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# DOCUMENTATION OF INVASIVE ALIEN PLANT SPECIES IN THE PALAKKAD GAP OF WESTERN GHATS, SOUTH INDIA

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**Abstract**–Invasive alien plant species (IAPS) pose a considerable threat to global biodiversity, ecosystems, and human health. The acceleration of globalization, heightened trade activities, and increased human movement have intensified the spread of these invasive species, rendering it a pressing concern that necessitates immediate action and thorough management approaches. Numerous nations are facing intricate and financially burdensome challenges related to invasive species. These species, which are non-native to their introduced environments, can inflict damage on ecosystems, economies, and public health. They frequently outcompete native species, disrupt ecological processes, and contribute to significant ecological disturbances. However, efforts to manage IAPS have often been undermined by the uncertainty among managers regarding the potential beneficial uses of these species. The Palakkad Gap, which is the focus of this study, is recognized as a biodiversity hotspot and is situated within the Western Ghats. It serves as a trade route connecting the states of Kerala and Tamil Nadu. The area has been invaded by IAPS, necessitating the implementation of management strategies to curb their spread and ultimately facilitate their removal from these ecosystems. Consequently, this study has undertaken the documentation of IAPS within the specified area.

## INTRODUCTION

Life is sustained through the harmonious coexistence of various organisms, which collectively drive an ecosystem. The impact of additional species within an ecosystem is determined by the utilization of available resources and the degree to which these resources are consumed by different organisms. Stable ecosystems maintain a state of equilibrium, and the introduction of invasive alien plant species (IAPS) disrupts this balance. An IAPS is defined as a plant species that humans introduce, either intentionally or accidentally, into regions outside its native habitat. Certain alien species, categorized as 'invasive,' can establish themselves and adversely affect native biodiversity as well as the ecosystem services that humans rely upon.

The phenomenon of globalization has led to increased trade, transportation, travel, and tourism, all of which can promote the introduction and spread of non-native species. If a new habitat closely resembles a species' native environment, that species may thrive and reproduce. For a species to be classified as invasive, it must effectively outcompete native organisms for resources, spread throughout its new surroundings, increase it's population, and inflict harm on the ecosystems within its introduced range.

The rise of new IAPS on a global scale is anticipated to continue due to ongoing human-induced disturbances (Seebens *et al.,* 2018). Addressing IAPS requires an integrated and transdisciplinary approach that combines insights from biology, biomedical sciences, and socio-ecological and economic perspectives on a common platform (Hulme, 2017). Biological invasions frequently result in detrimental effects on biodiversity. Over the past few decades, IAPS have emerged as significant threats to local biodiversity, ecosystem services, and environmental quality (Pejchar and Mooney, 2009; Kueffer, 2017; Jones and Mc Dermott, 2018; Bartz and Kowarik, 2019). This issue has become a major global concern. Previous efforts to manage plant invasions have often been

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undermined by the indecision of managers seeking beneficial applications for these species (Hiremath *et al.*, 2013).

Research on invasive plant species in India has indicated that approximately 60% of studies have been conducted since the year 2000, with only around 20% originating from protected areas. Investigations within these protected regions have predominantly concentrated on a limited range of invasive alien plants, with nearly half of the research focusing on a single species, *Lantana camara*, likely due to it's widespread presence. The proliferation of alien plants in India is influenced by both ecological factors and human activities.

The rise and spatial redistribution of invasive alien plant species (IAPS) are expected to have varied societal and environmental repercussions. Invasions pose a significant threat to global food security and livelihoods, particularly affecting developing nations that are most vulnerable. These countries, characterized by high levels of subsistence and smallholder agriculture, often lack the resources necessary to prevent and manage the encroachment of alien plant species.

IAPS diminish the resilience of natural ecosystems, rendering them more susceptible to the effects of climate change. For instance, certain grasses and trees that have become invasive can drastically modify fire regimes, particularly in regions experiencing increased warmth and aridity. This alteration heightens the frequency and intensity of wildfires, endangering habitats, urban areas, and human lives. Additionally, IAPS can adversely affect agricultural systems by compromising the health of crops and livestock.

These invasions rank among the leading causes of biodiversity loss and species extinction globally, raising significant concerns for ecosystems due to the ecological disturbances they create. Consequently, documentation efforts have been undertaken regarding the IAPS present in the Palakkad Gap, a notable biodiversity hotspot within the Western Ghats.

## METHODOLOGY

**Study area:** Palakkad Gap, situated in the Western Ghats of South India, is a low mountain pass that lies between Coimbatore in Tamil Nadu and Palakkad in Kerala. The average elevation of the Gap is approximately 140 meters, with a width ranging from 24 to 30 kilometers. It is positioned between

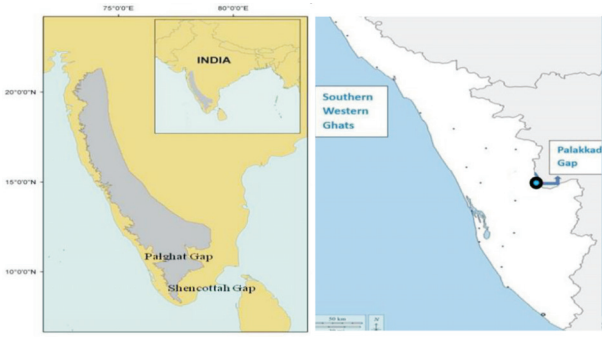


**Fig.1. and Fig.2.** The Palakkad Gap in the map of S.India

the Nilgiri Hills to the north and the Annaimalai Hills to the south, marking the border between Palakkad and Tamil Nadu. The geographical coordinates of Palakkad Gap are 10.16670 N, 77.06670 E.

Historically, this region has served as a vital trade route connecting the eastern and western coasts of peninsular India, significantly influencing the climate of the surrounding areas, particularly Coimbatore and Palakkad. The Gap facilitates the entry of the southwest monsoon into Coimbatore, which helps to moderate the summer temperatures and results in considerably higher rainfall compared to other districts in Tamil Nadu. The topography of the Gap is primarily shaped by processes of shearing and erosion.

Palakkad, previously known as Palghat, is a city located in central Kerala, in the southwestern part of India. It is situated along the Ponnani River within the Palghat Gap, encompassing a total area of 1,080 square kilometers. This region is noted for its rich biodiversity; however, the introduction of invasive species has begun to affect the natural ecosystems of the Palakkad Gap.

### Survey and Data Collection

A comprehensive survey of the Gap was conducted over three seasons, from January 2019 to December 2021, focusing on various natural habitats, including roadsides, fallow lands, agricultural regions, and forested areas. To gather relevant data, specific observation points were established within the Gap. The selection of these points was based on visual assessments, the presence of plant species, and their notable invasive characteristics (Sankaran K.V. *et al.*, 2012). Regional flora, such as the Flora of British India (Hooker, 1876) and the Flora of the Presidency of Madras (Gamble, 1957), were utilized for the identification of plant specimens.

The survey incorporated local interactions and information obtained from secondary data sources. A standardized method was employed for data collection using the quadrat method. The Importance Value Index (IVI) (Curtis, 1959) for dominance was calculated, based on community attributes, including density, frequency, and abundance. GPS coordinates of the sampling locations were recorded and mapped. The Generic Impact Scoring System (GISS) (Nentwig *et al.*, 2016) was applied to evaluate the impact categories of the dominant invasive alien plant species (IAPS).

## RESULT AND DISCUSSION

In the Palakkad Gap, certain invasive alien plant species (IAPS) exhibit remarkable adaptability due to their characteristics, which include rapid reproduction and growth, extensive dispersal capabilities, phenotypic plasticity—allowing them to physiologically adjust to new environments—and resilience in varying nutritional and environmental conditions. Research indicates that *Mimosa diplotricha*, demonstrates a particularly high level of invasiveness. The dominance of these IAPS through Importance Value Index (IVI) and Impact categorization with GISS are shown in Table 2 and Fig. 4. The study identified a total of 53 IAPS across 24 families within the Palakkad Gap (Fig. 3), with the Asteraceae family being the most prevalent. This family is recognized as the most evolutionarily advanced and dominant among dicots, characterized by its composite flower structure.

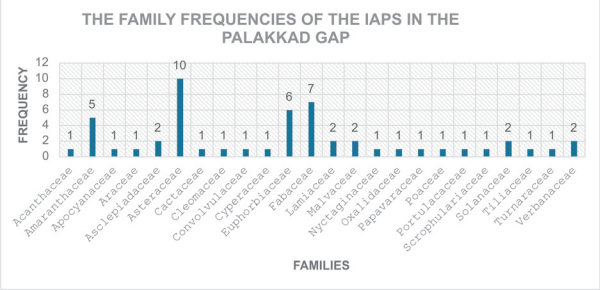


**Fig. 3.** IAPS and the family frequencies

When a species is introduced to a new environment, it must adapt to a variety of unfamiliar ecological challenges. The prevalent IAPS in the study area are particularly well-suited to these diverse pressures. The Dominant IAPS (Table 2) in the Palakkad Gap include *Mimosa diplotricha, Tridax procumbens, Hyptis suaveolens, Pennisetum polystachion, Chromolaena odorata, Parthenium hysterophorus, Lantana camara, and Ageratum conyzoides*, all of which demonstrate significant resilience to these pressures. *Amaranthus spinosus, Oscimum americanum, and Ricinus communis*, are exotic species, while *Tridax procumbens* is partially invasive. Impact percentages of the IAPS are : 15 % - for 8 IAPS (High), 32% for 17 IAPS (Medium) - and 53% for 28 IAPS (Low).

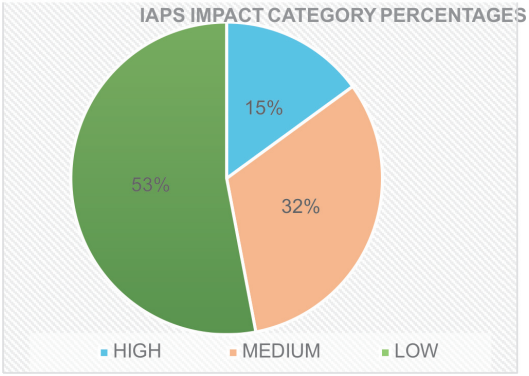


**Fig. 4.** Percentages for the impact categories of IAPS in the Palakkad Gap.

There is considerable variation in the rate of spread both within and among these species. The emphasis is often placed on the species that spread quickly, particularly the prevailing dominant invasive alien plant species (IAPS) in the Palakkad Gap. It is important to note that the current limited range for an alien species does not preclude the possibility of future widespread distribution. Over the long term, the consequences could be severe, necessitating the development and implementation of management strategies for the established alien plant species that may currently appear benign. Management strategies are to be adopted , strictly in this area, to conserve the species of the ecosystems as Western Ghats represents the richness of flora and also IAPS tend to have diversified socio-economic and health impacts.

No ecological phenomenon attracts public interest quite like biological invasion, which refers to the introduction and establishment of a species outside its native range, where it can proliferate and expand significantly. Some invasions result in substantial ecological and socioeconomic repercussions, which have driven a surge in research on bioinvasion over the past thirty years (Simberloff, 2013).

**Table 1.** List of IAPS in the Palakkad Gap of the Western Ghats. Observation indices : H- High , M – Medium and L- Low.

| Sl. .no | IAPS | Invasive /Exotic | Observation Index Range | Family | Life form | Nativity |
|---|---|---|---|---|---|---|
| 1. | *Acanthospermum hispidum DC.* | Invasive | M | Asteraceae | Herb | Brazil |
| 2. | *Acalypha indica L.* | Invasive | M | Euphorbiaceae | Herb | Old world trop. |
| 3. | Ageratum conyzoides L. | Invasive | H | Asteraceae | Herb | Trop.America |
| 4. | *Alternanthera brasiliana L.* | Invasive | L | Amaranthaceae | Herb | Southern Mexico ; Central America |
| 5. | *Alternanthera sessilis (L.)R.Br.ex DC.* | Invasive | M | Amaranthaceae | Herb | Old world Trop. and Sub Trop. |
| 6. | *Amaranthus spinosus L.* | Exotic | M | Amaranthaceae | Herb | Trop.America |
| 7. | *Argemone Mexicana L.* | Invasive | L | Papavaraceae | Herb | Trop.Central and South America |
| 8. | *Asclepias curassavica L.* | Invasive | L | Asclepiadaceae | Herb | Trop.America |
| 9. | *Bidens sulphurea (Cav)Sch.Bip.* | Invasive | L | Asteraceae | Herb | Mexico and South Western United States |
| 10. | *Caladium bicolor (Aiton)Vent.* | Invasive | M | Araceae | Herb | Latin America |
| 11. | *Calotropis procera (Ait).R.Br.* | Invasive | M | Asclepiadaceae | Shrub | Trop.Africa |
| 12. | *Catharanthes roseus (L.)* | Invasive | M | Apocyanaceae | Herb | Madagascar |
| 13. | *Centrosema mole Benth.* | Invasive | M | Fabaceae | Herb | Mexico ; Central America |
| 14. | *Chromolaena odorata (L.) King and Robinson* | Invasive | H | Asteraceae | Shrub | Trop.America |
| 15. | *Cleome viscosa L.* | Invasive | M | Cleomaceae | Herb | Australia |
| 16. | *Corchorus tridens L.* | Invasive | L | Tiliaceae | Herb | Trop.Africa |
| 17. | *Croton bonplandianus Boil.* | Invasive | L | Euphorbiaceae | Herb | Temperate South America |
| 18. | *Cyperus difformis L.* | Invasive | M | Cyperaraceae | Herb | Trop.America |
| 19. | *Datura stramonium L.* | Invasive | L | Solanaceae | Herb | North America |
| 20. | *Jatropha gossypifolia L.* | Invasive | L | Euphorbiaceae | Shrub | Mexico; South America; Carribean Islands |
| 21. | *Eclipta prostrata (L.)* | Invasive | M | Asteraceae | Herb | Trop.America |
| 22. | *Emilia sonchifolia (L.) DC.* | Invasive | L | Asteraceae | Herb | Trop.America |
| 23. | *Euphorbia heterophylla* | Invasive | L | Euphorbiaceae | Herb | Ameriacas |
| 24. | *Euphorbia hirta L.* | Invasive | L | Euphorbiaceae | Herb | Trop.America |
| 25. | *Gomphrena celosioides C.Mart.* | Invasive | M | Amaranthaceae | Herb | Argentina;Bolivia;Brazil |
| 26. | *Gomphrena serrata L.* | Invasive | L | Amaranthaceae | Herb | South America |
| 27. | *Hyptis suaveolens L.Poit.* | Invasive | H | Lamiaceae | Herb | Trop.America |
| 28. | *Ipomoea purpurea (L.) Roth.* | Invasive | L | Convolvulaceae | Herb | South America |
| 29. | *Lantana camara L.* | Invasive | H | Verbenaceae | Shrub | Trop.America |
| 30. | *Mimosa dipliotricha C.Wright.* | Invasive | H | Fabaceae | Shrub | Neotropics-Central America and Caribbean Islands |
| 31. | *M.pudica L.* | Invasive | M | Fabaceae | Herb | Brazil |
| 32. | *Mirabilis jalapa L.* | Invasive | L | Nyctaginaceae | Herb | Peru |
| 33. | *Oxalis corniculate L.* | Invasive | M | Oxalidaceae | Herb | Europe |
| 34. | *Oscimum americanum L.* | Exotic | L | Lamiaceae | Herb | Trop.America |
| 35. | *Opuntia stricta (Haw.) Haw.* | Invasive | L | Cactaceae | Shrub | Trop.America |
| 36. | *Parthenium hysterophorus L.* | Invasive | H | Asteraceae | Herb | Trop.North America |
| 37. | *Pennisetum polystachion (L.) Schult.* | Invasive | H | Poaceae | Herb | Tropical Africa |
| 38. | *Portulaca oleracea L.* | Invasive | L | Portulacaceae | Herb | Trop.South America |
| 39. | *Physalis angulata L.* | Invasive | L | Solanaceae | Herb | Trop.America |
| 40. | *Ricinus communis L.* | Exotic | L | Euphorbiaceae | Shrub | North Estern Africa |
| 41. | *Ruella tuberosa L.* | Invasive | M | Acanthaceae | Herb | Trop.America |
| 42. | *Scoparia dulcis L.* | Invasive | L | Scrophulareaceae | Herb | Trop.America |
| 43. | *Senna alata L.( Roxb.)* | Invasive | L | Fabaceae | Shrub | Amazon Rain Forest |
| 44. | *Senna occidentalis L.* | Invasive | L | Fabaceae | Shrub | Mexico ; South America |
| 45. | *Senna tora L.( Roxb.)* | Invasive | L | Fabaceae | Shrub | Tropics : India |
| 46. | *Sesbania bispinosa (Jacq.)W.Wight.* | Invasive | L | Fabaceae | Shrub | Asia and North Africa |
| 47. | *Sida acuta Burm.f.* | Invasive | M | Malvaceae | Shrub | Trop.America |
| 48. | *Sphagneticola trilobata (L.) Pruski* | Invasive | L | Asteraceae | Herb | Mexico Central America and Caribbean |
| 49. | *Synedrella nodiflora (L.)Geartn.* | Invasive | M | Asteraceae | Herb | West Indies |
| 50. | *Stachytarpheta jamaisensis (L)Vahl* | Invasive | L | Verbenaceae | Herb | Trop.America |
| 51. | *Tridax procumbens L.* | Partly Invasive | H | Asteraceae | Herb | Trop. Central America |
| 52. | *Turnera subulate J.E.* | Invasive | L | Turneraceae | Herb | Trop.America |
| 53. | *Urena lobata.L* | Invasive | L | Malvaceae | Herb | Trop.Africa |

**Table 2.** IAPS with IVI, GISS Scores and Impact Categories

| No. | IAPS | IVI | GISS SCORE | GISS Impact Category |
|---|---|---|---|---|
| 1 | *Mimosa diplotricha* | 36.6 | 33 | H |
| 2 | *Tridax procumbens* | 21.33 | 28 | H |
| 3 | *Hyptis suaveolens* | 18.15 | 26 | H |
| 4 | *Pennisetum polystachion* | 16.45 | 24 | H |
| 5 | *Chromolaena odorata* | 15.9 | 23 | H |
| 6 | *Parthenium hysterophorus* | 11.1 | 22 | H |
| 7 | *Lantana camara* | 11 | 20 | H |
| 8 | *Ageratum conyzoides* | 10.9 | 20 | H |

GISS Tool has a total score of 60. And the impact categories are as follows.
20 and above - H High impact category; 10-19 - M Medium impact category; 10 and below - L Low impact category

## CONCLUSION

The Palakkad Gap is experiencing invasion by IAPS, with high-impact species : *Mimosa diplotricha, Tridax procumbens, Hyptis suaveolens, Pennisetum polystachion, Chromolaena odorata, Parthenium hysterophorus, Lantana camara, and Ageratum conyzoides.* Invasive alien plant species pose a significant threat to local biodiversity, a situation exacerbated by the area's status as a major trade route. The IAPS in the Palakkad Gap are currently being documented, highlighting the necessity of formulating long-term management strategies, as biological invasions frequently result in a variety of impacts.

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