A COMPREHENSIVE INVENTORY AND ECOLOGICAL ASSESSMENT OF ALIEN PLANT INVASION IN MIZORAM, INDIA

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A COMPREHENSIVE INVENTORY AND ECOLOGICAL ASSESSMENT OF ALIEN PLANT INVASION IN MIZORAM, INDIA. Invasion by alien plants has a detrimental effect on the natural forest plant community, leading to the loss of native species. An inventory of alien plants facilitates in determining the potential threats to the natural plant biodiversity. This present paper evaluates the alien plants in Mizoram (an Indo-Burma hotspot region) and provides the first authentic inventory of alien plants of Mizoram along with their diversity, ecological aspects, origin, and status of invasion. Extensive field surveys were done during July 2018 to September 2019 in different protected areas of Mizoram. We adopted Random Sampling Technique using nested quadrats in a plot size of 400 m$^2$ (20 m × 20 m), within which a quadrat size of 5 m × 5 m was laid for shrubs and 1 m × 1 m was laid for herbs. Plant specimens were collected, dried, poisoned with 0.1% Mercuric Chloride (MgCl$_2$); voucher specimens were prepared and deposited in Central National Herbarium, Botanical Survey of India (CAL) after proper identification. The results revealed the occurrence of 163 alien plant species under 135 genera belonging to 51 families in Mizoram. Maximum species were represented by family Asteraceae with 29 species followed by Leguminosae (19 species), Convolvulaceae (9 species), Euphorbiaceae (7 species) and Amaranthaceae (7 species). The 57.66% of the alien species reported from Mizoram were of American origin followed by 11.65% from African, 7.36% from Mexican and 5.52% from Australian origin. Life form analysis revealed the presence of 58.64% herbs, 15.43% trees and 9.87% shrubs. Out of the whole alien plants recorded, 91 species were used for traditional medicines, 43 species as ornamental, 15 species were edibles, nine species used as timber and four species used as green manure. The study also recommends the ten most obnoxious species, five neo-invasive plants, which have the greatest potential threats to the native flora. The process and probable causes of invasion in the state were also discussed briefly, which may be utilized in the preparation of conservation or forest management policies.

Keywords: Alien plants, invasive, neo-invasive, biodiversity, Mizoram

INVENTARIASI KOMPREHENSIF DAN PENILAIAN EKOLOGI INVASI JENIS-JENIS ASING DI MIZORAM, INDIA. Invasi oleh tumbuhan asing memiliki efek yang merugikan pada komunitas tumbuhan hutan alam, yang menyerahkan hilingnya spesies asli. Inventarisasi tumbuhan asing memudahkan untuk menentukan potensi ancaman terhadap keanekaragaman hayati tumbuhan alam. Tulisan ini mengevaluasi tumbuhan asing di Mizoram (wilayah hotspot Indo-Burma) dan merupakan inventarisasi otentik pertama tanaman asing Mizoram bersama dengan keanekaragaman, aspek ekologi, asal-usul dan status invasi mereka. Survei lapangan ekstensif dilakukan dari Juli 2018 hingga September 2019 di berbagai kawasan lindung Mizoram. Pengambilan sampel mengadopsi Teknik Pengambilan Sampel Acak menggunakan kuadrat bersarang di plot berukuran 400 m$^2$ (20 m × 20 m), di mana ukuran kuadrat 5 m × 5 m diletakkan untuk semak dan 1 m × 1 m untuk tumbuhan. Spesimen tanaman dikumpulkan, dikeringkan, diracun dengan 0,1% Mercuric Chloride (MgCl$_2$); voucher spesimen disiapkan dan disimpan di Central National Herbarium, Botanical Survey of India (CAL) setelah identifikasi yang tepat. Hasil penelitian menunjukkan terjadinya invasi 163 spesies tumbuhan asing di bawah 135 genera milik 51 famili di Mizoram. Spesies terbesar yang teridentifikasi adalah famili Asteraceae dengan 29 spesies diikuti oleh Leguminosae (19 spesies), Convolvulaceae (9 spesies), Euphorbiaceae (7 spesies) & Amaranthaceae (7 spesies). 57,66% spesies asing yang dilaporkan dari Mizoram berasal dari Amerika diikuti oleh 11,65% dari Afrika, 7,36% dari Meksiko & 5,52% dari Australia. Analisis bentuk kehidupan menunjukkan keberadaan 58,64% tumbuhan, 15,43% pohon dan 9,87% semak. Dari seluruh tumbuhan asing yang tercatat, 91 jenis dimanfaatkan untuk pengobatan tradisional, 43 jenis

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I. INTRODUCTION

Alien plants, introduced or spread outside their natural habitats, have affected natural biodiversity in almost every ecosystem type on earth and are one of the greatest threats to biodiversity (UN, 2014). These plants not only affect the species composition, spatial distribution of the native flora but also impact directly or indirectly on the resources, structures and functions of natural ecosystems (Downey & Richardson, 2016). Efficient mechanism of seed dispersal, high growth rate, great adaptability to wide ranges of environmental conditions are some of the essential processes for the successful establishment of alien plants (Simberloff, Parker, & Windle, 2005). Species that can withstand a wide range of environmental conditions show a broader physiological niche and are likely to be more invasive (Higgins & Richardson, 2014). Almost 0.5–0.7% of global woody plant species is currently invasive outside their natural range (Rejmánek & Richardson, 2013).

Invasive alien species can be recognized as a critical component of global environmental change because, after establishment, they randomly proliferate in all direction; mainly when the environment is conducive as in a rough and sloppy mountain terrains (Rumlnerová, Vilá, Pergl, Nentwig, & Pyšek, 2016). The recent global climate change has also catalysed the rate of introduction and spread of alien species into areas where they were previously absent, or increased their performance as compared to native species. Evidence is quite common when many invasive alien species viz. Ageratum conyzoides, Ageratina adenophora, Chromolaena odorata, Lantana camara, Mikania micrantha and Parthenium hysterophorus have brought about havoc in terrestrial ecosystems, while Eichhornia crassipes, Pistia stratiotes in aquatic ecosystems by significantly changing the structure and composition of native vegetation (Raizada, Sharma, & Raghubanshi, 2008).

Taxonomic identity of alien species, their origin, distribution, spread pattern, habitat and mode of introduction are the prerequisite for any management strategy against invasive species. The entire region of Northeast India including Mizoram, Khasia and Jaintia hills (K&J hill), Lushai Hills, Manipur were under Assam province during the colonial era. Mikania micrantha was introduced during World War-II as a ground cover for tea plantations and camouflaged the airfields in this region (Shankar, Yadav, Rai, & Tripathi, 2011). Therefore, the introduction of the alien plants in Mizoram might have followed the path K&J hill- Silchar-Aizawl-Lushai hills and subsequently spread throughout the state. Report on the collection of Mikania micrantha dated back to 1956, Chromolaena odorata in 1938, Ageratina riparia in 1958 and Ageratina adenophora in 1931 from this region.

Sporadic information is available on alien species, particularly on Indian Himalayan regions. Ecological studies on invasive plants, mainly on Ageratum conyzoides, Parthenium hysterophorus and Lantana camara were reported from the north-western Himalayan region (Kohli, Batish, Singh, & Dogra, 2006); 571 alien species enumerated from the Kashmir Himalayas (Khuroo, Reshi, Rashid, & Dar, 2011); 190 alien species identified from Indian Himalayan region (Sekar, Manikandan, & Srivastava, 2012); 497 alien species enumerated...
from Himachal Pradesh (Jaryan, Uniyal, Gupta, & Singh, 2013). However, accurate estimation on the spread of invasive species and its potential threats is not available from North-eastern states of India, particularly from Mizoram. A proper estimation of floristic elements or landscapes infested with invasive alien plants is the need of the hour to build appropriate strategies for conservation and management of natural flora. Keeping in mind these problems, the present study was carried out in the state of Mizoram (a) to prepare a comprehensive inventory of alien plant species in Mizoram and (b) to evaluate the invasion status of the ten most obnoxious invasive alien plant species; and to propose the five neo- invasive alien plant species, which possess potential threats to the local flora.

II. MATERIAL AND METHOD

A. Study Site

The state of Mizoram is one of the smallest north-eastern states of India situated in the extreme eastern part of India (Figure 1); the state is bounded by two international boundaries viz., Myanmar (Burma) on the east and Bangladesh on the west; Tripura, Assam and Manipur also share a common border with the state. The forest cover of the state is 73.68% of the state’s total geographical area out of which only 6.75% is under protected area network. Summer temperature varies from 18°C to 29°C and winter temperature varies from 11°C to 24°C. The average annual rainfall of the state ranges between 2160 mm to 3500 mm (FSI, 2019). For the convenience of the present work, we have selected four protected

Figure 1. Map of the study site
areas viz. Phawngpui National Park (50 km²), Murlen National Park (100 km²), Lengteng Wildlife Sanctuary (60 km²) and Dampa Tiger Reserve (500 km²). Besides non-protected areas viz. Sangau, Aizawl, Knahlan were also selected. The vegetation of the state can be broadly categorized in to tropical (up to 900 m), subtropical (900−1800 m) and temperate (1800−3600 m) depending on the elevation and precipitation. All the studied plots were situated in subtropical and temperate regions of the state.

B. Methods

The present study was carried out during July 2018 to September 2019 as a part of the collaborative research project “Ecological Investigations to understand causes and consequences of invasion in Tripura & Mizoram” under the National Mission on Himalayan Studies (NMHS). Intensive field surveys were undertaken in a planned manner in different seasons to collect the plant specimens from selected protected and unprotected areas of Mizoram. Plant samples were collected for preparation of voucher herbarium specimens. The specimens were poisoned with 0.1% Mercuric Chloride (MgCl₂), mounted on standard handmade herbarium sheets (28 × 42 cm) and labelled (14.5 × 11 cm), after incorporating all the relevant field information. These were deposited in Central National Herbarium, Botanical Survey of India (CAL) after proper identification. An exhaustive inventory of alien plants of the state was prepared based on the collections from the field and also by examining the herbarium specimens from multiple herbaria (CAL, ASSAM and ARUN) of the region. Based on the mode of introduction, rate of invasion, nature of the invaded habitats and importance value index (IVI) ten most obnoxious invasive alien plants and five top neo-invasive species were grouped. For the collection of data on the mode of introduction and usefulness of alien plants, the local people were interviewed with an open-ended questionnaire.

C. Data Analysis

All the phytosociological data i.e., relative densities, relative frequency, relative dominance, IVI of each species were determined using formulas mentioned by (Misra, 1968). Importance Value Index (IVI) was calculated by the addition of relative values of frequency, density and dominance (Curtis & McIntosh, 1950).

The formulae used for the various calculations are:

\[ \text{Density} = \frac{\text{No. of individuals of a species}}{\text{Total No. of quadrats studied}} \]  
\[ \text{Frequency} = \frac{\text{No. of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}} \times 100 \]  
\[ \text{Abundance} = \frac{\text{Total No. of individuals of a species}}{\text{Number of quadrats of occurrence}} \]  
\[ \text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Frequency of all the species}} \times 100 \]  
\[ \text{Relative Density} = \frac{\text{Density of a species}}{\text{Density of all the species}} \times 100 \]  
\[ \text{Relative Dominance} = \frac{\text{Basal area of a species}}{\text{Basal area of all species}} \times 100 \]

Where: Basal area = \( \pi r^2 \), \( \pi = 3.14 \) and \( r = \text{radius of the species} \);
Importance Value Index (IVI) = Relative Frequency + Relative Density + Relative Dominance
Importance Value Index (IVI) was calculated separately for each species of the community. A particular species, that having highest value of importance value index (IVI) is considered as most dominant in the area and the species with lowest importance value is considered as the least dominant. The comparisons among the phytosociological data were analysed in Microsoft Excel Software (2019 versión). GPS locations were investigated and the digital elevation map of the study site was prepared using ArcGIS online tools. Based on the mode of introduction, rate of invasion, nature of the invaded habitats and importance value index (IVI) ten most obnoxious alien invasive alien plants and five top neo-invasive species were determined.

III. RESULT AND DISCUSSION

Extensive field exploration tours undertaken in the protected and non-protected areas of Mizoram resulted in a collection of more than 1045 plant samples. During the study, 163 alien plant species were recorded from Mizoram belonging to 135 genera and 51 families (See Appendix 1, Table 1). Out of these, 147 species belongs to 122 genera and 43 families were dicotyledons; 11 species belongs to 9 genera and five families were monocotyledons. Five species of gymnosperms under four genera and three families were also recorded.

Table 2. Top ten families among the alien plants (with minimum fourspecies)

| No. | Family       | Species |
|-----|--------------|---------|
| 1.  | Asteraceae   | 29      |
| 2.  | Leguminosae (s.l.) | 19   |
| 3.  | Convolvulaceae | 9      |
| 4.  | Euphorbiaceae | 7      |
| 5.  | Amaranthaceae | 7      |
| 6.  | Malvaceae    | 6      |
| 7.  | Solanaceae   | 7      |
| 8.  | Verbenaceae  | 5      |
| 9.  | Acanthaceae  | 4      |
| 10. | Poaceae      | 4      |

Besides, out of the total reported plant species, 95 plant species were represented by herbs (58.28%), 25 trees (15.33%), 20 shrubs (12.26%), 14 climbers (8.58%), four grasses (2.45%) and only two species of sedges (1.27%). Maximum percentage of alien plants, i.e., 38.03% (62 taxa) occur in Mizoram were from Tropical American origin followed by 13.49% (22 taxa) from South American, 9.81% (16 taxa) from Tropical African, 7.3% (12 taxa) from Mexican and 5.5% (9 taxa) from Australian origin. The plants belonging to the different nativity was given in Figure 2.

The most dominant families with maximum species diversity shown in Table 2. Asteraceae with 29 species represented was the most dominant family followed by Leguminosae, Convolvulaceae, Euphorbiaceae,
Amaranthaceae, and Malvaceae. Ten most dominating families contribute 59.06% of total alien species found.

Among the most dominant families, two families viz., Asteraceae, Convolvulaceae were also reported as dominant in Indian Himalayan region (Sekar, Manikandan, & Srivastava, 2012) as well as throughout India (Reddy, 2008). The dominance of these two families as effective invaders in natural forests may be attributed to the high production of viable seeds which usually dispersed by wind in Asteraceae, and successful vegetative reproduction in members of Convolvulaceae.

Observation on invaded habitats revealed that Tropical Wet Evergreen forest (31%) and Montane sub-tropical forest (17%) were most invaded forests whereas Fallow Lands (22%) and Jhumlands (20%) were invaded habitats outside the forest area (Figure 3). It is also found that 52.5% of alien plants were perennials and 47.5% annuals. The percentage of perennial alien plant contribution in Mizoram (52.5%) is higher than the average contribution of Indian Himalayan region (37%) implies that alien species are probably well established in Mizoram, or natural vegetation is more vulnerable. A moderate-higher percentage of annual alien species in the state indicates, the forest is degraded and also substantiate our findings of the gregarious spread of invasive species in mountain slopes (Figure 6). The preferred habitat of spreading of invasive species in different habitat in Mizoram is almost similar to other Indian Himalayan region (Sekar, Manikandan, & Srivastava, 2012) as well as throughout India (Reddy, 2008). The most preferred habitats of roadsidess, wetlands and fallow lands may be attributed to low competition and high disturbances in these regions.

An open-ended interview with the local villagers, forest officials and in-depth observation on the probable mode of introduction of the alien species revealed, 62.34% of the total alien species possibly introduced unintentionally while 29.62% of species were introduced for ornamental purpose and 8.02% were introduced as a food (Figure 4).

The biodiversity of a forest area controls the economy of the surrounding villages and partially fulfils their basic requirements like food, medicine, thatching material, and fodder etc. Study on the use pattern of the alien species among the local inhabitants revealed that 91 species had been used as medicinal purposes, 43 species as ornamental, 15 species as foods, nine species as fuel woods, four species as green manure and use of 6 species were not known to the locals (Figure 5). *Acmella oleracea* (flowers, stems), *Solanum torvum* (seeds) were
used for curing toothache; *Bidens pilosa* (leaf juice) was used for swollen glands and as eye-drops. Crushed leaf juice of *Chromolaena odorata*, *Mikania micrantha* were applied externally on cuts and wounds as antiseptic; leaves of *Oxalis corniculata* were eaten raw to reduce stomach ache. Leaf juice of *Achyranthus aspera* and *Ageratum conyzoides* were applied on sore-legs of domestic animals. Dried inflorescences of *Ocimum americanum* and dried leaves *Eryngium foetidum* were used as condiments in local cuisine. Tender fruit pods of *Leucaena leucocephala* were boiled with other vegetables for food. *Argemone mexicana* extract was used for adulteration purpose with mustard oil. *Annona reticulata* and *Annona squamosa* fruits were consumed widely by the locals. Leaves of *Saccharum spontaneum* and *Typha angustifolia* were used for rope making and thatching purpose. Brooms made up of dried leafless stems of *Sida acuta* were used for household cleaning purposes. 

Based on the phytosociological data, ten most invasive alien plants in four protected areas (Phawngpui National Park, Murlen National Park, Lengteng Wildlife Sanctuary, Dampa Tiger reserve) were observed highly proliferative. In Phawngpui national park, *Ageratina adenophora* (IVI-62.76), *Hypoestis phyllostachya* (IVI-29.06), *Ageratina riparia* (IVI-50.91) were the most dominant invasive alien species with associated native species like *Lobelia pyramidalis* (IVI-54.46), *Lindenbergia grandiflora* (IVI-52.27), *Anisochilus carnosus* (IVI-37.55) and *Ainsliaea latifolia* (IVI-36.01) occurring between
1400-2250 m of elevation whereas *Chromolaena odorata* (IVI-45.83), *Mikania micrantha* (IVI-59.64), *Imperata cylindrica* (IVI-24.83) were observed dominant over native species like *Strobilanthes maculata* (IVI-21.20) and *Impatiens stenantha* (IVI-32.53) up to 1550 m of altitude only. In Phawngpui National Park, frequency of native species was higher compared to other three protected areas. In Murlen National Park, native plants like *Ainsliaea latifolia* (IVI-23.65), *Oplismenus burmanii* (IVI-20.04) and *Strobilanthes maculata* (IVI-18.09) associated with dominant invasive plants *Ageratina adenophora* (IVI-57.94), *Ageratina riparia* (IVI-46.11), *Mikania micrantha* (IVI-57.10) and *Lantana camara* (IVI-44.48), *Chromolaena odorata* (IVI-37.05) were observed in 700-2149 m of elevation. In Lengteng Wildlife Sanctuary, between 400–1250 m of altitude, *Impatiens stenantha* (IVI-20.16), *Eragrostis curvula* (IVI-20.74), *Oplismenus burmanii* (IVI-23.96), *Strobilanthes maculata* (IVI-17.75) and *Osbeckia chinensis* (IVI-28.88) were dominant associated native species with invasive alien plants like *Osbeckia diversifolia* (IVI-33.41, 26.24), *Ipomoea hederifolia* (IVI-35.80, 36.50), *Ipomoea cairica* (IVI-29.10, 25.18), *Crassocephalum crepidioides* (IVI-45.53, 11.51), *Galinsoga parviflora* (IVI-21.12, 20.30). We have observed only one potential new invasive species *Ipomoea bederifolia* (IVI-37.53) in Murlen national park and two potential new invasive species *Ipomoea cairica* (IVI-46.58), *Crassocephalum crepidioides* (IVI-22.62) in Dampa tiger reserve in Mizoram. These new invasive species were firstly invading into the natural vegetation regions and posed a significant threat to it (Table 4).

From the present study, it can be concluded that *Ageratina adenophora*, *Ageratina riparia*, *Mikania micrantha*, *Lantana camara*, *Ageratum houstonianum*, *Chromolaena odorata*, *Hypoestis phyllostachya*, *Bidens pilosa*, *Imperata cylindrica*, *Ageratum conyzoides* are the most harmful alien plants responsible for a high-volume invasion in forest lands, roadsides and fallow lands which causing noticeable damage to the flora of Mizoram. Besides five most neo-invasive species, namely *Tithonia diversifolia*, *Ipomoea bederifolia*, *Ipomoea
Table 3. Phytosociological information of ten most-noxious invasive alien species in protected areas in Mizoram

| Name of the plants               | Frequency | Density | Abundance | IVI   |
|----------------------------------|-----------|---------|-----------|-------|
|                                  | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR |
| Ageratina adenophora             | 90   | 80   | 70  | -   | 12.5 | 17.5 | 14.9 | -   | 13.88 | 21.87 | 21.28 | -   | 62.76 | 57.94 | 55.31 | - |
| Ageratina riparia                | 70   | 70   | 80  | -   | 10.80 | 14.9 | 17.5 | -   | 15.43 | 21.29 | 21.88 | -   | 50.91 | 46.11 | 77.23 | - |
| Mikania micrantha               | 100  | 75   | 100 | 40  | 30.29 | 13.13 | 24.14 | 10.8 | 30.29 | 17.50 | 24.14 | 27  | 59.64 | 57.10 | 50.42 | 45.39 |
| Hypoestis phyllanthoides        | 60   | 10   | 40  | -   | 8.1  | 0.3  | 2.6  | -   | 13.5  | 2.00  | 4.50  | -   | 29.06 | 18.32 | 15.34 | - |
| Lantana camara                 | -    | 50   | 28.57 | 40  | 4.75 | 5.86 | 13   | -   | 9.50  | 20.50 | 32.5  | -   | 44.48 | 35.76 | 47.34 |
| Ageratum houstonianum           | 70   | -    | 40  | 50  | 9.50 | -    | 9.5  | -   | 9.50  | 19    | 35.96 | -   | 24.2  | 45.33 |
| Chromolaena odorata            | 28.57 | 70   | 57.14 | 60  | 5.86 | 5.5  | 5.57 | 4.8  | 20.50 | 7.85  | 9.75  | 8.00  | 45.83 | 37.05 | 45.26 |
| Bidens pilosa                  | 50   | 30   | 30  | 80  | 3.2  | 1.5  | 3.1  | 16.5 | 6.40  | 5.00  | 10.33 | 20.62 | 24.2  | 22.2  | 23.58 |
| Imperata cylindrica            | 50   | 30   | 30  | -   | 2.8  | 2.7  | 2.7  | -   | 20.00 | 9.80  | 9.00  | -   | 24.83 | 19.74 | 23.58 |
| Ageratum conyzaoides           | 20   | 60   | 20  | 90  | 0.60 | 7.3  | 2.5  | 23.1 | 3.00  | 12.16 | 12.50 | 25.66 | 10.63 | 18.88 | 25.35 |

Remarks: PNP=Phawngpui National Park, MNP= Murlen National Park, LWS= Lengteng wildlife Sanctuary, DTR=Dampa Tiger Reserve

Table 4. Phytosociological information of top ten dominant native species in protected areas in Mizoram

| Name of the plants               | Frequency (%) | Density | Abundance | IVI   |
|----------------------------------|---------------|---------|-----------|-------|
|                                  | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR | PNP  | MNP  | LWS | DTR |
| Lobelia pyramidalis              | 60   | -    | 50  | -   | 4.2  | -    | 7.00 | -   | 6.40 | 54.46 | 11.11 | -   | - |
| Lindenbergia grandiflora        | 30   | 60   | 40.00 | 4.7  | 3.40 | 2.70 | 5.67 | -   | 5.67 | 6.75 | 52.27 | 13.33 | 28.55 |
| Anisochilus carnosus            | 20   | 30   | 40  | 1.7  | 2.10 | -    | 14   | -   | 7.00 | 37.55 | 22.96 |
| Ainsliea latifolia              | 40   | 30   | 40  | 3.8  | 3.1  | 3.20 | 9.50 | 10.33 | 8.00 | 36.01 | 23.65 | 8.89 |
| Impatiens stenantha             | 30   | 60   | 20  | 20.00 | 2.5  | 1.30 | 1.60 | 1.70 | 8.33 | 6.50 | 8.00 | 8.50 | 32.53 | 20.16 | 22.44 |
| Eretracis curvula                | 60   | 30   | 20  | 20.00 | 2.5  | 2.7  | 1.40 | 2.80 | 17.86 | 9.00 | 7.00 | 32.74 | 19.74 | 20.74 |
| Oplismenus burmanii             | 60   | 20   | 30  | 40  | 2.80 | 8.00 | 15.00 | 11.00 | 6.00 | 27.41 | 20.04 | 23.96 |
| Strobilanthes maculata          | 50   | 40   | 20  | 20  | 2.2  | 2.6  | 1.50 | 12.22 | 6.50 | 7.50 | 21.20 | 18.09 | 17.75 |
| Osbeckia chinensis              | -    | 20   | 30  | 30.00 | -    | 2.80 | 1.90 | -   | 14.00 | 6.33 | -   | 23.88 | 18.89 |
| Elatostema sessile              | -    | 40   | 50.00 | 9.50 | 3.70 | -    | 2.25 | 2.70 | -   | 17.75 | 17.75 | -   | 31.90 |

Remarks: PNP=Phawngpui National Park, MNP= Murlen National Park, LWS= Lengteng wildlife Sanctuary, DTR=Dampa Tiger Reserve
Table 5. Phytosociological data of five neo-invasive alien species in protected areas in Mizoram

| Name of the plants       | Frequency | Density | Abundance | IVI |
|--------------------------|-----------|---------|-----------|-----|
|                          | PNP       | MNP     | LWS       | DTS |
|                          | PNP       | MNP     | LWS       | DTS |
|                          | PNP       | MNP     | LWS       | DTS |
|                          | PNP       | MNP     | LWS       | DTS |
|                          | PNP       | MNP     | LWS       | DTS |
| **Tithonia diversifolia**| 57.14     | -       | 42.86     | -   |
|                          | 6.71      | 5.71    | 11.75     | 13.33|
|                          | 33.41     | 26.24   | -         | -   |
| **Ipomoea hederifolia**  | 71.43     | 37.5    | 28.57     | -   |
|                          | 12.43     | 9.14    | 17.40     | 32.00|
|                          | 35.80     | 36.50   | -         | -   |
| **Ipomoea cairica**      | 42.86     | 71.43   | 60        | -   |
|                          | 4.86      | 11.33   | 4.80      | 27  |
|                          | 29.10     | 25.18   | -         | -   |
| **Crassocephalum crepidioides** | 60       | 20      | 7.30      | -   |
|                          | 1.6       | 3.5     | 8.00      | 7   |
|                          | 45.53     | 11.51   | 22.62     | -   |
| **Galinsoga parviflora** | 50        | 60      | 30        | -   |
|                          | 7.40      | 11.66   | 5.00      | -   |
|                          | 21.12     | 20.30   | -         | -   |

Remarks: PNP=Phawngpui National Park, MNP= Murlen National Park, LWS= Lengteng wildlife Sanctuary, DTR=Dampa Tiger Reserve
Cairica, Crassocephalum crepidioides, Galinsoga parviflora are the most potential invasive species spreading aggressively between 500 m to 1800 m of elevation (Table 5). The most probable reasons for these rapid invasions and declining biodiversity may be attributed to allelopathic effect, fragile soil, a high influx of tourist, land clearance and the livestock-dependent lifestyle of local inhabitants of this region (Chen, Peng, & Ni, 2009).

Some of the successful strategies which has been used to control invasive species include: (i) ecological restoration by allowing selected indigenous plant species with potential to outcompete invasive species to flourish, (ii) mechanical control in combination with crop-competition method, and (iii) cut-root-stock method combined with introduction of native legumes and grasses (CBD, 2019), chemical control and biological control (Singh, 2017).

Figure 6. The invasive spread of (A) Ageratina adenophora (Spreng.) M.King & H.Rob. (B) Mikania micrantha Kunth. (C) Ageratina riparia (Regel) R.M.King & H.Rob. (D) Ageratum houstonianum Mill. (E) Lantana camara L. (F) Mimosa diplotricha Wright. in Mizoram, India.
**Lantana camara** was reported to be efficient in heavy metal as well as particulate pollution phytoremediation in Mizoram which shows promising use of invasive plants in pollution abatement phytotechnologies to assist in their sustainable management (Rai & Singh, 2015). Education and awareness programmes developed by different agencies were essential which helped to restrict the spread of invasive species in the state. In this connection, during the study period, two awareness programmes were organized by the authors in collaboration with state Forest Department in Phawngpui national park and Mizoram University which had a great positive impact in the local stakeholders. Department of Environment, Forests and Climate Change, Government of Mizoram has taken up the task of developing a suitable framework to Control and Eradication of Forest Invasive Species in Mizoram (Singh et al., 2016).

**IV. CONCLUSION**

Mizoram is a biodiversity-rich state and invasion of alien species is emerging as a significant concern for the conservation of native flora. Majority of the population are forest dwellers and mainly dependant on forest resources. Therefore, first-hand information on native flora and invasive flora is needed for formulating scientific management strategy for long-term sustainable utilization. Controlled practices of traditional slash-and-burn cultivation, strict quarantine measures for importing of food crops and introduction of exotic plants are needed to be streamlined to strengthen a strategy for proper utilization, generate livelihood and wellbeing of the society. Regular awareness programmes may also to be conducted to appraise the local inhabitants about the impacts and control of invasive alien plants.

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| S.No. | Accepted names                          | Families      | Taxonomic Sub-group | Nativy | Habit | Growth form | Mode of introduction | Habitats invaded | Uses   |
|-------|----------------------------------------|---------------|---------------------|--------|-------|-------------|----------------------|------------------|--------|
| 1.    | *Acacia auriculiformis* Benth.         | Leguminosae(s.l)¹ | D                   | AUS    | P     | T           | OR                   | TWF              | Med    |
| 2.    | *Acmella radicans* (Jac.) R. R. Janses | Asteraceae     | D                   | MEX    | P     | H           | U                   | JL               | Med    |
| 3.    | *Aeschynomene americana* L.            | Leguminosae(s.l)³ | D                   | TAM    | P     | H           | U                   | MTF              | Man    |
| 4.    | *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. | Asteraceae     | D                   | MEX    | P     | H           | OR                  | MTF, TEF         | Man    |
| 5.    | *Ageratina riparia* (Regel) R.M.King & H. Rob. | Asteraceae     | D                   | CAM    | P     | H           | U                   | TEF              | Man    |
| 6.    | *Ageratum houstonianum* Mill.          | Asteraceae     | D                   | TAM    | A     | H           | OR                  | TWF, MTF         | Bio    |
| 7.    | *Ageratum ovzoides* (L.) L.            | Asteraceae     | D                   | TAM    | A     | H           | OR                  | TWF, MTF         | Med    |
| 8.    | *Alternanthera paronyxiioides* St. Hill. | Amaranthaceae  | D                   | TAM    | A     | H           | U                   | TWF              | Med    |
| 9.    | *Alternanthera philoceroides* (Mahrt.) Griseb. | Amaranthaceae  | D                   | TAM    | A     | H           | F                   | TWF              | Food   |
| 10.   | *Alternanthera sessilis* (L.) DC.      | Amaranthaceae  | D                   | TAM    | A     | H           | U                   | TWF              | Med    |
| 11.   | *Alternanthera ficoidea* (L.) Sm.      | Amaranthaceae  | D                   | TAM    | A     | H           | U                   | TWF              | Med    |
| 12.   | *Altha rosea* (L.) Cav.                | Malvaceae      | D                   | EUR    | P     | H           | OR                  | JL               | Orn    |
| 13.   | *Amaranthus spinosus* L.               | Amaranthaceae  | D                   | TAM    | A     | H           | F                   | JL               | Food   |
| 14.   | *Ammannia baureifera* L.               | Lythraceae     | D                   | TAM    | A     | H           | U                   | JL               | Med    |
| 15.   | *Anagallis arvensis* L.                | Primulaceae    | D                   | EUR    | A     | H           | U                   | JL               | Med    |
| 16.   | *Anethum graveolens* L.                | Apiaceae       | D                   | SWA    | A     | H           | F                   | JL               | Sp     |
| 17.   | *Annona reticulata* L.                 | Annonaceae     | D                   | TAM    | P     | T           | F                   | JL               | Food   |
| 18.   | *Annona squamosa* L.                   | Annonaceae     | D                   | TAM    | P     | T           | F                   | JL               | Food   |
| 19.   | *Antigonon leptopus* Hook. & Arn.      | Polygonaceae   | D                   | TAM    | P     | CL          | U                   | JL               | Orn,Med |
| 20.   | *Apium graveolens* L.                  | Apiaceae       | D                   | EUR    | A     | H           | F                   | JL               | Sp,Med |
| 21.   | *Arancaria columnaris* (G.Forst.) Hook. | Araucariaceae  | G                   | AUS    | P     | T           | OR                  | TEF              | T      |
| 22.   | *Arancaria excelsa* F. Br              | Araucariaceae  | G                   | AUS    | P     | T           | OR                  | TEF              | T      |
| 23.   | *Argemone mexicana* L.                 | Papaveraceae   | D                   | SAM    | A     | H           | U                   | JL               | Ad,Med |
| 24.   | *Artemisia vulgaris* L.                 | Asteraceae     | D                   | EUR    | P     | H           | U                   | MTF              | Med    |
| 25.   | *Asclepias curassavica* L.              | Asclepiadaceae | D                   | TAM    | A     | H           | OR                  | MTF              | Med    |
| 26.   | *Bidens pilosa* L.                     | Asteraceae     | D                   | TAM    | A     | H           | U                   | MTF, JL, FL      | Med    |
| 27.   | *Bixa orellana* L.                     | Bixaceae       | D                   | BRZ    | P     | T           | U                   | JL               | Med    |
| S.No. | Accepted names                          | Families       | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitats invaded | Uses   |
|-------|----------------------------------------|----------------|---------------------|----------|-------|-------------|----------------------|------------------|--------|
| 28.   | Blainvillea acmella (L.) Philipson     | Asteraceae     | D                   | TAM      | A     | H           | U                    | JL, TWF           | Med    |
| 29.   | Blumea lacera (Burm.f.) DC.            | Asteraceae     | D                   | TAM      | A     | H           | U                    | TWF              | Med    |
| 30.   | Bougainvillea glabra Choisy            | Nyctaginaceae  | D                   | BRZ      | P     | L           | OR                   | TWF              | Orn    |
| 31.   | Bougainvillea spectabilis Willd.       | Nyctaginaceae  | D                   | BRZ      | P     | L           | OR                   | TWF              | Orn    |
| 32.   | Brassia oleracea L.                   | Brassicaceae   | D                   | EUR      | P     | H           | F                    | JL               | Food   |
| 33.   | Brunfelsia americana L.                | Solanaceae     | D                   | TAM      | P     | SH          | OR                   | JL               | Orn    |
| 34.   | Brunfelsia bispicata Benth.            | Solanaceae     | D                   | TAM      | P     | SH          | U                    | JL               | Orn    |
| 35.   | Caesalpinia bondu (L.) Roxb.           | Leguminosae(s.l.) | D           | TAF      | P     | T           | U                    | TWF              | Med    |
| 36.   | Calotropis indicus (Aiton) Vent.       | Araceae        | M                   | SAM      | P     | H           | OR                   | TWF              | Orn    |
| 37.   | Calliandra haematocarpa Hassk.         | Leguminosae(s.l.) | D           | TAM      | P     | SH          | OR                   | TWF              | Orn    |
| 38.   | Callitomon citrinus (Curtis) Skeels    | Myrtaceae      | D                   | AUS      | P     | T           | OR                   | TWF              | Med    |
| 39.   | Calotropis gigantea (L.) R. Br.        | Asclepiadaceae | D                   | TAF      | P     | SH          | OR                   | TWF              | Med    |
| 40.   | Calotropis proceras (Ait.) R. Br.      | Asclepiadaceae | D                   | TAF      | P     | SH          | U                    | TWF, FL          | Med    |
| 41.   | Cardamine hirsuta L.                   | Brassicaceae   | D                   | TAM      | A     | H           | U                    | FL               | Unk    |
| 42.   | Cascabela serotina (L.) Lippold        | Apocynaceae    | D                   | MEX      | P     | T           | OR                   | FL               | Orn    |
| 43.   | Cassia fistula L.                      | Leguminosae(s.l.) | D           | NAM      | P     | T           | U                    | FL, TWF          | M      |
| 44.   | Casuarina equisetifolia L.             | Casuarinaceae  | D                   | AUS      | P     | T           | OR                   | MTF, TEF         | Orn, T |
| 45.   | Cataramus roseus (L.) G. Don.          | Apocynaceae    | D                   | TAM      | P     | H           | OR                   | FL               | Med    |
| 46.   | Ceyratia trifolia (L.) Domin           | Vitaceae       | D                   | AUS      | P     | CL          | U                    | TWF, FL          | Med    |
| 47.   | Celosia argentea L.                    | Amaranthaceae  | M                   | TAM      | A     | H           | F                    | MTF, FL          | Orn    |
| 48.   | Ceratophyllum demersum L.              | Ceratophyllaceae | M          | TAM      | A     | H           | U                    | WL               | Orn    |
| 49.   | Chloris barbata Sw.                    | Poaceae        | M                   | TAM      | P     | GR          | U                    | MTF, FL          | Fo     |
| 50.   | Chromolaena odorata (L.) R.M. King & H. Rob. | Asteraceae | D                   | SAM      | P     | H           | U                    | MTF, BAF, FL     | Med    |
| 51.   | Cleome rutidosperma DC.                | Capparaceae    | D                   | TAM      | A     | H           | U                    | TWF              | Med    |
| 52.   | Cleome viscosa L.                      | Capparaceae    | D                   | TAM      | A     | H           | U                    | TWF              | Med    |
| 53.   | Clerodendrum chinense (Osbeck) Mabb.   | Verbenaceae    | D                   | VIET     | P     | SH          | U                    | TWF              | Med    |
| 54.   | Crotalaria juncea L.                   | Tiliaceae      | D                   | SAM      | A     | H           | U                    | JL, FL           | Food   |
| S.No. | Accepted names | Families | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitats invaded | Uses |
|-------|----------------|----------|-------------------|----------|-------|-------------|---------------------|-----------------|------|
| 55.   | Corymbia maculata (Hook.) K.D.Hill & L.A.S.Johnson | Myrtaceae | D | AUS | P | T | OR | JL, FL | T |
| 56.   | Cosmos bipinnatus Cav. | Asteraceae | D | TAM | A | H | U | OR | MTF | Med |
| 57.   | Cassia obtusifolia (Benth.) S. Moore | Leguminosae(s.l.) | D | TAM | A | H | U | OR | MTF | Med |
| 58.   | Croton bonplandianus Baill. | Euphorbiaceae | D | SAM | P | H | U | OR | TWF | Med |
| 59.   | Cupressus sempervirens L. | Cupressaceae | D | AUS | P | T | U | OR | TEF | T,Med |
| 60.   | Cuscuta chinensis Lam. | Convolvulaceae | D | MED | P | CL | U | OR | MTF, BAF | Med |
| 61.   | Cuscuta reflexa Roxb. | Convolvulaceae | D | MED | P | CL | U | OR | MTF, BAF | Med |
| 62.   | Datura metel L. | Asteraceae | D | TAM | A | H | U | OR | TWF | Med |
| 63.   | Datura stramonium L. | Solanaceae | D | TAM | A | H | U | OR | TWF | Med |
| 64.   | Delonix regia (Hook.) Raf. | Leguminosae(s.l.) | D | MAD | P | T | OR | TWF, MTF | Orn |
| 65.   | Dombeya mastersii Hook. f. | Sterculiaceae | D | TAF | P | SH | U | OR | TWF, MTF | Orn |
| 66.   | Duranta erecta L. | Verbenaceae | D | TAM | P | H | U | OR | MTF | Med |
| 67.   | Dysphania ambrosioides (L.) Mosyakin & Clemants | Chenopodiaceae | D | TAM | P | H | U | OR | MTF | Med |
| 68.   | Echinochloa colona (L.) Link | Poaceae | D | TAM | A | H | U | OR | MTF | Med |
| 69.   | Eichhornia crassipes (Mart.) Solms. | Pontederiaceae | D | TAM | P | H | OR | OR | MTF | Med |
| 70.   | Echinocloa californica Cham. | Papaveraceae | D | TAM | A | H | U | OR | MTF | Med |
| 71.   | Encelia globularis Labill. | Myrtaceae | D | AUS | P | T | OR | MTF | Med |
| 72.   | Euphorbia milii Des Moul. | Euphorbiaceae | D | MD | P | H | OR | TWF | Med |
| S.No. | Accepted names                                      | Families       | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitat invaded | Uses       |
|-------|-----------------------------------------------------|----------------|---------------------|----------|-------|-------------|----------------------|----------------|------------|
| 81.   | *Euphorbia pulcherrima* Willd. ex Klotzsch.         | Euphorbiaceae  | D                   | MEX      | P     | SH          | OR                   | TWF, FL        | Orn        |
| 82.   | *Euphorbia hirta* L.                                | Euphorbiaceae  | D                   | TAM      | A     | H           | U                   | TWF            | Med        |
| 83.   | *Evolvulus nummularius* (L.)L.                      | Convolvulaceae | D                   | TAM      | P     | H           | U                   | TWF            | Unk        |
| 84.   | *Galinsoga parviflora* Cav.                         | Asteraceae     | D                   | TAM      | A     | H           | U                   | MTF            | Med        |
| 85.   | *Glandularia canadensis* (L.) Small                 | Verbenaceae    | D                   | TAM      | A     | H           | U                   | MTF            | Med        |
| 86.   | *Gomphrena serrata* L.                              | Amaranthaceae  | D                   | TAM      | A     | H           | U                   | MTF            | Med        |
| 87.   | *Grangea maderaspatana* (L.) Pori                    | Asteraceae     | D                   | TAM      | A     | H           | U                   | MTF            | Med        |
| 88.   | *Hygrophila auriculata* (Schumach.) Heine           | Acanthaceae    | D                   | TAM      | A     | H           | F                   | FL             | Food, Med  |
| 89.   | *Hypoestes phyllostachya* Baker                     | Acanthaceae    | D                   | TAM      | A     | H           | U                   | MTF, BAF       | Orn        |
| 90.   | *Hyptis suaveolens* (L.) Poit.                      | Lamiaceae      | D                   | TAM      | A     | H           | U                   | MTF, FL        | Med        |
| 91.   | *Imperata cylindrica* (L.) Rauny.                    | Poaceae        | M                   | TAM      | P     | GR          | U                   | FL             | Fo         |
| 92.   | *Indigofera trita* L.f.                             | Leguminosae(sl.)  | D                   | TAM      | P     | SH          | U                   | TEF            | Unk        |
| 93.   | *Ipomoea alba* L.                                   | Convolvulaceae | D                   | TAM      | P     | CL          | OR                  | MTF            | Med        |
| 94.   | *Ipomoea sayrica* Sweet                             | Convolvulaceae | D                   | TAM      | P     | CL          | OR                  | MTF            | Med        |
| 95.   | *Ipomoea quamoclit* L.                              | Convolvulaceae | D                   | TAM      | P     | CL          | OR                  | MTF            | Med        |
| 96.   | *Ipomoea carnea* Jacq.                              | Convolvulaceae | D                   | TAM      | P     | SH          | U                   | JL, FL         | Orn        |
| 97.   | *Ipomoea pesudofila* L.                             | Convolvulaceae | D                   | TAM      | A     | CL          | U                   | JL, FL         | Orn        |
| 98.   | *Ipomoea parpata* (L.) Roth                         | Convolvulaceae | D                   | TAM      | A     | CL          | OR                  | TWF            | Orn        |
| 99.   | *Jacaranda mimosa* D.Don                            | Bignoniaceae   | D                   | TAM      | P     | CL          | OR                  | TWF            | Med        |
| 100.  | *Jatropha gossypifolia* L.                           | Euphorbiaceae  | D                   | TAM      | P     | H           | U                   | TWF            | Med        |
| 101.  | *Juniperus communis* L.                             | Juniperaceae   | G                   | TAM      | P     | T           | OR                  | TEF            | T          |
| 102.  | *Kalanchoe pinnata* (Lam.) Merr.                    | Crassulaceae   | D                   | TAM      | P     | H           | OR                  | FL             | Orn, Med  |
| 103.  | *Kigelia pinnata* Jacq.                             | Bignoniaceae   | D                   | TAM      | P     | T           | OR                  | TWF            | Med        |
| 104.  | *Lantana camara* L.                                 | Verbenaceae    | D                   | TAM      | P     | H           | OR                  | TWF, MTF       | Orn, Bas   |
| 105.  | *Leonotis nepetifolia* (L.) R.Br.                   | Lamiaceae      | D                   | TAM      | A     | H           | U                   | TWF            | Med        |
| S.No. | Accepted names                      | Families            | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitats invaded | Uses     |
|-------|-------------------------------------|---------------------|---------------------|----------|-------|------------|---------------------|-----------------|----------|
| 106.  | *Leucaena leucocephala* (Lam.) de Wit | Leguminosae(s.l.)   | D                   | MEX      | P     | T          | U                   | TWF             | Food     |
| 107.  | *Ludwigia adscendens* (L.) Hara.     | Onagraceae          | D                   | TAF      | A     | H          | U                   | FL              | Med      |
| 108.  | *Ludwigia perennis* L.               | Onagraceae          | D                   | TAF      | A     | H          | U                   | FL              | Food,Med |
| 109.  | *Magnolia grandiflora* L.            | Magnoliaceae        | D                   | NAM      | P     | T          | U                   | MTF             | Orn      |
| 110.  | *Malvastrum coromandelianum* (L.) Garecke | Malvaceae         | D                   | TAM      | A     | H          | U                   | TWF, BAF        | Orn      |
| 111.  | *Malvastrus palmaeus* Pittier & Donn. Sm. | Malvaceae         | D                   | TAM      | P     | H          | OR                  | BAF             | Orn      |
| 112.  | *Manihot esculenta* Crantz.          | Euphorbiaceae       | D                   | TAM      | P     | T          | U                   | MTF             | Food,Med |
| 113.  | *Mecardonia procinthera* (Mill.) Small | Scrophulariaceae    | D                   | TNM      | A     | H          | U                   | JL, FL, MTF     | Med      |
| 114.  | *Melia alba* Medik. ex Desr.         | Leguminosae(s.l.)   | D                   | EUR      | A     | H          | F                   | JL, FL          | Med      |
| 115.  | *Melochia corchorifolia* L.          | Sterculiaceae       | D                   | TAM      | A     | H          | U                   | JL, FL          | Fo       |
| 116.  | *Mikania micranthi* Kunth.           | Asteraceae          | D                   | SAM      | P     | CL         | U                   | TWF, MTF, JL, BAF | Med      |
| 117.  | *Mimosa diplotricha* Wright         | Leguminosae(s.l.)   | D                   | SAM      | P     | SH         | U                   | BAF, TWF        | Med      |
| 118.  | *Mimosa pudica* L.                  | Leguminosae(s.l.)   | D                   | BRZ      | P     | H          | U                   | TWF, MTF        | Med      |
| 119.  | *Mucuna pruriens* (L.) DC.          | Leguminosae(s.l.)   | D                   | TAF      | P     | CL         | F                   | JL, FL          | Food, Med |
| 120.  | *Nicotiana plumaginifolia* Viv.      | Solanaceae          | D                   | TAM      | A     | H          | U                   | JL              | Med      |
| 121.  | *Oxanthus americanus* L.             | Lamiaceae           | D                   | TAM      | A     | H          | U                   | JL              | Med      |
| 122.  | *Opuntia vulgaris* Miller            | Cactaceae           | D                   | SAM      | P     | H          | U                   | JL              | Food, Med |
| 123.  | *Oscalis taunetilata* L.             | Oxalidaceae         | D                   | EUR      | P     | H          | U                   | JL              | Med      |
| 124.  | *Parthenium hysterophorus* L.        | Asteraceae          | D                   | TAM      | A     | H          | U                   | TWF, MTF        | Med      |
| 125.  | *Passiflora foetida* L.              | Passifloraceae      | D                   | SAM      | P     | CL         | OR                  | OR              | Med      |
| 126.  | *Peltophorum pterocarpum* (DC.) K. Heyne | Leguminosae(s.l.) | D                   | MAL      | P     | T          | OR                  | TWF             | Orn      |
| 127.  | *Piperumum pellucida* (L.) Kunth     | Piperaceae          | D                   | SAM      | A     | H          | U                   | TWF             | Med      |
| 128.  | *Physalis minima* L.                | Solanaceae          | D                   | TAM      | A     | H          | U                   | TWF             | Med      |
| 129.  | *Pilea microphylla* (L.) Liebm.      | Urticaceae          | D                   | SAM      | A     | H          | U                   | TWF             | Med      |
| 130.  | *Pistia stratiotes* L.               | Araceae             | M                   | TAM      | P     | H          | U                   | WL              | Orn      |
| S.No. | Accepted names                  | Families          | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitats invaded | Uses                  |
|-------|---------------------------------|-------------------|---------------------|----------|-------|-------------|----------------------|------------------|----------------------|
| 131.  | Plumeria rubra L.               | Apocynaceae       | D                   | MEX      | P     | T           | OR                   | TWF              | Orn                  |
| 132.  | Portulaca oleracea L.           | Portulaceae       | D                   | SAM      | A     | H           | F                   | JL, FL           | Orn                  |
| 133.  | Pyrostegia venusta (Ker Gawl.) Miers | Bignoniaceae   | D                   | BRZ      | P     | CL          | OR                   | FL               | Orn                  |
| 134.  | Ricinus communis L.             | Euphorbiaceae     | D                   | MED      | P     | SH          | F                   | TWF              | Food, Med           |
| 135.  | Rorippa dubia (Pers.) Hara.     | Brassicaceae      | D                   | TAM      | A     | H           | U                   | TWF              | Unk                  |
| 136.  | Ruellia tuberosa L.             | Acanthaceae       | D                   | TAM      | A     | H           | U                   | TWF              | Orn                  |
| 137.  | Saccharum spontaneum L.         | Poaceae           | M                   | TWA      | P     | GR          | U                   | FL               | F,R, Th             |
| 138.  | Senecio dubius L.               | Scrophulariaceae  | D                   | TAM      | A     | H           | U                   | FL               | Med                  |
| 139.  | Senna alata (L.) Roxb.          | Leguminosae(s.l.)² | D | SAM | P | SH | OR | JL, FL | Med, Orn |
| 140.  | Senna occidentalis (L.) Link.   | Leguminosae(s.l.)² | D | SAM | P | H | U | JL, FL | Med |
| 141.  | Senna tora (L.) Roxb.           | Leguminosae(s.l.)² | D | SAM | P | H | U | JL, FL | Med |
| 142.  | Sida acuta Burm.f.              | Malvaceae         | D                   | TAM      | A     | H           | U                   | FL               | Med                  |
| 143.  | Solanum tuberosum Sw.           | Solanaceae        | D                   | WI       | P     | SH          | U                   | FL               | Med                  |
| 144.  | Sonchus asper (L.) Hill         | Asteraceae        | D                   | MED      | A     | H           | U                   | TWF, FL          | Unk                  |
| 145.  | Sonchus oleraceus (L.) L.       | Asteraceae        | D                   | MED      | A     | H           | U                   | TWF              | Unk                  |
| 146.  | Spermacoce hispida L.           | Rubiaceae         | D                   | TAM      | A     | H           | U                   | TWF              | Med                  |
| 147.  | Spatholobus acmela (L.) L.      | Asteraceae        | D                   | BRZ      | A     | H           | U                   | FL               | Med                  |
| 148.  | Stachydronephtha jamaicensis (L.) Vahl | Verbenaceae  | D                   | TAM      | A     | H           | U                   | FL               | Orn                  |
| 149.  | Stellaria media (L.) Vill.      | Caryophyllaceae   | D                   | NAM      | A     | H           | U                   | JL               | Food, Med           |
| 150.  | Strelitzia reginae Banks        | Strelitziaceae    | M                   | SAF      | P     | H           | OR                  | JL               | Med                  |
| 151.  | Synedrella nodiflora (L.) Gaertn. | Astereaceae       | D                   | WI       | A     | H           | U                   | JL               | Med                  |
| 152.  | Tamaramus indica L.             | Leguminosae(s.l.)³ | D | TAF | P | T | F | TWF | Food, Med |
| 153.  | Thunbergia indica Bailey        | Cupressaceae      | G                   | NAM      | P     | T           | U                   | TEF              | T                   |
| 154.  | Thunbergia alata Bojer ex Sims  | Acanthaceae       | D                   | EAF      | P     | CL          | OR                  | MTF              | Orn, Med            |
| 155.  | Tithonia diversifolia (Hemsol.) A.Gray | Asteraceae    | D                   | MEX      | P     | H           | OR                  | MTF              | Med, Orn            |
| 156.  | Tridax procumbens (L.) L.       | Asteraceae        | D                   | CAM      | A     | H           | U                   | TWF              | Med                  |
| 157.  | Tridax rhomboidea Jacq.         | Malvaceae         | D                   | TAM      | A     | H           | U                   | TWF              | Med                  |
| S.No. | Accepted names       | Families | Taxonomic Sub-group | Nativity | Habit | Growth form | Mode of introduction | Habitats invaded | Uses  |
|-------|----------------------|----------|---------------------|----------|-------|-------------|---------------------|-----------------|-------|
| 158.  | *Typha angustifolia* L. | Typhaceae | M       | TAM | P    | GR | U | WL | Ht |
| 159.  | *Ulex europaeus* L.    | Leguminosae (s.l.)³ | D       | EUR | P    | SH | U | FL | Orn |
| 160.  | *Urena lobata* L.      | Malvaceae | D       | TAM | A    | H  | U | JL | Med |
| 161.  | *Xanthium strumarium* L. | Asteraceae | D       | TAM | A    | H  | U | JL | Med, FU |
| 162.  | *Youngia japonica* (L.) DC. | Asteraceae | D       | SAM | A    | H  | U | FL | Med |
| 163.  | *Eryngium foetidum* L. | Apiaceae | D       | MEX | A    | H  | F | FL | Sp. |

Abbreviations: *Leguminosae (s.l.)*:-Leguminosae (sensulato) includes all the three subfamilies (i.e., 1. Subfam. Mimosoideae, 2. Subfam. Caesalpinioideae, 3. Subfam. Papilionoideae); **Taxonomic Sub-group:** D:- Dicotyledons, M:- Monocotyledons, G:-Gymnosperms; **Habit**: P:- Perennial, A:-Annual; **Nativity**: TAM:-Tropical America, SAM:-South America, CAM:-Central America, TNM:-Tropical North America, TAF:-Tropical Africa, EAF:-Eastern Africa, NAM:- North America, SAF:-South Africa, WI:- West Indies, MEX:-Mexico, AUS:-Australia, EUR:-Europe, BRZ:-Brazil, MED:- Mediterranean; SWA= South West Tropical Asia; **Growth form**: H:-Herb, SH:-Shrub, GR:-Grass, SE:-Sedge, CL:-Climber, T:-Tree; **Mode of introduction**: U:-Unintentional, O:-Ornamental, F:-Food; **Habitats invaded**: TWF: - Tropical Wet Evergreen Forest, MTF:-Montane sub-tropical Forest, TEF- Temperate Forests, JL:-Jhumland, BAF:-Bamboo Forests, WL:-Wetland, FL:-Fallow Lands. **Uses** Med: medicinal, Man: Green manure, Bio: bioactive chemicals, Orn:ornamental, Sp:spice, T:timber, Ad:adulteration, Unk:unknown, Fo:fodder, R:rope making, Th: Thatching, Wwt :Waste water treatment, Ht: Hut thatch, FU: Biomass fuel, Bas: Basket Making.