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Review

Alien plant invasion and their impact on indigenous species diversity at global scale: A review

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Plant invasion is a potent threat to the species diversity around the world during the 21st century after habitat loss. Plant invasions are human introduced or of natural means like winds, birds, animals, water. It affects indigenous species diversity, soil ecology and dynamics and economics of agricultural ecosystem throughout the world. If this process of biological invasion is remained continuous for years to come then we can only transfer monocultures of species to our future generations. To preserve our indigenous species diversity, it is important to understand the process of plant invasions and their impact on species diversity in various habitats around the world.

Key words: Alien species, ecosystem, indigenous species, plant invasion.

INTRODUCTION

Invasion by the alien plant species were increased rapidly throughout the world during the present century and responsible for the homogenization of floras which causes a substantial threat to biodiversity and ecological integrity of native habitats and ecosystems (Booth et al., 2003; Hulme, 2003). Invasion by the species cause extensive effects on the habitats they invade, like impact on indigenous species diversity, soil nutrient composition, altering forest fire cycles and loss of productivity of invading ecosystems. It also becomes a threat to endangered or threatened plant species around the world (Pimentel et al., 2005). It is supposed that 10% of plant species, on an average, from any region are good colonizers. Thus, it can be estimated that from 260,000 vascular plant species known around the world, only 10% are potential invaders. Further, there are about 10,000 recognized invasives and 40% of these have been interchanged among different regions of the world (Rapoport, 1991). It is also estimated that 20% or more of the plant species are exotics in many continental areas and 50% or more on many islands (Rejmanek and Randall, 1994). The disturbances in the natural ecosystems provide the great opportunities to the alien invaders to establish themselves. The frequency of the alien herbal plants increased in the areas of human interference such as forest fragmentation (Higgins et al., 1996).

Alien species that can rapidly achieve high densities may have greater establishment success (Kolar and Lodge, 2001) and dominate invaded communities to the exclusion of indigenous species (Ortega and Pearson, 2005). The species capable of rapid colonization are, in general, more likely to have negative impacts on biodiversity (Callaway and Ridenour, 2004). It is estimated that as many as 50% of invasive species in general can be classified as ecologically harmful, based on their actual impacts (Richardson et al., 2000). In India especially NW Himalaya *Ageratum conyzoides* L., *Parthenium hysterophorus* L., *Lantana camara* L. and *Eupatorium adenophorum* Sp. (Syn. *Ageratina adenophora* (Spreng.) R. M. King and H. Rob.) are major invaders and causing huge loss to indigenous species diversity in this part of the world (Dogra et al., 2009). In view of the increased threat of alien plant species, this paper presents an insight into the type of plant invasions and their impact on species diversity throughout the world in the last centaury.

PLANT INVASIONS AND THEIR TYPE

Plant invasions dramatically affect the distribution, abundance and reproduction of many native species

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(Sala et al., 1999). Because of these ecological effects, alien species can also influence the evolution of natives exposed to novel interactions with invaders (Parker et al., 1999). Evolutionary changes in natives in response to selection from aliens are usually overlooked, yet common responses include altered anti-predator defenses, changes in the spectrum of resources and habitats used, and other adaptations that allow native populations to persist in invaded areas (Mooney and Cleland, 2001). So, introduction of such invasive species leads to change in the structure and composition of native communities (Rice and Emery, 2003). It is basically of two types:

1). Human introduced invasions
2). Natural invasions

Human introduced invasions

The human-made introductions in the new habitats are quick and responsible for rapid change within the indigenous communities (Ridenour and Callaway, 2001). The introduction of plant species by humans increased during the last five centuries, especially during the twentieth century, due to rapid increase in trade and travel across the globe. Planes, ships, and other forms of modern transport have allowed both deliberate and inadvertent movement of species, often resulting in unexpected and sometimes disastrous consequences (Moore, 2004). Some times the species are introduced in such environments which can not be chosen by the species themselves for their growth and establishment. The introduction of new species in the balanced ecosystems and habitats can affect the natural process which leads towards destruction or loss of biodiversity (Louda et al., 2003). Introduction of *Eucalyptus citriodora* Hook., *Populus deltoides* Marsh. and *Lantana camara* L. species in India is an example of human introduced invasions (Kohli et al., 2004; Dogra et al., 2009).

Natural invasions

The impact of natural invasion is almost similar to that of human made invasions but this kind of invasion mostly depends upon the dispersal ability of the invading plants and animals. The time scale for natural invasion can range from few years to several years. The sources for natural invasion are birds, animals, water and wind etc (Herbold and Moyle 1986). *Ageratum conyzoides* L. and *Parthenium hysterophorus* L. are examples of such type of invasions in India (Kohli et al., 2004; Dogra et al., 2009). After natural invasion by an alien plant species, there is a “lag phase” that may range from decades to centuries before an exponential phase of its fast spread (Ghate, 1991). The species that at a given time may appear to be non-invasive may suddenly begin to spread rapidly. *P. hysterophorus* fits well as an example in this regard. It is reported that the introduction of this species in India occurred accidentally (Roxburgh, 1884; Bennet et al., 1976; Maiti, 1983) in 1810 and lived in obscurity until Rao reported it in 1956 from Pune. However, its exponential spread was witnessed between 1985 and 1995 when it engulfed almost the whole of India including NW Himalaya (Himachal Pradesh) up to 2000 m (Dogra et al., 2009).

IMPACT OF PLANT INVASIONS

Studies of past introductions demonstrate that the effects of invasive species are complex and can permanently alter the structure of communities (Holway et al., 2002; Carlton, 2003). Invasive alien species pose a threat to native/indigenous plant communities globally, especially where these communities are disturbed (D’Antonio et al., 2001). However, relatively few alien plant species seem to have the capacity to invade undisturbed native plant communities (Rejm´anek, 1989). In India *A. conyzoides* L., *P. hysterophorus* L., *E. adenophorum* Sp. and *L. camara* L. are well recognized alien invaders which posed threat to indigenous plant communities under various habitats and areas from planes to hills (Table 1).

Impact on the natural plant species

Disturbed and unattended habitats are more prone to the invasion as compare to the well-managed ecosystems and habitats. The habitats which have more diverse communities are highly competitive and resist invasion (Crawley, 1987). For example, direct competition with the native flora can result in monocultures of an alien species, such as by *Psidium cattleianum* Sabine (strawberry guajava) in Mauritius and *P. hysterophorus* L. (white top) in Australia and India (Evans,1997).

The invasive trees introduced in Florida (USA) cause major threats to the native vegetation. The tree species included Brazilian pepper (*Schinus terebinthifolius*), Australian paperbark *(Melaleuca quinquenrvia*) and Australian pine THAT IS *Casuarina* sp. (Schmitz et al., 1997). Invasion by different pine species becomes a problem to natural habitats in Australia, New Zealand, and South Africa (Richardson et al.,1994). It was reported that in Christmas Island (Australia) 52.70% species have been found to be aliens (Claussen, 2001) and most of them are confined to disturbed regions such as minefields, overburden dumps, and road sides. These include *Leucaena leucocephala, Muntingia calabura, Ricinis communis, Carica papaya* and *Psidium guajava* (Green et al., 2004).

The alien terrestrial invaders are responsible for extensive and unpredictable irreversible changes to the natural habitats (Higgins et al., 1999). Many exotic tree

Table 1. Impact of some major invasive plants in India.

S/No.	Botanical, common name and habit of alien plants	Origin	Threat	Reference
1	*Ageratum conyzoides* L. (Goat Weed) Asteraceae Herb	Tropical America	Wastelands, plantations, pastures and all forest types. Posing threat to indigenous vegetation in the NW Himalaya and many other parts of India.	Dogra et al., 2009
2	*Eupatorium adenophorum* Sp. (Crofon Weed) Asteraceae Shrub	Mexico	The weed has occupied vacant places in teak, rubber and other forest plantations and causing serious threat to forests. In hilly areas of south and north India, it forms dense thickets on grazing lands	National Focal Point for APFISN, 2005
3	*Parthenium hysterophorus* L. (Carrot Weed, Congress Grass) Asteraceae Herb	Tropical America	Fields, forest areas, grass lands and urban areas, aggressive colonizer of degraded areas with poor ground cover and exposed soil such as fallow wastelands, roadsides and overgrazed pastures between existing plant cover and native weed density	National Focal Point for APFISN, 2005; Dogra et al., 2009
4	*Lantana camara* L. (Lantana) Verbeneaceae Shrub	Tropical America	Common throughout the country in the forests, plantations, agricultural land, disturbed areas, grass lands, wetlands, riparian and urban areas. A serious treat to grasslands and indigenous medicinal plants	National Focal Point for APFISN, 2005; Dogra et al., 2009

species worldwide introduced for commercial exploitation, economic reasons and for ornamental purpose have subsequently become noxious invaders. These tree species have impacted the natural above-ground herbal and other native vegetation. Some times, under the alien conditions or in new invaded ecosystems, such type of species become naturalized and expand over native ecosystems (Calder et al., 1992; Richardson, 1998). For example the introduction of pines in the Southern Hemisphere has affected large areas of natural grass and shrub lands. It brought a lot of change in the dominant life forms, decreased the species composition and modified vegetation patterns and nutrient cycles (Richardson et al., 1994).

The disturbed forest understories are more prone to invasion as compared to the undisturbed one. There are many species that establish and dominate low light forest understories in the Northwestern USA, such as *Alliaria petiolata* (Meekins and McCarthy,2001), *Acer platanoides* (Webb and Kaunzinger, 1993), *Lonicera bella, Rhamnus cathartica* (Harrington et al., 1989) and *Berberies thunbergii* (Silander and Klepeis, 1999).

The invasive species survive under the shade because rapid growth takes place in the gaps (Sanford et al., 2003). Further, impact of some major invasive species on global scale is listed as under (Table 2).

IMPACT ON THE SOIL DYNAMICS

Invasion by alien plant species affects the dynamics and composition of soil on a wide scale and have great impact on ecosystem functions such as soil nutrient cycling. Since these impacts result from differences in traits between the exotic and resident species, novel physiological traits such as nitrogen cycling may cause large alterations in ecosystem function (Yelenik et al., 2007).

The invasion of two exotic plants - *Berberis thunbergii* and *Microstegium vimineum* - in hardwood forests of New Jersey, Europe has shown a significant increase of pH in soils under the invasive plants as compared to soils from under native shrubs (*Vaccinium* sp.). Further, available nitrate and net potential nitrification were significantly higher in soils under the two exotic species (Kourtev et al., 1999). The introduced *Prosopis juliflora* is fast growing, highly aggressive and invasive, and causes substratum degradation in the semi-arid and arid areas of North and North-west India as compared to native species *P. cineraria*. This lack of integration amongst plant and soil characteristics and the ability to meet its

Table 2. Impact of some major invasive plants on global scale.

S/No.	Botanical, common name and habit of alien plants	Origin	Introduced	Threat	Reference
1	*Acer platanoides* L. (Norway Maple) Tree	Norway	Suburban Ithaca, New York., USA	It displace native flora especially understorey vegetation, where it casts deep shade.	Martin, 1999
2	*Acroptilon repens* (L.) DC. (Russian Knapweed) Forb	Russia	North America.	Effecting the seedling emergence and growth of native grasses	Grant et al., 2003
3	*Agropyron cristatum* (L.) Gaertn Grass	North American	Asia	It is a strong competitor which can displace or prevent the establishment of native species.	Bakker and Wilson, 2001
4	*Ailanthus altissima* (Mill.) Swingle, (Tree of Heaven) Tree	China	USA	It is a serious threat to ecosystems in introduced areas, as the plant is very competitive, especially due to chemicals that may inhibit the growth of many native plants	Ding et al., 2007
5	*Alliaria petiolata* (Bieb.) Cav. and Grand. (Garlic Mustard) Herb	European	Eastern US and Canada	Its invasion poses a severe threat to native plant communities.	Nuzzo, 1999
6	*Alternanthera philoxeroides* Mart.) Griseb (Alligator Weed) Herb	South America	China	By forming dense mats of interwoven stems over water or land, this invasive weed may threaten the native flora and fauna, reduce crops yields, block ships, and promote flooding	Holm et al., 1997
7	*Andropogon gayanus* Kunth (Gamba Grass) Grass	Africa	Humid Central and Northern Brazil	Threat to native species	Fisher et al., 1995
8	*Andropogon gayanus* Kunth. (Gamba Grass) Grass	Africa	Northern Australia	Serious threat to northern Australia's savannas, with the potential to alter vegetation structure and initiate a grass fire cycle.	Rossiter et al., 2003
9	*Ardisia elliptica* Thunb. (Duck;s Eye) Shrub	Southeast Asia	Southern Florida, USA	Displacing native species since its invasion in Florida.	Koop, 2004

Table 2. Contd.

10	*Arundo donax* L. (Giant Reed) Grass	India	California	Displacing native species around the water channels.	Duke and Mooney, 2004
11	*Berberis thunbergii* DC (Japanese Barberry) Shrub	Japan	USA	Dense clusters of its own monocultures and altering the ecosystem process and functions in the undisturbed forests. Now, considered as a serious problem in forest management.	Cassidy et al., 2004
12	*Bothriochloa ischaemum* (L.) Keng (Yellow Blue Stem) Grass	Eurasian	Edwards Plateau of Central Texas, USA,	Fast spreading invasive grass which reduces native herbaceous plant diversity.	Gabbard, 2007
13	*Brachiaria brizantha* (A. Rich.) Stapf (Signal Grass, Pasto Alambe) Grass	Humid tropical Africa	Humid Tropics	Threat to native plants.	Fisher et al., 1995
14	*Brachiaria mutica* (Forsk.) Stapf. (Pará Grass) Grass	Africa Tropical Africa	Humid tropics, sub-tropics	Serious threat to native vegetation.	Williams and Baruch, 2000
15	*Carduus acanthoides* L. (European Thistle) Herb	Europe	North America	It has a high probability of establishment and persistence and has a wide impact on native species.	Jongejans et al., 2007
16	*Carrichtera annua* (L. Aschers.) (Ward's Weed) Herb		South Australia.	Affecting the Native communities in chenopod shrublands of South Australia.	Harris and Facelli, 2003
17	*Celastrus orbiculatus* Thunb. (Oriental or Asian Bittersweet) Deciduous Liana	Southeast Asia	Southern Illinois, USA	It has created an ecological and economic threat to native ecosystems, particularly in disturbed temperate forest areas.	Pande et al., 2007
18	*Chromolaena odorata* (L.) R.M. King and H. Robin. (King in the Bush) Shrub	South Africa	America	Its foliage is reportedly flammable (contains essential oils), making it a threat to indigenous coastal forest patches, which are not resilient to fire.	Witkowski and Wilson, 2001

Table 2. Contd.

19	*Cinnamomum verum* Presl. (The True Cinnamon) Tree	Western Ghats of India and Sri Lanka,	Seychelles, Switzerland	It influences the course of forest succession by differentially affecting regeneration of native tree species.	Kueffer et al., 2007
20	*Conyza sumatrensis* (Retz.) E. Walker, (Fleabane) Herb		England UK	It spreads along transport routes from the capital (Greater London), such as railway lines, major roads and motorways. A threat to indigenous flora.	Wurzell, 1994
21	*Cryptostegia grandiflora* (Roxb.) R. Br. (Rubber Vine) Vine	Madagascar	Australia	A threat to native biodiversity	Grice et al., 2000
22	*Cytisu scoparius* (L.) Link (English or Scotch Broom) Shrub	Europe	South Australia	It displaces native understorey vegetation and grasses, finally forming monospecific stands.	Fogarty and Facelli, 1999
23	*Elaeagnus angustifolia* L. (Russian Olive) Tree or shrub	Russia	North America	This invader strongly influences the species composition, ecological processes, productivity, and biodiversity of native riparian forests	Lesica and Miles 2001
24	*Eragrostis lehmanniana* Nees. Grass	South Africa	Arizona, Southwestern USA	Exist in a wide range of ecological conditions with little to no genetic variation	Schussman et al., 2007
25	*Heracleum mantegazzianum* Sommier and Levier (Giant Hogweed) Herb	Western part of the Greater Caucasus Russia, Georgia	Europe, North America and New Zealand	It is a problem species, because it forms monocultures with a high cover, replaces resident vegetation, and produces photosensitive sap that is toxic for humans.	Nehrbass et al., 2007
26	*Heracleum mantegazzianum* Sommier et Levier (Giant Hogweed) Herb	Western part of the Greater Caucasus Russia, Georgia	Czech Republic	Replacement of native vegetation and injuries to human skin caused by phototoxic substances are the main reasons for attempts to eradicate it.	Pyseˇk et al., 2007
27	*Heracleum persicum* Desf. ex Fischer. Herb	Turkey, Iran, and Iraq	Scandinavia, Europe	Posing threat to native plant diversity.	Jahodová et al., 2007
28	*Heracleum sosnowskyi* Manden Herb	Eastern and central Caucasus, Transcauc-asia and northeast Turkey.	Russia, Belarus, Ukraine, Baltic countries, Eastern Germany.	Widely invasive species in various habitats.	Nielsen et al., 2005

Table 2. Contd.

29	*Hyparrhenia rufa* (Nees) Stapf. (Jaraguá Grass) Grass	Tropical and South Africa and Madagascar	Humid and sub-humid tropics, Central and South America, Cuba	African grass-dominated pasture produces radical changes in hydrologic balance.	Williams and Baruch, 2000
30	*Imperata cylindrica* (L.) Beauv. (Cogongrass, Alang-Alang) Grass	Subtropical and tropical Asia.	Southeastern USA	It displaces native plant and animal species and alters fire regimes. The Phosphorus addition by this species reduces invasion of a longleaf pine savanna in Southeastern USA.	Brewer and Cralle, 2003
31	*Ligustrum robustum* (Roxb.) (Srilakan Privet) Shrub	South Indian Hills (Western Gh´ats) and Sri Lanka (Central Highlands)	La R´eunion, Mauritius	This species is a major threat to the native ecosystems and one of the worst pest plants of Mauritian wet forests.	Lavergne et al., 1999
32	*Ligustrum sinense* Lour. (Chinese Privet) Shrub	China	North Carolina, USA	It has impact on the native plant diversity and on forest regeneration.	Merriam and Feil, 2002
33	*Lolium multiflorum* (Pers.) (Italian Raygrass) Grass	Spain	Alkali sites in California, USA	It may pose a long-term threat to native alkali biodiversity.	Dawson et al., 2007
34	*Lonicera maackii* (Rupr.) (Herder Amur-Honeysuckle) Shrub	Northeastern Asia,	Eastern North America,	Associated with reduced tree seedling density in Ohio forests.	Gorchov and Trisel, 2003
35	*Lythrum salicaria* L. (Purple loosestrife) Herb	Eurassia	North America	The plant is considered a problem because it displaces native plants, clogs waterways, and reduces the quality of habitat for wildlife.	Shadel and Molofsky, 2002
36	*Melia azadratica* L. (Dreak) Tree	India	South America	Threat to the native plant species diversity.	Luti et al., 1979
37	*Melinis minutiflora* Beauv. (Molasses Grass, Gordura) Grass	Tropical West Africa, Angola to Camaroon	Tropics of Central and South America, West Indies, Puerto Rico	The conversion of native forest to pasture and the establishment of African grasses can significantly alter water balance of ecosystems and watersheds.	Williams and Baruch 2000
38	*Microstegium vimineum* (Trin.) A. Camus, (Japanese Stilt Grass) Grass	Japan	Eastern and South Eastern United States	Threatening the growth of native species.	Redman, 1995

Table 2. Contd.

39	*Panicum maximum* Jacq., (Guinea Grass) Grass	Tropical Africa to sub-tropics of South Africa	South Eastern US, West Indies, Tropics of Central and South America	These effects are produced primarily by the extreme structural changes of the vegetation.	Williams and Baruch, 2000
40	*Pennisetum clandestinum* Hochst. (Buffel Grass) Grass	Hotter and drier parts of eastern and southern Africa	Semi-arid and arid tropics and sub-tropics, North Mexico, Southwestern US	Posing a threat to the native species.	Williams and Baruch, 2000
41	*Phacelia tanacetifolia* Benth. (Lacy Phacelia) Herb	North America	Europe	Affect pollinator visitation and female reproductive success of a native plant, *Melampyrum pretense* L. in recently disturbed and undisturbed boreal forests.	Totland et al., 2006
42	*Polygonum perfoliatum* L (Devil's Tail Tear-Thumb or Mile-a-Minute Weed) Herb	India, China, Korea, Japan, Bangladesh, and the Philippines	Northeastern USA	Causing ecological problems in invaded areas, as the plant grows rapidly and covers shrubs and other vegetation, dominating in its new community.	Ding et al., 2007
43	*Prosopis juliflora* (Swartz) DC. (Vilayeeti Babul) Tree	Jamaica	India	Aggressive and has not only successfully invaded several habitats but has also caused substratum degradation in these by causing loss of finer soil particles.	Sharma and Dakshini, 1998
44	*Pueraria Montana* (Lour.) Merr. var. lobata (Willd.) Maesen and Almeida (Kudzu) Vine	Asian	Philadelphia, USA	It poses a serious threat to biodiversity as it completely replaces existing vegetation and few plants can survive once smothered by kudzu.	Ding et al., 2007
45	*Rubus alceifolius* Poiret (The Giant Bramble) Shrub	Southeastern Asia and Malaysia,	Island of La-Réunion	Invaded a wide variety of habitats- lowland rainforest, mountain and submountain rainforest, *Acacia heterophylla* rainforest and disturbing native species.	Baret et al., 2004
46	*Senecio madagascariensis* Poir. (Fireweed) Shrub	Afro- Madagascan	Hawaii	Competes strongly with existing pasture flora for light, moisture, and soil nutrients (notably P and N), leading to the ultimate deterioration of pastures.	Roux et al., 2006
47	*Sorghum halepensis* L. (Johnson Grass) Grass	Mediterranean North Africa	Sub-tropics and warm temperate North and South America	Threat to indigenous plants.	Williams and Baruch, 2000

Table 2. Contd.

48	*Spartina densiflora* Braigu (Cordgrass) Grass	Chile	Gulf of Cadiz, Spain,	Poses a threat to the biodiversity of southern European marshes.	Castillo et al., 2000
49	*Tamarix ramosissima* Ledeb. (Salt Cedar) Tree	Russia	North America	These invaders strongly influence the species composition, ecological processes, productivity, and biodiversity of native riparian forests	Stohlgren et al., 1998
50	*Tibouchina herbacea* (DC) Cogn. (Glory Bush) Shrub	South America	Hawaii and Maui	Effecting the growth of native vegetation under the native forests.	Almasi, 2000
51	*Tradescantia fluminensis* Vell. (Small Leaf Spiderwort) Herb	South America	New Zealand	Effecting the litter decomposition and nutrient availability in a remnant of New Zealand lowland podocarp broadleaf forest.	Standish et al., 2004
52	*Ziziphus mauritiana* Lam (Indian Jujuba) Shrub or Tree	India	Australia	A threat to native biodiversity.	Grice et al., 2000

its nutrient requirements in all situations could be the basis of the phenomenal spread of *P. juliflora* across varying environmental conditions, in contrast to *P. cineraria* (Sharma and Dakshini, 1998).

Comparisons between habitats with contrasting levels of soil resource availabilities suggest that an increase in resource availability tends to increase invasion of native grassland communities by non-native plants. For example, nutrient enrichment (Davis et al., 2000; Kolb et al., 2002) has been consistently shown to increase the abundance of non-native plant species and decrease the abundance of native ones (White et al., 1997).

Economic loss due to invasion

The risks associated with the invasion of alien species are increasing, with increasingly rapid international exchange and convenient transportation (Chen and Xu, 2001). Invasive alien species expedites the losses of species and genetic biodiversity (Li and Xie, 2002; Wan et al., 2002), destroys the structure and functions of ecosystems (Zhang and Ye, 2002), and causes huge economic losses. Invasive alien species have caused losses worth USD 138 billion to the USA (Pimentel et al., 2000). The total economic losses caused by invasive alien species to China were to the time of USD 14.45 billion, with direct and indirect economic losses accounting for 16.59 and 83.41% of total economic losses, respectively (Xu and Ding, 2003). Oerke et al. (1994) calculated 13% loss in the world's agricultural output due to weeds (based on eight major crops). In maize alone, an actual loss due to weeds from 1997 - 1999 was around 1.7 billion USD. There has been an extensive movement of plant species around the world by humans as a consequence of trading activities. This has resulted in exotic species forming a significant part of the agricultural weed flora, and in natural ecosystems invasive weeds are almost exclusively alien (Groves et al., 2001).

Conclusions

Plant invasions in the new areas alter indigenous community composition, deplete species diversity, affect ecosystem process and thus cause huge economic and ecological imbalance. Studies of invasive species introductions in the past revealed that the impacts of their invasion are complex and can permanently alter the structure and function of communities, cause local extinctions and changes in ecosystem processes.

The increased incidence of invasion around the world poses a major threat to indigenous biological diversity.

Increase in the rate of invasion and deliberate introduction of aliens into an area by man is the byproduct of the globalization of regional economics. Large parts of the world are currently dominated by human modified ecosystems that often comprise a greater biomass of introduced than native organisms (Vitousek et al., 1997). Besides human actions, several other factors contribute to successful invasion by alien plants. The climatic and edaphic similarities between the original and new habitats are very important factors for the establishment of alien species (Holdgate, 1986). Thus, humid tropics of the Asia and Africa with highly leached soils are similar to Latin American home of species such as *L. camara*, *A. conyzoides*, *E. odoratum*, *E. adenoporum; P. hysterophorus* and *M. micrantha* enabling them to invade and colonise appropriate sites on these two continents (Ramakrishnan, 1991).

The magnitude and net effects of biological invasion escalated rapidly over the twentieth century. During each decade, more species become invasive, more ecosystems were irreversibly altered, and an ever-increasing array of functions and processes was impacted by invasive alien species (Rejmanek, 2000). There are thousands of alien species known to establish around the world and many more introduced species remain undetected or unrecognized (Ruiz et al., 2000). Their invasion cause a wide range of high-impact and high profile impacts, including decline in population of threatened and endangered species, habitat alteration and loss, increased frequency of fires, shifts in food webs and nutrient cycling, loss of agricultural crops and productive lands. So, plant invasions are clearly a potent force of change, operating on a global scale and affecting many dimensions of society (Wilcove et al., 1998; Ohlemuller et al., 2006). In view of the wide range of impacts of plant invasions as mentioned above comprehensive studies on long term basis are required at a global scale.

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