

issues related to invasives appeared. Out of 122 articles, only 2.5% and 6.6% of publication discussed about control and management of plant invasive species respectively.

Our analysis shows that the trajectory of the plant invasion literature in India follows the stage-based pattern of invasion process with exponential growth in terms of publication. The inference derived from the study is that we need to reorient our research focus from the trivial invasion process, like spread, establishment and impacts (although important), towards more applicable researches for the control and management of invasive plants. This warrants further efforts for

authoritative decision to reallocate research interest and funds towards researches focusing on the applied aspects of plant invasion control and management so that conservation efforts can be initiated instantaneously.

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ACKNOWLEDGEMENTS. A.P. thanks DST, New Delhi for funds. G.P.S. thanks University of Delhi for funds as seed and research grant and DST for fast track young scientist scheme. We also thank Prof. J. S. Singh and Prof. A. S. Raghubanshi for their valuable comments and suggestions on the earlier version of the manuscript.

ANKITA PANDEY
GYAN P. SHARMA*

Department of Environmental Studies,
University of Delhi,
Delhi 110 007, India
*e-mail: gyanprakashsharma@gmail.com

Mandu sacred grove in Upper Ganga Ramsar site, Uttar Pradesh

Ramsar sites are wetlands of international importance recognized under the Ramsar Convention, 1971. The Upper Ganga Ramsar site in Uttar Pradesh, one of the 25 sites in India, extends along 85 km stretch of the holy river Ganga, from Brij Ghat to Narora. The region is endowed with special attributes related to religious traditions, spiritual knowledge and cosmological beliefs depicting the cultural heritage of humanity and a source of aesthetic inspiration adorned with important local traditions. It also serves as a pilgrimage centre since ancient times, but is completely unexplored in terms of floristic riches with few eclipsed and naturally conserved forest patches that have evaded degradation during modernization. These forest patches are immune from human interference for ages, on grounds of staunch religious beliefs and comprise physically diverse patches of natural, primary forested enclosure of sacred trees and connected life-forms, supporting climax vegetation representative of their particular locality and hence emerge as sacred groves.

The small Mandu forest is one such undisturbed and naturally conserved patch which has twofold significance of being a sacred grove and a naturally conserved ecological entity of Ramsar site. It is embedded within a mantle of dense vegetation, on the northeastern flank of the Ganga, at 28.3700°N lat. and 78.2700°E long., 6 km from Unchagaon Fort in District Bulandshahr. The grove

spreads in about 9 ha area with 3 ha core zone (Figure 1a) of primary forested patch surrounded by 6 ha buffer zone, with an admixture of primary and secondary vegetation. On the southern boundary of the core zone flows the river Ganga and all other sides are bordered by the buffer zone. A twin *Ficus benghalensis* L. tree thrives at the centre of the core with two main stems, one of which is slightly damaged.

The grove is endowed with luxuriant vegetational cover and dense canopy of trees, mostly 10–30 m tall, the dominant 11 species being *F. benghalensis* L., *Ficus religiosa* L., *Ficus racemosa* L., *Cassia fistula* L., *Azadirachta indica* A. Juss., *Delonix regia* (Bojer ex Hook.) Rafin., *Albizia lebbek* (L.), *Aegle marmelos* (L.) Correa, *Callistemon lanceolatus* DC., *Acacia nilotica* (L.) Willd. ex Delile and *Bauhinia variegata* L. There are 10 species of important medicinal herbs – *Catharanthus roseus* (L.) G. Don, *Murraya paniculata* (L.), *Bacopa monnieri* (L.) Pennell, *Ocimum gratissimum* L., *Desmodium gangeticum* (L.) DC., *Acalypha indica* Forsk., *Adhoatoda vasica* Nees, *Achyranthes aspera* L., *Boerhavia diffusa* L. and *Calotropis gigantea* (L.) R.Br., as sustainable medicinal resources of the local clans. The occurrence of *Manilkara hexandra* (Roxb.) Dubard, a species of high economic value but restricted distribution, is of special interest. The forest is also rich in woody climbers of which the five prominent species are

Tinospora cordifolia (Willd.) Hook.f. & Thoms., *Clitoria ternatea* L., *Hemidesmus indicus* (L.) R.Br., *Cissampelos pareireia* L. and *Cocculus hirsutus* (L.) Diels. The entire vegetation of the grove is therefore of much significance in terms of original gene pool of economical and medicinal importance.

At present the groves are revered by the endogamous clans, the Jatas and Gujjaras, and completely secluded from anthropogenic disturbances. Hence these



Figure 1. Mandu sacred grove. a, Entrance to the core zone. b, Ancient Mandu temple.

are conserved informally as virgin forests¹ depicting a reservoir of *in situ* conservation which is managed over generations as valuable legacy from primitive practices of natural resource conservation². The locals consider it as 'Dev Bhumi', and the archaic Mandu temple (Figure 1b) and primary forest substantiate its origin during ancient times when the society had not settled in permanent dwellings. Worship of the sacred trees is practised, mostly on full-moon nights by the local clan. Removal of any plant material or dead wood is considered taboo and disrespect to the deity. Only the sacred tree is allowed to be touched at the twin stem region for prayers and the deity's blessings. Entry to the core zone is prohibited or guarded under strict vigil in special cases. Since adjoining forests of the grove have already suffered immense degradation during developmental activities, the Mandu grove stands as the last refuge of the diversity-rich, climax vegetation and centre of preserved biological diversity, representative of the Upper Gangetic plains, as it harbours the magnificent *Manilkara hexandra* (Roxb.) Dubard population. In-depth studies of many such species in virgin forests open vistas for future economic value. Adding to this the possibility of the ancient *F. benghalensis* L. being a representative genetic variant peculiar to this region cannot be ruled out, opening new prospects in future forest tree breeding programmes. Hence for scientific and aesthetic value the conservation measures of the Mandu grove must be strengthened through

cooperation of the Government agencies, Forest departments, environmentalists and the concerned non-governmental organizations to counteract the increasing anthropogenic pressures. The Mandu grove is also exposed to conservation bottleneck as there is an approved proposal of developing it into a tourist centre with consequent human influx, religious ceremonies and resultant developmental activities. Hence, in spite of the inadvertent protection and conservation by the local clans, the groves are prone to alteration in the race of modernization and vanishing religious sentiments unless stringent action is taken through formulation of environmental protection schemes, widening of buffer zone and blocking the developmental corridors which channelize anthropogenic pressures.

Till date, all other sacred groves established in India have been reported from various parts of the country^{1,3-6}, but never from any of the 25 internationally significant Ramsar sites, which are the cradles of biological diversity. Coupled with this, the surface and lower layers of soil of these wetlands often serve in regulating the global carbon cycle, including the carbon stores. Consequently, these conserved sacred groves are of additional significance in terms of probable carbon stores in the archaeologically potential forested wetland sites, many of which even function as open systems with respect to carbon⁷. The Mandu sacred grove therefore, is certainly a noteworthy outcome of the field exploration work under the MoEF-approved pro-

ject on Upper Ganga Ramsar site studies, under the aegis of the Botanical Survey of India. Further, the entire patch of the small Mandu forest comprises a miniature ecosystem sustained through the waters of the Ganga and adding to its grandeur are the Gangetic dolphins (*Platanista gangetica*).

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ACKNOWLEDGEMENTS. We thank the Director, Botanical Survey of India and the Head, Central Regional Centre, BSI, Allahabad for facilities and encouragement.

ARTI GARG*
VINEET SINGH

*Botanical Survey of India,
Central Regional Centre, 10,
Chatham Lines,
Allahabad 211 002, India
e-mail: kad_arti396@yahoo.com

Jellyfish bloom along the south Odisha coast, Bay of Bengal

Jellyfish (medusa) form an important group of marine denizens widely distributed in coastal and offshore water. They represent short-lived plankton phase of some invertebrates and also occur as holoplankton. All cubozoans as well as many hydrozoans and scyphozoans among the cnidarians (coelenterates) have a life history consisting of a sessile polyp phase and a planktonic medusa phase. Many polyps reproduce asexually through the process of strobilation, producing multiple ephyra which join the zooplank-

ton community in form of medusa¹. Some species of the medusa could form dense populations when the environmental conditions, particularly food supply is abundant. Jellyfish are conspicuous, but relatively little studied group of animals in coastal waters of India. Their population size fluctuates widely with changes in ocean climate and often experiences sudden outbursts known as 'blooms' followed by population crashes². Boero *et al.*³ and Richardson *et al.*⁴ had inferred that the life-cycle traits

make jellyfish suited to highly variable environments, because they can survive when conditions are extremely unfavourable and could multiply rapidly when conditions become conducive. Jellyfish and ctenophores are important consumers of zooplankton, including ichthyoplankton. Therefore, they stand as potential competitors of fish as plankton predators at the secondary and tertiary consumer levels of the marine food chain. In addition, the blooming of this group could interfere with fisheries by clogging fish-