilionoidea and Hesperoidea) and other protected fauna of Jones Estate, a dying watershed in the Kumaon Himalaya, Uttarakhand, India

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Author Details: Peter Smetacek is an authority on Indian Lepidoptera and has pioneered the use of insect communities as bio-indicators of climatic change and ground water.

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Abstract: Two hundred and forty three species of butterflies recorded from Jones Estate, Uttarakhand between 1951 and 2010 are reported. The ongoing rapid urbanization of Jones Estate micro-watershed will destroy the habitat of 49 species of wildlife protected under Indian law, as well as several species of narrow endemic moths and butterflies. The only known Indian habitat for the butterfly Lister's Hairstreak *Pamela dudgeoni* will be destroyed. The effect on the water flow of both the Bhimtal and Sattal lake systems will clearly be adverse, as is evident from the drying up of Kua Tal and the reduced flow of perennial water springs during the dry season on the Estate. The undoubtedly negative effect of urbanization on these valuable fresh water resources will be irreversible in the long term. The trend can be reversed by extending protection to Jones Estate by re-declaring it a Green Belt of Bhimtal and by banning construction in the catchment area of Bhimtal lake, as has been done in Nainital and Mussoorie, both in Uttarakhand.

Keywords: Bhimtal, drinking water, drying lakes, freshwater resources, Green Belt, Indian Wildlife (Protection) Act 1972, *Pamela dudgeoni*.

Hindi Abstract: सन् 1951 और 2010 के बीच जौंस स्टेट उत्तराखण्ड में संकलित 243 प्रजाति की तितलियों का वर्णन दिया गया है। वर्तमान में जौंस स्टेट सूक्ष्म जलागम में तेजी स`चल रही षहरीकरण की प्रक्रिया से भारतीय कानून के अन्तर्गत संरक्षित 49। वन जीव की प्रजातियां तथा कई विषेश पतंगे और तितलियों की प्रजाति (जो केवल जौंस स्टेट में पाई जाती हैं) के आवास नश्ट हो जायेंगे। इसमें लिस्ट्र्स हैयर स्ट्रीक तितली का भारत में एक मात्र निवास नश्ट हो जायेगा। भीमताल तथा साततात झीलों का पानी के जल स्रोत पर इसका कुप्रभाव पड़ेगा। इसका वर्तमान में कुंआताल जल स्रोत के सूखने तथा इलाके के सदाबहार जल स्रोत के गर्मी के मौसम में लगभग सूख जाने से स्पश्ट है। लंबे समयावधि में इन अमूल्य मीठे पानी के संषाधनों पर षहरीकरण के नकरात्मक असर का कोई सुधार तभी संभव है जब जौंस स्टेट को हरित पट्टी घोशित की जाये तथा भीमताल झील क`जल संग्रहण क्षेत्र में निर्माण कार्य पर पाबंदी लगे जैसे कि उत्तराखण्ड मं नैनीताल तथा मसूरी में किया गया है।

INTRODUCTION

Jones Estate ("June State" on Revenue Department records) is a forested microwatershed in Nainital district, Uttarakhand (29^{0}21'17"N & 79^{0}32'34.27"E), separating the Bhimtal and Sattal lake systems (Image 1). In the Himalaya, it is a unique geographical feature, being the only forested watershed separating two lake systems comprising a total of eight perennial and seasonal lakes. Bhimtal (tal = lake in Hindi) lies at the southeastern end while the Sattal lies along the northern half of the western face of the Estate. Comprising roughly 4.8 sq.km (1200 acres) of private forest in 1951, the forest area of Jones Estate has been reduced by roughly 30% due to cultivation and habitation over the years.

The lowest point is 1200m at the conjoined Ram and Sita lakes of the Sattal (seven lakes) system, while the highest point is Thala at 1731m. The range runs northwest to southeast for a distance of roughly 3km from Dhupchaura pass on the northwest to Tallital market and Bohrakun Village on its southeastern and southern faces respectively (Image 1). To the east lies the Bhimtal lake system comprising

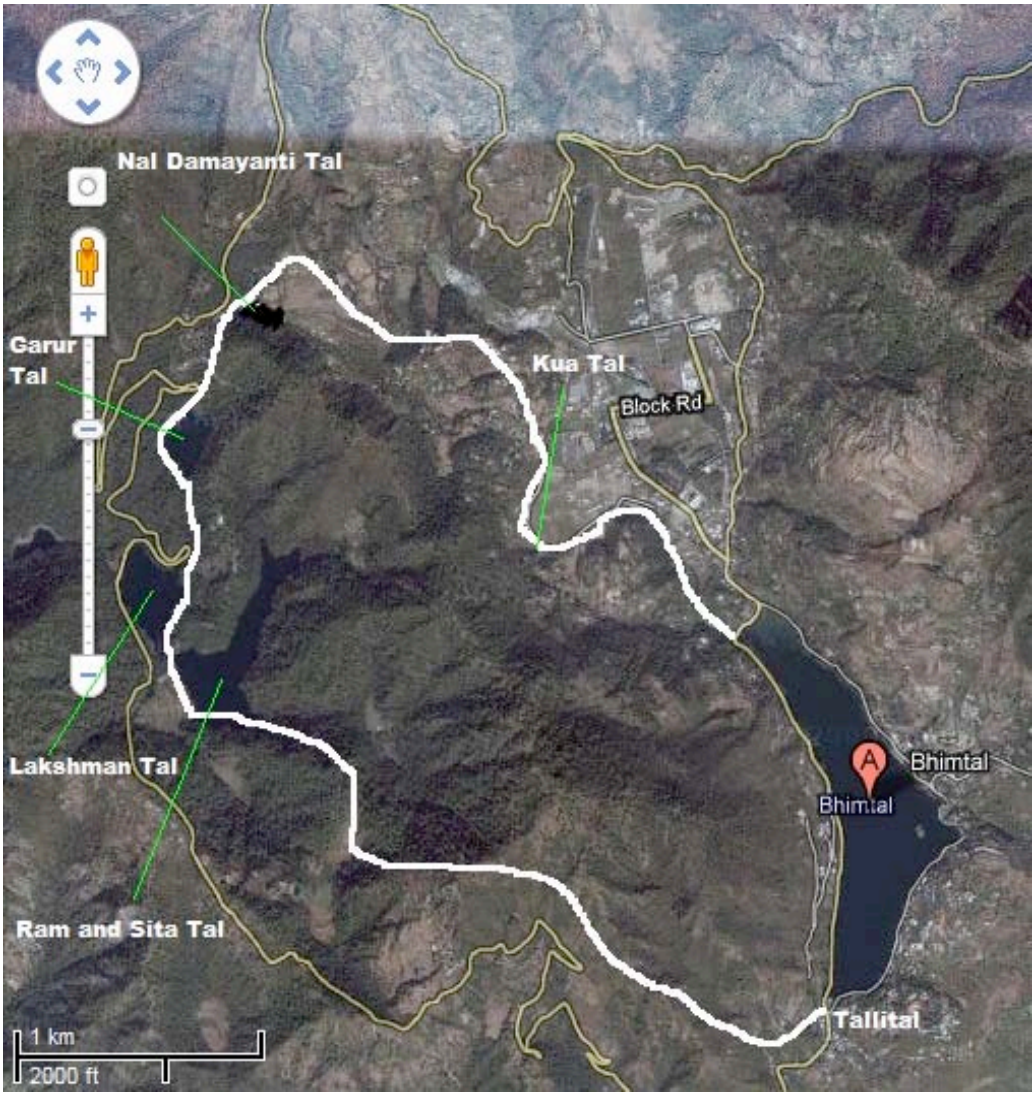

Image 1. Google map showing Jones Estate watershed outlined in white and adjoining lake systems. Source: Googlemaps

Image 2. Garurtal with the western face of Jones Estate in the background.

of three lakes—Nal-Damayantital, Kuatal and Bhimtal. To the west lies the Sattal lake system comprising of Pannatal (=Garurtal) (Image 2); Ramtal and Sitatal, Lakshmantal, Sukhatal, Sariyatal and Lokhamtal.

Jones Estate lies in the outermost range of the Himalayan foothills and receives heavy rainfall. Although Osmaston (1927) gives a range of 2000–3000 mm of rainfall for this area, actual precipitation is rather less nowadays, averaging 1443mm for the five-year period from 2005 to 2009 (Anonymous 2010).

The forest consists of three plant associations, namely sub-tropical broadleaf with Himalayan Oak *Quercus leucotrichophora* as a nodal species; Chir Pine *Pinus roxburghii* forest and elements of miscellaneous deciduous forest. In addition, there is

a patch of naturalized Himalayan Cypress *Cupressus torulosa* several acres in extent.

HISTORY

The Bhimtal Valley has been inhabited and cultivated for over a millennium and Atkinson (1882) noted that it was one of the largest single sheets of cultivation in the Kumaon Himalaya.

Jones Estate watershed and the Sattal Valley were not inhabited during past centuries, although some small patches of cultivation were attempted by share-croppers and itinerant families until 1952. The major part of the Estate has always been forested. It came into existence in 1867 as a fee-simple estate, with the main aim of developing it for the production of green tea for the Tibetan market. Since then, it has remained in private hands.

On 17 January 2001 the then Minister for Environment and Forests, Mr. Kandari, stated in the Uttarakhand State Assembly that all concerned government departments, including the Public Works Department, Forest Department, Pollution Control Department, etc. in their reports on the possibility of construction of buildings on the Jones Estate watershed, had stressed that any such move would result in disastrous consequences for Bhimtal and for the water storage capability of the Sattal lakes (Special Correspondent 2001).

In 1954, a Forest Working Plan was passed for Jones Estate by the Forest Department. In the Land Record Settlement known as the Bandobast in 1957, land use of the greater part of Jones Estate was recorded as "forest". Under the provisions of the Forest Conservation Act 1980, no land use change is permitted on such land without the permission of the Central Government.

Despite this, numerous houses and resorts are being constructed and there is no doubt that the eventual urbanization of the Estate is well under way, to the detriment of the Bhimtal and Sattal lake systems and the wildlife inhabiting the Estate at present. Therefore, the present paper documents the butterflies recorded on the Estate (Table 1) so as to get a better idea of what is being lost and the eventual consequences of urbanization of the Jones Estate watershed.

The present paper also documents the butterflies and vertebrates afforded protection under the Schedules of the Indian Wildlife (Protection) Act 1972 (Anonymous 2006) that have been recorded on the Estate (Table 2). In total, these constitute 49 species, 11 on Schedule 1 and 39 on Schedule 2 (*Hypolimnas misippus* Linnaeus figures on both Schedules and is counted only once).

MATERIAL AND METHODS

The butterflies of the Estate have been studied since 1951. Some original specimens still exist, but the major resource from this era is in the form of notes maintained by my father, the late Fred Smetacek Sr. In the course of studying local butterflies, two butterfly subspecies new to science were discovered on the Estate, namely *Neptis miah varshneyi* Smetacek and *Neptis clinia praedicta* Smetacek (both Nymphalidae) (Smetacek 2002; 2011b). Besides, several butterflies previously unrecorded from the Western Himalaya have been reported (Smetacek 2010). Moths have been studied since 1972. Several species new to science have been described from the Estate (Smetacek 2002; 2005; 2010a). Besides, the population of hawkmoths (Lepidoptera: Sphingidae) on the Estate provided material for pioneering work in using members of an insect community as bio-indicators to predict and track climate change (Smetacek 1994; 2004).

The sightings of mammals and birds included in Annexure 2 were compiled mostly during the 1980s, when much time was spent patrolling the forest. They are all based on actual sightings by the author. The most recent sighting of a mammal protected under the provisions of the Wildlife (Protection) Act 1972 and listed as Near Threatened on the IUCN Red Data List is of a Himalayan Serow (*Capricornis sumatraensis thar*) which was sighted and photographed outside the Butterfly Research Centre, Jones Estate at 10am on 07 November 2011.

The use of a lepidopteran community as an indicator of forest health and consequently the health of the ecosystem including sub-surface water resources has been explored on the Estate by the author for the past 30 years (Smetacek 1993–2010). The format of Image 1, which enables a great deal of information to be presented concisely, has been taken with kind

Table 1. Butterflies recorded in Jones Estate, Bhimtal, Between 1951 and 2011.

1 - Name

2 - Geographic distribution of the species.

3 - General distribution G - garden species, found everywhere; NA - widespread but only in undisturbed areas; LO - localized in colonies; RM - not resident, but regular migrants; SM - sporadic,rare migrants;

4 - Usual Habitat: U - universal across all habitats; SE - subtropical evergreen forest above 1200m; TD - tropical deciduous forest between 400 and 1400 m; SR - *Shorea robusta* forest below 1000m; S - scrubland; G - grassland.

5 - Relative abundance, sightings per day during seasonal optimum: V - very rare, none or one: R - rare (2–4); O - occasional (5–9); A - abundant (10–49); C - common (>50).

6 - Index of relative movement of an average individual during adult lifespan. The values are existential estimates and subject to error. 0 - moves less than 100m; 1 - moves 100–1000 m; 2 - moves 1–5 km; 3 - strongly migratory/dispersive.

7 - Voltinism, Number of complete life cycles per year. S - Univoltine, single generation; B - Bivoltine, two discrete generations; M - Multivoltine, multiple, usually overlapping generations. Months during which adults have been recorded are in parentheses eg (iii–vii).

8 - Stage of life cycle that diapauses: O - none; E - egg; L - larva; P pupa; A - adult.

9 - Span of larval food plant (FP) preferences: M - Monophagous, feeds on plant species within one genus; O - Oligophagous, feeds on plant genera within one family; P - Polyphagous, feeds on plants in two or more families.

10 - Larval food plant families; in cases where the spectrum of families is very wide, only two of the most important families in the area are included. For others, reference may be made to Robinson et al. (2001).

Throughout the paper, the symbol ? indicates the lack of dependable data.

1	2	3	4	5	6	7	8	9	10
PAPILIONIDAE									
1. *Troides aeacus* Felder & Felder	Himalaya from Garhwal east to China and Taiwan	SM	SE	R	1 or 2	B: v-vii.	? P	O	Aristolochiaceae
2. *Atrophaneura aidoneus* Doubleday	Himalaya from Garhwal east to Vietnam	LO	SE	R	1 or 2	B: iv-v; vii-viii	? P	O	Aristolochiaceae
03. *Byasa dasarada ravana* Moore	Himalaya from Afghanistan to Indo-China	?RM/ LO	SE	O	1 or 2	B:iv-vi; vii-ix.	?P	O	Aristolochiaceae
04. *Byasa polyeuctes letincius* Fruhstorfer	Himalaya from Afghanistan to Vietnam	?RM/ LO	SE	R	1 or 2	B: iv-vi; viii-ix	?P	O	Aristolochiaceae
05. *Byasa latreillei* Donovan	Afghanistan to China and Vietnam.	SM	SE	V	?	?B: v; viii.	?P	?O	Aristolochiaceae
06. *Pachliopta aristolochiae aristolochiae* Fabricius	Afghanistan through India to Japan and Indonesia.	?RM/ NA	SR, S	O	2/ 3	M: i; iii-v; x-xii.	?	P	Aristolochiaceae; Dioscoreaceae.
07. *Papilio agestor govindra* Moore	West Himalaya to Indo-China.	NA	SE	R	0 to 2	S: iii-v.	P	O	Lauraceae
08. *Papilio clytia clytia* Linnaeus	India to Malaysia.	NA	TD, SR	O	0 to 2	M: iii- viii; x.	?P	P	Lauraceae, Sapotaceae
09. *Papilio protenor protenor* Cramer	Pakistan to Japan	NA	SE, S	O	1 to 2	M: ii-x.	P	P	Lauraceae; Rutaceae; Polygalaceae.
10. *Papilio bianor polyctor* Boisduval	Pakistan to Indo-China.	NA	SE, S	O	1 to 2	M: ii-vii; viii-x.	P	O	Rutaceae
11. *Papilio paris* Linnaeus	India to China and S.E. Asia	NA	SE, S	R	2	M: iii-v; vii; x.	?P	O	Rutaceae
12. *Papilio polytes romulus* Cramer	Pakistan throughout India to Indonesia..	G, NA	U	A/C	2	M: iii-x.	P	O	Rutaceae
13. *Papilio demoleus* Linnaeus	Iran to China and Australia.	G, NA	U	O	2, 3	M: iii-x.	?P	O	Rutaceae
14. *Papilio machaon* Linnaeus	Palaearctic Region	G, LO	S, G	O	0 - 2	M: ii-vii.	P	O	Umbelliferae
15. *Graphium*(*Pazala*) *eurous cashmirensis* Rothschild	West Himalaya to Indo-China.	SM	SE	V	1 to 2	S: iv-v.	P	O	Lauraceae

1	2	3	4	5	6	7	8	9	10
16. *Graphium* (*Pathysa*) *nomius* Esper	India to Thailand.	SM	TD, SR	V	1, 2	B: iv-v; vii.	?	O	Annonaceae
17. *Graphium* (*Graphium*) *cloanthus* Westwood	Himalaya to China	NA	SE	O	1, 2	M: iii-vi; viii-x.	P	O	Lauraceae
18. *Graphium* (*Graphium*) *sarpedon* Linnaeus	India to Japan and Australia.	NA	SE	O	1, 2	M: ii-x.	P	P	Lauraceae; Annonaceae
19. *Graphium* (*Graphium*) *agamemnon* Linnaeus	India to China and Australia.	RM	SR	V	3	B or M: iii-iv; viii.	?	P	Annonaceae; Magnoliaceae; etc
PIERIDAE									
20. *Leptosia nina* Fabricius	India to the Philippines.	LO	TD, SR	V	O	M: ii-v; ix-xii.	?	O	Capparaceae
21. *Pontia daplidice moorei* Röber	Palaearctic.	G, NA	S, G	O	2, 3	M: iii-vii; ix-x; xii.	?P	O	Cruciferae
22. *Pieris canidia indica* Evans	India to China.	G, NA	U	A	2	M: i-v; vii; ix-xii.	?P	O	Cruciferae
23. *Pieris brassicae nipalensis* Gray	Palaearctic.	G, NA	U	C	3	M: iii-xi.	?P	P	Cruciferae; Resedaceae; etc.
24. *Aporia agathon* Gray	Himalaya to China	NA	SE	A	0 to 2	S: iv-vi.	?	O	Berberidaceae
25. *Delias eucharis* Drury	Throughout India	RM	TD, SR	O	2 - 3	M: i-v; x-xii,	?	P	Loranthaceae; Malvaceae; etc.
26. *Delias belladonna horsfieldii* Gray	West Himalaya to China.	LO	SE	O	1 to 2	M: ii-v; viii-x.	?	O	Loranthaceae
27. *Delias acalis* Godart	Himalaya to Indo-China	SM	TD	V	2 to 3	B: iii-iv; ix.	?	?	?
28. *Anaphaeis aurota* Fabricius	Throughout India to S.E. Asia	RM	SR, S	A	3	M: iv-v; viii-x;xii.	?	P	Capparaceae; Oleaceae
29. *Cepora nerissa phryne* Fabricius	Throughout India to S.E. Asia.	RM	SR, S	A	3	M: iii-iv; vi-xii.	?	O	Capparaceae
30. *Appias lalage lalage* Doubleday	Himalaya to Indo-China.	RM	?	O	3	M: ii-v; viii; xii.	?	?	Leguminosae
31. *Catopsilia pomona* Fabricius	Indo-Australian Region.	RM	U	C	3	M: i-xii.	?	O	Leguminosae
32. *Catopsilia pyranthe minna* Herbst	Throughout India to S.E. Asia	RM	U	C	3	M: ii-x.	?	O	Leguminosae
33. *Gonepteryx rhamni nepalensis* Doubleday	Palaearctic Region.	NA	SE, S	O	1 to 2	M: i-xii.	A	?P	Rhamnaceae; Ericaceae
34. *Eurema brigitta rubella* Wallace	Africa through India to Malaysia.	G, NA	U	A	0 to3	M: i-xii.	?	P	Leguminosae; Guttiferae; etc.
35. *Eurema laeta* Boisduval	India to Japan and Australia.	G, NA	U	A	0 to ?2	M: i; iii-iv; vi-xii.	?	O	Leguminosae
36. *Eurema hecabe fimbriata* Wallace	African and Indo-Australian Regions	G, NA	U	C	0 to ?2	M: i-xii.	?	P	Leguminosae; Euphorbiaceae; etc.
37. *Colias fieldii* Menétries	Eastern Palaearctic Region	G, NA	SE, G	A	3	M: i-xii.	?	?	?
38. *Colias erate* Esper	Palaearctic Region	NA	SE, G	O	3	M: i-xi.	?	O	Leguminosae
39. *Ixias pyrene* Linnaeus	India to China.	SM	S	V	3	B: ix-x; xii-i.	?	O	Capparaceae
40. *Ixias marianne* Cramer	India	SM	S	V	3	B: i-iv; xii.	?	O	Capparaceae
41. *Pareronia valeria* Cramer	India to the Philippines.	RM	TD, SR	R	3	M: iii-v; x-xii.	?	O	Capparaceae
NYMPHALIDAE									
42. *Parantica aglea melanoides* Moore	Himalaya to S.E. Asia.	G, NA	SE, TD	O	0 to 2	M: ii-v; vii-x; xii.	?	O	Asclepiadaceae

1	2	3	4	5	6	7	8	9	10
43. *Parantica sita* Kollar	Himalaya to Japan and Malaysia.	NA	SE	R	1 to 2	B: iii-v; ix-xi.	?	O	Asclepiadaceae.
44. *Tirumala limniace mutina* Fruhstorfer	Oriental Region	NA	U	O	2 to 3	M: iii-x.	?	?O	Asclepiadaceae
45. *Tirumala septentrionis septentrionis* Butler	India to China	NA	NA/ ?RM	O	3	B: iii-v;ix-x.	?	P	Apocynaceae; Asclepiadaceae; etc.
46. *Danaus chrysippus* Linnaeus	African, Oriental and Australian Regions	G, NA	U	A	1 to 2	M: i-xii.	P	P	Asclepiadaceae; Moraceae; etc.
47. *Danaus genutia* Cramer	Oriental Region	G, NA	U	A	1 to 2	M: i-xii.	P	O	Asclepiadaceae
48. *Euploea mulciber mulciber* Cramer	Himalaya to S.E. Asia	NA	SE, TD,	O	0 to 2	M: iii-vii; ix-x.	?P	P	Asclepidiaceae; Moraceae; etc.
49. *Euploea core core* Cramer	Indo-Australian Region	NA	SE, TD, SR	C	0 to 3	M: ii-vii; ix-x.	P	P	Asclepidiaceae; Moraceae; etc.
50. *Euploea sylvester* Fabricius	India to S.E. Asia	SM	?	V	0 to 3	?S: iv.	?	P	Ascelpidiaceae; Moraceae; etc.
51. *Mycalesis perseus* Fabricius	Indo-Australian Region	NA	TD, SR	A	0 to 1	M: iii-v; x.	?	O	Graminae
52. *Mycalesis mineus* Linnaeus	India to China	NA	TD, SR	O	0 to 1	M: iii-v; x.	?	O	Graminae
53. *Mycalesis visala visala* Moore	India to Malaysia	NA	TD, SR	O	0 to 1	B: iv-vi; x.	?	O	Graminae
54. *Mycalesis heri* Moore	Himalaya	NA	TD	O	0 to 1	B: iv-vi; viii-x.	?	?	?
55. *Lethe rohria dyrta* Felder & Felder	India to China	NA	SE, TD	C	0 to 2	M: iii-ix.	?	O	Graminae
56. *Lethe confusa confusa* Aurivillius	Himalaya to China and Malaysia.	NA	SE, TD	O	0 to 2	M: iii-x.	?	O	Graminae
57. *Lethe kansa* Moore	Himalaya	NA	SE	R	0 to 2	B: iii-v; x.	?	?	?
58. *Lethe verma verma* Kollar	Himalaya to China and Malaysia	NA	SE	R	0 to 1	B: v-vi; viii-ix.	?	?O	Graminae
59. *Lasiommata schakra* Kollar	Himalaya	NA, LO	S, G	R	0 to 1	M: iii-ix.	?	?	?
60. *Orinoma damaris* Gray	Himalaya	NA	SE	R	0 to 1	B: iv-vi; ix-x.	?	?	?
61. *Aulocera swaha swaha* Kollar	Himalaya	SM	S, G	V	0 to 2	S: vii-x.	?	?	?Graminae
62. *Aulocera saraswati* Kollar	Himalaya	SM	S, G	V	0 to 2	S: viii-ix.	?	?	?Graminae
63. *Callerebia hybrida* Butler	West Himalayan endemic	NA	S, G	A	0 to 2	B: v-vi; viii-x.	?	?	?
64. *Callerebia annada caeca* Watkins	Himalaya to China	NA	SE, S, G	O	0 to 2	B: iii-vi; viii-x.	?	?	?
65. *Ypthima nareda nareda* Kollar	Himalaya to China	NA	SE, S, G	O	1 to 2	M: iv-x.	?	O	Graminae.
66. *Ypthima hubneri hubneri* Kirby	Himalaya	G, NA	TD, S, G	O	1 to 2	M: vi-viii; xii-iii.	?	O	Graminae.
67. *Ypthima lisandra avanta* Moore	India to Myanmar	NA.	SE; S; G.	O	1 to 2	M: xii-iii; vi-viii.	?	?O	Graminae
68. *Ypthima baldus* Fabricius	India to Korea, Japan and Malaysia	G, NA	U	O	1 to 2	M: vi-iii.	?	O	Graminae.
69. *Ypthima asterope mahratta* Moore	India	NA.	TD; SR.	C	1 to 2	B: viii-x.	?	O	Graminae.
70. *Ypthima nikaea* Moore	Himalaya	NA	SE, G	A	1 to 2	M: v-x.	?	?	?
71. *Melanitis leda* Linnaeus	African, East Palaearctic and Indo-Australian Regions	G, NA	U	C	0 to 2	M: v-ix.	?	P	Graminae; Palmae.

1	2	3	4	5	6	7	8	9	10
72. *Melanitis phedima galkissa* Fruhstorfer	India to Malaysia.	NA	SE, TD, SR	R	0 to 2	M: v-x.	?	O	Graminae
73. *Melanitis zitenius* Herbst	Oriental Region	LO	TD	R	0 to 2	S: viii.	?	O	Graminae.
74. *Elymnias hypermnestra undularis* Drury	India to Malaysia.	LO.	SR.	R.	0 to 2	M: iv-xi.	?	O	Palmae
75. *Elymnias malelas nilamba* Fruhstorfer	Himalaya to Malaysia.	LO	TD	R	0 to 2	M: iv-v; viii-xi.	?	?M	Musaceae
76. *Polyura athamas* Drury	Oriental Region	NA	SE, TD	O	0 to 2	M: iv; vi-x.	?	P	Leguminosae; Tiliaceae.
77. *Polyura agraria* Swinhoe	Oriental Region	NA	TD, SR	R	?	B: iv; ix-x.	?	?	?
78. *Polyura dolon* Westwood	Himalayan to S.E. Asia	SM	SE	V	0 to 2	B: v; ix.	?	?	?
79. *Dilipa morgiana* Westwood	Himalaya	?SM/LO	SE	V	?	M: iii; v; viii.	?	?	?
80. *Apatura (Mimathyma) ambica ambica* Kollar	Himalaya	?SM/LO	SE	V	?	M: iv-x.	?	M	Ulmaceae
81. *Sephisa dichroa* Kollar	West Himalayan endemic	LO	SE	A	0 to 1	M: v-x.	?P	M	Fagaceae
82. *Euripus consimilis* Westwood	Himalaya to S.E. Asia, S. India	LO	TD, SR	R	0 to 1	B: iii-v; vii-ix.	?	O	Ulmaceae
83. *Hestina persimilis zella* Butler	Himalaya	LO	SE	R	1 to 2	M: iii-x.	?	O	Ulmaceae
84. *Hestinalis nama* Doubleday	Himalaya to Malaysia	NA	SE, TD	R	1 to 2	M: ii-vi; ix-x.	?	?	Urticaceae
85. *Dichorragia nesimachus* Boisduval	Himalaya to Japan and Philippines	?SM/LO	SE	V	?1	B: iii-iv; viii.	?	O	Meliosmaceae
86. *Stibochiona nicea nicea* Gray	Himalaya to Malaysia.	LO	SE/ TD	R	1 to 2	M: iv-vii; ix-x.	?	P	Moraceae; Urticaceae.
87. *Tanaecia julii appiades* Menétries	Himalaya to Indo-China	SM	TD/ SR	V	?	?: v.	?	?O	Sapotaceae
88. *Euthalia aconthea* Hewitson	Oriental Region	G	TD, SR	O	0 to 2	M: iii-iv; vi-vii; x-xi.	?P	P	Anacardiaceae; Moraceae; etc.
89. *Euthalia lubentina indica* Fruhstorfer	India to Malaysia.	NA	TD, SR	R	0 to 2	M: iii; v; viii, x-xi.	?	O	Loranthaceae
90. *Euthalia patala patala* Kollar	West Himalaya to China	LO	SE	O	0 to 2	S: v-viii.	P	O	Fagaceae
91. *Symphaedra nais* Forst	Indian Subcontinent.	SM	SR	V	0 to 2	?B: iv; ix.	?	P	Dipteracarpaceae; Ebenaceae.
92. *Auzakia danava* Moore	Himalaya to Myanmar	NA	SE	R	0 to 2	M: iv-v; viii; x.	?	?	?
93. *Moduza procris procris* Cramer	India to Philippines and Indonesia.	SM	SR	V	1 to 2	?M: iv; x-i.	?	P	Rubiaceae; Capparaceae.
94. *Athyma cama* Moore	Himalaya	NA	SE	O	0 to 2	M: iv-x.	?	?	Euphorbiaceae
95. *Athyma selenophora selenophora* Kollar	India to China	NA	TD, SR	R	0 to 2	M: ii-vi; xi.	?	?	Rubiaceae
96. *Athyma opalina opalina* Kollar	Himalaya	NA	SE	O	0 to 2	M: iii-xii.	P	O	Berberidaceae
97. *Athyma perius* Linnaeus	India to China and Malaysia.	NA	TD	O	0 to 2	M: iv-xii.	?	O	Euphorbiaceae
98. *Athyma asura* Moore	Himalaya.	SM	SE	V	?	?B: vi; viii.	?	?	Rubiaceae
99. *Phaedyma columella ophiana* Moore	Himalaya.	SM	TD, SR	V	0 to 2	M: iv; vi-vii; xii-i.	?	P	Guttiferae; Leguminosae; etc.
100. *Neptis nata yerburii* Butler	India to Borneo.	LO	SE, TD, SR	O	0 to 2	M: iii- vi; ix-x.	?	?P	?Ulmaceae; ?Combretaceae.

1	2	3	4	5	6	7	8	9	10
101. *Neptis clinia praedicta* Smetacek	India to Indo-China.	LO	TD, SR	O	0 to 2	M: iii-vi; x-xi.	?	?P	?Bombacaceae; Ulmaceae; etc.
102. *Neptis hylas kamarupa* Moore	Himalaya	NA	TD, SR	O	1 to 2	M: iii-vi; ix-xi.	?	P	Leguminosae; Bombacaceae; etc.
103. *Neptis sappho astola* Moore	Palaearctic Region.	NA	SE, TD, SR, S	A	0 to 2	M: ii-vi; ix-xi.	?	O	Leguminosae
104. *Neptis soma butleri* Eliot	India to China.	LO	SE	A	0 to 2	M: iii; v-x.	?	O	Ulmaceae
105. *Neptis sankara sankara* Kollar	Himalaya to China.	LO	SE	O	0 to 2	B: iv-viii; x.	?	?	?
106. *Neptis cartica cartica* Moore	Himalaya.	LO	?SE/ ?TD	V	?0 to ?2	S: iv- vi.	?	?	?
107. *Neptis miah varshneyi* Smetacek	West Himalaya to China.	LO	TD	O	0 to 2	B: iv-vi; x-xi.	?	?	?
108. *Neptis zaida zaida* Westwood	West Himalaya to China.	LO	?SE/ ?TD	V	0 to 1	S: v-vii.	?	?	?
109. *Neptis ananta* Moore	Himalaya to Malaysia.	LO	SE/ TD	R	1 to 2	B: v-vi; viii-x.	?	O	Lauraceae
110. *Pantoporia hordonia hordonia* Stoll	Oriental Region	RM	TD, SR	O	0 to 2	B: iv-vi; x-xi.	?	O	Leguminosae.
111. *Pantoporia sandaka* Moore	Oriental Region	RM	TD, SR	O	0 to 2	B: iv-vi; x-xi.	?	?O	Leguminosae.
112. *Cyrestis thyodamas ganescha* Kollar	India to Japan.	NA	SE, TD	O	0 to 2	M: ii-x.	?	?P	Moraceae; ?Dilleniaceae;
113. *Pseudergolis wedah* Kollar	Himalaya to China.	NA	SE	O	0 to 2	M: iii-ix.	?	O	Urticaceae.
114. *Hypolimnas bolina* Linnaeus	Indo-Australian Region	RM	TD, SR	R	2 to 3	M: iii; vii-xiii.	?	P	Acanthaceae; Convolvulaceae; etc.
115. *Hypolimnas misippus* Linnaeus	African, southern Palaearctic, Oriental, Australian, southern Nearctic and northern Neotropical Regions	SM	SR	V	2 to 3	?M: iv; viii-xii.	?	P	Acanthaceae; Convolvulaceae; etc
116. *Kallima inachus huegeli* Kollar	India to China	NA	SE, TD	O	0 to 2	M: iv-x.	?	P	Urticaceae, Acanthaceae; etc.
117. *Junonia hierta hierta* Fabricius	Oriental Region	NA	TD, SR, S	A	1 to 3	M: iii-viii; x.	?	O	Acanthaceae
118. *Junonia orithya* Linnaeus	African, Palaearctic, Indo-Australian Regions	NA	TD, SR, S	A	1 to 3	M: iii-vi; ix-x; xii-i.	?	P	Acanthaceae; Convolvulaceae; etc.
119. *Junonia lemonias persicaria* Fruhstorfer	India to China and Malaysia	G, NA	TD, SR, S	A	0 to 2	M: i-xi.	?	P	Acanthaceae; Cannabaceae
120. *Junonia almana* Linnaeus	India to the Philippines	NA	TD, SR, S	O	0 to 2	M: i-vi; ix-x.	?	P	Acanthaceae; Graminae; etc.
121. *Junonia atlites* Linnaeus	India to Sulawesi	NA	TD	O	0 to 2	M: iv-vi; x-xii.	?	P	Acanthaceae; Amaranthaceae; etc.
122. *Junonia iphita siccata* Stichel	India to China and Malaysia	NA	SE, TD	A	0 to 2	M: i-x.	P	O	Acanthaceae
123. *Vanessa cardui* Linnaeus	Nearctic, African, Oriental, Australian, Palaearctic Regions	NA	U	A	3	M: i- xi.	?	P	Urticaceae, Asteraceae, etc.
124. *Vanessa indica indica* Herbst	India to S.E. Asia.	NA	SE	A	0 to 3	M: iii-i.	?P	P	Urticaceae; Tiliaceae; Ulmaceae.
125. *Kaniska canace himalaya* Evans	India to Malaysia.	NA	SE	O	0 to 2	M: I; v-vii; ix-xi;	?	P	Liliaceae, Smilacaceae, Dioscoreaceae

1	2	3	4	5	6	7	8	9	10
126. *Nymphalis xanthomelas fervescens* Stichel	Palaearctic Region.	SM	SE	V	0 to 2	M: iii; v; ix.	P	P	Ulmaceae; Salicaceae; Anacardiaceae.
127. *Aglais cashmirensis aesis* Fruhstorfer	Himalaya.	G, NA	SE	O	0 to 2	M: i-xii.	A	O	Urticaceae
128. *Symbrenthia lilaea khasiana* Moore	India to China and Malaysia.	NA	SE	O	0 to 2	M: ii-v; viii-x.	?	O	Urticaceae
129. *Symbrenthia brabira* Moore	Himalaya to W. China.	NA	SE	V	0 to 2	B: v; viii.	?	?	?Urticaceae
130. *Symbrenthia niphanda hysudra* Moore	Himalaya.	NA	SE	V	0 to 2	?S: v.	?	?	?
131. *Argynnis (Argyreus) hyperbius* Linnaeus	Abyssinia through India to Australia	NA	SE, S, G	O	1 to 2	M: iv-v; vii-viii; x-xii.	?	P	Violaceae; Scrophulariaceae
132. *Argynnis (Childrena) childreni sakontala* Kollar	Himalaya to China	NA/?RM	SE	V	1 to 2	B: v-x.	?	?	?
133. *Issoria lathonia issaea* Doubleday	Palaearctic Region.	SM	SE, G	V	0 to 2	M: iii-x.	?	O	Violaceae.
134. *Cupha erymanthis lotis* Sulz	India to Malaysia.	RM	TD	A	2 to 3	B: iv-vi; viii-x.	?	P	Flacourtiaceae; Sapindaceae.
135. *Phalanta phalantha* Drury	India to Japan and Australia.	G, NA	TD, SR	C	0 to 3	M: v-x.	?	P	Salicaceae; Flacourtiaceae; etc.
136. *Vagrans sinha pallida* Evans	Indo-Australian Region.	NA/?RM	TD, SR	O	1 to 2	M: v; vii-x.	?	P	Flacourtiaceae; Dilleniaceae.
137. *Ariadne merione tapestrina* Moore	India to Malaysia.	NA/G	TD, SR	C	0 to 2	M: iii; v-xii.	?P	O	Euphorbiaceae
138. *Acraea issoria anomala* Kollar	Himalaya to China.	NA	SE	C	0 to 1	M: iv-ix.	?P	P	Rubiaceae; Urticaceae
139. *Acraea violae* Fabricius	India to Sri Lanka.	SM	SR, S	V	1 to 2	M: iv; vii-viii; x.	?	P	Malvaceae; Passifloraceae, etc.
140. *Libythea lepita lepita* Moore	India to China.	NA	SE	O	0 to 1	M: i-xi.	?	O	Ulmaceae
141. *Libythea myrrha sanguinalis* Fruhstorfer	India to China.	NA	SE	O	0 to 1	M: ii-x.	?	O	Ulmaceae
LYCAENIDAE									
142. *Zemeros flegyas indicus* Fruhstorfer	Himalaya to China and Malaysia.	SM	TD, SR	V	0 to 2	M: iii-x.	?	O	Myrsinaceae.
143. *Dodona durga* Kollar	Himalaya to China.	SM	SE	R	0 to 2	M: iii-xi.	?	O	Graminae
144. *Dodona eugenes* Bates	Himalaya to China.	SM	SE	V	0 to 2	M: iii-x.	?	P	Myrsinaceae; Graminae
145. *Dodona dipoea nostia* Fruhstorfer	Himalaya	SM	SE	V	0 to 2	M: iii-xi.	?	O	Myrsinaceae
146. *Abisara echerius suffusa* Moore	India to China.	LO	TD, SR	R	0 to 2	M: iv-v; vii-x.	?	?	Myrsinaceae
147. *Abisara fylla* Doubleday	Himalaya to China.	LO	SE	R	1 to 2	B: iii-v; ix.	?	?	Myrsinaceae
148. *Poritia hewitsoni hewitsoni* Moore	Himalaya	SM	SR	V	1 to 2	M: iii; v; ix.	?	O	Dipterocarpaceae
149. *Miletus chinensis assamensis* Doherty	Himalaya to China.	LO	SE	V	0 to 2	?M: ix.	?	Insecta	Aphididae
150. *Allotinus drumila* Moore	Himalaya to Myanmar.	LO	?	V	?	?	?	Insecta	?
151. *Talicada nyseus* Guérin-Menéville	India to Thailand	LO	TD, SR	R	0 to 2	M: i - xi..	?	O	Crassulaceae
152. *Chilades laius laius* Cramer	India to China, S.E. Asia	G; NA.	TD; SR	A	0 to 2	M: xi-iii	?	P	Rutaceae; Anacardiaceae; etc.

1	2	3	4	5	6	7	8	9	10
153. *Chilades pandava* Horsfield	India to Sumatra.	NA.	SE; TD.	O	0 to 2	M: vi-x.	?	P	Rutaceae; Leguminosae; etc.
154. *Neopithecops zalmora* Butler	India to Australia.	NA.	TD.	O	0 to 2	B: iii; vii.	?	P	Rutaceae; Ebenaceae.
155. *Everes argiades indica* Evans	Himalaya	NA.	SE.	O	1 to 2	M: iv; vii-ix.	?	O	Leguminosae
156. *Everes diporides* Chapman	Himalaya to Indo-China.	NA.	SE.	O	1 to 2	M: v-x.	?	?	?
157. *Everes huegelii dipora* Moore	Himalaya to Indo-China.	NA.	SE.	O	1 to 2	M: iv; ix.	?	?	Leguminosae
158. *Megisba malaya sikkima* Moore	Himalaya to Taiwan and Sulawesi.	NA.	SE; TD; SR.	A	1 to 2	B: vii; x.	?	P	Euphorbiaceae; Sapindaceae; etc.
159. *Acytolepis puspa gisca* Fruhstorfer	India to Japan and the Philippines.	G; NA.	SE; SR.	O	0 to 2	M: vii-x.	?	P	Fagaceae; Ericaceae, etc.
160. *Udara dilecta dilecta* Moore	Pakistan to Japan and Malaysia.	NA.	SE.	R	2	M: v; viii; x.	?	O	Fagaceae.
161. *Celastrina huegelii huegelii* Moore	West Himalaya to China.	NA.	SE.	C	0 to 1	M: iv-x.	?	?O	Rosaceae
162. *Celastrina gigas* Hemming	West Himalayan endemic.	NA.	SE.	C	0 to 1	M: iv- x.	?	M	Rosaceae
163. *Celastrina argiolus kollari* Westwood	Palaearctic Region.	G; NA.	SE.	C	1 to 2	M: iv-x.	?	?P	Leguminosae; Rosaceae; etc.
164. *Aricia agestis* Denis & Schiffermuller	Palaearctic Region..	NA.	SE.	O	0 to 2	M: iii-vii.	?	?	?
165. *Leptotes plinius* Fabricius	India to Australia	G; NA; RM.	U.	A	2-3	M: iv; vii -ix..	?	P	Leguminosae; Rhamnaceae; etc.
166. *Freyeria trochylus* Freyer	India to Sumatra.	NA.	TD; SR; S; G.	O	1 to 2	M: x.	?	P	Boraginaceae; Leguminosae; etc.
167. *Pseudozizeeria maha maha* Kollar	Iran to India and Japan.	G; NA.	TD; SR; S; G.	C	0 to 1	M: vii-x.	?	P	Oxalidaceae; Acanthaceae; etc.
168. *Zizeeria karsandra* Moore	N. Africa through Asia to Australia.	G; NA.	TD; SE; SR; S; G.	O	1 to 2	M: iv-ix.	?	P	Leguminosae; Amaranthaceae.
169. *Zizula hylax* Fabricius	African Region, N. America, Asia south of the Himalaya.	G; NA.	TD; SR; S; G.	O	1 to 2	B: iv; viii.	?	P	Acanthaceae; Leguminosae; Graminae; etc.
170. *Zizina otis otis* Fabricius	India to China, Taiwan and Australia.	NA.	TD; SR; S; G.	O	1 to 2	M: vii-x.	?	P	Leguminosae; Zygophyllaceae.
171. *Euchrysops cnejus* Fabricius	India to China and Australia.	G; NA; RM.	U	C	3	M: iv-x.	?	P	Leguminosae; Orchidaceae; etc.
172. *Catochrysops strabo* Fabricius	India to Moluccas	G; NA; RM.	U	C	2	M: iv-x.	?	P	Leguminosae; Sapindaceae
173. *Lampides boeticus* Linnaeus	African, Palaearctic and Indo-Australian Regions.	G; NA; RM.	U	C	3	M: ii-x.	?	P	Leguminosae; Liliaceae.
174. *Jamides bochus bochus* Cramer	India to Australia.	NA; RM.	TD; SR.	O	1 to 2	B: iv; x.	?	O	Leguminosae.
175. *Jamides celeno celeno* Cramer	India to Sulawesi.	NA.	TD; SR.	O	0 to 2	M: iv- x.	?	P	Leguminosae; Zingiberaceae; etc.
176. *Prosotas nora nora* Felder & Felder	India to Myanmar.	NA.	TD; SR.	O	0 to 1	M: i-xii.	?	P	Leguminosae; Combretaceae; etc.
177. *Prosotas noreia hampsoni* de Nicéville	India to Myanmar.	NA.	TD; SR.	R	0 to 1	M : vii.	?	?	?
178. *Lycaena pavana* Kollar	West Himalayan endemic.	NA ; LO.	S ; SE.	R	0 to 1	M : i ; iv-vi.	?	?	?Polygonaceae

1	2	3	4	5	6	7	8	9	10
179. *Lycaena phlaeas indicus* Evans	Palaearctic and Nearctic Regions	NA.	S ; SE.	O	0 to 1	M : ii-x.	?	P	Polygonaceae; Malvaceae.
180. *Heliophorus sena* Kollar	Himalayan.	G ; NA.	S ; SE.	A	0 to 2	M : iv-x.	?	P	Polygonaceae; Malvaceae.
181. *Heliophorus moorei coruscans* Moore	Himalaya to W.China.	SM.	S ; SE.	V	0 to 2	B : v-iv ; ix.	?	?	?
182. *Pamela dudgeoni* de Nicéville	Himalaya to Indo-China.	LO.	SE.	V	?	B : iv ; x.	?	?	?
183. *Thermozephyrus ataxus ataxus* Doubleday	Himalaya to China.	LO.	SE.	V	0 to 1	M : v-x.	?	?O	Fagaceae
184. *Chrysozephyrus syla syla* Kollar	Himalaya.	NA ; LO.	SE.	R	0 to 2	B : iv-vi ; ix-x.	?	?	?
185. *Euaspa ziha* de Nicéville	West Himalayan endemic.	NA ; LO.	SE.	A	0 to 1	S : v-vi.	?	?	?
186. *Curetis bulis* Doubleday & Hewitson	India to Japan	G ; NA.	TD ; SR.	R	0 to 2	M : v-x.	?	O	Leguminosae
187. *Curetis acuta dentata* Moore	India to S.E. Asia.	G; NA.	TD; SR.	R	0 to 2	M : v-x.	?	O	Leguminosae
188. *Iraota timoleon* Stoll	India to China.	NA ; ?RM.	TD; SR.	O	0 to 2	M : v ; vii ; x.	?	P	Lythraceae; Moraceae;
189. *Arhopala atrax* Hewitson	India to Malaysia.	RM.	SR.	O	0 to 2	S : vi.	?	M	Dipterocarpaceae
190. *Arhopala singla* de Nicéville	Himalaya to S.W. China.	SM.	?	V	?	S : v.	?	?	?
191. *Arhopala dodonea* Moore	West Himalayan endemic.	NA ; LO.	SE.	O	0 to 2	M : v-vi ; x ; xii-i.	?	M	Fagaceae
192. *Arhopala rama rama* Kollar	Himalaya	NA.	SE ; SR.	O	0 to 2	M : iii-vi ; x ; xii-i.	?	O	Fagaceae; Dipterocarpaceae
193. *Arhopala ganesa ganesa* Moore	Himalaya to Japan	NA.	SE.	A	0 to 2	S : v-vi.	?	O	Fagaceae
194. *Surendra vivarna* Horsfield	India to Sulawesi.	NA.	TD.	O	0 to 2	M : vii.	?	O	Leguminosae.
195. *Loxura atymnus* Cramer	India to Philippines	NA ; ?RM.	TD ; SR.	O	1 to 2	M : iv-x.	?	P	Dioscoreaceae; Smilacaceae
196. *Cigaritis nipalicus* Moore	Himalayan.	NA ; LO.	SE.	C	0 to 2	B : iv-v ; viii.	?	?	?
197. *Pratapa deva lila* Moore	Himalaya to Java.	LO.	TD ; SE.	V	0 to 2	S: vii- viii.	?	O	Loranthaceae
198. *Tajuria diaeus* Hewitson	Himalaya to Indo-China.	NA ; LO.	SE.	V	?		?	O	Loranthaceae.
199. *Tajuria illurgis* Hewitson	Himalaya to Indo-China	NA ; LO.	SE.	R	1 to 2	B : iii-iv ; vi-viii.	?	?O	Loranthaceae.
200. *Horaga onyx onyx* Moore	India to Malaysia.	NA ; LO.	SE.	R	1 to 2	B : iv ; ix-x.	?	?O	Coriariaceae; Bombacaceae.
201. *Horaga albimacula viola* Moore	India to S.E. Asia.	NA; LO.	SE.	V	1 to 2	B : x	?	?P	Coriariaceae.
202. *Chliaria kina kina* Hewitson	Himalaya to Indo-China.	NA ; LO.	SE.	R	0 to 2	M : iv-x.	?	O	Orchidaceae
203. *Chliaria othona* Hewitson	Himalaya to Indo-China.	NA ; LO.	TD.	V	0 to 2	S : iv-v.	?	O	Orchidaceae
204. *Deudorix epijarbas ancus* Fruhstorfer	India to Australia	G ; NA.	TD ; SR.	O	0 to 2	M : v-x.	?	P	Lythraceae; Sapindaceae; etc.
205. *Deudorix isocrates* Fabricius	India to Myanmar.	G ; NA.	TD ; SR.	O	0 to 2	B : vii-ix.	?	P	Euphorbiaceae ; Lythraceae; etc.
206. *Rapala varuna grisea* Moore	India to Australia.	NA; LO.	SE.	A	0 to 2	B : iv-vi ; ix-x.	?	P	Combretaceae; Myrtaceae; Sapindaceae; etc.
207. *Rapala manea schistacea* Moore	India to S.E. Asia.	NA.	SE; TD.	A	0 to 2	M : iv-xi.	?	P	Caprifoliaceae; Leguminosae; etc.

1	2	3	4	5	6	7	8	9	10
208. *Rapala pheretima petosiris* Hewitson	Himalaya to Borneo.	LO.	TD ; SR.	O	0 to 2	B: iv- v.	?	P	Anacardiaceae; Myrtaceae; etc.
209. *Rapala iarbus* Fruhstorfer	India to the Sunda Islands.	NA.	TD; SR.	O	0 to 2	M : iv-v ; vii-xi.	?	P	Anacardiaceae; Leguminosae; etc.
210. *Rapala nissa* Kollar	Himalaya to China, Malaysia.	NA.	SE.	A	0 to 2	M : v-xii.	?	P	Leguminosae; Rosaceae; etc.
211. *Sinthusa chandrana* Moore	Himalaya.	NA ; LO.	SE.	V	?	B : iv ; ix.	?	O	Rosaceae.
212. *Sinthusa nasaka pallidior* Fruhstorfer	Himalaya to Malaysia.	NA ; LO.	SE.	V	?	S : iv-v.	?	?	?
HESPERIIDAE									
213. *Hasora chromus chromus* Cramer	India to Australia.	NA.	SR ; TD.	R	2	B : vi ; viii-ix.	?	P	Euphorbiaceae; Leguminosae; etc.
214. *Bibasis oedipodea belesis* Mabille	Himalaya to China and Indo-China	NA ; ?SM.	TD.	V	2 to 3	B : i ; iii.	?	?	Combretaceae
215. *Bibasis anadi* de Nicéville	Himalaya to Indo-China	NA; LO.	SE.	A	0	B: v-vi ; viii-ix.	?	?	?
216. *Bibasis sena* Moore	India to the Philippines.	NA ; LO.	SE.	R	?2	M : v-ix.	?	?	Combretaceae; Malphigiaceae
217. *Badamia exclamationis* Fabricius	India to Australia.	NA.	SR ; TD.	R	3	B : iv ; viii-ix.	?	P	Combretaceae; Moraceae; etc.
218. *Choaspes benjaminii japonica* Murray	Himalaya to China and Japan.	NA; ?SM.	SE.	V	2	M : iii – ix..	?	P	Sabiaceae; Meliosmaceae.
219. *Celaenorrhinus pero pero* de Nicéville	Himalaya.	NA ; LO.	SE.	R	0 to 2	B : iv-vi ; viii.	?	?	?
220. *Celaenorrhinus leucocera leucocera* Kollar	India to Indo-China.	NA.	SE.	A	0 to 2	M : iv-x.	?	O	Acanthaceae
221. *Celaenorrhinus munda munda* Moore	Himalaya.	NA ; LO.	SE.	R	0 to 2	M : iv- ix.	?	?	?
222. *Celaenorrhinus pulomaya* Moore	Himalaya.	NA ; LO.	SE.	R	0 to 2	?S: iv.	?	?	?
223. *Lobocla liliana ignatius* Plotz	W. Himalaya.	NA.	SE.	C	0 to 2	B : v-vi ; x.	?	?	?Leguminosae
224. *Tagiades litigiosa litigiosa* Moschler	Himalaya to China.	NA.	SE ; TD.	C	0 to 2	?S : ix.	?	O	Dioscoreaceae.
225. *Tagiades japetus ravi* Moore	Himalaya to Indo-China.	NA ; ?RM.	?TD.	V	?	M : iv-x.	?	O	Dioscoreaceae.
226. *Pseudocoladenia dan fatih* Kollar	India to Malaysia.	NA.	SE ; TD ; S.	C	0 to 2	B : iv-v ; x.	?	O	Amaranthaceae.
227. *Sarangesa dasahara* Moore	India to Malaysia.	NA.	S ; SE ; TD.	C	0 to 2	M : v-xi.	?	O	Acanthaceae
228. *Sarangesa purendra purendra* Moore	India.	NA.	S ; SE ; TD.	C	0 to 2	M : iii-vi ; ix-x	?	?M	Acanthaceae.
229. *Caprona alida yerburyi* Evans	India to China.	SM.	?	V	?2 to 3	M : v-xi.	?	?	?
230. *Spialia galba* Fabricius	India to Myanmar.	NA.	S ; G ; SE.	O	0 to 2	B : iv-v ; x.	?	?	?
231. *Suastus gremius* Fabricius	India to China.	NA.	S; G.	O	0 to 2	M : vi-x.	?	?	?
232. *Aeromachus stigmata* Moore	Himalayan	NA.	SE; S.	A	0 to 2	S : v.	?	O	Graminae
233. *Notocrypta feisthamelii alysos* Moore	India to Malaysia.	NA.	SE.	O	1 to 2	B: v; viii.	?	O	Zingiberaceae.

1	2	3	4	5	6	7	8	9	10
234. *Notocrypta curvifascia* Felder & Felder	India to Malaysia.	NA.	SE.	O	1 to 2	B: iv-vi.	?	P	Costaceae; Zingiberaceae; Musaceae.
235. *Erionota torus* Evans	Himalaya to Malaysia.	NA.	SE; TD.	R	0 to 2	B : iii ; ix-x	?	P	Musaceae; Plamae
236. *Matapa aria* Moore	India to the Philippines.	SM.	?SR.	V	?	M : iii.	?	O	Graminae.
237. *Taractrocera danna* Moore	India.	NA.	S; G.	O	0 to 2	S : v-vi.	?	?	?Graminae.
238. *Ampittia dioscorides dioscorides* Fabricius	India to Myanmar.	SM.	S; G.	O	1 to 2	S: viii.	?	O	Graminae
239. *Udaspes folus* Cramer.	India to Malaysia	G; NA.	S; G.	O	1 to 2	B : iv-ix	?	P	Zingiberaceae; Liliaceae; Loganiaceae.
240. *Pelopidas assamensis* Wood-Mason & de Nicéville	India to Malaysia.	NA.	SE.	R	1 to 2	M : ii-xi.	?	O	Graminae
241. *Pelopidas mathias* Fabricius	India to China.	NA.	SE ; S.	A	0 to 2	M : iii-xi.	?	P	Graminae, Leguminosae, Palmae
242. *Polytremis lubricans* Herrich-Schaeffer	India to Sulawesi.	NA.	SE.	V	?	B: iv; ix.	?	?	?
243. *Polytremis eltola* Hewitson	India to Malaysia.	NA.	S; SE.	O	0 to 2	S : ix-x.	?	O	Graminae.

permission from Mattoni (1990) and Mattoni & Vannucci (2008), for which I am grateful.

The information recorded in Table 1 regarding voltinism is based on specimens recorded or bred, while the information regarding diapause is based on breeding experiments by Fred Smetacek Sr. and the author.

WATERSHED FUNCTIONS

Both the Bhimtal and Sattal lake systems depend largely on subsurface water from this watershed to sustain them. This fact was acknowledged by Atkinson (1882) in the words, "The hills on the western side of the [Bhimtal] lake [i.e. present day Jones Estate] are considerably higher than on the east, and are of such formation that it is highly improbable that the lake can ever dry up." Of course, back then, it was improbable that Mr. Atkinson could even conceive of the present threat of urbanization facing Bhimtal in general and Jones Estate in particular (Image 3).

Today, one lake of the system, Kuatal, has actually dried up during the last decade. With regard to Kuatal, the only thing that has changed during the past 30 years is that the Himalayan Oak forest in its catchment area in Jones Estate has been severely degraded (Image 4). In the wake of nearly unprecedented rain during July and September 2010, Kuatal filled twice for the first time in over 60 years. A photograph from around 1890 (Image 5) shows the area as it apparently used to be and Image 6 shows Kuatal when it was full in 2010. The loss of Kuatal is not recognized by any level of Government. Government maps used by the Lakes Development Authority and other Governmental departments do not even have a lake marked at the spot.

The only over-ground feeder for any of the lakes, is a small stream that rises on the Aru Plain north of Bhimtal and enters the northern end of Bhimtal after a course of roughly 3km, of which nearly 1km is underground. This stream entirely dried up for two months between May 2012 and July 2012, for the first time in history. This is an extremely worrisome development since the prospect of Bhimtal lake becoming seasonal in the coming years is a very real probability. For the first time, too, water supply from Bhimtal Lake to Haldwani City was extended from 15–30 June 2012 by the State Irrigation Department due to the lack of alternate water resources to supply the city. In addition to the subsurface springs feeding the lakes, there are two over-ground water springs on the eastern

Table 2. Annotated list of wildlife included in the Indian Wildlife (Protection) Act 1972 and subsequent notifications recorded in Jones Estate since 1974.

SCHEDULE 1
Mammals
1) 16B Leopard (*Panthera pardus*): regular visitor. Jones Estate forms an integral part of the home range.
2) 17. Leopard Cat (*Felis bengalensis*): often seen.
3) 31A: Serow (*Capricornis sumatraensis*): last recorded in Jones Estate on 7 November 2011.

Birds
4) 2. Cheer Pheasant (*Catreus wallichi*): a group of 4 sighted repeatedly during 1984 to 1986 near the highest point of the Estate, Thalla Ridge.
5) 6. Lammergeyer (*Gypaetus barbatus*): often seen over the Estate during the daytime.
6) 7. Large Falcons (*Falco peregrinus*): often seen flying about the Estate.
7) 22. Kalij Pheasant (*Lophura leucomelas*): at least 70 individuals in over 14 parties resident on the Estate. The number greatly increases after the breeding season.

Butterflies
8) *Horaga albimacula*: (=*Horaga albimacula viola*) found on the Estate in spring.
9) *Listeria dudgeoni*; (=*Pamela dudgeoni*): one record from March 1974.
10) *Nacaduba noreia hampsoni* (=*Prosotas noreia hampsoni*): resident population. Several favoured sites. A common butterfly in June.
11) *Hypolimnas misippus*: singletons recorded. A male last recorded in October 2010.

SCHEDULE 2
Mammals
1) Common Langur (*Presbytis entellus*): several resident parties of up to 25 individuals each.
2) Rhesus Macaque (*Macaca mulatta*): several resident parties totaling roughly 80 individuals which greatly increases during the monsoon months.

Butterflies
3) *Dodona dipoea*: recorded in Jones Estate.
4) *Libythea lepita*: well established, common resident.
5) *Bibasis sena*: resident. Rare.
6) *Chliaria kina*: used to be common before macaques pulled off all orchids, its larval foodplants, from trees during the late 1990s. Now present in reduced numbers.
7) *Euchrysops cnejus*: common in large numbers, especially during the spring migrations and in winter.
8) *Horaga onyx*: well established resident in several discrete populations.
9) *Lampides boeticus*: swarms in spring. In smaller numbers the rest of the year.
10) *Poritia hewitsoni*: a few individuals of this low elevation butterfly recorded over the years.
11) *Pratapa deva*: one record of a male from Sattal, May 1990; another male in 1994.
11) *Rapala varuna*: a common, well established butterfly on the Estate.
12) *Spindasis nipalicus*: a common, well established species. Jones Estate holds the densest known population of this butterfly.
13) *Tajuria diaeus*: single record of a male, 1974.
14) *Tajuria illurgis*: two stable populations in Jones Estate.
15) *Thecla ataxus ataxus* (=*Thermozephyrus ataxus ataxus*): a pair recorded on the western border of the Estate in October1980.
16) *Thecla ziha* (=*Euaspa ziha*): extremely common in some years. Jones Estate holds one of three known populations of this butterfly and probably the largest one.
17) *Diagora persimilis* (=*Hestina persimilis*): the only known population of this butterfly in Uttarakhand is in Jones Estate, where it is quite common.
18) *Eriboea dolon* (=*Polyura dolon*): stragglers from higher elevation recorded.
19) *Euripus consimilis*: present in small numbers.
20) *Hypolimnas misippus*: stragglers from lower elevation stay for a few days, patrolling a beat.
21) *Limenitis danava* (=*Auzakia danava*): a resident. Small numbers regularly seen every year.
22) *Neptis zaida*: the only known population in Nainital district. Two other populations are known, one in the main range and one in Garhwal.
23) *Pantoporia asura asura* (=*Athyma asura*): single record from Jones Estate in October 1969.
24) *Symbrenthia niphanda*: small numbers recorded over the year. Apparently quite rare. Seen sporadically.
25) *Metaporia agathon* (=*Aporia agathon*) a common resident but several populations of this butterfly on the Estate have been wiped out recently due directly to destruction of its larval hostplant, *Berberis* sp.
26) *Elymnias malelas nilamba*: resident population. Common in some years. Population greatly diminished over most of the Estate due to habitat change.
27) *Erebia hyagriva* (=*Dallacha hyagriva*): common resident.
28) *Mycalesis heri*: a common resident species.

Mammals
29) Civets (Viverridae):Common Palm Civet (*Paradoxurus hermaphroditus*) a pest on cultivated fruit including mulberries.
30) Civets (Viverridae): Himalayan Palm Civet (*Paguma larvata*): common on cultivated fruit.
31) Flying Squirrel: *Petaurista petaurista*: common but eradicated from most parts of the Estate during the last 20 years due to habitat destruction.
32) Himalayan Black Bear (*Selenarctos thibetanus*): occasional winter visitor in severe winters. Last personally seen in 1986 but there have been subsequent reports of this animal on the Estate.
33) Jackal (*Canis aureus*): common. At least one resident family.
34) Martens (*Martes flavigula*): commonly seen, especially in winter.
35) Otters (*Lutra* sp.): one species steals all fish from fish ponds in the area. Probably common otter.
36) Red Fox (*Vulpes vulpes*): regular winter visitor. Sightings usually between December to March, but one individual seen in May 2009.
37) Weasels: Himalayan yellow-bellied weasel (*Mustela kathiah*): a pair resident for a few months in summer 2002

Reptiles and Amphibians
38) *Varanus* species: Monitor Lizard: a few individuals reside on the Estate.
39) Indian Cobra (*Naja naja*): resident: last seen in September 2010 at the Butterfly Research Centre, Jones Estate.

Image 3. Looking west over Bhimtal Lake, showing ongoing urbanization on Jones Estate watershed in January 2012.

Image 4. Kuatal catchment in the background, showing degraded broadleaf forest when Kuatal filled for the first time in living memory July 2010.

Image 5. Kuatal, circa 1890.

Image 6. Kuatal when it filled in July 2010 for the first time in living memory.

face of the watershed and three on its western face. In addition, there are several sub surface springs on the lake beds of both lake systems. Of the over-ground springs, both eastern face springs used to be perennial but one is now almost seasonal, with its flow reduced to a thin trickle during the dry season. Similarly, all of the three western-face springs, which used to be perennial, are seasonal today, due, presumably, to depleted Oak forest in the catchment areas of these springs. It is clear that as long as the Oak forest was in good condition, the springs were perennial. Changes to the Oak forest ecosystem in the form of the large scale drying up of trees due to forest fires, destruction of the canopy due to lopping for fodder, cutting of trees, etc were reflected in reduced flow during the dry season and increased flow, sometimes even forming new outlets, during the wet season.

DISCUSSION

The Jones Estate watershed separates two lake systems which together constitute five perennial lakes and several seasonal ones. These lakes are an inestimably valuable resource of drinking quality water for future generations. However, with the urbanization of the Jones Estate watershed, their future looks uncertain, especially the Sattal lake system, which has no over-ground tributaries and a very small catchment area.

Of the 400+ species of butterflies known from Uttarakhand (Mackinnon & de Nicéville 1899; Hannyngton 1910, 1915; Smetacek 1987, 1992, 1993a, 1995, 1999, 2001, 2002, in press b, unpub. data;

Singh 2003, 2005, 2005a, 2006, 2007), 243 species of butterflies (Annexure 1) and approximately 550 species of macro-moths (Smetacek 2008, 2009) have been recorded from the Jones Estate watershed. This may be compared with the entire Indian Peninsula, which is home to 330 species of butterflies (Gaonkar 1996) and an undetermined number of moth species.

Forty nine species of wildlife included in the Schedules of the Indian Wildlife Protection Act, 1972 have been recorded on the watershed (Table 2), yet even this impressive figure is not enough to prevent the ongoing destruction of this forest ecosystem.

Of special interest is the record of Lister's Hairstreak *Pamela dudgeoni* de Nicéville (=*Listeria dudgeoni*) (Lepidoptera: Lycaenidae) in March 1974 in Jones Estate. This butterfly was known from Sikkim (Type locality: specimen described in 1894) and Mussoorie (Evans 1932). Wynter-Blyth (1957) noted a specimen from Siuni camping ground near Ranikhet in Kumaon. The single specimen was recorded in 1909 and is currently in the collection of the Natural History Museum, London. It has not been recorded from Sikkim since the type was reported and was evidently recorded from Mussoorie between 1899 and 1932, since Mackinnon & de Nicéville (1899) do not report it. The male specimen on whose basis Evans (1932) reported it from 1829m (6000ft) elevation in Mussooorie is currently in the collection of the Forest Research Institute, Dehradun. Sidhu (2011) has reported the substantial loss of habitat for the Lycaenidae in Mussoorie. It is almost certain that *Pamela dudgeoni* will not be found in that area now. This leaves Jones Estate as the only known habitat where this extremely rare butterfly has been recorded recently. The genus is monobasic and was believed to be confined to the Himalaya (Varshney 1997; 2010) although Inayoshi (1996–2011) has reported it from Thailand. It is not improbable that the ongoing destruction of the insect's habitat in Jones Estate will result in the global extinction of the species.

Besides this, Jones Estate is one of three known localities for *Euaspa ziha* de Nicéville (Lepidoptera: Lycaenidae) (P. Smetacek unpub. data); one of two known localities for *Neptis miah varshneyi* Smetacek; one of two known localities for *Comostola hauensteini* Smetacek (Lepidoptera: Geometridae) (Smetacek 2002). It supports one of the two known populations of *Hestina persimilis* Westwood in Uttarakhand (Schedule 2, Indian Wildlife (Protection) Act 1972) (P. Smetacek unpub. data).

Populations of most butterfly species listed in Tables 1 and 2 are now concentrated around the Butterfly Research Centre, due to the destruction of habitat in other parts of the Estate, prior to the process of building houses. However, the area where these butterfly and moth species are now confined is very small and the possibility that they become locally extripated from the Estate in the near future is a very real probability.

The only way to have prevented the ongoing destruction and to stabilize the Bhimtal and Sattal lake systems as a drinking water resource for future generations would be, as earlier, to ban the construction of houses, resorts and cottages on the Estate. However, lacking Governmental will to do so, the future outlook for this watershed is bleak from the point of view of insect communities, water resources, the existing forest ecosystems and especially for the residents of the areas downstream, who might have relied upon the Bhimtal and Sattal lakes for a dependable supply of drinking quality water.

RECOMMENDATIONS

If competent decision making bodies make the following decisions and ensure their implementation, the gravity of the situation outlined above can be reduced or reversed in the long term:

1. Re-declare Jones Estate a Green Belt, with the area extended to include the area outlined in Fig. 1.

2. Establish a competent Central Government committee to look into the implementation of existing laws, especially the Forest Conservation Act, 1980 and the bylaws of the Lakes Development Authority, in Jones Estate, and break down illegal constructions to restore the status quo ante.

3. Ban the keeping of cattle and goats within the jurisdiction of the Bhimtal Town Area Committee in the same way this is banned within the Nainital Municipal Area.

Extrapolating the results of the above findings to the catchment area of Bhimtal and Sattal lake systems is not difficult, since the areas are contiguous and within the same altitudinal limits.

If the Bhimtal and Sattal lakes systems are to be stabilized in the long term, then the following points may be taken into consideration:

1. An immediate ban be put into effect on construction of roads, houses and commercial establishments within the catchment areas of Bhimtal and Sattal lakes, i.e. extending from the Catholic Church in Bhowali, east along the crest line to Ghorakhal, thence along the ridges to the hamlet of Binayak, south along the crest of Karkot and thence west to Bohrakoon hamlet, then further west to Suriya Gaon and northwards along the crest of Hidamba (Hirrup) to the crest of Hatchhina and thence again following the line of crests to the Catholic Church in Bhowali. The same provisions as applied in Nainital or Mussoorie Municipalities regarding construction be made applicable within this area.

2. Within this area, so as not to alienate residents, a provision be made to permit residents for at least two generations (i.e. 40 years) to construct additional housing for extended families or build commercial establishments for a source of family income. The verification for this may be made sensible but strict so that lower officials do not consider the possibility of issuing fake reports or certificates, as the case may be.

3. A ban on cattle and goat breeding be implemented within the jurisdiction of the Bhimtal Town Area Committee, on the same lines as that in force within Nainital Cantonment and Municipality.

4. A ban on free range grazing by cattle within the catchment area, to be enforced by concerned agencies, i.e. Forest Department and Van Panchayats.

5. A wood depot be set up in Bhimtal so that residents are able to purchase fuel legally, as in other small towns throughout Kumaon.

6. If necessary, one or more fodder depot(s) be set up in the higher reaches of the catchment area, eg. in Farsoli, to cater to the needs of villages in that area and reduce dependence on lopping forest trees.

All these recommendations are well within the scope of the Government, require no extra funds and will have to be implemented in due course in the Bhimtal Valley in any case. If it is done now, then the action will come into force before the damage is irreversible, unlike Nainital and Mussoorie, where the bans came into effect after the damage had been done.

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