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REVIEW ARTICLE

Utilisation Potential and Conservation Issues of Plant Genetic Resources of Andaman & Nicobar Islands: An Outlook of Explorers

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Abstract

Andaman & Nicobar Islands form part of two out of 36 world's biodiversity hotspots - the Indo-Burma and Sundaland, respectively, and assume greater significance for *ex situ* plant biodiversity conservation, as they hold unique flora of plant genetic resource importance that are largely unavailable in the genebanks elsewhere. Considering this, five well-planned explorations (2017-20) spanning over 70 field days were undertaken to broaden the genetic base of crops and promote crop diversification by introducing new potential crops. Potential germplasm of value as plant genetic resources is briefly highlighted under convenient headings-trait-specific crop germplasm, crop wild relatives with potential traits, new potential crops (including wild edible plants), wild ornamentals, life-supporting species, plants for ecosystem restoration and other wild economic species. In view of natural and man-made disasters, complementary *ex situ* conservation strategies are strongly advocated to provide additional protection for germplasm and improve utilisation. A few basic and applied research studies have been suggested to unlock the potential of the identified genetic resources.

Keywords: Biodiversity hotspots, Crop wild relatives, *Ex situ* conservation, Plant Exploration, Wild economic plants

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Introduction

Andaman & Nicobar Islands (A&N), a union territory of India, encompasses a north-south oriented group of over 350 small and big islands and over 200 islets (6 to 14° N and 92 to 94° E) situated on a submerged mountainous hill range arching from the Arakan-Yoma in Myanmar in the north to Sumatra in the south in the Bay of Bengal, stretching over a length of about 912 km and maximum width of 57 km, with a total landmass of about 8,249 sq. km. The northernmost point (Landfall Island) is about 190 km from Cape Negrais in Myanmar. In contrast, the southernmost point (Indira Point in Great Nicobar Island) is about 150 km from the western tip of Sumatra in Indonesia. The Andaman group of islands, consisting of about 290 islands (6,408 sq. km), is separated from the Nicobar group of 28 islands (1841 sq. km) by a 155-km-wide deep-sea channel with strong tidal flow (called the 10° Channel). Prominent divisions in the Andaman include North Andaman, Middle Andaman, and South Andaman (collectively known as the Great Andaman). Other important islands in Andaman include Landfall Island on the extreme north, Sentinel and Interview Islands on the west, Ritchie's Archipelago, Baratang and Long Islands on the east, Labyrinth Archipelago in the southwest, and Rutland and Little Andaman on the south. The three major divisions in Nicobar are

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Car Nicobar and Batti Malv Island in the north, the Nancowrie group of islands (Bampuka, Champin, Chowra, Hithui, Kamorta, Katchal, Nancowrie, Teressa, Tillangchong and Trinket) in the centre, and the Great Nicobar Biosphere Reserve (incl. Little Nicobar and Kondul) in the south.

The topography of most of the islands is hilly, with small, undulating mountains and narrow valleys, covered by dense tropical jungles. The highest peaks are Saddle Peak (732 m above MSL) in North Andaman and Mount Thullier (642 m above MSL) in the Great Nicobar Island. The coastline, 1,962 km long, is highly indented with several creeks. As these islands are located near the equator, a warm, humid tropical climate with a mean temperature ranging from 22 to 30°C prevails. These islands receive heavy rainfall (3,000 to 3,800 mm) from both the southwest and north-east monsoons, with May to December being the active rainy months. Cyclonic winds accompanied by thunder and lightning are common phenomena during the monsoon. The mean relative humidity ranges from 66 to 85% throughout the year. Sandy alluvial soil is generally found along creeks and coasts, while grey, brown, and red soils are found in inland forests. All these climatic and topographic factors lead to rich plant diversity in these islands. In fact, these two island groups are part of two of the world's biodiversity hotspots: the Indo-Burma (Andaman) and Sundaland (Nicobar).

The natural vegetation of the A&N Islands can be broadly classified as tropical evergreen, and forests occupy nearly 85% of the area. Balakrishnan (1989) classified the vegetation into two types, *viz.*, littoral and inland, based on proximity to the sea. While the littoral forests are further classified as mangrove forests, strand vegetation, and tidal or swamp forests, the inland vegetation is classified into evergreen forests, deciduous forests, grasslands, and hydrophytic vegetation. Although the flora shows closer affinity with those of Myanmar, Thailand, and Malesia, millions of years of physical isolation from the neighbouring landmasses have resulted in the evolution of a rare and unique flora on these islands.

The six aborigines of these Islands fall under two ethnic groups, namely Negrito stock (Jarawas, Sentinelese, Great Andamanese, and the Onges) in the Andaman Islands and Mongoloid group (Nicobarese and the Shompens) in the Nicobar Islands; barring Nicobarese, all others are few in number. These tribals depend entirely on forests for their sustenance and maintain a wide range of food sources. The significant population on these islands is dominated by settlers from Myanmar (Karen tribes) and mainland India (mostly from Tamil Nadu, Kerala, Andhra Pradesh, Jharkhand, and West Bengal). It is to be noted that human habitation is limited to only 37 islands (24 in Andaman; 13 in Nicobar).

Plant Diversity of the Andaman & Nicobar Islands

The flora of the Andaman & Nicobar Islands comprises 3,219 species across 1,251 genera in 299 families belonging to algae, lichens, bryophytes, pteridophytes, gymnosperms, and angiosperms (Singh *et al*., 2014). Of them, angiosperms constitute 2,428 species, accounting for 75% of the Islands' flora. Top angiospermous plant families include Poaceae (80 genera; 197 species), Fabaceae (69; 172), Orchidaceae (63; 152), Rubiaceae (48; 147), and Euphorbiaceae (41; 139). According to Pandey and Diwakar (2008), genera with more than 10 species represented in these islands are *Ficus* (50), *Cyperus* (32), *Fimbristylis* (24), *Diospyros* (22), *Dendrobium*, *Ixora* (19 each), *Garcinia*, *Ipomoea*, *Psychotria* (18 each), *Syzygium* (17), *Hedyotis*, *Memecylon* (16), *Calamus* (15), *Blumea*, *Scleria* (13 each), *Jasminum*, *Phyllanthus* (12 each), *Bulbophyllum*, *Dracaena* (11 each), *Aglaia*, *Clerodendrum*, *Euphorbia*, *Glochidion*, *Macaranga*, *Salacia* and *Solanum* (10). It is worth noting that about 50 per cent of these genera contain species with significant economic value. Approximately 42% of angiosperm taxa are representatives of Malesian and Southeast Asian elements (Mathew, 2017); however, 1,026 species are common to the A&N Islands and the Western Ghats.

The endemic taxa of the Andaman & Nicobar Islands comprise 315 taxa across 187 genera in 74 families, representing around 13% of endemism in this small geographic area (8,249 sq. km) (Singh *et al*., 2014). Four genera are exclusively restricted to these islands, namely *Nicobariodendron*, *Pseudodiplospora*, *Pubistylus,* and *Sphyranthera*. There are 12 endemic species of *Calamus*, 9 of *Psychotria*, and 7 of *Garcinia*. The IUCN Red List of 2011 lists 112 species of threatened vascular plants from these islands.

Pandey and Diwakar (2008) enumerated approximately 315 non-native angiospermous taxa from these Islands. According to an estimate by Mathew (2017), there are about 500 useful taxa from the A&N islands identified for various purposes, including 40 species for plywood and timber, 10 for boat and canoe making, 15 for construction and furniture, 15 for fuel wood, 50 for ornamental value, 14 as wild edible fruits and 72 species as potential medicinal plants.

Agriculturally Important Plant Diversity of the Andaman & Nicobar Islands

The A&N Islands are significant for agrobiodiversity

collection/conservation, with a special emphasis on crop wild relatives. Sharma *et al.,* (2018) estimated that about 153 wild species (76 genera/27 families) are related to crop plants, including 34 endemic species. The majority of the crop wild relatives (CWR) are found in tropical evergreen forests. These islands harbour self-sown primitive forms of crops such as coconut and areca nut, as well as wild forms/populations of betel vine. Progenitors of cultivated banana, *Musa acuminata* Colla and *M. balbisiana* Colla, are found in wild conditions here. Crop genera for which a rich number of species exist include *Artocarpus*, *Citrus*, *Curcuma*, *Dioscorea*, *Garcinia*, *Mangifera, Musa*, *Piper*, *Solanum*, *Syzygium*, *Vigna*, and *Zingiber* (Abraham *et al*., 2008).

Among native tribes, only the Nicobarees practice agriculture, and that too mainly of coconut and tuber crops. Karen tribal settlers from Myanmar in the Mayabunder tehsil of North and Middle Andaman primarily practice subsistence agriculture, placing great importance on rice cultivation. It is, in fact, the settlers from mainland India, notably from the southern states of Andhra Pradesh, Tamil Nadu, and Kerala, and the eastern states of Jharkhand and West Bengal, who have infused rich germplasm diversity into these Bay Islands. It may not be incorrect to say that crop diversity in these islands epitomises that of tropical India as a whole. Therefore, rich diversity in tropical crops such as chilli, taro, citrus, greater yam (4 types), potato yam (4 types), banana (8-10 types of both vegetable and table values), giant taro (3 types), cocoyam (2 types), coconut, and areca nut exists. Backyard gardens, rather than fields, play a crucial role in maintaining crop species diversity.

In taro, cultivated representatives belonging to botanical vars. *antiquorum* (Schott) FT Hubb. & Rehder (eddoe), *esculenta* (dasheen), *stolonifera* (Haines) HB Naithani (stoloniferous shoots), *aquatilis* Hassk. (swamp-type, in which both corm and petioles are consumed), and leafy types signify diversity and utilisation. In *Citrus*, spontaneous hybrids among horticultural species are cultivated; variability exists in bunch-bearing habit, prolificacy, seedlessness, spininess, branching habit, and fruit rind aroma. It is possible to obtain canker-resistant germplasm, as differential responses to this disease are observed across the surveyed areas. In chillies, apart from high morphological diversity in fruits (involving 4-5 taxa), great variation in pungency was observed.

The information detailed below on the utilisation potential of PGR is based on explorations undertaken across various islands during 2017-2020, spanning over 70 days to document and collect germplasm in crops, their wild relatives, and other economically important species. Poor representation of the PGR wealth of these Islands in the Indian National Genebank system prompted these field trips, with the ultimate purpose of broadening food baskets by infusing novel genetic variability into crops and introducing new potential crops into mainstream agriculture. Logistical aspects of explorations in remote areas, such as the Nicobar Islands, have been covered in detail in our earlier publication (Joseph John *et al*., 2020).

Utilisation Potential of Plant Diversity in A&N Islands

Although a vast number of economically important species exist here, only those of use in crop improvement and with immediate potential for utilisation as new crops are highlighted.

A. Trait-specific crop germplasm: Unique/novel germplasm diversity within the crop germplasm arises due to both human and natural selection. These islands normally offer scope to study abiotic stresses, such as adaptability to high rainfall, salinity tolerance, and flood/submergence. Some crop germplasm with desirable breeding traits are as follows:

- Lesser yam (*Dioscorea esculenta* (Lour.) Burkill) is believed to have its centre of origin and diversity in Southeast Asia. Breeding work is hampered by the lack of female plants. A female flowering plant was located in Little Nicobar.
- Primitive form of brinjal from Little Nicobar, Trinket, and Little Andaman with possible tolerance to bacterial wilt.
- Salinity-tolerant lablab found in mangrove edges and estuaries.
- *Bael* and *ber* adapted to the high rainfall conditions of tropical humid regions.
- Non-acrid forms in giant taro [*Alocasia macrorrhizos* (L.) G. Don] from Little Andaman.
- Greater yam with violet-purple flesh from Teressa Island.
- Extra-large mother corm in taro from Teressa Island.
- Early maturing (January-February), polyembryonic, high-rainfall-adapted, pickling mangoes.
- Very sweet table-type jackfruit.
- Red-skinned bullock heart (*Annona reticulata* L.) with pink flesh.
- Primitive sea island cotton [*Gossypium barbadense* L. var. *acuminatum* (Roxb. ex G. Don) Triana & Planch.] with probable salinity tolerance from Little Nicobar.

Apart from them, agronomically superior germplasm of small bitter gourd, red-fleshed guava, breadfruit, and germplasm with possibly high active

compounds in ginger, turmeric, cinnamon and lemongrass, all from the Nicobar Islands, were observed.

B. CWR with potential traits: Crop wild relatives constitute wild forms, progenitors and wild species closely related to their cultivated counterparts. In perennial horticultural crops, wild relatives also serve as potential rootstocks for resistance to various biotic and abiotic stresses, for instance, *Artocarpus* spp. (for jackfruit), *Myristica* spp. (for nutmeg), and *Garcinia* spp. (for kokum, mangosteen and Malabar tamarind).

Wild flowering forms of betel vine (*Piper betle* L.) occurring in the A&N Islands would offer scope for improvement of cultivated germplasm. Wild ash gourd collected from Teressa Island is small, roundish, and bitter-free. Germplasm of *Cucumis melo* L. var. *agrestis* (Naudin) Pangalo, the wild form of the melon group of crops, is prolific-bearing, resistant to fruit flies and tolerant to salinity and low sunshine hours. A few of its germplasm collections, free from bitterness and readily crossable with various melon types, offer great opportunities for melon improvement. *Oryza meyeriana* (Zoll. & Moritzi) Baill. var. *indandamanica* (J.L. Ellis) Veldkamp, restricted to only two sites in the Andaman Islands (Fig. 1), may have potential for shade and drought tolerance; additionally, it takes only 16 days from anthesis to seed maturity (while rice takes about 30 days) (Pradheep *et al*., 2023). *Vanilla andamanica* Rolfe, a threatened endemic species in the Andaman Islands, is resistant to *Phytophthora* rot and *Fusarium* root rot.

The *wild Musa* taxa from Andaman and Nicobar, like *M. balbisiana* Colla var. *andamanica* D.B. Singh, Sreek., T.V.R.S. Sharma & A.K. Bandyop., *M. acuminata* Colla, and *M. acuminata* subsp. *burmannica* (often considered as *M. kattuvazhana* K.C. Jacob; Fig. 2), *M. indandamanensis* L.J. Singh (often considered as *M. sabuana* K. Prasad, A. Joe, Bheem. & B.R.P. Rao; Fig. 2), offer good scope for banana breeding. During Panama wilt resistance screening conducted under natural epiphytotic conditions at four locations in Kerala, *M. balbisiana* var. *andamanica* was found to be resistant to Panama wilt, and this result was confirmed under laboratory conditions as well (Dr Anitha Cherian, ex-Head, Dept. of Plant Pathology, KAU). Later, it was also found to be resistant to the rhizome weevil (ICAR-NBPGR, 2023). The endemic species, *M. indandamanensis*, which is more closely related to *M. acuminata*, has a peculiar orangish flesh and a unique flavour.

The North Andaman endemic species, *Phoenix andamanensis* S.Barrow, unlike date palm, is adaptable

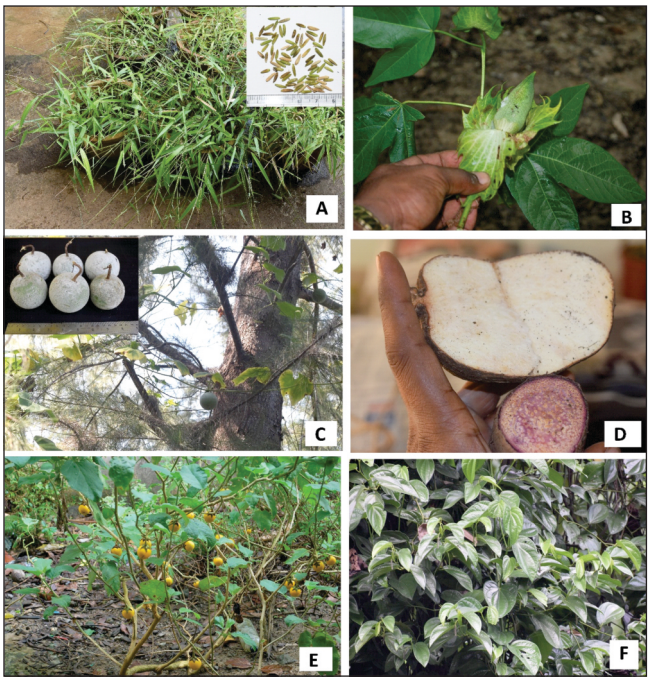


Fig. 1: PGR of the A&N Islands - I. A. *Oryza meyeriana* var. *indandamanica*–niche-specific CWR of rice, endemic to Andaman (inset: Seeds); B. Primitive sea island cotton (*Gossypium barbadense* var. *acuminatum*), in home gardens in Little Nicobar; C. Wild ash gourd from Teressa Island, Nicobar (inset: Fruits); D. Greater yam with violet-purple flesh (compared with white-fleshed) from Teressa Island, Nicobar; E. Primitive form of brinjal from Little Nicobar; F. Wild form of betel vine.

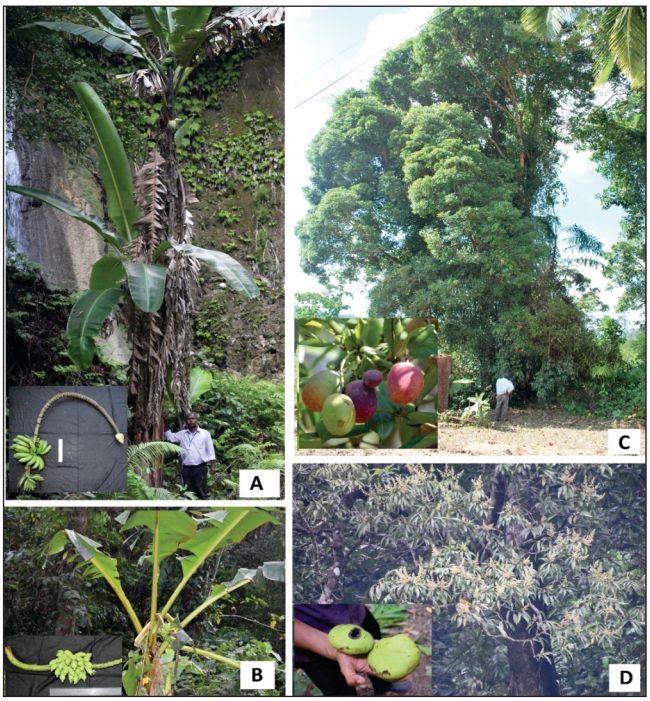


Fig. 2: PGR of the A&N Islands - II. Banana wild relatives-*Musa indandamanensis* from Little Andaman **(**A; inset: Fruiting bunch) and *M. acuminata* subsp. *burmannica* from Middle & North Andaman (B; inset: Fruiting bunch); mango wild relatives-*Mangifera griffithii* from South Andaman (C; inset: Fruits**)** and *M. camptosperma* from littoral forests in Great Nicobar (D; inset: Fruits**)**.

to high rainfall and high humidity, thereby offering scope for breeding date palm varieties adapted to high-humidity areas. *Mangifera camptosperma* Pierre is a component of littoral forests (Fig. 2), therefore tolerant to periodic flooding and salinity. *Mangifera andamanica* King and *M. griffithii* Hook. f. (Fig. 2) have uniformly red-purple skin and pulp, rich in antioxidants and carotenoids.

C. New potential crops

1. *Garcinia kurzii* Pierre : A potential under exploited fruit crop brought to cultivation by the Nicobarees, especially of Central Nicobar, as a table fruit, is of great significance (Fig. 3). This evergreen tree is a close relative of the mangosteen and has similar potential. Unlike mangosteen, it is adaptable to marginal, low upland soils and requires no exacting water or alluvial soil conditions (Nissar *et al*., 2025). Locally known as *inchom*, its fruits ripen by January-February, thus available much earlier than those of mangosteen (April-August). Variability in fruit size, sweetness and rind colour was noticed. Fruits have very thin eggshell-like rinds and possess a TSS of about 20° Brix. The tree is graft-compatible with the rootstock of its closely related species, *Garcinia celebica* L. Horticultural evaluation and fine-grid sampling of the best fruit-quality genotypes may yield new table fruit for the humid tropics.

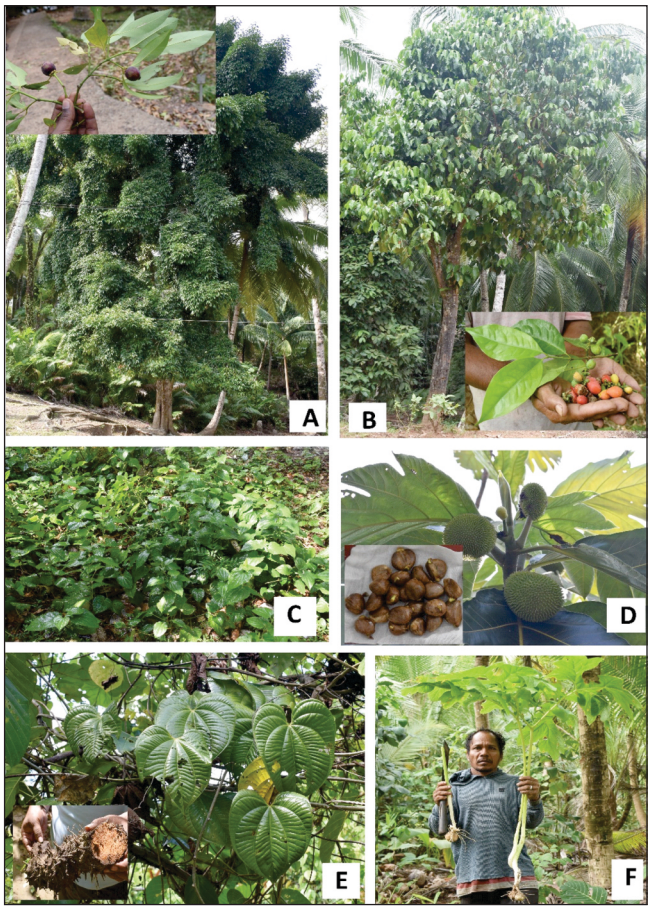


Fig. 3: PGR of the Andaman & Nicobar Islands - III. A. *Garcinia kurzii*–endemic fruit species, cultivated by Nicobarees (inset: Fruiting shoots); B. *Gnetum gnemon* – leafy vegetable cultivated by Nicobarees (inset: Leafy twigs and infrutescence); C. *Piper sarmentosum* - tender leaves consumed as a condiment/vegetable by settlers in Andaman; D. Breadnut cultivated by Karens in the Mayabunder area for edible nuts (inset: Nuts); E. *Dioscorea piscatorum* –edible tuber species having protective thorns, found in Little Nicobar (inset: A portion of tuber); F. Fiji arrowroot–often cultivated by Nicobarees.

2. *Alpinia* sp.: This robust herbaceous perennial species, is closely resembling *A. galanga* (L.) Willd., but nil- or shy-flowering. It is occasionally cultivated in the homestead gardens of Nicobarees in Little Nicobar and the Nancowrie group of islands. Its fresh rhizome is harvested year-round for use as a ginger substitute, finds a place in masala tea, and is used in fish curry and meat preparations. It has huge potential for application in the pharmaceutical and perfume industry. It yields about 0.1% volatile oil, with 33% contributed by 1, 8-cineole (an aromatic component) (Dr NK Leela, ICAR-IISR, pers. comm.). It has an ethnobotanical application (e.g., flavouring rice spirit and food) similar to *Alpinia conchigera* Griff. in Thailand. Further studies are warranted to confirm its species identity, which is hindered by its non-flowering habit, and to conduct agronomic trials to enable its commercial cultivation.

3. *Pandanus leram* Jones ex R Millar: This common species of lowland marshes and littoral zones was once the staple food of Nicobaree tribes, especially before the operation of the public distribution system, and still finds a significant place in their culture. The individual fruits separated from mature fruit bunches are steamed, and the mealy pulp is extracted from the mesocarp. The orange-coloured dough is mixed with grated coconut, kneaded, and prepared as a steamed cake (called 'koila'), which is served on auspicious occasions.

4. *Gnetum gnemon* L.: This is a woody liana species grown as a small tree in the Nicobaree homesteads and used as a leafy vegetable (Fig. 3). Highly esteemed by the Nicobarees, its tender leaves need no precooking and have an acceptable taste. One tree would suffice the vegetable needs of a family with 4-5 people. Efforts to grow in ex situ conditions on the mainland indicate slow initial growth, i.e., a long gestation period. Moreover, seeds take about nine months to germinate.

5. *Champereia manillana* (Blume) Merr.: Locally known as *meetabhaji* by Chotanagpur tribal settlers in the

A&N Islands, the tender leaves of this evergreen shrubby species are used as salad leaves and have an agreeable taste.

6. *Piper wallichii* (Miq.) Hand.-Mazz: A wild species growing in the Andaman Islands is harvested for its woody stem, and its bark is used to flavour curries. Mature woody cuttings are sold in the markets of South, Middle, and North Andaman, and one kg of produce costs about ₹500/-. A small piece of the same is used as a finishing spice to flavour meat, fish, and vegetarian dishes, mainly by Bengali settlers, imparting a sweet, pungent, spicy flavour. The Karen tribe of North Andaman Island uses its leaves and stems for curing various ailments. Earlier, it was harvested destructively; now, it is under cultivation, offering scope for domestication and extended cultivation in iso-climatic regions elsewhere on the mainland (Joseph John *et al.,* 2019a). The agriculture department may initiate trial plantations in tribal-dominated areas and make buyback arrangements. Although this species has recently been identified as *P. pendulispicum* C.DC. (Waman *et al*., 2024), a species native to northern Vietnam, a critical taxonomic appraisal is awaited.

7. *Piper sarmentosum* Roxb.: Locally known as *pipal sag*, this species is occasionally found in Little and South Andaman (Fig. 3). Tender leaves are consumed as a condiment/vegetable, and dried spikes are used as an ingredient in curry powder. Bengali settlers prefer to add tender leaves to prawn and lobster curries. *Rasam* prepared from its leaves is delicious. It is easily propagated by nodal cuttings. Being tolerant of shade, it can be tried as an intercrop in rubber/coconut plantations.

8. *Nypa fruticans* Wurmb: Dense strands of this niche-specific palm species are occasionally found in mangrove deltas and estuarine alluvial riverbanks in both groups of Islands. The fruit kernels of this palm are sweet and delicious, and a source of edible oil used by the Nicobarees. Leaves are used for thatching, and the palm has potential as a species suitable for protecting coastal areas/ riverbanks with saline habitats.

Other crops sparingly cultivated by Nicobarees, but have potential for promotion in the mainland are santol (*Sandoricum koetjape* (Burm.f.) Merr.; cultivated for edible fruits), *Spondias dulcis* Parkinson (fruit value) and *Pandanus amaryllifolius* Roxb. ex Lindl. (leaves for flavouring rice and other dishes). Karens cultivate breadnut (*Artocarpus camansi* Blanco; Fig. 3), and its seeds are cooked as a vegetable; this could be promoted in the mainland. Table 1 lists 19 wild edible plant species with potential for utilisation. Two bitter leafy vegetables used by Nicobarees are *Claoxylon indicum* (Reinw. ex Blume) Hassk. and *Clerodendrum japonicum* (Thunb.) Sweet. Tuber-bearing species such as *Dioscorea piscatorum* Prain & Burkill (Pradheep *et al*., 2019; Fig. 3), *D. glabra* Roxb., and *D. nummularia* Lam. are famine foods for the Nicobarees.

D. Wild ornamentals

There are numerous species across various ornamental groups, such as orchids, palms, ferns, and gingers, awaiting their turn to be included in the ornamental basket. Some traditionally recognised ornamental genera (other than orchids) represented in these islands include *Aglaonema*, *Alocasia*, *Areca*, *Caryota*, *Colocasia*, *Curcuma*, *Cyathea*, *Cycas*, *Etlingera*, *Gardenia*, *Jasminum*, *Pinanga*, *Piper*, *Sterculia*, *Zingiber*, and so on. During the survey and exploration, the ornamental potential of the following species has been identified:

1. Foliage ornamentals: *Aglaonema simplex* Blume, *Stachyphrynium repens* (Körn.) Suksathan & Borchs., *Amischotolype glabrata* Hassk., *Piper clypeatum* Wall. ex Hook.f., *Homalomena cordata* Schott, *Alocasia* spp., *Freycinetia* spp., *Hoya parasitica* (Wall. ex Hornem.) Wight, *Molineria capitulata* (Lour.) Kuntze.

2. Ornamental palms: *Pinanga manii* Becc., *Rhopaloblaste augusta* (Kurz) H. E. Moore (Fig. 4), *Bentinckia nicobarica* (Kurz) Becc. (Fig. 4), *Licuala peltata* Roxb. ex Buch.-Ham., *Nypa fruticans, Cycas zeylanica* (J. Schust.) A. Lindstr. & K. D. Hill*, Phoenix paludosa* Roxb. and *Areca triandra* Roxb. ex Buch.-Ham., *Caryota mitis* Lour.

3. Ornamental ferns: *Sphaeropteris albosetacea* (Bedd.) Copel., *Glychenia* spp., *Pteris* spp., *Nephrolepis* spp.

4. Ornamental gingers: *Curcuma roscoeana* Wall., *Zingiber odoriferum* Blume, *Z. parishii* Hook. f., *Etlingera fenzlii* (Kurz) Škorničk. & M Sabu.

5. Flowering climbers, shrubs and trees: *Jasminum elongatum* (P.J. Bergius) Willd., *Oxyceros longiflorus* (Lam.) T. Yamaz., *Gardenia tubiflora* Andrews, *Uvaria* spp., *Archidendron* spp., *Sterculia parviflora* Roxb. ex G Don.

   Special mention is warranted for *Curcuma roscoeana* from the Andaman Islands (Fig. 4), which bears beautiful, long-lasting orange terminal spikes, making it useful for cut flowers and floral bouquets. However, it tends to shy multiplication; therefore,

Table 1: Some wild edible plants of the Andaman & Nicobar Islands having the potential for cultivation in mainland India

S. No.	Botanical name*	Common name(s)	Family	Distribution in A&N Islands	Remarks
1.	*Acrostichum speciosum* Willd.	Mangrove fern	Pteridaceae	Widely distributed	Called as *lal bhaji*/*tekke bhaji*, the circinate fronds and tender leaves are used as a cooked, tasty vegetable. Potential leafy vegetable for saline tracts; often sold in the markets
2.	*Artocarpus chama* Buch.-Ham. (syn. *A. chaplasha* Roxb.)	Chaplash	Moraceae	Widely distributed	Local people have identified unique types for fruit purposes; tender fruits are used as vegetables. The tree resembles *A. hirsutus* Lam. of the Western Ghats
3.	*Baccaurea ramiflora* Lour. (syn. *B. sapida* (Roxb.) Müll. Arg.)	Burmese grape	Phyllanthaceae	Widely distributed	Small tree; the aril of ripe fruits is eaten, with a sour and sweet taste; seasonal fruit
4.	*Bentinckia nicobarica* (Kurz) Becc.	Nicobar palm	Arecaceae	Central & Southern Nicobar	The delicate apex of the trunk forms a tasty salad
5.	*Bouea oppositifolia* (Roxb.) Meisn. (syn. *Mangifera oppositifolia* Roxb.)	Maprang, plum mango	Anacardiaceae	Andaman	Cultivated as a fruit tree by the Karen community
6.	*Cissus repanda* (Wight & Arn.) Vahl (syn. C. *repens* Lam.)	-	Vitaceae	Widely distributed	Locally known as *khatta bhaji*, used as a leafy vegetable by the settlers
7.	*Cycas zeylanica* (J. Schust.) A. Lindstr. & K. D. Hill	Maha-madu	Cycadaceae	Widely distributed; endemic to A&N	A gymnosperm, occasionally found in littoral forests. Kernels are sun-dried, soaked in several changes of water, pounded, and the resulting flour is used as an edible starch/ carbohydrate. Amenable to vegetative propagation. Seeds have low germination and need an 8-9 month gestation period in soil
8.	*Dinochloa nicobariana* RB Majumdar	Nicobar climbing bamboo	Poaceae	Nicobar	These bamboo shoots are used as vegetables by Shompens and settlers from Jharkhand
9.	*Diplazium esculentum* (Retz.) Sw.	Vegetable fern	Polypodiaceae	Widely distributed	Locally known as *kukud bhaji*, wild-gathered tender coiled fronds are sold in the market. Eaten after cooking. It has scope for marshy wasteland cultivation
10.	Sphenoclea zeylanica Gaertn.	Gooseweed	Sphenocleaceae	Widely distributed	Used as a medicinal and leafy vegetable by Bengalis
11.	*Garcinia dhanikhariensis* S.K. Srivast.	Andaman kokum	Clusiaceae	Restricted to South Andaman	Fruits yield kokum-like edible fleshy aril/pigmented juice
12.	*Garcinia andamanica* King	-	Clusiaceae	Andaman	Fruit rinds are potential acidulants, and seeds are a source of edible oil (Bohra *et al*., 2021)
13.	*Garcinia cowa* Roxb. ex Choisy	Cowa mangosteen	Clusiaceae	Widely distributed	Slightly sour fruits are fondly eaten. Potential to make jam and use it as a preservative.
14.	*Parsonsia alboflavescens* (Dennst.) Mabb.	Spiral-vined silkpod	Apocynaceae	Widely distributed	Scandent vine with milky latex, used as a leafy vegetable by Nicobarees in Kamorta
15.	*Haematocarpus validus* (Miers) Bakh.f. ex Forman	Blood fruit	Menisperm-aceae	Widely distributed	Locally known as "khoon phal", its anthocyanin-rich fruits are used for raw consumption, as a dyeing agent and for treating ailments
16.	*Momordica cochinchinensis* (Lour.) Spreng. subsp. *andamanica* Kattuk., Y.C. Roy & Krishnaraj	Gac, sweet gourd	Cucurbitaceae	Middle & North Andaman	A perennial dioecious climber; tender leaf clippings and tender fruits as vegetables by settlers from Chotanagpur and West Bengal.
17.	*Solanum lasiocarpum* Dunal (syn. *S. ferox* L.)	Indian nightshade	Solanaceae	Central Nicobar	Fruits are utilised in place of tomato as a souring agent, cultivated occasionally
18.	*Syzygium samarangense* (Blume) Merr. & L.M. Perry	Java apple, wax apple	Myrtaceae	Widely distributed	Gigantic tree; can be used as a natural coastal windbreak; minor fruit also
19.	*Tacca leontopetaloides* (L.) Kuntze	Fiji /Tahiti arrowroot	Dioscoreaceae	Widely distributed	Tuber value for Nicobarees; yields edible starch like arrowroot

*Most potential ones

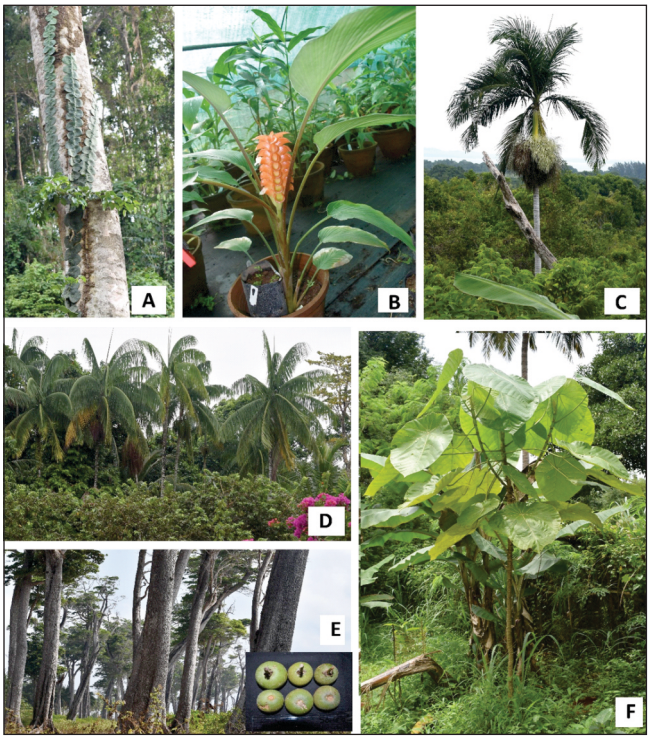


Fig. 4: PGR of the A&N Islands - IV. A. *Piper clypeatum*–a wild foliage ornamental from Great Nicobar; B. *Curcuma roscoeana*- wild ornamental from the Andaman Islands; C. *Bentinckia nicobarica* – multipurpose palm endemic to Nicobar; D. *Rhopaloblaste augusta* – multipurpose palm endemic to Nicobar; E. Giant trees of *Manilkara littoralis* in seashores of Little Andaman (inset: Fruits); F. *Macaranga nicobarica*–leaves a potential alternative to plastic food wrappers/dining plates, from Nicobar.

micropropagation may be attempted. Burmese fishtail palm (*Caryota mitis*), a native of the Andaman Islands, is a handsome, dwarf, suckering palm (up to 5 m high) suitable for landscaping avenues (Joseph John *et al*., 2014). It propagates well from seed and lasts 5-7 years. Its leaves may serve as fodder for elephants. *Piper clypeatum* from the Nicobar Islands (Fig. 4) is a beautiful foliage ornamental, adapted to shade, therefore suited for indoor gardens.

Sphaeropteris albosetacea, the tree fern adaptable to the wet and shaded places of humid tropics, is a good candidate for landscaping. The plant's unique foliage and trunk lend the gardens the beauty of a primitive forest.

6. Life supporting species: These are mostly multipurpose tree species that provide a range of services to humans. Nutmeg-related trees like *Knema andamanica* (Warb.) W.J. de Wilde, *Myristica andamanica* Hook. f., and *Horsfieldia glabra* (Blume) Warb. serve as excellent long-lasting poles/rafters used extensively, similar to *Casuarina* poles, by the natives for hut construction. Unlike *Casuarina*, these broad-leaved species exert no allelopathic effect on other species and enrich the soil with more litter biomass. The split wood of the Nicobar endemic palms *Bentinckia nicobarica* and *Rhopaloblaste augusta* is used by the natives for durable platform construction/make-shift bridges, and the like. Fronds of native palms such as *Licuala peltata* and *L. spinosa* Wurmb are extensively utilised by native tribals and settlers for thatching, and are said to remain usable for 4-5 years after initial smoke treatment. Rattan spiny stems often serve as a coconut grater.

7. Plants for ecosystem restoration: Fronds and sheaths of palms such as *Pinanga* spp., *Bentinckia nicobarica*, and *Rhopaloblaste augusta* may be useful for preparing eco-friendly food plates and nursery grow-bags. The gigantic leaves (70 cm × 65 cm) of *Macaranga nicobarica* N.P. Balakr & Chakr. (Fig. 4) would serve as a potential alternative to plastic food wrappers/dining plates (Joseph John *et al*., 2019b) and would therefore form a renewable source of packaging material. Nicobarese use it like banana leaves for wrapping/cooking/steaming pandanus cakes. It is well established in Kerala conditions. The seed-setting banana, *Musa balbisiana* var. *andamanica*, could aid artificial reseeding of degraded forest lands to control elephant raids on adjacent agricultural plots. It has over 160 seeds/fruit, 5000-6000 seeds/bunch, with nearly 100% germination. Seeds may be sown by dibbling, thereby reducing planting costs (conventionally, pits are dug to plant suckers). In addition to its use as fodder, leaf harvest for dining plates is an added advantage.

   Various plant species inhabiting coastal areas serve as coastal bio-shields/shelter belts. Thanks to the key species, a significant proportion of coastal areas in the A&N islands did not experience the serious wrath of the 2004 tsunami. Giant trees like *Manilkara littoralis* (Kurz) Dubard (Fig. 4) and *Syzygium samarangense* (Blume) Merr. & L.M. Perry, leguminous shrubs like *Dendrolobium umbellatum* (L.) Benth., stilt-root bearing various *Pandanus* and mangrove species, mangrove palm *Nypa fruticans*, and legume cover crops like *Vigna marina* (Burm.) Merr., all can contribute to coastal ecosystem restoration.

8. Other wild economic species: Grasses and legume forage species abundant in the grasslands of Kamorta, Champin, Teressa, and Katchal need to be studied for potential utilisation as livestock feed in the dairy and animal husbandry industry, as is also

the case with other crop groups – medicinal plants, forestry-related plants, and other economic plants. There is a substantial population of important medicinal plants, such as *Andrographis paniculata* (Burm f.). Wall. ex Nees, *Costus speciosus* (J. Koenig) Sm., various *Sida* spp., *Bacopa monnieri* (L.) Wettst., and *Eclipta alba* (L.) across different habitats. The wild species *Blumea balsamifera* (L.) DC. often finds a place in the homestead gardens of the Nicobarees of Central Nicobar; its aromatic leaves are boiled in coconut oil and used as a massaging oil for children and for glowing skin. *Micromelum minutum* (G. Forst) Wight & Arn., a species related to curry leaf (*Murraya koenigii* (L.) Spreng.), is commonly found in the kitchen gardens of the Karen community and is used similarly. The wood of the Andaman endemic *Diospyros marmorata* R. Parker is a potential species for trial plantation by the forest department, as it is useful in the woodcarving industry for crafting high-value ornamental items.

Conservation Issues

This region is prone to natural calamities such as earthquakes, cyclones, heavy winds, floods, heavy rainfall, and seawater intrusion. The famous Indira Point was submerged during the tsunami. More than 89 per cent of mixed mangroves and 86.3% of littoral beach forests in the Great Nicobar Biosphere Reserve were either submerged or severely damaged by the tsunami (Porwal *et al*., 2012). These islands also have geostrategic importance for defence, logistics, commerce and industries, eco-tourism, and coastal tourism. A mega infrastructure project called "Great Nicobar Development Project" has four components, namely Galathea Bay International Container Transhipment Terminal, Great Nicobar International Airport, Great Nicobar Gas and Solar Power Plant, and two new greenfield coastal cities, all of which had already been granted environmental clearance by the Ministry of Environment, Forest and Climate Change's Expert Appraisal Committee in 2022. As only a part of the Galathea WLS (in which the above project is envisioned) has been covered in earlier explorations, a rescue mission involving various stakeholders is urgently warranted for the remaining areas of the Galathea WLS earmarked for this project, particularly the southern and western parts. It was observed that many invasive alien species, such as *Mikania micrantha* Kunth, *Chromolaena odorata* (L.) R.M. King & H. Rob and *Hyptis capitata* Jacq. are spreading at an alarming rate, endangering the seedling growth of native plants. Human population expansion is another major detrimental issue, particularly to endemic taxa. The population in 1951 was 31,000, and as per the recent Census of India, it is now around 4 lakhs.

From 1999 to 2007, ICAR-NBPGR, in collaboration with ICAR-CIARI/other ICAR institutes, collected 1,234 accessions (92 taxa) (Abraham *et al*., 2008); however, a significant share of the collected germplasm couldn't be conserved due to various constraints. During our explorations in 2017-2020, A total of 773 samples (wild-491; cultivated-282) consisting of 292 taxa (wild-216; cultivated-76) were collected primarily from diversity-rich areas like the Great Nicobar Biosphere Reserve and Nancowrie group of Islands in Nicobar, and Mt. Manipur (Mt. Harriet), Rutland, Chidya Tapu, Little Andaman, Swaraj Dweep, Saddle Peak and Ross & Smith Islands in Andaman. So far, about two-thirds of these collections are conserved successfully. Some gap areas identified for future exploration include Mt. Thullier, Galathea to Indira Point, and the whole western part in the Great Nicobar Biosphere Reserve; Tillangchong, Chowra, Katchal, Car Nicobar, and the grasslands of the Nancowrie group of Islands in Nicobar; Long Island, Interview Island, Shaheed Dweep, northern parts, and Karen settlements in Andaman. Apart from this, under-collected crop groups such as M&AP, ornamentals, and forages, as well as leafy vegetables, need focus for ex-situ conservation.

Some valuable species of PGR importance (for instance, *Mangifera nicobarica* Kosterm., *M. andamanica, M. camptosperma*, *M. griffithii*, *Musa indandamanensis*, *M. balbisiana* var. *andamanica*, *Oryza meyeriana* var. *indandamanica*, *Vanilla andamanica*, wild *Piper betle*), occur only in this part of India. This demands, in addition to *in situ* conservation, complementary conservation strategies such as *ex situ* conservation in seed, *in vitro* and cryo genebanks, and field genebanks, are needed to aid the protection of genetic resources and their better utilisation. The native Nicobarese tribals collect wild yams, *Tacca*, bananas, and pandanus fruits, protect them in the wild, and bring some wild species into homestead cultivation. Thus, the Nicobar Islands would be the best site for studying the domestication patterns of indigenous crops. Systematic documentation of the traditional knowledge of dwindling tribal communities, such as the Ongees and Jarawas, would pave the way for the inclusion of more plants in bioprospecting. Simplifying the norms for bona fide collectors to conduct surveys and studies and to collect PGR from Protected Areas by the forest and the tribal welfare departments would help a lot in this direction.

Future Thrust and Conclusion

As a significant proportion of economically important species from these islands are unrepresented in

mainland India, both basic and applied research are of paramount importance to unlock their potential. These include the standardisation of seed germination/ dormancy breaking/ conservation protocols (thereby enabling their conservation in Seed/Cryo Genebank), adaptability studies in simulated *ex-situ* conditions (in inhabited islands and on the mainland), propagation studies, and rootstock compatibility studies within and across genera, for instance, *Myristica andamanica*, *Knema* spp. and *Horsfieldia glabra* for nutmeg; *Semecarpus prainii* King and *S. kurzii* Engl. for cashew; *Artocarpus peduncularis* Kurz for bread nut and breadfruit; *Garcinia kurzii* for mangosteen; *Manilkara littoralis* for sapota. Additionally, studies on improving storage conditions for vegetative propagules and live plants in transit (including during packing) would enhance germplasm survival.

Further, crossability studies/wide hybridisation with CWR, screening of crop germplasm and CWRs for various abiotic and biotic stresses, and biochemical evaluation of wild edible species and medicinal plants for their proximate principles and antinutrients, if any, would help in the efficient utilisation. Plants identified as having potential for ecosystem restoration, such as coastal bioshield and dining plates, may be tried in mainland India. A large number of islands, including some human-inhabited ones, remain underexplored and require systematic exploration across different seasons, which may offer opportunities to collect PGR that has hitherto gone uncollected.

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