

Diversity of Invasive Plant Species in Boluvampatti Forest Range, The Southern Western Ghats, India

V. Aravindhan and A. Rajendran

Department of Botany, Plant Systematics Laboratory, School of Life Sciences
Bharathiar University, Coimbatore-641 046 Tamil Nadu, India

Abstract: The present study deals with the implication of invasive plant species on the diversity of Boluvampatti forest range in Southern Western Ghats of Tamil Nadu, India. A total number of 90 invasive alien species under 74 genera belonging to 37 families have been recorded based on field exploration and literature consultations. Among these, 53 species are being used by local inhabitants who residing in this forest range for medicinal purposes. It is evident from the study that, 13 species have been introduced intentionally, while the remaining species established unintentionally through trade. The present study concluded that, a better planning is needed for early detection to control and reporting of infestations of spread of naturalized species to be scrutinized.

Key words: Invasive species • Floristic composition • Habitat loss • India

INTRODUCTION

Understanding the diversity of nature in various forms is fundamental goal of ecological research [1]. Apart from the immense economic, ethical and aesthetical benefits, it is essential for the ecosystem function and stability [2-4]. It has also attracted world attention because of the growing awareness of its importance on the one hand and the anticipated massive depletion on the other [5]. Biodiversity hotspots around the world contain high degree of endemism and are undergoing exceptional loss of habitats [6]. The plant diversity around the world is facing various threats and is reducing very rapidly [7].

The invasive species are widely distributed among all categories of living organisms as well as all kinds of ecosystems throughout the world. The invasion of alien plant species in the new regimes became a second highest threat to plant diversity after the habitat loss [8]. The spread of species beyond their natural habitats has always played a key role in the dynamics of biodiversity. But the present rate of species exchange is unprecedented and has become one of the most intensively studied fields in ecology. Invasive species may displace or otherwise adversely affect native plant species. These species often

produce prolific seeds that may disperse widely and remain viable in the soil for long periods of time [9].

IUCN (International Union for Conservation of Nature and Natural Resources) defines Invasive Species as an alien species which becomes established in natural or semi-natural ecosystems or habitat, an agent of change and threatens native biological diversity. A taxon can be considered successfully naturalized after overcoming geographical, environmental and reproduction barriers, while an invasive species requires, in addition, to overcome dispersal barrier within the new region [10]. They are noxious and cause negative impact in environment, ecosystems, habitats, native biodiversity, economics and even human health [11].

Introduction of these species may occur accidentally or through their being imported for a limited purpose and subsequently escaping or deliberately on a large scale [12]. Many of these species have allelopathic potential and possess high tolerance to different abiotic conditions [13]. Many people introduce non-native species into new habitats for economic reasons [14] and most cases of invasive species can be linked to the intended or unintended consequences of economic activities [15]. The differences between native and exotic plant species in their requirements and modes of resource acquisition

Corresponding Author: V. Aravindhan, Plant Systematics Laboratory, Department of Botany,
School of Life Sciences Bharathiar University, Coimbatore-641 046 Tamil Nadu, India.

and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability [16, 17].

The biotic invaders tend to establish a new range in which they proliferate, spread and persist to the detriment of the environment [18]. Invasive species has faster rates of growth and biomass production compared to native species, higher competitive ability, high reproductive efficiency including production of a large number of seeds, efficient dispersal, vegetative reproduction, rapid establishment and other traits that help them adapt to new habitats [19, 20]. Despite the recent recognition of the impacts caused by invasive plants worldwide [21], there are still many regions in the world where basic information on naturalized plant taxa and plant invasions is only anecdotal or completely lacking like Asia and neighbouring regions [22, 23].

In India, comprehensive studies on invasive species and plant invasions are still missing except a few studies [24–28]. A large number of exotics are naturalized, affecting the distribution of native flora and a few among them have conspicuously altered vegetation patterns of the country. There is an apparent need for a regional and national authentic database on invasive alien species for

monitoring the spread their and impact in various regions and for devising appropriate management strategies. In view of these facts, the present study was conducted to study the implication of invasive plant species on the diversity of Boluvampatti forest range in Southern Western Ghats of Tamil Nadu.

MATERIALS AND METHODS

Study Area: The study area (Boluvampatti forests) is situated about 30 km west of Coimbatore city and is a continuation of the Western Ghats lying North of Palghat Gap and to the South-east of the Nilgiris (Fig. 1). The area comes under the Boluvampatti range of Coimbatore forest division which includes the villages namely Irrutupallam, Sadivayal, Semmedu and Siruvani. It lies between $10^{\circ} 56'$ and $10^{\circ} 58'$ N latitude and $76^{\circ} 42'$ and $76^{\circ} 44'$ E longitude.

The elevation of this area is between 625 to 650 m above MSL [29]. The rock formation is of Archaean age and consists of principally gneiss and its metamorphic variations. The gneiss foliated and is composed of quartz, feldspar and biotite (black mica) with an occasional admixture of garnet. The soil is reddish with irregular galleries filled with yellow clay running through and it has the property of hardening on to the air [30].

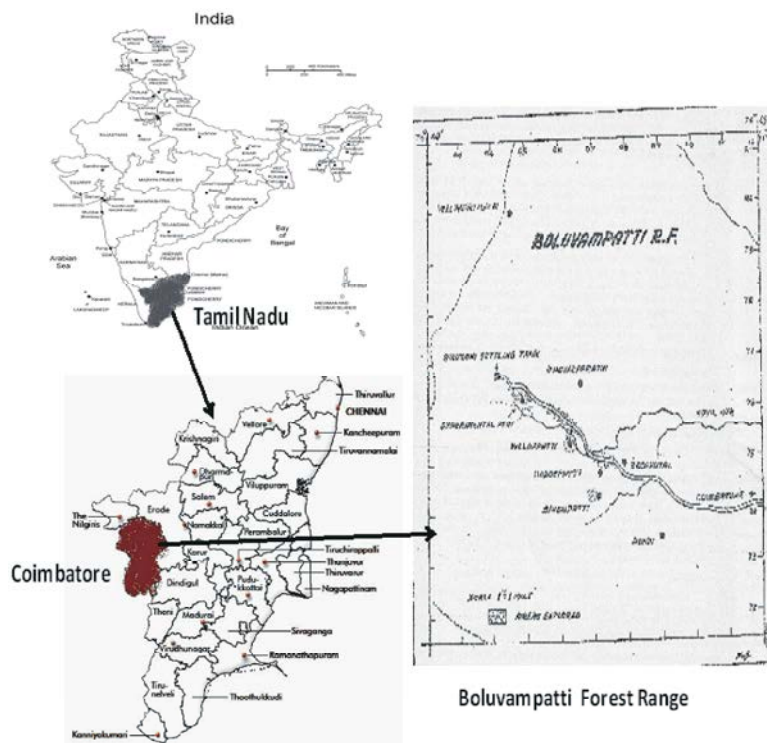


Fig. 1: Location of Boluvampatti forests in Coimbatore district of Tamil Nadu, India

The climate is cool and pleasant for the major part of the year except during the month of March to May when it is hot and dry. The difference in elevation between the plains and the hilly areas makes appreciable variations in their climatic conditions. The temperature of this area ranges from 21°C to 38°C and the mean annual humidity is 51%. The vegetation of this area includes scrub jungle, moist deciduous and sub-tropical evergreen forests. These forests are subjected to extreme biotic influences and extensive areas near Sadivayal and Siruvani settling tank are planted with eucalyptus, teak, bombax, etc. The natural regeneration of trees in these forests is very poor. Perhaps this may be due to excessive grazing and other biotic influences. There is a profound invasion of many non-native species on biodiversity of this area.

Floristic Exploration: The present study was conducted during 2010-2012 to compile a comprehensive list of invasive alien plant species. Intensive field studies were conducted in a planned manner repeatedly in different seasons in order to document maximum representation of invasive plant species. During the repeated field visits, the observations on field characters such as habit, habitat, spread, important species traits associated with invasiveness were made. Almost the entire forest area was surveyed in order to know the impact of invasiveness on native vegetation in the study area.

During the course of study, the invasive plant species were collected in their natural habitats and filed numbers were assigned to each species. All the collected plant species were identified with the help of regional floras [31-35]. Plant species collected were dried and herbarium specimens were prepared by using standard methods as suggested by Jain and Rao [36]. The voucher specimens were deposited in the Herbarium of Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu for future reference.

The nativity of the invasive plants has been recorded from the published literature [37-48]. The modes of introduction of these species were documented from the published literature and categorized according to their economic uses as food, fodder, medicinal and ornamental. Plants were also categorized by life form i.e., herb, shrub, climber and tree. Literature and local people were consulted for use value or anthropogenic use, if any.

RESULTS AND DISCUSSION

The present study was undertaken to identify the diversity of invasive plant species in Boluvampatti forest range, the Southern Western Ghats of Tamil Nadu. A total

number of 90 alien plants from 37 families belonging to 74 genera were documented from the study region. They are listed alphabetically in tabular form, followed by author's abbreviation, name of the family, nativity, life form, habitat, uses and voucher specimen number (Table 1). Among these the dicotyledons have represented by 32 families, 67 genera and 83 species; monocotyledons by 5 families, 7 genera and 7 species. All the species reported in this study were also reported as weeds in other countries or invasive alien plants in most of the regions and are included in the *Global Compendium Weeds* [49].

Out of 90 species, only 13 namely *Ageratum conyzoides*, *Amaranthus spinosus*, *Asclepias curassavica*, *Cassia alata*, *Catharanthus roseus*, *Celosia argentea*, *Chenopodium ambrosioides*, *Ipomoea eriocarpa*, *Lantana camara*, *Mirabilis jalapa*, *Passiflora foetida*, *Portulaca oleracea* and *Solanum nigrum* seems to have been introduced deliberately and the rest of them unintentionally through trade exchange including grain import. Further, it has been observed that few species like *Parthenium hysterophorus*, *Lantana camara*, *Eupatorium odoratum*, *Prosopis juliflora* and *Ageratum conyzoides* are highly invasive and have invaded on the fringes of forests as well as inside the reserved forests.

On the basis of the nativity of the species, a total of 17 different geographical regions were recorded in the present study. In that, about 72% are contributed by five major geographical regions viz., Tropical America (59%), Tropical Africa (15%), Australia (3%), Europe (4%) and South America (13%) (Fig. 2). It is interesting to note that, most of the invasive species in the study region owe their origin to tropical regions i.e., America have contributed (72%), Africa and Europe contribute 14% and 3% respectively. The remaining 28% species were collectively contributed by 9 regions.

Habit wise analysis showed that herbs with 70 species (78%) predominate followed by shrubs 10 species (11%), climbers 5 species (6%) and trees 5 species (5%). Annuals comprised about 52 % of the invasive species in the study and the remaining are perennials. In terms of number of species, Asteraceae found to be the most dominant family with 15 species among the reported invasive species followed by Amaranthaceae (6 sp.), Convolvulaceae (5 sp.), Caesalpiaceae and Solanaceae (4 sp. each), Asclepiadaceae, Poaceae, Euphorbiaceae, Malvaceae and Lamiaceae (3 sp. each). The genera with highest number of invasive species in the study area are *Cassia* and *Ipomoea* (4 sp. each), *Cleome*, *Corchorus* (3 sp. each), *Alternanthera*, *Blumea*, *Calotropis*, *Euphorbia*, *Solanum* and *Tribulus* (2 sp. each).

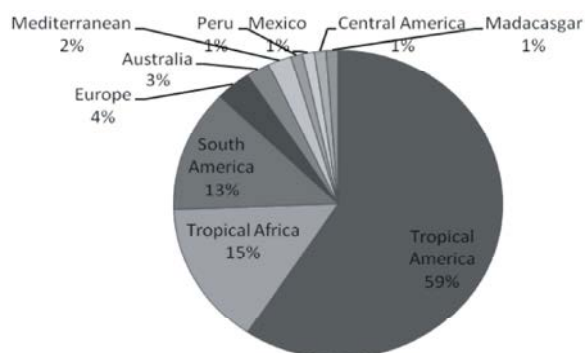


Fig. 2: Contribution of different geographical areas to invasive species in the study

Table 1: List of invasive plant species in Boluvampatti forests, Coimbatore district of Tamil Nadu, India

Name of the species	Family	Voucher specimen No.	Nativity	Life form	Habit	Uses
<i>Acacia dealbata</i> Link.	Mimosaceae	1127	Australia	Tree	Perennial	Fuel wood
<i>Acanthospermum hispidum</i> DC.	Asteraceae	1134	Brazil	Herb	Annual	Medicinal
<i>Ageratum conyzoides</i> L.	Asteraceae	1135	Tropical America	Herb	Annual	Medicinal
<i>Alternanthera pungens</i> Humb.	Amaranthaceae	1174	Tropical America	Herb	Perennial	Medicinal
<i>Alternanthera sessilis</i> (L.) DC.	Amaranthaceae	1175	Tropical America	Herb	Perennial	Medicinal, Fodder
<i>Amaranthus spinosus</i> L.	Amaranthaceae	1176	Tropical America	Herb	Annual	Medicinal, Fodder
<i>Argemone mexicana</i> L.	Papaveraceae	1101	South America	Herb	Annual	Medicinal
<i>Asclepias curassavica</i> L.	Asclepiadaceae	1150	Tropical America	Herb	Perennial	Medicinal
<i>Bidens pilosa</i> L.	Asteraceae	1136	Tropical America	Herb	Annual	Medicinal, Fodder
<i>Blumea eriantha</i> DC.	Asteraceae	1137	Tropical America	Herb	Perennial	Fodder
<i>Blumea lacera</i> (Burm. f.) DC.	Asteraceae	1138	Tropical America	Herb	Annual	Medicinal
<i>Borassus flabellifer</i> L.	Arecaceae	1185	Tropical Africa	Tree	Perennial	Fruit edible
<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	1151	Tropical Africa	Shrub	Perennial	Medicinal
<i>Calotropis procera</i> (Ait.) R. Br.	Asclepiadaceae	1152	Tropical Africa	Shrub	Perennial	Medicinal
<i>Cassia alata</i> L.	Caesalpinaceae	1123	South America	Shrub	Perennial	Medicinal
<i>Cassia obtusifolia</i> L.	Caesalpinaceae	1124	Tropical America	Herb	Perennial	Medicinal
<i>Cassia occidentalis</i> L.	Caesalpinaceae	1125	South America	Herb	Perennial	Medicinal
<i>Cassia tora</i> L.	Caesalpinaceae	1126	South America	Herb	Annual	Medicinal
<i>Catharanthus roseus</i> L.	Apocynaceae	1149	Tropical America	Herb	Perennial	Medicinal
<i>Chenopodium ambrosioides</i> L.	Chenopodiaceae	1180	Tropical America	Herb	Annual	Fodder
<i>Chloris barbata</i> (L.) Sw.	Poaceae	1188	Tropical America	Herb	Perennial	Fodder
<i>Chromolaena odorata</i> L.	Asteraceae	1139	Tropical America	Shrub	Perennial	Medicinal
<i>Cleome viscosa</i> L.	Cleomaceae	1104	Tropical America	Herb	Perennial	Medicinal
<i>Cleome gynandra</i> L.	Cleomaceae	1102	Tropical America	Herb	Annual	Medicinal
<i>Cleome monophylla</i> L.	Cleomaceae	1103	Tropical Africa	Herb	Annual	Fodder
<i>Corchorus aestuans</i> L.	Tiliaceae	1110	Tropical America	Herb	Annual	Medicinal
<i>Corchorus tridens</i> L.	Tiliaceae	1111	Tropical Africa	Herb	Annual	Fibre, Fodder
<i>Corchorus trilocularis</i> L.	Tiliaceae	1112	Tropical Africa	Herb	Annual	Fibre
<i>Crotalaria retusa</i> L.	Fabaceae	1119	Tropical America	Herb	Annual	Fodder, Ornamental
<i>Croton bonplandianum</i> Baill.	Euphorbiaceae	1181	South America	Herb	Perennial	Fodder
<i>Cuscuta reflexa</i> Roxb.	Cusutaceae	1158	Mediterranean	Climber	Annual	Medicinal
<i>Cyperus difformis</i> L.	Cyperaceae	1187	Tropical America	Herb	Annual	Fodder
<i>Datura metel</i> L.	Solanaceae	1159	Tropical America	Shrub	Perennial	Medicinal
<i>Digera muricata</i> (L.) Mart.	Amaranthaceae	1178	South West Asia	Herb	Annual	Medicinal
<i>Echinochloa colona</i> (L.) Link.	Poaceae	1189	South America	Herb	Annual	Fodder
<i>Echinops echinatus</i> Roxb.	Asteraceae	1140	Afghanistan	Herb	Annual	Medicinal

Table 1: Continued

<i>Eclipta prostrata</i> (L.) Mant.	Asteraceae	1141	Tropical America	Herb	Annual	Medicinal, Ornamental
<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	1142	Tropical America	Herb	Annual	Medicinal
<i>Euphorbia cyathophora</i> Murray	Euphorbiaceae	1182	Tropical America	Herb	Annual	Ornamental
<i>Euphorbia hirta</i> L.	Euphorbiaceae	1183	Tropical America	Herb	Annual	Medicinal
<i>Evolvulus nummularis</i> L.	Convolvulaceae	1153	Tropical America	Herb	Perennial	Fodder
<i>Gomphrena serrata</i> L.	Amaranthaceae	1179	Tropical America	Herb	Annual	Fodder
<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	1170	Tropical America	Herb	Annual	Medicinal
<i>Indigofera trita</i> L.	Fabaceae	1120	Tropical Africa	Shrub	Perennial	Fodder
<i>Ipomoea eriocarpa</i> R. Br.	Convolvulaceae	1154	Tropical Africa	Herb	Annual	Medicinal
<i>Ipomoea obscura</i> (L.) Ker. - Gawal.	Convolvulaceae	1155	Tropical Africa	Climber	Perennial	Medicinal
<i>Ipomoea pes-tigridis</i> L.	Convolvulaceae	1156	Tropical Africa	Climber	Annual	Medicinal
<i>Ipomoea staphylina</i> Roem. and Schult.	Convolvulaceae	1157	Tropical Africa	Climber	Annual	Fodder
<i>Lantana camara</i> L.	Verbenaceae	1168	Tropical America	Herb	Perennial	Medicinal, Ornamental
<i>Leonotis nepetifolia</i> (L.) R.Br.	Lamiaceae	1171	Tropical Africa	Herb	Annual	Medicinal
<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	1106	Tropical America	Herb	Annual	Medicinal, Fibre
<i>Martynia annua</i> L.	Pedaliaceae	1164	Tropical America	Herb	Perennial	Medicinal
<i>Melia azedarach</i> L.	Meliaceae	1117	India	Tree	Perennial	Medicinal
<i>Mikania micrantha</i> Kunth.	Asteraceae	1143	Tropical America	Climber	Annual	Medicinal
<i>Mimosa pudica</i> L.	Mimosaceae	1128	Brazil	Herb	Perennial	Medicinal
<i>Mirabilis jalapa</i> L.	Nyctaginaceae	1173	Peru	Herb	Annual	Ornamental
<i>Ocimum americanum</i> L.	Lamiaceae	1172	Tropical America	Herb	Annual	Ornamental
<i>Opuntia stricta</i> Haw.	Cactaceae	1132	Tropical America	Shrub	Perennial	Fruits edible
<i>Oxalis corniculata</i> L.	Oxalidaceae	1116	Europe	Herb	Perennial	Vegetable
<i>Parthenium hysterophorus</i> L.	Asteraceae	1144	North America	Herb	Annual	Fodder
<i>Passiflora foetida</i> L.	Passifloraceae	1131	South America	Climber	Perennial	Medicinal
<i>Pedaliium murex</i> L.	Pedaliaceae	1165	Tropical America	Herb	Perennial	Medicinal
<i>Peristrophe paniculata</i> (Forssk.) Brummit	Acanthaceae	1166	Tropical America	Herb	Annual	Medicinal
<i>Physalis minima</i> L.	Solanaceae	1160	Tropical America	Herb	Annual	Medicinal
<i>Pilea microphylla</i> (L.) Liebm.	Urticaceae	1184	South America	Herb	Annual	Vegetable, Ornamental
<i>Portulaca oleracea</i> L.	Portulacaceae	1105	South America	Herb	Annual	Medicinal, Vegetable
<i>Prosopis juliflora</i> (Sw.) DC.	Mimosaceae	1129	Mexico	Tree	Perennial	Fuel wood
<i>Ruellia tuberosa</i> L.	Acanthaceae	1167	Tropical America	Herb	Annual	Ornamental
<i>Scoparia dulcis</i> L.	Scrophulariaceae	1163	Tropical America	Herb	Perennial	Medicinal
<i>Sesbania bispinosa</i> (Jacq.) Wight.	Fabaceae	1121	Tropical America	Shrub	Annual	Fibre, Vegetable
<i>Sida acuta</i> Burm. f.	Malvaceae	1107	Tropical America	Herb	Annual	Medicinal, Fibre
<i>Solanum nigrum</i> L.	Solanaceae	1161	Tropical America	Herb	Annual	Medicinal, Edible
<i>Solanum torvum</i> Sw.	Solanaceae	1162	Tropical America	Shrub	Perennial	Medicinal
<i>Sonchus asper</i> (L.) Hill	Asteraceae	1145	Mediterranean	Herb	Annual	Medicinal
<i>Sorghum halepense</i> (L.) Pers.	Solanaceae	1190	Tropical America	Herb	Perennial	Fodder
<i>Spermacoce hispida</i> L.	Rubiaceae	1133	Tropical America	Herb	Perennial	Medicinal
<i>Spilanthes acmella</i> (L.) Murr.	Asteraceae	1146	South America	Herb	Annual	Fodder
<i>Stachytarpheta jamaicensis</i>	Verbenaceae	1169	Tropical America	Herb	Annual	Medicinal
<i>Stylosanthes hamata</i> L.	Febaceae	1122	Tropical America	Herb	Perennial	Fodder
<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	1147	West Indies	Herb	Annual	Ornamental
<i>Tribulus terrestris</i> L.	Zygophyllaceae	1115	Tropical America	Herb	Perennial	Medicinal
<i>Tridax procumbens</i> L.	Asteraceae	1148	Central America	Herb	Perennial	Medicinal
<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	1113	Tropical America	Herb	Annual	Medicinal
<i>Turnera ulimifolia</i> L.	Turneraceae	1130	Tropical America	Herb	Annual	Ornamental
<i>Typha angustata</i> Bory and Chaup.	Typhaceae	1186	Tropical America	Herb	Perennial	Ornamental
<i>Urena lobata</i> L.	Malvaceae	1108	Tropical Africa	Shrub	Perennial	Fibre
<i>Waltheria americana</i> L.	Sterculiaceae	1109	Tropical America	Herb	Perennial	Medicinal
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	1118	Australia	Tree	Perennial	Fruits edible

Table 2: List of medicinally useful invasive species in the study

S.No.	Name of the plant	Part(s) used	Medicinal uses
1.	<i>Ageratum conyzoides</i> L.	Leaves	Leaf-juice used in healing the wounds, sores and skin diseases.
2.	<i>Alternanthera sessilis</i> (L.) R. Br.	Whole plant	Plants used in snake-bite.
3.	<i>Amaranthus spinosus</i> L.	Whole plant	Plants used in snake-bites, bowel and kidney complaints.
4.	<i>Argemone mexicana</i> L.	Whole plant	Roots used in scorpion sting.
5.	<i>Asclepias curassavica</i> L.	Leaves and roots	Roots used in curing piles. Leaf juice used for hemorrhages.
6.	<i>Bidens pilosa</i> L.	Flower	Dried flowers buds used in tooth-ache.
7.	<i>Calotropis gigantea</i> (L.) R. Br.	Latex	Latex used as disinfectant to wounds.
8.	<i>Cassia tora</i> L.	Leaves and seeds	Leaves and seeds used as skin diseases.
9.	<i>Catharanthus roseus</i> (L.) G. Don.	Root	The roots are great commercial value in medicine.
10.	<i>Celosia argentea</i> L.	Seeds	Seeds used in blood disease and mouth sores.
11.	<i>Cleome gynandra</i> L.	Whole plant	Plants used in scorpion-sting and snake-bite.
12.	<i>Digera muricata</i> (L.) Mart.	Flowers and seeds	Flowers and seeds used in urinary troubles.
13.	<i>Eclipta prostrata</i> L.	Root	Roots used as antiseptic to ulcers and wounds in cattle.
14.	<i>Emilia sonchifolia</i> (L.) DC.	Leaves	Leaf-juice used in curing wounds and sore ears.
15.	<i>Euphorbia hirta</i> L.	Whole plant	Plants used in bowel complaints for children.
16.	<i>Ipomoea eriocarpa</i> R. Br.	Whole plant	Plants used in the treatment of rheumatism and headache
17.	<i>Ipomoea obscura</i> (L.) Ker-Gawl.	Leaves	Leaves used in the treatment of ulcers.
18.	<i>Ipomoea pes-tigridis</i> L.	Leaves	Leaves used as an antidote to dog-bite; also used in boils.
19.	<i>Martynia annua</i> L.	Leaves	Leaves used in epilepsy.
20.	<i>Melia azedarach</i> L.	Leaves and seeds	Leaves used as anthelmintic; seeds used in rheumatism.
21.	<i>Mimosa pudica</i> L.	Root	Roots used in asthma, dysentery, etc.
22.	<i>Ocimum americanum</i> L.	Whole plant	Plants used in fever.
23.	<i>Oxalis corniculata</i> L.	Leaves	Leaves used in fever.
24.	<i>Passiflora foetida</i> L.	Leaves	Leaves used in headache.
25.	<i>Pedalium murex</i> L.	Leaves and fruits	Leaves used in gonorrhoea; fruits used in incontinence of urine.
26.	<i>Physalis minima</i> L.	Leaves	Leaf juice used in earache.
27.	<i>Scoparia dulcis</i> L.	Whole plant	Plants used in tooth-ache.
28.	<i>Solanum nigrum</i> L.	Fruits and leaves	Leaf-juice used in chronic enlargement of the liver and dysentery; berries used in eye disease.
29.	<i>Spilanthes acmella</i> (L.) DC.	Leaves	Leaves used to relieve tooth-ache and in treatment of skin diseases.
30.	<i>Stachytarpheta jamaicensis</i> (L.) Vahl.	Whole plant	Plants used in fever, rheumatism and dysentery.
31.	<i>Tribulus lanuginosus</i> L.	Whole plant	Plants used as diuretic and aphrodisiac.

Invasive alien plant species are used for a variety of functional and aesthetic purposes. Many people who seek to introduce a non-native species into a new habitat do so for an economic reason [14] and most cases of invasiveness can thus be linked to the intended or unintended consequences of economic activities. Commercial use of invasive alien plant species can contribute in uplifting the economic status of poor rural communities [50].

For example, *Lantana camara* is being used for basket-making and some other purposes.

A search in literature and consultation with local people indicated that several of the invasive species are also used for different purposes for example, the stem of *Malvastrum coromandelianum*, *Sesbania bispinosa* and *Sida acuta* for fibre and *Borassus flabellifer* for making hand-held fans [28].

It is obviously recorded from the study that, 30 invasive species are under the consideration of medicinal purposes (Table 2). Several of these are used

for adulteration: for example, mustard oil is adulterated with extract from seeds of *Argemone mexicana*. But, some of the species like *Parthenium hysterophorus*, *Lantana camara* and *Prosopis juliflora* are having high allelopathic potential and harmful to natural plant population. These invasive alien species are ready colonizers in disturbed areas and cause considerable ecological damages to natural areas.

CONCLUSION

The results of the present study have shown that most of the exotic plant species currently spreading were intentionally introduced. They have not only disturbed the environment and ecosystem but have also threatened the indigenous flora of study region as a number of plants are getting rare. There is every possibility that if the invasion of alien species will continue to operate unchecked, the endemic species may get extinct and the germplasm of economic plants may become rare or even

be exterminated. Therefore, it is very important to make an effective database for the management of invasive species, knowledge about their diversity, life form, habitat and uses for further studies.

ACKNOWLEDGEMENTS

Authors are thankful to University Grants Commission (UGC), New Delhi for providing financial assistance (F. No. 39-422/2010 (SR) dated 7th January 2011) for the study. We also admire the help provided by Botanical Survey of India, Southern Circle (Coimbatore) in identification of various plant species. Thanks are also due to Professor and Head, Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu for providing necessary facilities and encouragement.

REFERENCES

1. Lubchenco, J., A.M. Olson, L.B. Brubaker, S.R. Carpenter, M.M. Holland, S.P. Hubbell, S.A. Levin, J.A. Macmahon, P.A. Matson, J.M. Melillo, H.A. Mooney, C.H. Peterson, H.R. Pulliam, L.A. Real, P.J. Regal and P.G. Risser, 1991. The sustainable biosphere initiative: an ecological research agenda. *Ecology*, 72: 371-412.
2. Ehrlich, P.R. and E.O. Wilson, 1991. Biodiversity studies-science and policy. *Science*, 253: 758-762.
3. Holdgate, M., 1996. The ecological significance of biological diversity. *Ambio*, 25: 409-416.
4. Tilman, D., 2000. Causes, consequences and ethics of biodiversity. *Nature*, 405: 208-211.
5. Singh, J.S., 2002. The biodiversity crisis: a multifaceted review. *Current Science*, 82: 638-647.
6. Meyer, J.Y., 2000. Preliminary Review of the Invasive Plants in the Pacific Islands, In: G. Shreley, (Ed.) *Invasive Species in the Pacific: A Technical Review and Draft Regional Strategy*, South Pacific Regional Environmental Programme, Samoa, pp: 85-114.
7. Dogra, K.S., R.K. Kohli and S.K. Sood, 2009. An assessment and impact of three invasive species in the Shivalik hills of Himachal Pradesh, India. *International Journal of Biodiversity and Conservation*, 1(1): 4-10.
8. Hobbs, R.J. and S.E. Humphries, 1995. An integrated approach to the ecology and management of plant invasions. *Conservational Biology*, 9: 761-770.
9. Drake, S.J., J.F. Weltzin and P. Parr, 2003. Assessment of non-native invasive plant species on the United States Department of Energy Oak Ridge National Environmental Research, Australia. *Castanea*, 68(1): 15-30.
10. Richardson, D.M., P. Pysek, M. Rejmanek, M.G. Barbour, F.D. Panetta and C.J. West, 2000. Naturalization and invasion of alien plants: Concepts and definitions. *Diversity Distribution*, 6: 93-107.
11. Khanna, K.K., 2009. Invasive alien angiosperms of Uttar Pradesh. *Biological Forum-An International Journal*, 1(2): 41-46.
12. Levine, S.A., 1989. Analysis of Risk for Invasions and Control Program, In: Drake, J.A., H.A. Mooney, F. Di Castri, R.H. Grooves, F.J. Druger, M. Rejmanek and M. Williamson, M. (eds.) *Biological Invasion: A Global Perspective*. John Wiley and Sons, New York, pp: 425-435.
13. Huang, Q.Q., J.M. Wu, Y.Y. Bai, L. Zhou and G.X. Wang, 2009. Identifying the most noxious invasive plants in China: role of geographical origin, life form and means of introduction. *Biodiversity Conservation*, 18: 305-316.
14. McNeely, J.A., 2001. An introduction to human dimensions of invasive alien species, ISSG, IUCN.
15. Perrings C., M. Williamson, E.B. Barbier, D. Delfino, S. Dalmazzone, J. Shogren, P. Simmons and A. Watkinson, 2002. Biological invasion risks and the public good: an economic perspective. *Conservational Ecology*, 6(1): 1-4.
16. Walck, J.L., J.M. Baskin and C.C. Baskin, 1999. Effects of competition from introduced plants on establishment, survival, growth and reproduction of the rare plant *Solidago shortii* (Asteraceae). *Biological Conservation*, 88: 213-219.
17. Vila, M. and J. Weiner, 2004. Are invasive plant species better competitors than native plant species?-evidence from pair-wise experiments. *Oikos*, 105: 229-238.
18. Mack, R.N., D. Simberloff, W.M. Lonsdale, H. Evans, M. Clout and F.A. Bazzaz, 2000. Biotic invasions: causes, epidemiology, global consequences and control. *Ecological Applications*, 10: 689-710.
19. Simberloff, D., I.M. Parker and P.M. Windle, 2005. Introduced species policy, management and future implications. *Current Science*, 88: 726-734.

20. Sharma, G.P., J.S. Singh and A.S. Raghubanshi, 2005. Plant invasions: Emerging trends and future implications. *Current Science*, 88: 726-734.
21. Mooney, H.A. and R.J. Hobbs, 2000. The exotic flora of Rajasthan. *Journal of Economic and Taxonomic Botany*, 18(1): 105-121.
22. Corlett, R.T., 1988. The naturalized flora of Singapore. *Journal of Biogeography*, 15: 657-663.
23. Enomotto, T., 1999. Naturalized Weeds from Foreign Countries into Japan, In: Yano, E., M. Matsuo, M. Shiyomi and D.A. Andow (Eds.). *Biological Invasion of Ecosystem by Pests and Beneficial Organisms*, National Institute of Agro-Environmental Science, Tsukuba, pp: 1-14.
24. Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A. Da Fonseca and J. Kent, 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403: 853-858.
25. Reddy, C.S., 2008. Catalogue of invasive alien flora of India. *Life Science Journal*, 5(2): 84-89.
26. Singh, K.P., A.N. Shukla and J.S. Singh, 2010. State-level inventory of invasive alien plants, their source regions and use potential. *Current Science*, 90(1): 107-114.
27. Chandra Sekar, K., 2012. Invasive alien plants of Indian Himalayan Region-Diversity and Implication. *American Journal of Plant Science*, 3: 177-184.
28. Chandra Sekar, K., R. Manikandan and S.K. Srivastava, 2012. Invasive alien plants of Uttarakhand, Himalaya. *Proceedings of Natural Academic Sciences of India*. doi 10.1007/s40011-012-0040-2.
29. Subramanyam, K., 1959. Observations on the Flora of Boluvampatti forests, Coimbatore Taluk. *Bulletin Botanical Survey of India*, 1: 127-137.
30. Subramaniyan, K.N., 1996. Further contributions to the flora of Boluvampatti Valley forests, Coimbatore District, Madras State. *Indian Forester*, 92: 39-50.
31. Gamble, J.S. and C.E.C. Fischer, 1915-1936. *Flora of Presidency of Madras*. Vols. 1-3. Reprint ed. 1957, Adlard and Sons Ltd., London.
32. Matthew, K.M., 1983. *The flora of Tamilnadu Carnatic, The Rapinat Herbarium, Tiruchirapalli, Tamil Nadu, India*.
33. Nair, M.P. and A.N. Henry, 1983. *Flora of Tamil Nadu, India. Series I (Analysis): Vol. I. Botanical survey of India, Southern Circle, Coimbatore, Tamil Nadu*.
34. Henry, A.N., G.R. Kumari and V. Chitra, 1987. *Flora of Tamil Nadu, India. Series I (Analysis): Vols. II-III., Botanical Survey of India, Southern Circle, Coimbatore, Tamil Nadu*.
35. Chandrabose, M. and N.C. Nair, 1988. *Flora of Coimbatore*. Bishen Singh Mahendra Pal Singh, Dehra Dun.
36. Jain, S.K. and R.R. Rao, 1976. *A handbook of Field and Herbarium Methods*, Today and Tomorrow Publishers, New Delhi.
37. Chatterji, D., 1947. Influence of east Mediterranean regions flora on that of India. *Science Culture*, 13: 9-11.
38. Maheswari, J.K., 1960. Studies on the Naturalized flora of India, In: Maheswari, P., B.M. Johri and I.K. Vasil (Eds.) *Proceedings of the Summer School of Botany*, pp: 156-170.
39. Srivastava, J.D., 1964. Some tropical American and African weeds that have invaded the state of Bihar. *Journal of Indian Botanical Society*, 43: 102-112.
40. Matthew, K.M., 1969. Alien flora of Kodai Kanal and Palni Hills. *Recordings of the Botanical Survey of India*, 20(1): 1-241.
41. Maheswari, J.K. and S.R. Paul, 1975. The alien flora of Ranchi. *Journal of Bombay Natural Historical Society*, 72(1): 158-188.
42. Nayar, M.P., 1977. Changing patterns of the Indian flora. *Bulletin Botanical Survey of India*, 19: 145-154.
43. Sharma, B.D., 1984. *Exotic flora of Allahabad*, Botanical Survey of India, Dehra Dun.
44. Hajra, P.K. and B.K. Das, 1982. Vegetation of Gangtok with special reference to alien plants. *Indian Forum*, 107: 554-566.
45. Saxena, K.G., 1991. Biological Invasion in the Indian Sub-Continent: Review of Invasion by Plants. In: Ramakrishnan, P.S. (Ed.) *Ecology of Biological Invasion in the Tropics*. International Scientific Publications, New Delhi, pp: 53-73.
46. Pandey, R.P. and P.J. Parmer, 1994. The exotic flora of Rajasthan. *Journal of Economic and Taxonomic Botany*, 18: 105-135.
47. Reddy, C.S. and V.S. Raju, 2002. Additions to the weed flora of Andhra Pradesh, India. *Journal of Economic and Taxonomic Botany*, 26: 195-208.
48. Negi, P.S. and P.K. Hajra, 2007. Alien flora of Doon Valley, North West Himalaya. *Current Science*, 92(7): 968-978.
49. Randall, R.P., 2012. *A Global Compendium of Weeds*, 2nd Edition, Department of Agriculture and Food, Western Australia.
50. Semanya, S., P.T. Milingoni and T.P. Martin, 2012. Invasive alien plant species: A case study of their use in the Thulamela local municipality, Limpopo Province, South Africa. *Scientific Research Essays*, 7(27): 2363-2369.