

Full Length Research Paper

Diversity of true mangroves and their associates in the Pondicherry region of South India and development of a mangrove knowledgebase

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Mangroves are salt-tolerant forest ecosystems of tropical and subtropical intertidal regions of the world. There may be no other group of plants with such highly developed morphological and physiological adaptations to extreme conditions. They are a rich source of steroids, triterpenes, saponins, flavonoids, alkaloids and tannins. The Pondicherry region in South India has no forest, but has scattered patches of mangroves and remnants of tropical dry evergreen forest in the form of sacred groves. The present study documents the directly observed diversity of true mangroves and their associates, in four geographical regions of Pondicherry in South India; namely Pondicherry, Karaikal, Mahe and Yanam. These places are far from one another and the mangrove species diversity varies from one place to another, due to factors such as climate, tidal factors and anthropogenic pressures. In addition, we have also developed a knowledgebase entitled "Mangroves of Pondicherry", which contains information including botanical name, English name, local name (Tamil language), Family, description, images and common uses of true mangroves and their associates. This knowledge resource is available for open access at <http://web.iitd.ac.in/~sundar/mangroves/>.

Key words: Mangroves, knowledgebase, sacred groves, tropical dry evergreen forest, Pondicherry, South India.

INTRODUCTION

Mangroves are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. Mangrove formations depend on terrestrial and tidal waters for their nourishment, and silt deposits from upland erosion as substrate for support. Mangrove is one of the most productive ecosystems and a natural renewable resource (Kathiresan, 2003). However, across the globe, the world's mangroves are threatened. Mangrove habitats are being destroyed as rivers are dammed, their waters diverted and the intertidal zone extensively developed for

agriculture or aquaculture. Mangroves are distributed globally, occurring in over 112 countries. Global coverage has been variously estimated at 10 million ha (Bunt, 1992), 14 - 15 million ha (Schwamborn and Saint-Paul, 1996) and 24 million ha (Twilley et al., 1992). They are largely restricted to latitudes between 30° N and 30° S. Northern extensions of this limit occur in Japan (31° 22' N) and Bermuda (32° 20' N); southern extensions are in New Zealand (38° 03' S), Australia (38° 45' S) and on the East Coast of South Africa (32° 59' S) (Kathiresan and Bingham, 2001). In South India, Pichavaram and Muthupet are two places, which have dense mangrove vegetation in the state of Tamilnadu (Krishnamurthy and Jeyaseelan 1983; Kathiresan, 2000; Rajkumar et al., 2009). These plants have several commercial uses,

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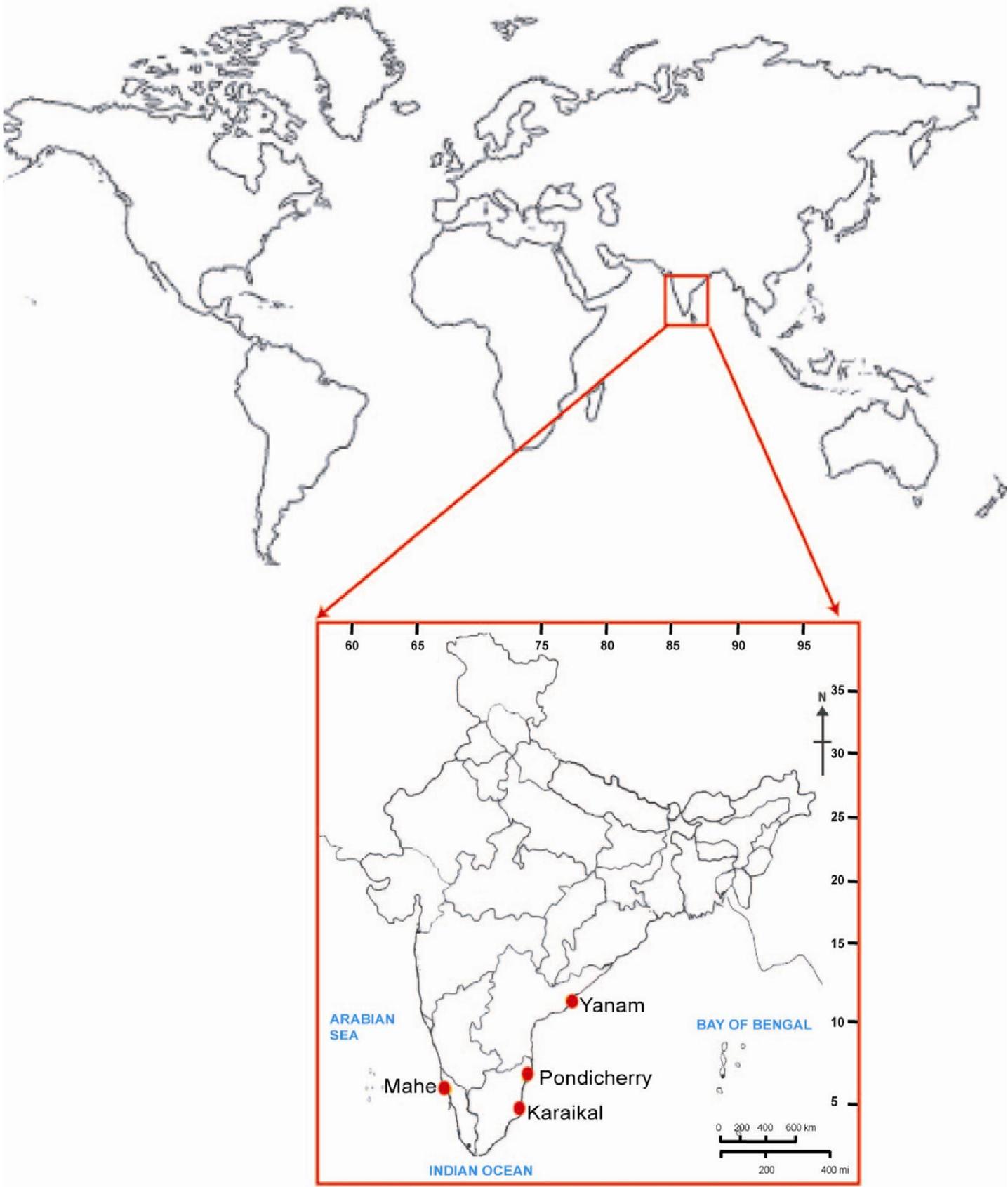


Figure 1. Map of India showing the location of Pondicherry.

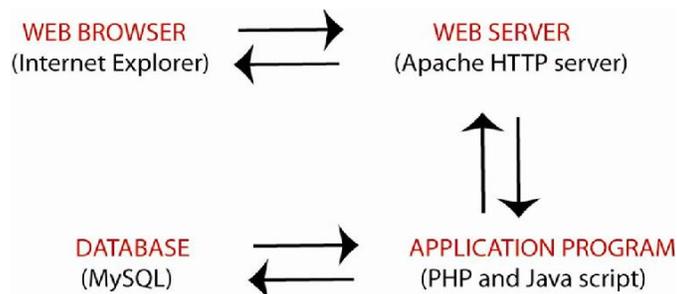


Figure 2. Process of development of the knowledgebase. The “forward arrow” indicates request and “reverse arrow” represents response.

particularly charcoal production. They are also used locally to fashion fish traps and for boat construction. They also support the growth of microbial flora. Some antibiotic producing actinomycetes are present in this environment, which is essential for inhibition of pathogenic microorganisms. Some novel chemical molecules and metabolites have been identified from mangroves and their associates (Bandaranayake, 1998). Mangroves possess enormous ecological value, including production of organic carbon, thereby contributing to the global carbon cycle.

The main objective of the present study is to understand the plant diversity of mangroves and their associates, which is helpful in deriving taxonomical information based on species diversity, morphological changes and economical importance from the four different regions in the Pondicherry state of South India. Further, we have also developed a computational resource on true mangroves and their associates, which is available for open access.

METHODS

Study site

Pondicherry State in South India consists of four regions: Pondicherry, Karaikal, Mahe and Yanam and its location is shown in Figure 1. The four regions are at different locations, isolated from one another. Pondicherry region, which is the largest of all the four, lies on the East Coast of India and it is located between 11° 42' N to 12° 30' N and 76° 36' E to 79° 53' E. Karaikal region is about 130 km south of Pondicherry and is surrounded by Nagapattinam district of Tamilnadu. It is located between 10° 49' N to 11° 01' N and 79° 43' E to 79° 52' E. Yanam region is located between 16° 42' N to 16° 46' N and 82° 11' E to 82° 19' E, about 840 km north of Pondicherry near Kakinada in Andhra Pradesh. Mahe region lies almost parallel to Pondicherry region and it is located between 11° 42' N to 11° 43' N and 75° 31' E to 75° 33' E 653 km away on the West Coast near Tellicherry in Kerala. The first three regions are located on the coast of the Bay of Bengal, while Mahe is on the West Coast of India. The three eastern regions receive an average rainfall of about 127 cm from both the Southwest and Northeast monsoon. The average temperature is 28°C, and average humidity is 80%. Mahe receives showers only from the South-west monsoon, and it receives more rainfall than the three eastern regions. These

are situated well in the tropics near 12° N and are greatly influenced by a hot and humid tropical maritime type of climate.

The main entity of the state, that is, Pondicherry region is almost semicircular, comprising 292 km². The region is flat, with an average elevation of 15 m above sea level, and it is intersected by the deltaic channels of the rivers Gingee and Ponnaiyar and other streams forming two main drainage basins, interspersed with lagoon, lakes, and tanks. Superficially, the coast is flat and sandy, and the border has a length of 22 kms.

Data collection and curation

Consequent surveys were made along the beaches, deltaic regions, river channels and the mouth of estuaries to explore the successful results of the true mangroves and their associates. The nomenclature of the specimens followed Gamble (1957) and Matthew (1983). The collected specimens have been manually curated and deposited in AURO Herbarium, Shakti, Auroville, Tamil Nadu, India.

Development of a knowledgebase

A web-based, platform-independent knowledgebase “Mangroves of Pondicherry” was developed based on directly observed data and literature by using MySQL (Vaswani, 2003) a relational database management system that serves as the backend for storing the data. PHP 5 (<http://www.php.net/>) and Java Script (<http://www.javascript.internet.com>) were used as application programs for integrating the backend and conversion of dynamic web interface. Apache (<http://www.apache.org/>) was used as the web server for building the interface between the web browser and application programs and HTML was used to design the static web interface. The overall process is shown in Figure 2. Unique key was used to maintain the non-redundant records in this knowledgebase.

RESULTS AND DISCUSSION

The results after the intensive survey, made from the Ariyankuppam river, Chunnambar or Kilijalar, Malatar, Bahour tank surplus course and the Murthikuppam river of Pondicherry region showed the following nine distinct formations or groups of plants including the *Rhizophora*, which was introduced by the Department of Agriculture, Government of Pondicherry, India. The other species that were found are *Acanthus ilicifolius*, *Bruguiera cylindrica*,

Table 1. The diversity of true mangroves from the Pondicherry State of South India. (Py - Pondicherry, KI - Karaikal, Me - Mahe, Ym - Yanam).

No.	Family name	Plant name	Py	KI	Me	Ym
1	Acanthaceae	<i>Acanthus ebracteatus</i> Vahl.	+			
2	Acanthaceae	<i>Acanthus ilicifolius</i> L.	+	+	+	+
3	Avicenniaceae	<i>Avicennia alba</i> Blume				+
4	Avicenniaceae	<i>Avicennia marina</i> (Forsk.) Vierh.	+	+	+	+
5	Avicenniaceae	<i>Avicennia officinalis</i> L.	+	+	+	+
6	Combretaceae	<i>Lumnitzera racemosa</i> Willd.				+
7	Euphorbiaceae	<i>Excoecaria agallocha</i> L.	+	+	+	+
8	Fabaceae	<i>Dalbergia spinosa</i> Roxb.				+
9	Fabaceae	<i>Derris trifoliata</i> Lam.	+	+	+	+
10	Meliaceae	<i>Xylocarpus mekongensis</i> Pierre				+
11	Myrsinaceae	<i>Aegiceros corniculatum</i> (L.) Blanco				+
12	Poaceae	<i>Myriostachya wightiana</i> (Nees ex Steud.) Hook.f.				+
13	Rhizophoraceae	<i>Bruguiera cylindrica</i> (L.) Blume	+	+		+
14	Rhizophoraceae	<i>Bruguiera gymnorrhiza</i> (L.) Lamk.	+			+
15	Rhizophoraceae	<i>Ceriops tagal</i> C. B. Robins.				+
16	Rhizophoraceae	<i>Rhizophora apiculata</i> Blume	+	+		+
17	Rhizophoraceae	<i>Rhizophora mucronata</i> Lam.	+			+
18	Sonneratiaceae	<i>Sonneratia apetala</i> Buch.-Ham.				+

Table 2. The diversity of mangrove associates from the Pondicherry State of South India. (Py – Pondicherry, KI – Karaikal, Me – Mahe, Ym – Yanam).

No.	Family name	Mangrove associate	Py	KI	Me	Ym
1	Aizoaceae	<i>Sesuvium portulacastrum</i> (L.) L	+	+	+	+
2	Anacardiaceae	<i>Lansea coromandelica</i> (Houtt.) Merr.	+			
3	Asclepiadaceae	<i>Sarcolobus carinatus</i> Wall				+
4	Boraginaceae	<i>Heliotropium curassavicum</i> L.	+			+
5	Caesalpiniaceae	<i>Caesalpinia bonduc</i> (L.) Roxb.	+	+	+	+
6	Chenopodiaceae	<i>Salicornia brachiata</i> Roxb.				+
7	Chenopodiaceae	<i>Suaeda maritima</i> (L.) Dumort.	+			+
8	Chenopodiaceae	<i>Suaeda monoica</i> Forssk. ex J.Gmelin	+			+
9	Clusiaceae	<i>Calophyllum inophyllum</i> L.	+			
10	Combretaceae	<i>Terminalia catappa</i> L.	+			
11	Convolvulaceae	<i>Cressa cretica</i> L.	+	+		+
12	Convolvulaceae	<i>Ipomoea pes-caprae</i> (L.) R.Br.	+	+	+	+
13	Cyperaceae	<i>Cyperus rotundus</i> L.	+	+	+	+
14	Cyperaceae	<i>Fimbristylis ferruginea</i> (L.) Vahl	+	+	+	+
15	Fabaceae	<i>Pongamia pinnata</i> (L.) Pierre	+	+	+	+
16	Malvaceae	<i>Hibiscus tiliaceus</i> L.	+	+		+
17	Malvaceae	<i>Thespesia populnea</i> (L.) Sol. ex Corr. Serr.	+	+		+
18	Mimosaceae	<i>Prosopis juliflora</i> (Sw.) DC.	+	+	+	+
19	Pandanaceae	<i>Pandanus tectorius</i> Solander	+	+		
20	Poaceae	<i>Aeluropus lagopoides</i> (L.) Trin.ex Thwaites	+	+	+	+
21	Rubiaceae	<i>Morinda coriea</i> Buch.-Ham.	+			
22	Verbenaceae	<i>Clerodendrum inerme</i> Gaertn.	+	+	+	+
23	Verbenaceae	<i>Premna serratifolia</i> L.	+	+		

A

MANGROVES OF PONDICHERRY

Home Mangroves Study site Search Sitemap

Search by Botanical name

True Mangroves

Select/Type Botanical name to view details

submit

- Acanthus ilicifolius L.
- Acanthus ebracteatus Vahl.
- Aegiceros corniculatum(L.)Blanco
- Avicennia alba Blume
- Avicennia marina(Forsk)Vierch.

Mangrove Associate

Select/Type Botanical name to view details

submit

- Aeluropus lagopoides(L.)Trin.ex Thwaites
- Caesalpinia bonduc(L.)Roxb.r
- Calophyllum inophyllum L.
- Clerodendrum ineme Gaertn.
- Cressa cretica L.

B

MANGROVES OF PONDICHERRY

Home Mangroves Study site Search Sitemap

Search by Geographical location

Select below to view species with varieties

Pondicherry region submit

- Pondicherry region
- Karaikal region
- Mahe region
- Yanam region

Figure 3. Screenshot of search pages (A) botanical name. (B) geographical location.

MANGROVES OF PONDICHERRY

Avicennia officinalis L.

Botanical name: *Avicennia officinalis* L.

Tamil name: Karungkandai

Family: Avicenniaceae

Description: A tree, branching low, with smooth yellowish-grey bark; leaves 5 to 10 cm long, obovate to elliptic, acute or rounded coriaceous with a very fine silvery-white tomentose beneath; flowers yellow, sessile, collected in small clusters and arranged in lax corymbs; capsule velvety, compressed, ovate and pointed, opening into two valves. Flowering & Fruiting from June - August.

Common uses: Leaves are used as fodder to increase milk in cattle and the dry leaves are smoked by the local people in Kutch and Saurashtra for relief from asthma and the plant is used to cure leprosy. Bark yields a dye and ash from its wood is used for washing. The flowers are a rich source of honey.

[Next](#)

Figure 4. A screenshot of a mangrove entry (e.g. *Avicennia officinalis* L.) of Pondicherry region.

Avicennia (*Avicennia marina* and *Avicennia officinalis*), *Rhizophora* (*Rhizophora apiculata* and *Rhizophora mucronata*), *Sesuvium portulacastrum*, *Suaeda* (*Suaeda maritima* and *Suaeda monoica*), *Clerodendrum inerme*, *Ipomoea pescapre* and *Pandanus tectorius*. However, *Excoecaria agallocha* was seen sporadically growing along the riversides, instead of forming the community or clump. The mangrove diversity observed is presented in Tables 1 and 2.

The taxa *A. marina* and *C. inerme* are represented in all the study sites of Pondicherry region, whereas *Excoecaria* is recorded only in Murthikuppam River and *Bruguiera* is present only in Ariyankuppam riversides.

Yanam region has a maximum of 17 true mangrove species, whereas only 10 species are represented in Pondicherry region. The poor representation is from Karaikal and Mahe region. Interestingly, there are 21 taxa of mangrove-associated species recorded from Pondicherry region than the other three regions viz. 17 taxa from Yanam and 14 species from Karaikal. Totally, 31 species were recorded from Pondicherry, 21 species from Karaikal, 14 from the Mahe and 34 from Yanam region.

Earlier reports suggested that the East Coast of India was covered with thick mangrove vegetation. We could

see their remnants in the estuaries and in the riverbeds of the backwater areas along the Bay of Bengal. All four regions of Pondicherry, according to Kjerfve (1984), are of the estuarine riverine type. In Pondicherry region, the brackish water, with low salinity and the addition of fresh water from various rivers, channels and canals, favour the growth and development of this vegetation. Saenger et al. (1983) have summarized the role of fresh water on the mangrove ecosystem. Blasco (1984) suggested that both temperature and rainfall are the two essential bioclimatic factors for mangrove and other terrestrial ecosystems. The edaphic factor with the micronutrients, rainfall, temperature, humidity and pH of water also favours the growth and development of mangroves.

The rich diversity in Yanam could be influenced by the Coringa Mangrove Reserve, located in Andhra Pradesh, which is very close to Yanam. The mangrove at Pondicherry represents the species as found at Pitchavaram, which is 75 kms south of Pondicherry. The Cauvery river basin called "Muthupet" has 1200 ha of this vegetation representing 20 numbers of species. Though the Karaikal region is close to Muthupet, the species representation is very limited because of anthropogenic pressure. Overall, in the four regions of Pondicherry that were studied, *E. agallocha* is well represented followed

by *A. marina*, which had developed impenetrable formations in Pondicherry and Yanam.

The knowledgebase called “Mangroves of Pondicherry” was developed based on the directly observed curated data and literature. There are two search options (botanical name and geographical location) available to access a record from the knowledgebase and these are represented in Figure 3. The record consists of botanical name, English name, Tamil name, Family, description, common uses and images for three versions such as habitat, flower and fruit. In addition, three separate links (sitemap, study site and mangroves) are provided to access the site map, description of study site and general information about mangroves. A sample record of this knowledgebase is shown in Figure 4. “Mangroves of Pondicherry” is maintained with a user -friendly deliberated dynamic web interface, so that the user can effortlessly get the preferred details at any time. This computational resource will offer great utility in the study of plant variety of mangroves and their associates in general and in particular to the Pondicherry region of South India. This is freely available in the public domain and is accessible at <http://web.iitd.ac.in/~sundar/mangroves>. The current version of this knowledgebase contains 41 entries [True mangroves: 18 and Mangrove associates: 23].

Conclusion

The vegetation and plantation of mangroves and its associates were successful and well preserved in the region of Pondicherry and Yanam. The Pondicherry region in South India is a breeding ground for aqua fauna and avifauna and the region has the potential to be developed for ecotourism, and to make a wind-breaking zone along the coast of India. To our knowledge, this computational resource is one of the most valuable resources on mangroves for South India, and we plan to update and further improve this knowledgebase. We are also planning to incorporate three more search options (common name, English name and local name) into this resource. A feature that we plan to implement in the next version of “Mangroves of Pondicherry” is to include medicinally important compounds of mangrove plants, which will be useful for potential drug discovery studies.

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