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Uses of invasive alien plant species of Chandaka-Dampada wildlife sanctuary: a management implication

Abstract

A reconnaissance survey was conducted on the uses and role of invasive alien species (IAS) to local livelihoods in the Chandaka Dampada Wildlife Sanctuary (CDWS) located in Khurdha and cuttack districts of Odisha, India. The vegetation of the sanctuary was sampled in 100 quadrats, each having 20 m×20 m through a combination of random and systematic sampling. Group discussions were also arranged with one hundred twenty local inhabitants (10 % of the total inhabitants) to document the various uses of IAS. A total of 18 alien plant species belonging to 8 different families, of which Asteraceae constitutes the highest number (7 species), include herbs (5 species), shrubs (1 species) and climbers (1 species). The majority of the identified species were found to be used for medicine, followed by human food, fodder, insecticidal and ornamental purposes. It is true that the alien species have some negative impacts on local ecosystems, but not all of them are harmful. Therefore, assessment and careful documentation on utilization of invasive alien plant species of the sanctuary in terms of economic and social benefit to the local community was done to provide a possible and effective tool for management of IAS.

Keywords: Chandaka Wildlife Sanctuary (CWS), ecosystem, invasion, Invasive Alien Species (IAS), Management

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S. Prusty,[1] RK Mishra,[2] AK Biswal[3]
[1]Department of Botany, Maharaja Sriram Chandra Bhanja Deo University, India
[2]Department of Wildlife and Biodiversity Conservation, Maharaja Sriram Chandra Bhanja Deo University, India
[3]Department of Botany, F. M. University, India

Correspondence: RK Mishra, Department of Wildlife and Biodiversity Conservation, Maharaja Sriram Chandra Bhanja Deo University, Takatpur, Baripada-757 003, Odisha, India, Tel +91-9861032952, Email rabikumishr@gmail.com

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Introduction

One of the biggest worldwide issues that natural ecosystems face is the invasion of exotic species. Plant invasion of the ecosystem occurs both naturally and with human assistance.[1] In addition to causing the extinction of native species, these species are also responsible for biodiversity loss, global environmental changes, endangering species, and disturbances to ecosystem processes.[2–7] Moreover, managing these invasive species comes with a huge financial expense.[8] Even though many invasive species are known to exist in India, a comprehensive inventory of the status of such species is still lacking.

Nayar et al.,[9] 1977 estimated that roughly 18% of the flora in India comprise adventives aliens, of which about 55% are from America, 15% are from Europe and Central Asia, and 30% are from Asia. According to Reddy,[10] there are 173 invasive plant species in 44 families and 117 genera. Studies revealed that Tropical America and Tropical Africa contributed the greatest contributions to India's invasive flora i.e. around 74% and I1%, respectively.[11] As long as the public and policymakers are aware of these, the rapidly advancing field of invasion biology and the developing technologies for managing established invasive species and identifying unintentionally introduced invaders can lead to significant progress in the struggle against invasive exotic species.

There are considerable inconsistencies in the definition and application of the term invasive alien species (IAS), and not all of these species are harmful, despite the widespread belief that damaging characteristics of IAS frequently threaten the local biodiversity.[12] Most crops in many locations are imported, as are many of the animals raised for food. Introduced species form the foundation of a few lucrative forest industries. Furthermore, introductions for the biological control of alien pests have frequently led to significant reductions in crop loss and pesticide use. Our agricultural and forestry systems rely heavily on a variety of foreign species.[13] Harun et al.,[14] from Malayasia recently noted that one of the main IAS of Malayasia and other tropical nations is the dried root of the water hyacinth. This powder can significantly lower the arsenic levels in water and make it safe for human consumption.[15] More than 360 IAS are believed to exist in India.[16] Some of these IAS are invasive, growing either freely or widely farmed across the nation.[17] Among these, the majority of the shrubs and herbs were brought to the nation during the British colonial era for their aesthetic value, while the majority of the timber species were brought in between the late 1980s and the early 1990s to satisfy the nation's quickly expanding need for timber. At the worldwide, national, and regional levels, a number of researches have been done on the ecological and economic effects of IAS.[17–19]

Locally Chandaka-Damapara Wildlife Sanctuáry (CDWS) near Bhubaneswar represents the north-eastern limits of Eastern Ghats and is now an isolated forest, which once formed a part of vast Eastern Ghats forest and Central Indian Elephant range has been explored floristically by many workers,[20–23] but till yet no investigation was carried out to document the invasive alien plants in its forest covers. As invasive species has huge ecological impacts and preference over native species in forest ecology, documentation of alien plants in this important sanctuary is necessary. Keeping in view of the above mentioned facts the study attempts to make an inventory of the alien flora, their classification and uses to local livelihoods in and around the sanctuary.

Study area

The Chandaka Dampara Wildlife Sanctuary (CDWS) is a wildlife reserve located in the north western fringe of Bhubaneswar in the Indian state of Odisha. Nestled on Khurda uplands of the Eastern Ghats biotic region, Chandaka forest is spread over 193 square kilometres of rolling table land and small sprawling hillocks of Khurda and Cuttack districts. It was designated as an elephant reserve in December 1982. Geographically, the area lies between 20°12' 30"-20°26 03" N and 85°49'35"-85°34'42" E (Figure 1). The legal boundary of the sanctuary has been duly described by forest block boundaries in the State Govt. notification No. 13482/FFAH, dated 10.06.1988

comprising of reserved forests (7RFs), demarcated protected forests (11 nos. DPFs), revenue lands, private lands and human settlements. Chandaka wildlife sanctuary and its adjoining areas coming under the Chandaka wildlife division is under the administrative jurisdiction of Khurda and Cuttack districts. It includes 47 villages and 7 reserve forests namely Chandaka, Damana, Banapita, Tarkai, Chudanga, Jagannatha Prasad and Bharatpur reserve forest.

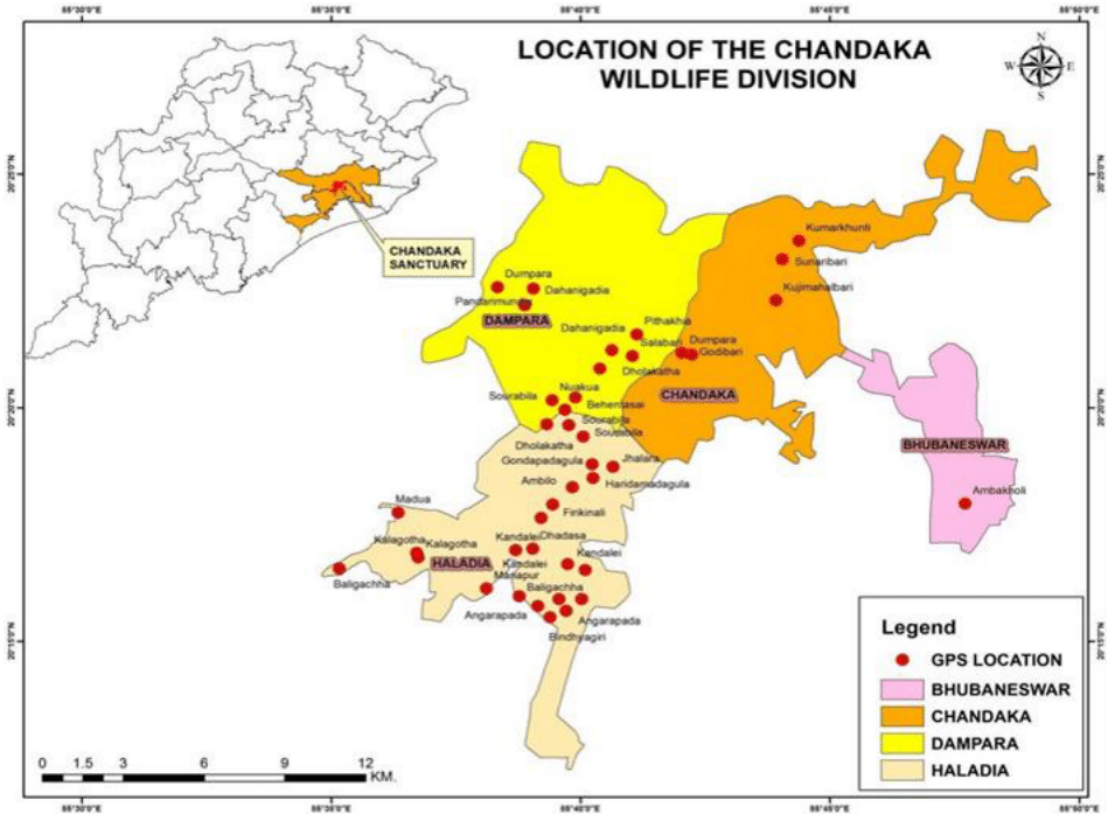

Figure 1 Location map of the study area.

The sanctuary experiences a wet tropical monsoon type of climate with three distinct seasons i.e. summer, monsoon and winter. The maximum daily temperature of the study area recorded in May is around 42°C and the minimum temperature recorded in the month of December is around 11°C. Average relative humidity of the study area is generally very high i.e. 77% in the morning and 68% in evening. The sanctuary receives moderate rainfall of about 1500 mm per annum.[22] The terrain is generally undulating; the north-west and south-west portions are mostly hilly which is broken by small low hills with moderate to steep slopes. The north east to central portions is relatively flat with undulations.

The sanctuary is a biodiversity hotspot and home to a wide range of flora and fauna. Floristically the sanctuary is characterized by mixed tropical dry deciduous and moist deciduous forests with miscellaneous species dominated by *Strychnous nuxvomica*, *Diospyros sylvatica*, *Aegle marmelos*, *Xylia xylocarpa*, *Pterospermum xylocarpum*, *Cassia fistula*, *Shorea robusta*, *Careya arborea*, *Syzygium cumini*, *Pongamia pinnata*, *Tectona grandis*, and *Lagerstroemia parviflora*. In addition to the diverse group of plant species the animal species of the sanctuary includes 37 species of mammals, 167 species of birds, 33 species of reptiles, 13 species of amphibians and 28 species of fishes.[24]

Materials and methods

The entire area of Chandaka-Damapara Wildlife Sanctuary was divided into smaller units for floristic inventory. The entireSanctuary area was divided into smaller grids, which formed the sampling plots both for qualitative and quantitative assessment of plant biodiversity. In each grid, random quadrats of 20 m × 20 m were laid fixing GPS points for enumeration of all standing trees >30cm girth at breast height (gbh). Saplings, shrubs and climbers/ lianas were enumerated from five 5 m × 5 m plot within each 20 m × 20 m quadrat. Likewise enumerated data on herbaceous species were collected from five small sample plots measuring 1 m × 1 m within each 5 m × 5 m plot. During the field trips, the plants were initially identified by the respondents (community members / local people of the villages inhibited in and around the sanctuary) by vernacular names. Furthermore, 120 numbers of local inhabitants who have long been inhabited in and around the sanctuary area were interviewed to explore their perception regarding utilisation of invasive alien plant species for various purposes as medicine, timber, fodder, etc. In addition to these community consultations, field observations, literature review, group discussions were also taken into consideration to know the utilisation of invasive alien plant species of the sanctuary. To identify the invasive alien plant species of the sanctuary, flora of Haines,[25] Gamble and Fischer,[26] Saxena and Brahmanm,[27] Mooney[28] were followed. The nativity of the species was recorded based on the available literature.[10,29–33]

Results

A total number of 18 species belonging to 17 genera and 8 families have been recorded as invasive alien plants of the sanctuary. The

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habit, nativity, and the impact of invasive species on forest and other ecosystems including grassland and scrubland ecosystems of the sanctuary were noticed to prepare a catalogue of invasive alien/exotic plant species (Table 1). Among these, the monocot was represented by a single genus (*Cyperus*) and a single family (Cyperaceae). However, dicots were represented by 16 genera and 7 families. Among the families of alien species, Asteraceae was the most dominant (7 species) followed by Fabaceae (4 species) and Lamiaceae (2 species). However, rest of the families having one species each (Figure 2). Considering the geographical regions, majority of the aliens (17 species) have their origin from American continent while only one species has its origin from African continent. In view of habit, annuals comprise 61% (11 species) of invasive flora of the sanctuary. Moreover, most of the recorded species of IAS were herbs (78%) followed by shrubs (17%) and climbers (5%); however, not a single species of IAS was recorded under trees (Table 1). The majority of the species were inadvertently brought about by trade, notably the import of grains.

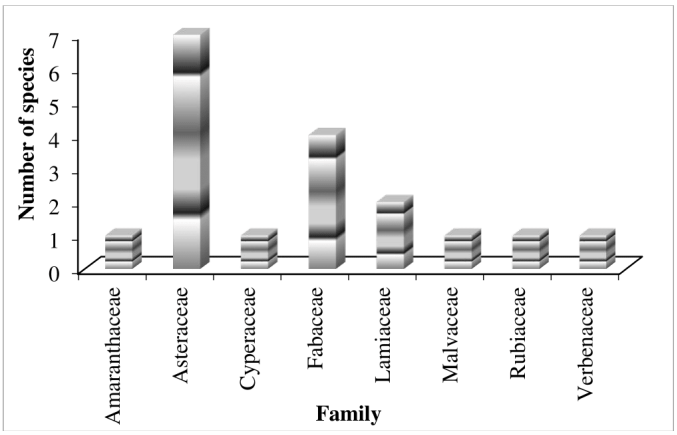

Figure 2 Number of species under different families of IAS.

Table 1 Various invasive alien plant species found in the Chandaka Wildlife Sanctuary, Odisha

Scientific name	Family	Habit	Life form	Suspected origin	Purpose of invasion	Uses	Parts used	Level of invasion	Categories
Ageratum conyzoides L.	Asteraceae	Annual	Herb	Tropical America	Medicinal	M, I,	Leaves, Whole plant	+++	Noxious
Alternanthera paronychioides A. St. Hil	Amaranthaceae	Perennial	Herb	Central America	Fodder, Forage, Medicinal	M, Fod	Leaves	+	Naturalised
Blumea lacera (Burm.f.) DC.	Asteraceae	Annual	Herb	Tropical America	Medicinal, Fodder, Food/vegetables	M, Fod, Fm	Leaves	++	Interfering
Cassia occidentalis L.	Fabaceae	Perennial	Herb	Tropical south America	Medicinal,	M	Leaves and stem	+++	Noxious
Cassia tora L.	Fabaceae	Annual	Herb	Tropical south America	Medicinal, Fuel	M, Fu	Leaf, root and seed	+++	Noxious
Chromolaena odorata (L.) King & Robins.	Asteraceae	Perennial	Shrub	Tropical America	Medicinal	M	Leaf	+++	Noxious
Crotalaria pallida Ait.	Papilionaceae	Annual	Shrub	Tropical America	vegetable (flower), beverag(seeds), Medicinal	Fm, M	Leaf, seed	+++	Noxious
Cyperus difformis L.	Cyperaceae	Annual	herb	Tropical America	Medicinal	M	Leaf and stem	+	Naturalised
Hyptis suaveolens (L.) Poit	Lamiaceae	Annual	Herb	Central America	Medicinal and mint flavour in beverages	M, Fm	Root	++	Interfering
Lantana camara L.	Verbenaceae	Perennial	sub-shrub	Central America	Medicinal (leaf) & Ornamental, Others	M, O,Oth	Seed, whole plant	+++	Noxious
Mikania micrantha (L.) Willd.	Asteraceae	Annual	Climber	South America	Medicinal & Ornamental	M, O	Leaf, stem	+++	Noxious
Mimosa pudica L.	Mimosaceae	Annual	herb	South America	Medicinal	M	Root	+	Naturalised
Ocimum canum Sims	Lamiaceae	Perennial	Herb	Central America	Medicinal	M, I	Leaf	+	Naturalised
Parthenium hysterphorus L.	Asteraceae	annual	Herb	North America	Medicinal, Adulteration in food grains	M, Fm	whole plant	+++	Noxious
Sida acuta Burm.f.	Malvaceae	Annual	Herb	Central America	Medicinal	M	Root	+	Naturalised
Spermacocehispida L.	Rubiaceae	Perennial	Herb	Tropical Africa	Medicinal	M	Flower	++	Interfering
Synedrella nodiflora (L.) Gaertn.	Asteraceae	Annual	Herb	Central America	Medicinal treatment of epilepsy	M	Leaves	+	Naturalised
Tridax procumbens L.	Asteraceae	Perennial	Herb	Tropical America	Medicinal	M	Leaves	+	Naturalised

Level of invasion: based on people's perceptions; +, low impact; ++, moderate; and +++, high level of invasion.

Uses: Fod, fodder; Fu, fuel; Fm, food for man; M, medicinal; O, ornamental; Oth, others; I, insecticide

The study documented seven uses of the identified species in the Chandaka Wildlife Sanctuary based on people's perception (Figure 3). However, most of the species were found to be of medicinal use. Apart from medicinal uses the other predominant uses of the identified IAS of the sanctuary were found to be used for human food, fodder, insecticidal and ornamental purposes (Figure 3). However, fuel and other uses of IAS of the sanctuary were limited as compared to medicinal, human food, fodder, insecticidal and

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ornamental uses. Further, from the study it was revealed that forest dependent community used different parts of invasive plants in their day to day practices for different purposes. The uses of invasive plants mentioned by the respondents were mostly consumed after processing such as macerating, squeezing, grinding, blending, soaking or boiling in water, milk, or mustard oil, rubbing or burning. Some are taken raw and some are applied externally. The most plant parts that were used are 46% leaves, followed by 15.4% roots, 12% whole plant, seeds and stem of 11.5% each and 3.8% flower (Fig.4). It is obviously recorded that more than 60% percent of the invasive species were under the consideration of medicinal purposes.

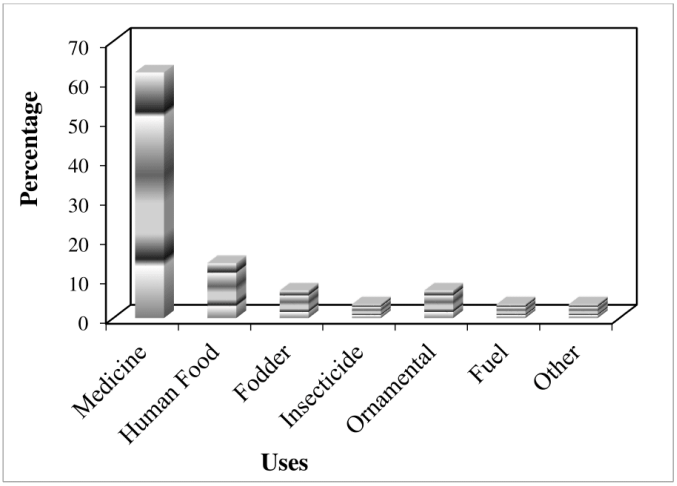

Figure 3 Major uses of IAS in the Chandaka wildlife sanctuary, Odisha.

Discussion

All the 18 exotic species belonging to eight different families were reported as invasive alien species (IAS) from various literatures.[15,18,34,35] The alien species amounted to 2.75% of 655 wild terrestrial plant species of the sanctuary.[23] Though most of the alien species are invasive and cause a major threat to the local ecosystem, but many of the identified IAS in the locality was introduced to meet the increasing demand for health care, horticulture, farming and ornamental purpose in an immense manner.[13] Out of 8 IAS families only two families accounts the 61% of the total alien flora. Asteraceae is the dominant alien family having 39% of total alien flora of the sanctuary followed by Fabaceae and Lamiaceae. Our finding about the distribution of families of alien species in CWDS is in accordance with the findings of earlier workers in other parts of India.[36,37] In this catalogue of alien species 5 families are represented by single species while one family has only two species (Table-1). Much more number of IAS in Asteraceae in comparison to other families may be a much higher reproductive capacity than those of other families. This high reproductive potential is achieved by partitioning of reproductive capital into a large number of propagules that are minute, light, and wind dispersed.[38] Various other workers have also reported the dominance of Asteraceae among invasive alien species in India[39,40] and in Indian Himalayan region.[41] Family Asteraceae is followed by Fabaceae one among the largest families of alien flora of India and having the potential of nitrogen fixing capacity would be helpful to them in colonizing the empty niches.[40] Furthermore, most of the recorded species of IAS were herbs (78%) followed by shrubs (17%) and climbers (5%) but not a single species of IAS was recorded under trees (Table 1). Regarding the prevalence of herbaceous plants in the IAS, a number of researches conducted in India and other nations corroborate our findings.[42–44] The presence of herbaceous IAS flora may be due to its easier accessibility in the surrounding areas compared to trees, shrubs, and climbers/lianas (Lulekal et al., 2013). Within the range of IAS in various wildlife sanctuaries in India, which ranged from 4 to 163 species, is the number of IAS recorded in the current study.[45–50]

The local population of the sanctuary utilized a variety of IAS plant parts, including leaves, stems, roots, whole plants, seeds, and flowers (Figure 4). The most often used plant parts were the leaves (12 sp.) followed by roots (4 sp.), the entire plant, the seed and stem with 3 sp. each, and the flower (1 sp.) (Figure 4). Leaves and roots were the most favoured plant parts as they contain a high concentration of the bioactive compounds.[51] Based on the findings of the study, it was confirmed that the aerial part of the plant is the most preferred plant part (77.78%) and underground and whole plant are the less preferred plant parts (38.89%). This claim is supported by a scientific study by Hamburger and Hostettmann.[52] However, wide utilization of roots[53] and whole plants[54] has serious consequences as it could result in the complete destruction of an individual plant species. Leaves, buds and flowers are the soft parts which are the richest sources of volatile compounds.[55] Numerous researchers have indicated that leaves are mostly used in various parts of India.[43,44,56–62]

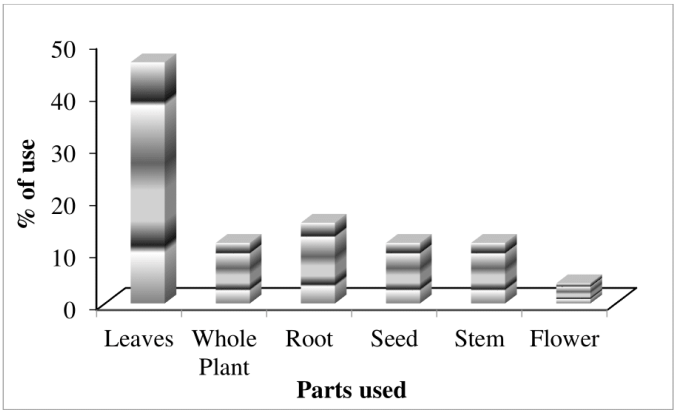

Figure 4 Percentage of IAS parts used for different purposes.

Conclusion

The aggressive colonisation skills of invasive species and their increased adaptability to the new ecosystem they invade make them a bigger threat to native flora. The distinction is that, in contrast to native species, invasive plant species may alter the structure, decomposition, and nutrient content of the soil through their resource acquisition and consumption. Therefore, invasive species seriously impede conservation efforts and have detrimental effects on the products and services that ecosystems provide. However, it becomes clear that invading species have both advantageous and harmful effects. There are conflicts of interest among stakeholders due to the dual cost characteristics of many invasive species. In order to fully utilise the potential of invasive species, possible dangers associated with each species should be recognised and documented, followed by the development of a plan to reduce negative effects on biodiversity and habitat. A suitable marketing channel and the sustained commercial harvesting of useful invasive species that do not harm native species can be crucial in this situation. The local community can participate in this opportunity as buyers, sellers, managers, and workers, giving them the chance to make money and significantly lowering their level of poverty. The findings of the study concluded that a national programme aimed at increasing the inventory, monitoring, and research of invasive plants is necessary in order to differentiate dangerous from harmless plant species, as well as to determine the uses and effects of these species. In addition to proactive government

backing and coordinating planning and management efforts with other agencies, stakeholders are required, as is raising local communities understanding of the right use of invasive species. Simultaneously, additional research and phytochemical analyses must to be carried out to fully explore the potential of these plants as pharmaceuticals, and appropriate certification for their traditional medical uses should be established.

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Conflicts of interests

The authors declare that they have no conflict of interests.

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