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Mapping Butterfly Hotspots: A New Approach to Identify Prime Butterfly Areas of Meghalaya, India

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ABSTRACT: In India, butterflies are legally protected under various schedules of Indian Wildlife Protection Act, 1972. During the present study, a model consisting of a total of 104 target species listed under Schedule I and II of the act were used to identify the Prime Butterfly Areas (PBAs) of Meghalaya. The selection of PBAs depends highly on the richness, availability and distribution pattern of the target species. A total of 29 PBAs were identified among 7 districts of the state covering National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserve Forests, Protected Forests, Sacred Groves and all the habitat rich areas that could support a substantial number of the target species. An effort has been made to construct a map of PBAs identified during the study. Agricultural intensification, forest degradation and habitat loss, followed by monoculture, coal mining and burning of forest and vegetation were identified as the principal threats within most of the PBAs. The results of the present study can be used by the conservation agencies to construct a valuable strategy for conservation of target species within PBAs.

Keywords: Mapping Butterfly Hotspots in Meghalaya

Abbreviation: PBAs, Prime Butterfly Areas; IW(P), Indian Wildlife Protection.

I. INTRODUCTION

Meghalaya "The Abode of the clouds" with a geographical area of 22,429 sq. km is situated in the north-eastern part of India and comprises of South Garo Hills, West Garo Hills, East Garo Hills, West Khasi Hills, East Khasi Hills, Ri-bhoi and Jaintia Hills districts lying between 25°47″ – 26°10″ N latitude and 89°45″ – 92°45″ E longitude with elevation ranges from 60 meters to 1,950 meters above sea level. The state has a 496 km long international boundary with Bangladesh in the south and west. It is bordered by Assam in the north and east. The eastern part is bound by the Karbi Hills which is a continuation of the Meghalaya plateau. On all other sides of the state lies an extensive plain drained by the river Brahmaputra (in the north and west) and the river Surma and its tributaries (in the south). The climate is monsoonic with distinct warm-wet and cold-dry periods. The period between May and October is wet. The dry period extends from November to February.

Study on butterflies in Meghalaya has started many years ago and came into recognition after the major taxonomic and natural history work in Khasi and Jaintia hills in eastern Meghalaya [1-5]. Since then this group of insect gained less attention in this region from lepidopterists with few notable exceptions [6, 7, 8, 9]. In India, butterflies are legally protected under various schedules of Indian Wildlife Protection Act, 1972 [10]. The Act establishes Schedule I as the official list of wildlife species at risk. It classifies those species as being extirpated, endangered, threatened, or a special concern. The Act also establishes Schedule II list for butterflies that provide absolute protection. Any offences made against these species prescribed the highest penalties. Keeping this view in mind, a new approach have been undertaken in this study to identify the Prime Butterfly Areas (PBAs) of Meghalaya based on the occurrence and availability of schedule species over different localities of the state.

II. MATERIALS AND METHODS

The present work is based on a 3 year project to identify PBAs of Meghalaya where conservation efforts should be focused. Legal protection and proper management of these areas will not only help to conserve butterflies *in situ* but also other invertebrates, plants and animals occurring in the same habitats. Field trips and surveys were conducted to different parts of the state collecting primary and secondary information on the occurrence and availability of Schedule I and Schedule II species. Additional information was gathered from all past publications concerning butterflies in the state. In order to build up an effective technique for selecting PBAs of Meghalaya, we selected a total of 104 target species that are being legally protected under Schedule I (25 species) and II (79 species) of Indian Wildlife Protection Act, 1972 (Table 1). To gather more information on the occurrence of Schedule species, we incorporated conclusions drawn from previous scientific studies in the state; our personal field experiences [11-13] and from working together with governmental organizations and from the review of scientific literature [1-8].

Table 1: List of the 104 target Schedule I and II species that are used as markers to identify PBAs of Meghalaya.

Scientific Names	Common Names	Schedule Status as per Indian Wildlife Protection Act, 1972
Family: Hesperiidae		
Arnetta atkinsoni	Atkinson's Bob	Schedule II
Bibasis sena	Orange-tail Awl	Schedule II
Halpe homolea	Indian Ace	Schedule II
Family: Lycaenidae		
Acytolepis puspa	Common Hedge Blue	Schedule I
Ancema blanka	Silver Royal	Schedule II
Anthene lycaenina	Pointed Ciliate Blue	Schedule II
Arhopala bazaloides	Tamil Oakblue	Schedule II
Arhopala belphoebe	Doherty's Oakblue	Schedule II
Arhopala fulla	Spotless Oakblue	Schedule II
Arhopala silhetensis	Sylhet Oakblue	Schedule II
Bindahara phocides	Plane	Schedule II
Castalius rosimon	Common Pierrot	Schedule I
Catapaecilma major	Common Tinsel	Schedule II
Chliaria kina	Blue Tit	Schedule II
Chliaria othona	Orchid Tit	Schedule I
Cigaritis lohita	Long-Banded Silverline	Schedule II
Deudorix epijarbas	Cornelian	Schedule I
Euchrysops cnejus	Gram Blue	Schedule II
Flos apidanus	Plain Plushblue	Schedule II
Heliophorus androcles	Green Sapphire	Schedule II
Horaga onyx	Common Onyx	Schedule II
Jamides pura	White Cerulean	Schedule II
Lampides boeticus	Pea Blue	Schedule II
Miletigrapha drumila	Great Darkie	Schedule I
Nacaduba hermus	Pale-Four Lineblue	Schedule II
Poritia hewitsoni	Common Gem	Schedule II
Prosotas aluta	Banded Lineblue	Schedule II
Prosotas dubiosa	Tailless Lineblue	Schedule II
Prosotas noreia	White-tipped Lineblue	Schedule I
Rapala suffusa	Suffused Flash	Schedule II
Rapala varuna	Indigo Flash	Schedule II
Remelana jangala	Chocolate Royal	Schedule II
Udara albocaerulea	Albocerulean	Schedule II
Una usta	Singleton	Schedule II
Yasoda tripunctata	Branded Yamfly	Schedule II
Family: Nymphalidae		
Algia fasciata	Branded Yeoman	Schedule II
Amathuxidia amythaon	Koh-I-Noor	Schedule II
Athyma asura	Studded Sergeant	Schedule II
Athyma kanwa	Dot-dash Sergeant	Schedule II
Athyma pravara	Unbroken Sergeant	Schedule II
Athyma ranga	Blackvein Sergeant	Schedule II
Bassarona teuta	Banded Marquis	Schedule II
Callerebia orixa	Moore's Argus	Schedule I
Charaxes marmax	Yellow Rajah	Schedule II
Charaxes solon	Black Rajah	Schedule II
Cyrestis cocles	Marbled Map	Schedule II
Doleschallia bisaltide	Autumn Leaf	Schedule I
Dophla evelina	Red Spot Duke	Schedule II
Elymnias malelas	Spotted Palmfly	Schedule I
Elymnias patna	Blue-striped Palmfly	Schedule II
Elymnias pealii	Peal's Palmfly	Schedule I
Elymnias penanga	Pointed Palmfly	Schedule I
Euploea midamus	Blue-spotted Crow	Schedule II
Euthalia aconthea	Common Baron	Schedule II
Euthalia anosia	Grey Baron	Schedule II

Euthalia franciae	French Duke	Schedule II
Euthalia nara	Bronze Duke	Schedule II
Helcyra hemina	White Emperor	Schedule I
Hypolimnas misippus	Danaid Eggfly	Schedule I
Lethe dura	Scarce Lilacfork	Schedule I
Lethe europa	Bamboo Treebrown	Schedule I
Lethe isana	Common Forester	Schedule II
Lethe sinorix	Tailed Red Forester	Schedule II
Lexias cyanipardus	Great Archduke	Schedule II
Lexias dirtea	Dark Archduke	Schedule II
Limenitis austenia	Grey Commodore	Schedule I
Melanitis zitenius	Great Evening Brown	Schedule II
Mimathyma ambica	Indian Purple Emperor	Schedule II
Mimathyma chevana	Sergeant Emperor	Schedule II
Mycalesis adamsoni	Watson's Bushbrown	Schedule II
Mycalesis anaxias	Whitebar Bushbrown	Schedule II
Mycalesis malsarida	Plain Bushbrown	Schedule II
Neope yama	Dusky Labirynth	Schedule II
Neptis columella	Short-Banded Sailer	Schedule I
Neptis jumbah	Chestnut-Streaked Sailer	Schedule I
Neptis magadha	Spotted Sailer	Schedule II
Parthenos sylvia	Clipper	Schedule II
Penthema lisarda	Yellow Kaiser	Schedule II
Polyura delphis	Jewelled Nawab	Schedule II
Polyura dolon	Stately Nawab	Schedule II
Polyura moori	Malayan Nawab	Schedule I
Prothoe franck	Blue Begum	Schedule I
Ragadia crito	Dusky-striped Ringlet	Schedule II
Rhinopalpa polynice	Wizard	Schedule II
Sephisa chandra	Eastern Courtier	Schedule I
Symbrenthia silana	Scarce Jester	Schedule I
Tanaecia lepidea	Grey Count	Schedule II
Family: Papilionidae		
Graphium aristeus	Chain Swordtail	Schedule II
Graphium eurypylus	Great Jay	Schedule II
Graphium megarus	Spotted Zebra	Schedule II
Losaria coon	Common Clubtail	Schedule I
Papilio clytia	Common Mime	Schedule I
Papilio epycides	Lesser Mime	Schedule II
Papilio paradoxa	Great Blue Mime	Schedule II
Family: Pieridae		
Appias albina	Common Albatross	Schedule II
Appias indra	Plain Puffin	Schedule II
Appias lyncida	Chocolate Albatross	Schedule II
Cepora nadina	Lesser Gull	Schedule II
Cepora nerissa	Common Gull	Schedule II
Dercas lycorias	Plain Sulphur	Schedule II
Eurema andersonii	One-spot Grass Yellow	Schedule II
Family: Riodinidae		
Dodona adonira	Striped Punch	Schedule II
Dodona dipoea	Lesser Punch	Schedule II
Dodona egeon	Orange Punch	Schedule II

III. RESULTS AND DISCUSSION

The present study was aimed to identify the PBAs of Meghalaya. A total of 29 PBAs were identified among 7 districts of the state covering National Parks, Wildlife Sanctuaries, Biosphere Reserves, Reserve Forests, Protected Forests, Sacred Groves and all the habitat rich areas consisting of grasslands, hills streams, agricultural landscapes, villages, stream lands, lakes, forested roads and waterfalls, that supports a high species richness in terms of number, rarity and abundance. These PBAs are spread over an elevation range from as low as 26.03 meters at Dawki to as high as 2000 meters above mean sea level at upper Shillong and Mawsynram. The number of PBAs identified in the state depends on many different factors, such as size of the area, species richness, record of rare and threatened species, threat level and suitability of habitats [14].

Table 2: List of 29 PBAs identified in Meghalaya with District name, respective coordinates and elevation range.

Major District	Name of PBA	Coordinates	Elevation	No. of schedule species under IW(P) Act, 1972	
				Schedule I	Schedule II
Ri-Bhoi	Nongkhyllem WLS	25°45' - 26°00'N, 91°45' - 92°00'E	200 – 950 m	12	48
	Nongkhyllem RF	25° 49' 05.1"N, 91° 50' 17.8"E	567 – 616 m	08	33
	Umsaw Forest	25° 49' 50.8"N, 91° 48' 21.0"E	576 m	04	27
	Jirang village	25.9258°N, 91.5714°E	497.92 m	04	22
	Byrnihat MR	26.0515°N, 91.8696°E	67.58 m	06	38
	Sumer village	25.6955143N, 91.9076621E	880 m	04	19
	Umiam Dam	25.6596716N, 91.9004122E	976 m	05	23
Khasi Hills	Pynursla	25.3100°N, 91.9025°E	1339.98 m	09	39
	Pongtung	25.2509°N, 91.9508°E	782.22 m	15	66
	Riwai village	25.1962° N, 91.9005° E	412.54 m	13	74
	Mawlynnong	25.2017° N, 91.9160° E	475.89 m	11	41
	Dawki	25.1840° N, 92.0248° E	c. 26.03 m	16	63
	Sohra	25°16.109' N, 91°44.380' E	c. 1,350 m	20	75
	Nongriat	25.2374° N, 91.6796° E	c. 653.95 m	13	47
	Mawkishyiem	25.2756° N, 91.7266° E	c. 1354.38 m	12	42
	Mawlong-Tyrna Forest Hills	25.2140° N, 91.6818° E	400 – 734 m	17	68
	Mawphlang SG	25° 28' 00" N, 91° 43' 60" E	1,800 m	10	28
	Shella	25.1803° N, 91.6416° E	94.12 m	05	38
Jaintia Hills	Sonapyrdi	25° 06' 28" N, 92° 21' 45" E	48 m	12	33
	Narpuh WLS	25° 08' 60" N, 92° 27' 30" E	100 - 1,000 m	17	64
	Saipung RF	25° 19' 60" N, 92° 45' 00" E	1108.08 m	13	46
	Amlarem Forest	25°13'51''N, 92°5'35''E	737 m	07	54
	Jarain	25.3841 N, 92.1504 E	690 m	05	39
Garo Hills	Tura peak	25.517377 N, 90.2066783 E	285 m	04	33
	Nokrek NP	25.3036° N, 90.1201° E	600 - 1,412 m	07	32
	Baghmara WLS	25.1243° N, 90.3811° E	85.22 m	11	42
	Siju WLS	25.2137° N, 90.4187° E	235.24 m	09	29
	Baghmara NP	25.1446° N, 90.5324° E	50 - 1,026 m	13	52
	Karwani	25.211313 N, 90.653355 E	100 m	06	22

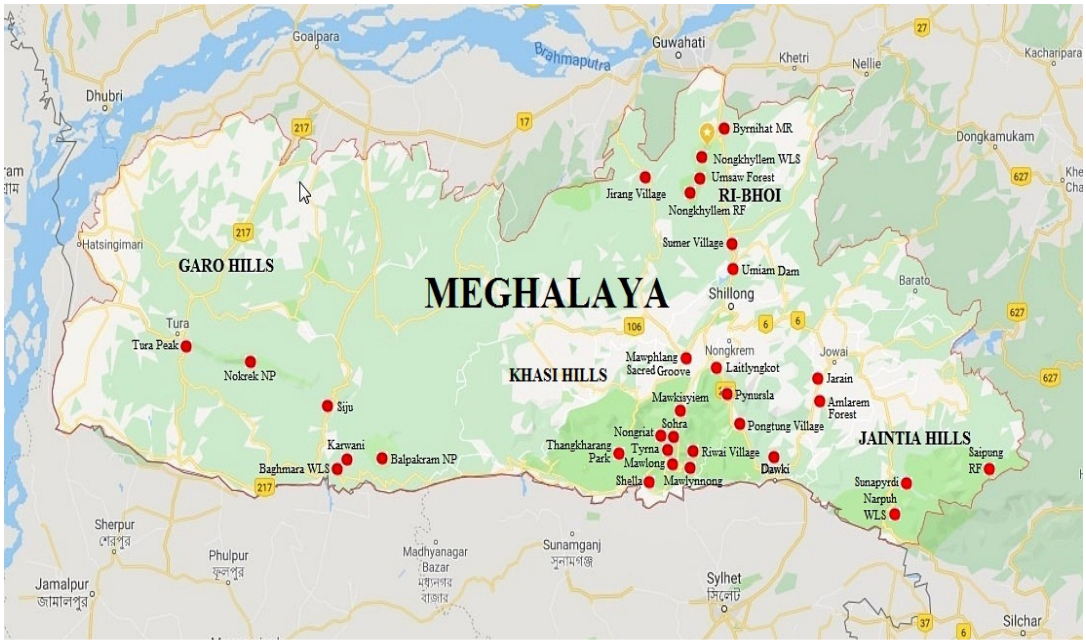

Fig. 1. The location of the 29 Prime Butterfly Areas of Meghalaya, identified for the 104 target species.

An effort has been made to prepare a butterfly map of Meghalaya covering all the PBAs that are identified during the present study. Out of the total count, Khasi hills district top the list with a total of 11 PBAs, followed by Ri-bhoi district with 7 PBAs, Garo hills district with 6 and Jaintia hills with 5 PBAs respectively. The threats facing PBAs are diverse, ranging from adverse management activities, land-use, urban or industrial developments, and impacts of land-uses from neighbouring areas. The main types of threats affecting PBAs are agricultural intensification, forest degradation and habitat loss, monoculture, coal mining and burning of forest and vegetation for shift cultivation. Other important threats include urbanization and natural events like landslide [15].

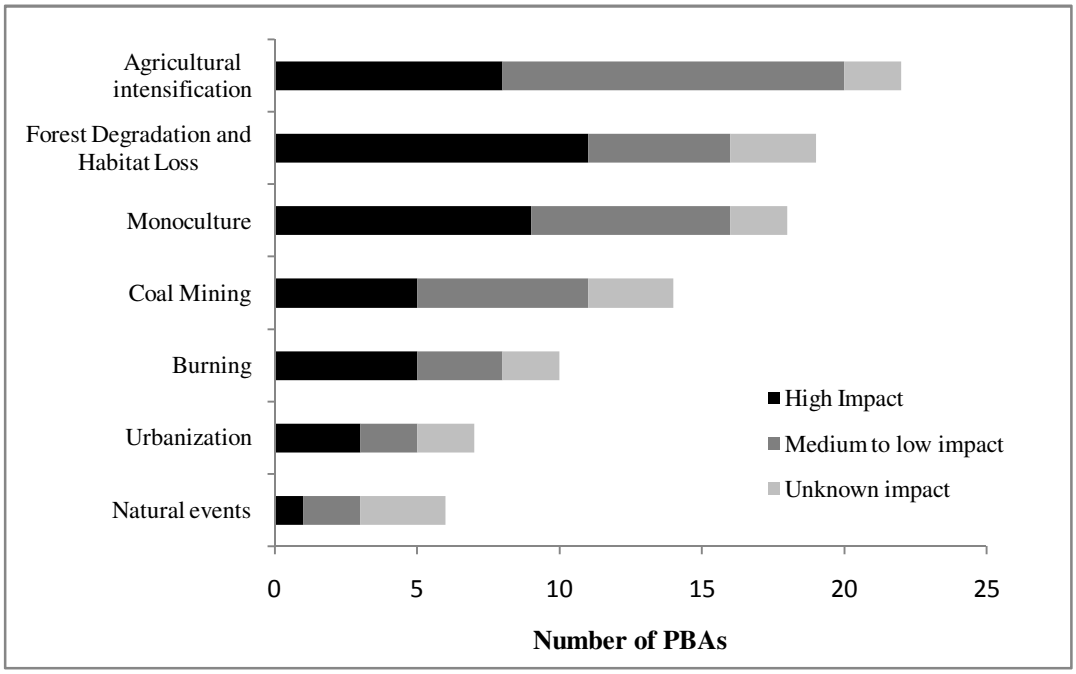

Fig. 2. Main threats to target species within Prime Butterfly Areas.

The most frequently occurring species within PBAs are *Appias lyncida*, *Appias albina* and *Cepora nerissa*, which are found in almost all PBAs in substantial number. However, many other target species have a far more restricted range and the sites selected are of the utmost importance for the conservation of such species. They include species like *Una usta*, *Neope yama*, *Callerebia orixa* and *Bhagadatta austenia.*

IV. CONCLUSION

This study documents for the first time the most important butterfly sites across Meghalaya and we strongly suggest the conservation agencies to use the list of PBAs reported here for the construction of valuable action plans along with the help of subject experts. The authors strongly recommend the following specific actions:

(1). Produce a detailed description of all the PBAs and if possible designate them as protected areas under state and national legislation.

(2). Ensure wildlife friendly habitat management within PBAs.

(3). Monitor populations of target species and conduct research to identify appropriate habitat management techniques.

(4). Keep revising the list of PBAs every year to maintain an up-to-date list.

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Conflict of Interest: The authors declare no conflict of interest.

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