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Conservation and Utilization of Wild Relatives of Important Spices and Plantation Crops in Andaman and Nicobar Islands, India- An Overview

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Abstract

Andaman and Nicobar islands are one of the regions with unique diversity of flora including about 300 endemic species. These islands are also home to six native tribes, some of which are still living their life in primitive ways. The native phyto-diversity is routinely employed by these aboriginals and settler communities for a variety of purposes including food, medicines, timber etc. In the present review, diversity of crop wild relatives of commercial spices and plantation crops present in the islands along with their utilization by the tribes and other communities is discussed. Further, being botanically related to commercial crops, such species could greatly contribute in crop improvement programmes to meet the challenges arising out of climate change. Considering these, systematic studies are envisaged to document, regenerate, conserve and characterize such economically and ecologically useful species so that they could be utilized for the betterment of human kind. Present review concerned highlighting the importance of these issues in the context of fragile island ecosystem of the Bay Islands.

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Introduction

Humid tropical Andaman and Nicobar Islands (ANI) situated in the Bay of Bengal are composed of 572 islands and isles. The islands are distributed between two biodiversity hotspots *viz*. Arakan Yoma ranges of Myanmar and the Sumatra, thereby contributing to diversification of flora in this region. Geographically these islands are separated from the Indian mainland and are rather closely situated to other South East Asian countries such as Indonesia, Malaysia and

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Thailand. The climate is typical tropical with annual rainfall of 300-310 cm, spread over 8-9 months and less temperature fluctuations. The islands are home to six native tribes- two of mongoloid (Nicobarese and Shompens) and four of negrito (Great Andamanese, Jarawa, Onge, Sentinelese) races of which Sentinelese is still hostile as evidenced by the recent incidence (November 2018) of death of an American citizen due to their attack. Presently, settler communities are the major population of these islands, which have migrated from different states of India and adjacent countries.

The ANI harbor rich diversity of flora, which is well protected in dense forests of islands spread over about 81.8% of total geographical area.[1] These islands have more than 19.6% area in protected forests in the form of national parks (9), sanctuaries (96) and a biosphere reserve.[2] About 2,314 species of Angiosperms belonging to 181 botanical families have been reported from these islands. Though the area is comparatively smaller, higher degree of endemism i.e. ca. 300 endemic species has been reported from the ANI.[1] Species from flora of Myanmar, Thailand, Malaysia, Indonesia etc. have been reported to occur in these islands.[3,4] Though considerable diversity has been reported from these islands, systematic efforts on their sustainable utilization have not been taken up in most of these species.[5-7]

The islands are vulnerable to a number of natural calamities including occurrence of cyclones, earthquakes, storms etc. The Tsunami of 2004 caused considerable damage to the natural resources of these islands and rendered many areas devastated. These calamities are cause of concern as they pose direct threat to the floral diversity.[8] Distinct dry spells during January to April and soils with poor water holding capacity create drought like situation in some parts of these islands, while rainy months of the year sometimes cause short duration flood in low-lying areas. Apart from the natural disasters, various anthropogenic activities including rapid urbanization, tourism development, pollution, introduction of invasive species, climate change etc. have contributed in threatening the plant diversity.[9,10] Under such conditions, protection of diversity and its sustainable utilization is of prime importance.[6]

Agriculture in ANI is the occupation of some settler communities, who mostly concentrate on

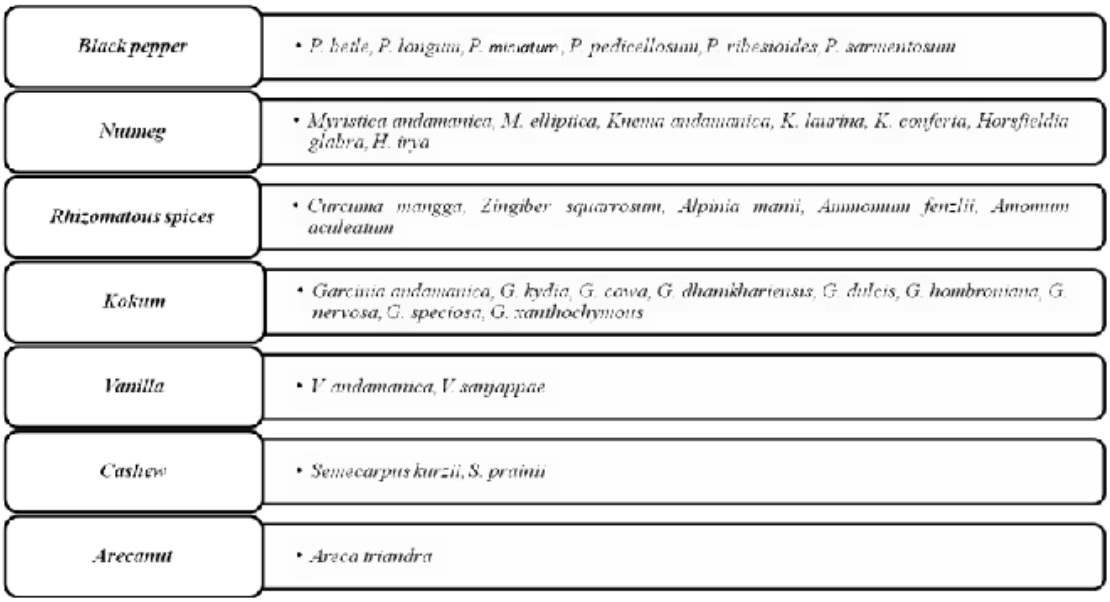

Fig. 1: Important wild relatives of spices and plantation crops reported from the Andaman and Nicobar islands[1,4,5]

a few crops of economic importance. Coconut, arecanut, rice, tuber crops, spices, indigenous fruits and vegetables are some of the important agri-horticultural commodities of ANI. Many exotic/ non-native species have also been introduced in the islands and some of them have naturalized here. A number of species are cultivated mainly for homestead and domestic consumption as detailed in our previous report.[5] Spices and plantation crops are amongst the most important cash crops cultivated by the settler communities. However, the islands are known to harbor considerable diversity of wild related species of these crops (Fig. 1), which are being used by the native tribes and settler communities for variety of purposes. Considering their ecological, food, medicinal, horticultural and breeding importance, these species need to be conserved and characterized for promoting their sustainable utilization. Crop wild relatives have been considered as valuable genetic resources as they may harbor genes, which could address the issues of present as well as future crop production. Both spices and plantation crops are the most profitable crops grown in different parts of the world. In order to address the emerging threats posed by climate change, pests/ diseases and nutritional/ economic security related issues in these crops, role of their wild relatives would be phenomenal. However, scarce information is available on these aspects and hence, in the present review, efforts have been made to discuss various issues pertaining to wild relatives of spices and plantation crops of Andaman and Nicobar islands.

Diversity of Flora

Flora of Andaman group and Nicobar group of islands are considerably different as these landmasses are physically separated by ten degree channel. Mainly wild related species of black pepper (*Piper betle* L. wild types; *P. longum* L., *P. miniatum* Blume, P*. pedicellosum* Wall. ex DC.; *P. ribesioides* Wall.; *P. clypeatum* Wall. ex Hook. f. and *P. sarmentosum* Roxb.), nutmeg (*Knema andamanica* (Warb.) de Wilde ssp. *andamanica*; K. *andamanica* (Warb.) de Wilde ssp. *nicobarica* (Warb.) de Wilde; *K. conferta* Warb.; *K. laurina* (Blume) Warb.; *Myristica andamanica* Hook. f.; *M. elliptica* Wall. ex Hook. f. et Thoms.; *Horsfieldia glabra* (Blume) Warb. and *H. irya* (Gaertn.) Warb.), rhizomatous spices (*Amomum aculeatum* Roxb.; *Ammomum fenzlii* Kurz; *Alpinia manii* Baker; *Curcuma mangga*; *Zingiber squarrosum* Roxb), kokum (17 species including

Table 1: Food and medicinal uses of important taxa by native tribes of ANI (N: Nicobarese; S: Shompen; GA: Great Andamanese; O: Onge and J: Jarawa) [11, 20-24]

Family	Species	Tribe				
		N	S	GA	O	J
Anacardiaceae	*Semecarpus kurzii* Engler.	√	√	-	√	-
Arecaceae	*Areca triandra* Roxb.	√	√	√	√	√
	Phoenix paludosa Roxb.	√	√	√	√	√
Clusiaceae	*Garcinia cowa* Roxb. ex DC.	-	√	√	-	-
	Garcinia nervosa Miq.	√	-	-	-	-
	Garcinia xanthochymus Roxb.	√	√	√	√	√
Myristicaceae	*Horsfieldia* sp.	-	-	-	√	-
	Myristica andamanica Hook. f.	√	-	-	-	-
	Myristica peltata Roxb.	-	√	-	-	-
	Myristica elliptica Wall.	√	-	-	-	-
Piperaceae	*Peperomia pellucida* (L.) Kunth.	√	-	-	-	-
	Piper betle L.	√	-	-	-	-
Zingiberaceae	*Amomum aculeatum* Roxb.	-	-	-	√	-
	Zingiber squarrosum Roxb.	-	-	-	√	-

seven endemic- *Garcinia andamanica* King *var. andamanica*; G. *cadeliana* King; G. *calycina* Kurz; G. *dhanikhariensis* S. K. Srivastava; G. *kingii* Pierre ex Vesque; G. *kurzii* Pierre and *G. microstigma* Kurz), arecanut (*Areca triandra* Roxb., cashew (*Semecarpus kurzii* Engler.; *S. prainii* King), Vanilla (*Vanilla andamanica*) etc. have been reported from these islands.[5] Of these, few species could be directly used for consumption, while others could be studied in detail for identification of useful products/ genes/ applications arising out of them. Some of these species have been commonly used by the tribal communities for food and healthcare purposes in their day to day lives (Table 1), while other species are being used for non-food purposes (Table 2) including uses for wood work, construction of huts/ canoes, fuel, insect repelling etc.

Management of Native Diversity: Recent Initiatives and Thrust Areas

Assisted Regeneration

First step in the direction of sustainable utilization of a species is its conservation as in the absence of robust conservation strategies; threatened species may be lost permanently, while other species are pushed towards risk. The tradition of sustainable conservation of local biodiversity needs to be learnt from the primitive tribes, who take only the required amount of material and allow the remaining plants to flourish.[11] However, considering the natural and manmade disasters, conscious efforts are required for conserving these useful resources. To support natural regeneration process of some important species of these islands, experiments have been initiated in authors' Institute to standardize mass multiplication through *in vitro* and *ex vitro* means. As a number of crop wild relatives described are endemic and facing conservation issues, efforts were made to regenerate the prioritized species (Table 3) for taking up habitat enrichment and further research. Seed pre-treatments for improving seed germination and seedling vigour have been standardized for wild nutmeg species -*Myristica andamanica* and *Horsfieldia glabra*,[12] wild cashew species- *Semecarpus prainii* and *Semecarpus kurzii*,[13] wild kokum species- *Garcinia gummi-gutta* (L.) Roxb., *G. andamanica* and *G. kydia* etc.(unpublished). Vegetative propagation has been standardized for *Piper sarmentosum*,[14] which is used as a leafy vegetable and medicine by the settler communities. biotechnological approaches have been suggested as important tools for conservation of biodiversity of Bay islands and micropropagation has a key role to play in multiplication of native species.[15] Improved protocol for *in vitro* mass multiplication has been standardized in *Curcuma mangga*,[14] while protocols

Table 2: Non-food uses of important taxa by native tribes of ANI (N: Nicobarese; S: Shompen; GA: Great Andamanese; O: Onge; J: Jarawa) [11, 18, 20-21]

Family	Species	Tribe					Uses
		N	S	GA	O	J	
Arecaceae	*Areca triandra*	-	√	-	-	-	Leaves for thatching
Anacardiaceae	*Semecarpus kurzii*	√	√	-	-	-	For hut construction, twigs for avoiding evil spirit
Clusiaceae	*Garcinia andamanica*	-	-	-	√	-	For hut construction
	Garcinia nervosa	√	√	-	-	-	For making paddles of canoe
	Garcinia speciosa	√	√	-	-	-	For making paddles of canoe
Myristicaceae	*Myristica* sp.	-	-	-	√	-	Fuel wood
Myrtaceae	*Syzygium samarangense*	√	-	-	-	-	For hut construction and canoes
Zingiberaceae	*Alpinia manii*	-	-	√	-	-	Sap of stem and leaves as bee repellent, while honey collection
	Amomum aculeatum		√	-	-	√	-do-
	Ammomum fenzlii		√	-	-	-	-do-

for direct and indirect regeneration were optimized for *P. sarmentosum*.[16] Apart from these, protocols need to be developed for a large number of endemic species of these islands by setting the priorities.

In Situ and Ex Situ Conservation

In situ conservation ensures continuity of natural evolution of a species in its native habitat, wherein the species also offer other ecosystem benefits to associated fauna and microflora. *Ex situ* conservation, on the other hand, is of prime importance especially for endemic species as the island ecosystem is vulnerable to natural and manmade disasters and any loss to such species could result in their extinction. Further, detailed characterization and evaluation of utility of the species could be easily carried out, when the species is conserved under *ex situ* conditions. Hence, both in situ and ex situ conservation are required to ensure conservation and sustainable utilization of the species. Considering these points, multiplied seedlings of important species are being used for habitat enrichment activities.

Exclusive conservation blocks for wild nutmeg species *viz*. *Myristica andamanica*, *Knema andamanica*, *Horsfieldia glabra* and nine species of *Garcinia* (including endemic G. *dhanikhariensis*, *G. andamanica*, and rare *G. kydia*) have been developed at Garacharma farm of the authors' institute. Endemic species have also been conserved

Table 3: Regeneration methods developed for native species of Andaman and Nicobar islands at authors' Institute[12-14]

Species	Technique	Protocol developed
Curcuma mangga (native, medicinal spice)	Micropropagation	Dextrose (3%) as carbon source gave highest multiplication ratio (1:5) and higher accumulation of total chlorophylls (2.315 mg/g). Single step *ex vitro* rooting cum hardening with 90% survival was observed in the absence of auxins. This technique significantly reduced the time, labour and inputs required for acclimatization.
Piper sarmentosum (native, medicinal species)	Stem cutting	Double node cuttings with 1,000 mg/L IBA as pre-treatment improved sprouting percentage and plant growth. Further, removal of leaves from the cuttings was beneficial for improving the plant growth.
Semecarpus kurzii (native wild cashew)	Seed germination	Treatment of seeds with KNO_3 (9.9 mM) for 24 h was suitable for obtaining 94% germination.
Garcinia andamanica (Endemic)	Seed germination	Soaking of seeds with 0.1% KNO_3 promoted seed germination and seedling growth
Garcinia kydia (Native, rare)	Seed germination	Soaking of seeds with 0.1% potassium nitrate significantly improved seed germination and seedling growth parameters
Horsfieldia glabra (Native wild nutmeg)	Seed germination	Soaking of freshly harvested seeds with GA_3 (100 mg/l) for 24 h facilitated improved germination (79%) with lowest T_{50} value (27.2 days).
Myristica andamanica (Endemic, vulnerable wild nutmeg)	Seed germination	Non-rattling and water sinking seeds were found useful for propagation. Retention of hull on the seed and soaking in water for 24 h helped in obtaining 76% germination with high seedling vigour index (2,945)

in the Chidiyatapu Biological Park, South Andaman for its ensured protection. Further, a number of research institutes have been collecting the germplasm from various regions of ANI and selected endemic species of crop wild relatives have been conserved at ICAR- National Bureau of Plant Genetic Resources, New Delhi, ICAR-Indian Institute of Spices Research, Kozhikode, ICAR-Indian Institute of Horticultural Research, Bengaluru, Jawaharlal Nehru Tropical Botanical Garden and Research Institute, Thiruvananthapuram etc. Domestication of useful species and promotion of their cultivation has been regarded as a viable means for conservation of valuable germplasm. Mango ginger (*Curcuma mangga*) is one of the potential crops identified for commercial scale cultivation in the islands and production technology has been standardized for the same.[17]

Characterization and Utilization

Characterization of the diversity helps in identification of desirable/ superior types for further conservation and utilization. Efforts have been initiated at authors' institute for analyzing the diversity amongst ecotypes of various species including *Piper*,[16] *Garcinia*,[14] *Curcuma mangga* and wild nutmegs on morphological and biochemical basis. Fatty acid profiling of wild nutmeg species and *Garcinia* species was also carried out to determine their potential uses and promising results were obtained. As a number of these species are being used for medicinal purpose, systematic studies on phytochemistry and further bio-prospection are required for validating the claims.[18] This could also help in development of new products and a part of the revenue could be diverted towards the development of these communities through benefit sharing mechanism. Recently, screening of some *Piper* collections of the islands against pathogenic bacteria has shown promising results.[16]

Piper ribesioides, a wild relative of cultivated black pepper, is found distributed in the forests of Andaman Islands. Stem pieces of this species are used as a spice to impart pungency and unique flavor to vegetarian and non-vegetarian cuisines by the settler communities. Studies have revealed its potential as a novel spice for cultivation as a commercial as well as backyard crop in the islands. Studies by author's team have revealed stem thickness based changes in the phytochemicals of this unique spice (unpublished). It has been conserved in the germplasm block of the author's institute and national identity (IC-0625887) has been obtained for a collection from Little Andaman Island. Phytochemical studies in *Curcuma mangga* have revealed it as alternate source of curcumin and essential oil, which have high industrial potential.[17] Inter and intra-specific diversity of *Garcinia* was evaluated for physico-chemical characters and species such as *G. kydia*, G. *dhanikhariensis*, *G. cowa*, *G. hombroniana*, *G. andamanica* and *G. dulcis* were found to possess promising traits for promotion as backyard or commercial crops in the islands.[14] In species with commercial potential, vegetative propagation should be standardized for which mother plants of desirable genotypes could be utilized. Molecular techniques would be useful for various purposes such as sex determination in dioecious species *viz*. *Garcinia*, *Myristica* and *Piper* species.[5,6,15]

Salinity, prolonged dry and wet spells are the major areas of research in the context of ANI. Considering the evolution of native species in these islands since time immemorial, these species can probably tolerate such stresses in much better way. Efforts are required to identify and evaluate species of wild nutmeg, wild pepper, wild cashew and *Garcinia* for identification of rootstocks for commercial species. These species could also be regarded as gene sources for future and hence detailed studies are envisaged. Polyembryony has been reported in *Myristica andamanica*,[19] which requires thorough studies. Sap of a number of plants such as *Alpinia manii, Amomum aculeatum* etc. are used as bee repellants by the aboriginals.[20] Systematic studies could be made to explore the possibility of using them for commercial bee keeping industry.

Conclusion

In a nutshell, the tropical islands of Andaman and Nicobar harbor large diversity of flora, which could be utilized for development of novel products and technologies for the betterment of human kind. Regeneration techniques through both sexual and asexual means should be standardized for subsequent utilization of these species. Characterization could help in finding their utility in crop improvement of commercial species. A number of species were found to have potential

for domestication and promotion as new crops. Nutritional and biochemical profiling could be helpful for identification of useful types. Biotechnological approaches could help in achieving these objectives in long run. However, conservation would be the key to protect this pristine diversity from natural and man-made vagaries.

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