



Exploration of Forest Resources by Both Humans and Butterflies—A Case Study on Utilization of Medicinal Plants as Larval Resource by Nymphalinae Butterflies [†]

Panchali Sengupta 

Department of Zoology, West Bengal State University, Berunanpukaria, Malikapur, Barasat 700126, West Bengal, India; panchali17sg@gmail.com

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Abstract: India is renowned for its rich medico-cultural heritage. The chemical constituents of medicinally significant plants form the basis of host plant identification by butterflies. The documentation of such therapeutically significant food plants of nymphalinae butterflies (Family: Nymphalidae) along with the recognition of their medicinal potential was undertaken across the Himalayan landscape of West Bengal, India. Informant Consensus Factor (ICF), Utilization Value (Uv) and Fidelity levels (F_L) were determined, followed by the calculation of Host Plant Specificity (HPS) and Polyphagy Index (P_i). An ICF value of 1.000 was cited for diseases of the digestive and respiratory system. The maximum F_L was noted for *Artemisia vulgaris*, *Dioscorea deltoidea* and *Mimosa pudica*. *Urtica dioica* and *Hygrophila auriculata* displayed the maximum Uv. Furthermore, *Junonia lemonias*, *J. orithiya*, *Hypolimnas bolina* and *H. misippus* possessed the highest HPS. A maximum P_i value was determined for *Junonia lemonias*. Besides providing an immense benefit to traditional healers, such plants enable the sustenance of butterflies through life history stages.

Keywords: fidelity level; host plant specificity; informant consensus factor; polyphagy index; utilization value



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1. Introduction

The Government of India has been actively promoting AYUSH (Ayurveda, Unani, Siddha and Homeopathy) in the pharmaceutical sector and encouraging the amalgamation of traditional systems with modern medicines. The WHO has also acknowledged the contribution of traditional medicine practitioners and encouraged modernization and scientific advancements in healthcare. Interestingly, the chemical constituents of such medicinally significant plants (primarily alkaloids, terpenoids, glycosides, flavonoids and tannins) also form the basis of host plant recognition by butterflies. Olfactory and gustatory cues and their associated chemosensory mechanism of host plant identification at the dual stages of their life cycle (i.e., larval feeding and oviposition) have been previously investigated [1,2]. With their global distribution, Nymphalinae are said to inhabit a large geographic range and thereby feed from several host plant families. The oscillation hypothesis of plant-driven diversification probably holds the key to such events among Nymphalinae [3]. Besides feeding on ancestral urticalean rosids [4], the food plant clades of nymphalinae oscillate mainly between Lamiales and Asterales. Such plasticity in host plant utilization could probably be the driving force behind increased speciation and diversification [5]. Specialization in host plant utilization enables lepidopteron to utilize their available resources in a judicious manner. The occurrence of hierarchy in host choice also enlightens their ability in selecting suitable chemical constituents as forming the basis of their resource selection. The present study involved the documentation of medicinally significant plant species followed by recognizing their significance as a larval resource of nymphalinae butterflies.

2. Materials and Methods

2.1. Study Area

The entire study was conducted from March 2023 to February 2024 across five districts in the East Himalayan landscape of West Bengal, India. Alipurduar (26.489° N, 89.527° E), Coochbehar (26°22' N, 89°29' E), Darjeeling (26°52' N, 88°18' E), Jalpaiguri (26.52° N, 88.73° E) and Kalimpong (27.06° N, 88.47° E) were selected for the purpose of the study. The selection of the study site (three locations in each district) was conducted in 2022 during a preparatory survey to determine the potential areas of study prior to the actual study period.

2.2. Sampling Protocol

The entire study was divided into two phases. Firstly, fieldwork consisted of interviews, identification, collection and the subsequent documentation of the medicinal plants used by the indigenous people. A total of 40 elderly members of the populace were selected from among 35 households for this study. The age of the informant varied from 60 to 80 years. The selection of the informant for interviews was of fundamental importance for increasing the reliability of the study. Such elders were identified by community members as being the most knowledgeable in such therapy.

Interviewees who had strong connections with traditional agriculture systems and practiced therapeutic activities professionally were selected. Informants were provided with a semi-structured questionnaire regarding their traditional knowledge, plant utilization and diseases for treatment. Interviews were conducted for 60–90 min. Based upon such information, a database was generated.

Secondly, the identification of nymphalinae butterflies exploring such therapeutically significant plants as their larval resource was conducted. Plant species were identified in the field based on earlier reports and the observation of larvae during a survey walking across specially created quadrats. Since the study area was surveyed to develop an idea of the occurrence of plant and butterfly species, the proportion of herb, shrub and trees in the study site formed the basis of the selection of the number and dimension of quadrats. Three types of quadrats, namely TQ (for trees, including climbers and epiphytes), SQ (for shrubs) and HQ (for herbs) were used for the sampling of plant species. For the sampling of trees, shrubs and herbs, a total of 10, 20 and 40 quadrats were laid down, respectively. Quadrats of 10 m × 10 m in dimension were used for the tree layer, 5 m × 5 m were used for shrubs and 2 m × 2 m were used for the sampling of herb species. Therefore, a combination of different numbers and varying dimensions of quadrats were established for such purposes. Besides carefully observing the eggs and larvae on such medicinally significant plants, locating ovipositing nymphalinae butterflies was also undertaken on several instances. All observations on larval host plants were also interpreted based on reliable records from the literature [6–8].

2.3. Data Analysis

Following the first phase of the study, information provided during the interactions with the local populace were used to generate a database, followed by determination of the Informant Consensus Factor (ICF), Fidelity level (F_L) and Utilization Value (U_V).

The Informant Consensus Factor (ICF) was calculated using the following formula: $ICF = (N_{ur} - N_t) / (N_{ur} - 1)$, where N_{ur} refers to the number of use-reports in each category and N_t refers to the number of taxa used for a particular category by all informants [9]. Importantly, the ICF value varies from 0 to 1, with high values (approaching 1) referring to well-defined selection criteria in a particular community. In contrast, low (near 0) values indicate cases where plants are selected randomly or where there is no exchange of information about their utilization among informants. Fidelity level (F_L) values were calculated using the following formula: $F_L = N_p / N$, where N_p is the number of use-reports cited for a given species for a particular ailment and N is the total number of use reports cited for a given species [10]. Significantly, higher F_L values (approximately 100%) are

obtained for species where almost all use-reports fall under the same category of ailment, whereas low F_L values represent species which are being used for different purposes. Utilization Value (U_V) was calculated using the following formula: $U_V = (\sum U_i)/n$, where “ U_i ” refers to the number of use-reports cited by each informant about a given species and “ n ” refers to the total number of informants [11]. A higher U_V denotes a greater usage of the plant species and lower values refer to a lower usage of the plant species.

In the final phase of the study, such therapeutically significant plant species serving as larval host plants of nymphalinea butterflies were used for the determination of the Polyphagy Index (P_i) and Host Plant Specificity (HPS). The Polyphagy Indices of the butterfly species were measured as $P_i = (A \times B)^{1/2}$; where A = the number of genera of host plants, and B = taxonomic diversity of the hosts (1 = one plant species; 2 = one plant genus; 3 = one plant family; 4 = one plant order; 5 = two or more plant orders) [12]. The Host Plant Specificity (HPS) of each butterfly species was denoted by a number indicating their preference for only one plant species (1S), one plant genera (1G), one plant family (1F), two plant families (2F) and three or more plant families ($\geq 3F$).

3. Results

The therapeutic benefits of the 35 plant species used against several categories of ailments, as informed by the local populace, have been presented (Table 1). Based on such information, the Informant Consensus Factor (ICF), Fidelity level (F_L) and Utilization Value (U_V) were determined. Maximum ICF values of 1.00 from among all the studied plant species were cited for diseases of the digestive system and disorders associated with the respiratory system. The highest F_L of 100% was noted for *Artemisia vulgaris*, *Dioscorea deltoidea* and *Mimosa pudica*, thereby indicative of their usage for the treatment of single ailments. However, *Portulaca oleracea* (21%) and *Strobilanthes capitatus* (16%) recorded the lowest F_L values (Table 2). *Hygrophila auriculata* ($U_V = 0.89$) and *Urtica dioica* ($U_V = 0.87$) displayed rich potential in the treatment of diseases. On the contrary, *Barleria prionitis* ($U_V = 0.17$) was indicative of fewer reports with lesser benefits (Table 2).

Table 1. Therapeutic benefits of plant species, as reported by local populace during interviews.

Plant Species	Medicinal Benefits as Documented During Interview
Urticaceae <i>Urtica dioica</i>	Possesses analgesic, anti-inflammatory, antiviral, anticancer, anti-Alzheimer and anti-oxidant properties. Also effective against jaundice, digestive problems, nephritis, rheumatism and arthritis
<i>Urtica parviflora</i>	Used in the treatment of goitre, cough, stomach pain, ulcer, allergies, alopecia and fever
<i>Boehmeria penduliflora</i>	Possesses anti-diabetic, antimicrobial, anti-oxidant, anti-hepatitis and anti-inflammatory properties
<i>Boehmeria diffusa</i>	Known for its anti-diabetic, antimicrobial, anticancer, anti-hepatitis and anti-bacterial properties
<i>Boehmeria glomerulifera</i>	Recognized for its anti-inflammatory, anti-allergic and anti-colitis role
<i>Elatostema sessile</i>	Possesses anti-depressant, analgesic, neurological, anti-bacterial and anti-arthritis functions
<i>Elatostema cuneatum</i>	Known for its anti-depressant, neurological, anti-bacterial and anti-cough properties
<i>Girardinia heterophylla</i>	Recognized for its anti-inflammatory, anticancer, anti-microbial and anti-diabetic properties
<i>Debregeasia velutina</i>	Cures dysentery, arthritis, skin ulcers, digestive disorders and ulcers
<i>Debregeasia wallichiana</i>	Prevents digestive disorders and respiratory problems
<i>Parietaria judaica</i>	Used in the treatment of cough, allergies, digestive disorders and fever
<i>Poikilospermum suaveolens</i>	Known for its anti-depressant, neurological, anti-cough and anti-colitic properties

Table 1. Cont.

Plant Species	Medicinal Benefits as Documented During Interview
<i>Laportea interrupta</i>	Possess anti-diabetic, antimicrobial, anti-hepatitis and anti-inflammatory properties
Acanthaceae <i>Justicia procumbens</i>	Cures diarrhea, dysentery, vomiting, and chronic bronchitis, and is antipyretic, antispasmodic and anti-asthmatic
<i>Justicia japonica</i>	Cures fever, cough, colitis and gastritis
<i>Justicia adhatoda</i>	Cures respiratory and digestive problems
<i>Hygrophila auriculata</i>	Effective against fever, diarrhea, cough, pain, neurological disorders, snakebites, diabetes and tuberculosis
<i>Barleria strigosa</i>	Provides relief from toothache and gastric problems
<i>Barleria cristata</i>	Has analgesic, antiseptic, immunological and anti-asthmatic properties
<i>Barleria prionitis</i>	Cures respiratory, fever, joint pain, burns, urinary and paralytic problems
<i>Asystasia macrocarpa</i>	Provides relief from digestive disorders, fever and cough
<i>Nelsonia campestris</i>	Possesses anti-bacterial, anti-oxidant, anti-inflammatory, anti-diabetic and analgesic properties
<i>Strobilanthes capitatus</i>	Known for its anti-diabetic, antimicrobial, anticancer, wound healing, anti-ulcerogenic, anti-rheumatic and anti-inflammatory properties
Asteraceae <i>Artemisia vulgaris</i>	Recognized for its antiseptic, antispasmodic, anti-flatulent, anti-oxidant, anti-cough and hepato-protective properties
<i>Gnaphalium affine</i>	Possesses anti-hypouricemic, antifungal and anti-inflammatory properties.
Dioscoreaceae <i>Dioscorea deltoidea</i>	Recognized for anti-inflammatory, anti-bacterial, anti-oxidant and hepato-protective properties
Malvaceae <i>Sida rhombifolia</i>	Has anti-oxidant, anti-cough, anti-analgesic and wound healing properties.
<i>Abelmoschus manihot</i>	Provides relief from respiratory and digestive problems
<i>Hibiscus scandens</i>	Cures influenza, fever, cough and stomach pain
Portulacaceae <i>Portulaca oleracea</i>	Possesses anticancer, anti-diabetic, neuro-protective, hepato-protective, nephro-protective, wormicidal and insecticidal properties.
Melastomataceae <i>Osbeckia muralis</i>	Cures respiratory, colitic and digestive problems
Tiliaceae <i>Corchorus capsularis</i>	Has cardiac, anti-inflammatory and immuno-protective functions
Fabaceae <i>Erythrina variegata</i>	Cures problems related with female infertility, gonorrhea and infection
<i>Mimosa pudica</i>	Has anti-toxic, anti-cough, anti-inflammatory and wound healing properties. Effective against flatulence, diarrhea, fever and chest infection
Smilacaceae <i>Smilax rigida</i>	Has anti-infective, anti-inflammatory and anti-colitis properties

Additionally, 35 plant species served as the larval resource of 23 nymphalines butterflies (Table 3). The Polyphagy Index (P_i) and Host Plant Specificity (HPS) were determined to reflect the importance of such medicinal plant species as larval resources of butterflies. A maximum P_i value was determined for *Junonia lemonias* (5.477), followed by *Hypolimnas bolina* and *H. missipus* (5.000) (Table 4). On the contrary, *Araschnia prorsoides*, *Symbrenthia niphanda*, *Aglaia urticae*, *Polygonia egea*, *Rhinopalpa polynice*, *Kallima inachus* and *K. alompra*, with P_i values of 1.000, utilized single plant species (Table 4). *Junonia lemonias*, *J. orithiya*,

Hypolimnias bolina and *H. misippus* possessed the highest HPS, exploring three plant families (Table 4).

Table 2. Utilization Value (Uv) and Fidelity level (F_L) of plant species.

Plant Species	Uv	F _L
<i>Urtica dioica</i>	0.87	84%
<i>Urtica parviflora</i>	0.74	54%
<i>Girardinia heterophylla</i>	0.66	62%
<i>Elatostema cuneatum</i>	0.22	25%
<i>Elatostema sessile</i>	0.21	26%
<i>Laportea interrupta</i>	0.61	55%
<i>Debreagesia velutina</i>	0.82	87%
<i>Debreagesia wallichiana</i>	0.77	79%
<i>Boehmeria glomerulifera</i>	0.80	82%
<i>Boehmeria penduliflora</i>	0.62	66%
<i>Boehmeria diffusa</i>	0.42	52%
<i>Parietaria judaica</i>	0.35	63%
<i>Poikilospermum suaveolens</i>	0.44	49%
<i>Hygrophila auriculata</i>	0.89	88%
<i>Justicia adhatoda</i>	0.46	45%
<i>Justicia procumbens</i>	0.44	66%
<i>Barleria cristata</i>	0.28	72%
<i>Barleria stigosa</i>	0.46	64%
<i>Barleria prionitis</i>	0.17	42%
<i>Nelsonia campestris</i>	0.54	35%
<i>Asystasia macrocarpa</i>	0.42	31%
<i>Strobilanthes capitatus</i>	0.69	16%
<i>Justicia japonica</i>	0.66	32%
<i>Sida rhombifolia</i>	0.72	89%
<i>Hibiscus rosa chinensis</i>	0.61	34%
<i>Abelmoschus esculenta</i>	0.53	44%
<i>Portulaca oleracea</i>	0.66	21%
<i>Dioscorea deltoides</i>	0.81	100%
<i>Artemesia vulgaris</i>	0.77	100%
<i>Corchorus capsularis</i>	0.42	35%
<i>Gnaphalium affine</i>	0.52	40%
<i>Mimosa pudica</i>	0.78	100%
<i>Smilax glabra</i>	0.26	75%
<i>Erythrina vulgaris</i>	0.34	56%
<i>Osbeckia muralis</i>	0.50	51%

Table 3. Larval host plant species utilized by nymphalinae butterflye.

Butterfly Species	Larval Host Plant Species
<i>Araschnia prorsoides</i> (Blanchard)	<i>Urtica dioica</i> (Urticaceae)
<i>Symbrenthia niphanda</i> Moore	<i>Boehmeria penduliflora</i> (Urticaceae)
<i>Symbrenthia hypselis</i> (Godart)	<i>Debregeasia velutina</i> , <i>Elatostema sessile</i> (Urticaceae)
<i>Symbrenthia hippoclus</i> (Cramer)	<i>Debregeasia velutina</i> , <i>D. wallichiana</i> (Urticaceae)
<i>Vanessa indica</i> (Herbst)	<i>Boehmeria diffusa</i> , <i>B. glomerulifera</i> , <i>B. penduliflora</i> , <i>Urtica dioica</i> (Urticaceae)
<i>Limenitis trivena</i> Moore	<i>Boehmeria penduliflora</i> , <i>Girardinia heterophylla</i> (Urticaceae)
<i>Vanessa cardui</i> (Linnaeus)	<i>Artemisia vulgaris</i> , <i>Gnaphalium affine</i> (Asteraceae); <i>Boehmeria diffusa</i> , <i>Girardinia heterophylla</i> (Urticaceae)
<i>Aglais cashmiriensis</i> (Kollar)	<i>Urtica dioica</i> , <i>U. parviflora</i> , <i>Boehmeria diffusa</i> (Urticaceae)
<i>Aglais urticae</i> (Linnaeus)	<i>Urtica parviflora</i> (Urticaceae)
<i>Kaniska canace</i> (Linnaeus)	<i>Dioscorea deltoidea</i> (Dioscoreaceae); <i>Smilax rigida</i> (Smilacaceae)
<i>Polygonia egea</i> (Cramer)	<i>Parietaria judaica</i> (Urticaceae)
<i>Rhinopalpa polynice</i> (Cramer)	<i>Poikilospermum suaveolens</i> (Urticaceae)
<i>Junonia orithiya</i> (Linnaeus)	<i>Hygrophila auriculata</i> , <i>Justicia procumbens</i> (Acanthaceae); <i>Sida rhombifolia</i> (Malvaceae); <i>Mimosa pudica</i> (Fabaceae)
<i>Junonia hierta</i> (Fabricius)	<i>Barleria strigosa</i> , <i>Hygrophila auriculata</i> (Acanthaceae)
<i>Junonia atlites</i> (Linnaeus)	<i>Barleria strigosa</i> , <i>Hygrophila auriculata</i> (Acanthaceae)
<i>Junonia iphita</i> (Cramer)	<i>Justicia adhatoda</i> , <i>J. japonica</i> , <i>Hygrophila auriculata</i> (Acanthaceae)
<i>Junonia lemonias</i> (Linnaeus)	<i>Barleria prionitis</i> , <i>Hygrophila auriculata</i> , <i>Justicia procumbens</i> , <i>Nelsonia campestris</i> (Acanthaceae); <i>Sida rhombifolia</i> (Malvaceae); <i>Corchorus capsularis</i> (Tiliaceae)
<i>Junonia almana</i> (Linnaeus)	<i>Barleria strigosa</i> , <i>Hygrophila auriculata</i> (Acanthaceae); <i>Osbeckia muralis</i> (Melastomataceae)
<i>Hypolimnas bolina</i> (Linnaeus)	<i>Sida rhombifolia</i> , <i>Hibiscus scandens</i> (Malvaceae); <i>Potulaceae oleracea</i> (Portulacaceae); <i>Elatostema cuneatum</i> , <i>Laportea interrupta</i> (Urticaceae)
<i>Hypolimnas misippus</i> (Linnaeus)	<i>Asystasia macrocarpa</i> , <i>Barleria cristata</i> (Acanthaceae); <i>Abelmoschus manihot</i> , <i>Hibiscus scandens</i> (Malvaceae); <i>Portulaca oleracea</i> (Portulacaceae)
<i>Kallima inachus</i> (Boisduval)	<i>Strobilanthes capitatus</i> (Acanthaceae)
<i>Doleschallia bisaltide</i> (Cramer)	<i>Urtica dioica</i> (Urticaceae); <i>Erythrina variegata</i> (Fabaceae)
<i>Kallima alompra</i> Moore	<i>Asystasia macrocarpa</i> (Acanthaceae)

Table 4. Host Plant Specificity (HPS) and Polyphagy Index (P_i) of butterflies.

Butterfly Species	HPS	P _i
<i>Araschnia prorsoides</i> (Blanchard)	1S	1.000
<i>Symbrenthia niphanda</i> Moore	1S	1.000
<i>Symbrenthia hypselis</i> (Godart)	1F	2.449
<i>Symbrenthia hippoclus</i> (Cramer)	1G	1.414
<i>Vanessa indica</i> (Herbst)	1F	2.449
<i>Limenitis trivena</i> Moore	1F	2.449
<i>Vanessa cardui</i> (Linnaeus)	2F	4.472

Table 4. Cont.

Butterfly Species	HPS	P _i
<i>Aglaia cashmiriensis</i> (Kollar)	1F	2.449
<i>Aglaia urticae</i> (Linnaeus)	1S	1.000
<i>Kaniska canace</i> (Linnaeus)	2F	3.162
<i>Polygonia egea</i> (Cramer)	1S	1.000
<i>Rhinopalpa polynice</i> (Cramer)	1S	1.000
<i>Junonia orithiya</i> (Linnaeus)	3F	4.475
<i>Junonia hierta</i> (Fabricius)	1F	2.449
<i>Junonia atlites</i> (Linnaeus)	1F	2.449
<i>Junonia iphita</i> (Cramer)	1F	2.449
<i>Junonia lemonias</i> (Linnaeus)	3F	5.477
<i>Junonia almana</i> (Linnaeus)	2F	3.873
<i>Hypolimnas bolina</i> (Linnaeus)	3F	5.000
<i>Hypolimnas misippus</i> (Linnaeus)	3F	5.000
<i>Kallima inachus</i> (Boisduval)	1S	1.000
<i>Doleschallia bisaltide</i> (Cramer)	2F	3.162
<i>Kallima alompra</i> Moore	1S	1.000

4. Discussion

Modern healthcare facilities still appear insufficient for the local populace in the study area. However, in most cases, knowledge about traditional medicines is undocumented and any novel information could probably open up newer avenues in the pharmacological sector, benefiting millions. Exploration of the therapeutic potential of the plant species studied could also help in their greater recognition, enhancing the transmission of such knowledge to the present generation. Higher Utilization Values (Uv) representing greater therapeutic importance were found for *Urtica dioica* and *Hygrophila auriculata* in this study. As observed, such plant species were previously reported to treat different categories of ailments [13,14]. However, the lower Utilization Values (Uv), as reported for *Barleria prionitis*, could probably be due to their reduced popularity among locals or less reports being made by informants during the interviews. *Artemisia vulgaris*, *Dioscorea deltoidea* and *Mimosa pudica*, with the highest F_L values, were recognized to be immensely beneficial for the treatment of a single disease, which was also documented previously [15–17]. However, *Strobilanthes capitatus* and *Portulaca oleracea*, with lower F_L values, were less preferred for the treatment of single ailments, but were used for curing multiple diseases [18,19]. Species possessing a higher ICF are associated with problems involving the digestive and respiratory systems. However, lower ICF values for others could probably be attributed to the availability of alternative pharmaceuticals, thereby reducing the dependence on traditional remedies.

Besides being recognized for their immense medicinal benefits, Urticaceae with their highly toxic stinging hairs are the most popular host plant of Nymphalini butterflies in this study [20,21]. Nymphalinae butterflies, i.e., *Vanessa*, *Aglaia*, *Symbrenthia* and *Polygonia*, occur mostly in the Himalayas, while *Junonia* and *Hypolimnas* preferably inhabit the tropics. Additionally, colonization on multiple host plants (predominantly Malvaceae, Acanthaceae, Potulaceae, Fabaceae) by Junoniini and Kallimini could probably be associated with the need for a huge spectrum of phytochemicals in this study. Strict specificity among *Araschnia prorsoides* and *Aglaia urticae*, as observed for *Urtica*, could probably be attributed to the plethora of secondary metabolites abundant in them [22]. *Aglaia* larvae possess a set

of detoxification-related genes and protective enzymes in their bodies to counteract the influence of secondary metabolites [23,24].

Nymphalini is believed to have diverged from Nymphalidae during the Palaeocene, approximately 60–65 Mya. Host order Lamiales was reported to be colonized after this event, but before the emergence of present-day clade (Kallimini and Melitaeini) [5]. Although the shift in feeding preferences originating in lineages in the late Paleocene or early Eocene has been observed, the tendency to feed on urticalean rosids was still retained among *Doleschallia* in this and previous studies [5]. Interestingly, elevated diversity in host plant utilization among Nymphalinae could be linked to their ancestral polyphagy [4]. The present study represents an instance of polyphagy among *Junonia* and *Hypolimnias*. By feeding on one or more plant families, such butterflies probably utilize a varied set of phytochemicals. Significantly, phytophagy among butterflies is intricately linked to plant taxonomic diversity [25], involving specialization on a set of closely related plant species [26–28]. The choice of larval host plants in butterflies is determined both at the egg-laying stage and at multiple larval feeding stages [29]. In order to be quite precise in host recognition, such phytophagous insects utilize multiple sensory modalities. Besides visual, olfactory mechanism and gustatory cues, allelochemicals originating from both host and non-host plants play a decisive role in egg-laying behavior [30–32]. Butterflies are known to display hierarchy in their host preferences, discriminating among plant species, among genotypes and among individuals, demonstrating different phenological and physiological preferences [33]. Importantly, phytochemical diversity also enlightens the fact that the mixture of secondary metabolites within plant species may differently impact herbivores possessing a varied diet breadth, in turn creating plant-specific herbivore assemblages [34,35]. Higher specificity in host plant choice is associated with lower polyphagy among those species. So, Pi and HPS can be considered to be inversely related. Importantly, monophagy, as observed among *Araschnia prorsoides*, *Symbrenthia niphanda*, *Aglaia urticae*, *Polygonia egea*, *Rhinopalpa polynice*, *Kallima inachus* and *K. alompra*, could probably be associated with a strict preference for a particular group of phytochemicals among their host plants. Specialist herbivores are known to share a similar co-evolutionary history with plants, often being specially adapted to a particular class of compounds [36]. The association of *Junonia* with *Barleria*, as observed in this study, appears significant. With its glycoside sequestering ability [37], *Junonia* appears likely to justify such a relationship with its food plant. The abundance of iridoid glycosides in such plant species also appears to be worth mentioning [38,39]. According to the “extreme diet breadth hypothesis”, higher phytochemical diversity could be associated with a narrow diet breadth among specialists and a wide diet breadth among generalists [36].

5. Conclusions

The interaction of herbivore insects with their host plants could probably be attributed to the presence of a unique combination of phytochemicals. The enormous benefits of such plants due to their therapeutic potential are also noteworthy. The proper utilization of the knowledge of ethnic people, along with the conservation of such plants, is essential. Similar strategies should also be designed for the management of these plants which serve as the larval resources of butterflies.

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