

Collection of plant genetic resources from Andaman and Nicobar Islands

Z. Abraham · R. Senthilkumar · K. Joseph John ·
T. V. R. S. Sharma · N. V. Nair · M. Unnikrishnan ·
P. M. Kumaran · Johnson K. George ·
S. Uma · M. Latha · S. S. Malik · S. K. Mishra ·
D. C. Bhandari · S. K. Pareek

Received: 8 August 2007 / Accepted: 26 March 2008 / Published online: 26 April 2008
© Springer Science+Business Media B.V. 2008

Abstract The Andaman and Nicobar (A&N) group of islands is immensely rich in plant biodiversity. Andaman's native tribes are hunter-gatherers, sustaining on wild or marine food and practically do not have any cultivation. Diversity in cultivated crops is presently maintained in home gardens by settlers from the mainland and other adjoining countries. The National Bureau of Plant Genetic Resources (NBPGR) through explorations either alone or in association with CARI or with other ICAR institutes has collected 1234 accessions in 48 exploration and collection missions. Variability was collected in rice, cowpea, black gram, green gram, okra, Chinese spinach, ash gourd, taro,

cucumber, pumpkin, bottle gourd, ridge gourd, bitter gourd, chilli, greater yam and coconut. Indigenous landraces are absent. The *in situ* conservation of the wild relatives of crops is well taken care of by a large number of protected forest reserves.

Keywords Andaman · Collection · Crop plants · Exploration · Nicobar · Plant biodiversity · Wild relatives

Abbreviations

KAU Kerala Agricultural University
A&N Andaman and Nicobar

Z. Abraham (✉) · K. J. John · M. Latha
National Bureau of Plant Genetic Resources Regional
Station, Vellanikkara, KAU, Thrissur 680 656, Kerala,
India
e-mail: nbpgrtsr@gmail.com

R. Senthilkumar
Cardamom Research Centre, Indian Institute of Spices
Research, Appangala, Kodagu 571 201, Karnataka, India

T. V. R. S. Sharma
Central Agricultural Research Institute,
Port Blair 744 101, A&N Islands

N. V. Nair
Sugarcane Breeding Institute, Coimbatore 641 007,
Tamil Nadu, India

M. Unnikrishnan
Central Tuber Crops Research Institute, Sreekaryam,
Thiruvananthapuram 695 017, Kerala, India

P. M. Kumaran
Central Plantation Crops Research Institute,
Kasaragod 671 124, Kerala, India

J. K. George
Indian Institute of Spices Research, Marikkunnu,
Kozhikode 673 012, Kerala, India

S. Uma
National Research Centre for Banana, Thayanur,
Tiruchirappalli 620 102, Tamil Nadu, India

S. S. Malik · S. K. Mishra · D. C. Bhandari · S. K. Pareek
National Bureau of Plant Genetic Resources, Pusa
Campus, New Delhi 110 012, India

CARI	Central Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
NBPGR	National Bureau of Plant Genetic Resources
CPCRI	Central Plantation Crops Research Institute
NRC B	National Research Centre for Banana
CTCRI	Central Tuber Crops Research Institute
IISR	Indian Institute of Spices Research
SBI	Sugarcane Breeding Institute
PIU	Project Implementation Unit, NATP
NATP-PB	National Agricultural Technology Project on Plant Biodiversity

Introduction

The Andaman and Nicobar (A&N) group of islands has been designated as one of the 12 bio-geographical zones in India. Nearly 2,100 species of indigenous and exotic angiosperms have been reported from these islands, of which 11% are strictly endemic (Balakrishnan and Ellis 1996). The reserved and protected forests extend over 86% area of the territory and the forest cover is more than 92%. About 50% of the forests have been set aside as Tribal Reserves, National Parks and Wildlife Sanctuaries, which are inviolate. The A&N Archipelago consists of 572 islands located in the Bay of Bengal approximately 1,200 km from the mainland of India. The terrain of most of these islands is hilly with undulating small mountains. The coastline is highly indented and several creeks penetrate into these islands from on land bays. The coastal and inland forest vegetation is largely undisturbed throughout most of these islands. Climate of the Islands is that of warm humid tropics with temperature ranging from 23.2 to 30.7°C. The relative humidity ranges from 80 to 90%. These islands receive an average rainfall of about 3,000 mm, during both the southwest and northeast monsoons distributed from May to December. The diversity of plant forms in these islands had been documented from the British days (Parkinson 1923) and more recently by the Botanical Survey of India (Hajra et al. 1999; Hajra and Rao 1999). The representation of ecotypes and wild forms from these islands in the crop germplasm collections was inadequate or totally absent, with respect to important crops. In view of the same, these islands were explored by NBPGR along with several crop-based

research institutes in the country and collected valuable germplasm of crop plants, their wild relatives and other economic plants.

Exploration and collection

National Bureau of Plant Genetic Resources (NBPGR) has played an important role in collection and conservation of plant genetic resources from A&N Islands. The NBPGR through explorations either alone or in association with CARI or with other ICAR institutes had collected a sizeable number of accessions of various crops and their wild relatives from these islands. During the period from 1999 to 2007, a total of 1234 accessions has been assembled in 48 exploration and collection missions which included the trips made by the individual institutes and a special collaborative mission organized during March 2003 under the National Agricultural Technology Project on Plant Biodiversity (NATP-PB) as given in Table 1.

The above institutes surveyed the major islands including North Andaman, Middle Andaman, South Andaman, Car Nicobar, Katchal, Camorta and Nancowrie to collect germplasm from farmers' field and adjoining private areas. Variability collected in major crop groups is presented below.

Cereals and millets

A total of 231 accessions including 228 of rice (*Oryza sativa* L.), 2 of maize (*Zea mays* L.) and 1 of finger millet [*Eleusine coracana* (L.) Gaertn.] was collected. This included landraces of rice from mainland Indian, Burmese, Malaysian, Thailand and Chinese origins namely 'ameta', 'anamel', 'appeem', 'bhavani', 'bhurkhuch', 'black Burma', 'black jeera dhan', 'Burma dhan', 'Chinese dhan', 'gol Burma', 'Jaganath', 'jungle dhan', 'kapilee', 'kho-chu', 'khushbaya', 'lal swarna', 'murkhul', 'mushley', 'nama dhan', 'nona dhan', 'white Burma', 'jeera chamba' and 'Taichung Sen Yu'.

Pulses and their wild relatives

In all 64 accessions including 4 cultivated crops - red gram, horse gram, French bean and black gram, and their wild relatives belonging to the genus *Vigna* Savi. were collected (Table 2). *Vigna marina*, collected

Table 1

No.	Institutes	Seasons of collection	Major crops collected	No. of trips	No. of accessions
1 ^a	CTCRI, CPCRI, IISR, CARI, NBPGR & SBI	March	Coconut, taro, greater yam, <i>Dioscorea vexans</i> , betel leaf, long pepper, sugarcane and wild sugarcanes	1	106
2	CARI	January, February, March, September	Rice, chilli, cowpea, black gram, green gram, horse gram, nutmeg, betel leaf, wild relatives of mango, banana and ginger	13	331
3	NBPGR	February, March, April, May, August, November	Bael, purging nut, bitter gourd, small bitter gourd, sponge gourd, okra, brinjal, pumpkin, field bean, cucumber, bottle gourd, Chinese spinach, cowpea, <i>Solanum incanum</i> and wild relatives of mango	31	737
4	CPCRI	January	Coconut	1	30
5	NRCB	April, December	Banana and its wild relatives	2	30
Total				48	1234

^a Special collaborative mission

Table 2 Pulses & their wild relatives

Crop	Botanical name	No. of accessions
Red gram	<i>Cajanus cajan</i> (L.) Millsp.	3
Horse gram	<i>Macrotyloma uniflorum</i> (Lam.) Verdc.	3
French bean	<i>Phaseolus vulgaris</i> L.	1
Ranmug	<i>Vigna dalzelliana</i> (O. Kztc) Verdc.	1
Beach pea, Dune-bean	<i>Vigna marina</i> (Burm.) Merr.	2
Black gram	<i>Vigna mungo</i> (L.) Hepper	10
Jhikrai	<i>Vigna pilosa</i> (Roxb.) Baker	3
Green gram	<i>Vigna radiata</i> (L.) R. Wilczek	8
Mungan, Mugun	<i>Vigna trilobata</i> (L.) Verdc.	1
Ricebean	<i>Vigna umbellata</i> (Thunb.) Ohwi et H Ohashi	1
Cowpea	<i>Vigna unguiculata</i> (L.) Walp.	31

from Nicobar Islands, is a species highly tolerant to salt and show rhizobial symbiosis.

Vegetables and their wild relatives

A total of 185 accessions including cultivated tomato, pumpkin, bottle gourd, Chinese spinach, cucumber, sponge gourd, field bean, ash gourd, Malabar spinach, brinjal, bitter gourd, jack bean, livid amaranth, ivy gourd, okra, ridge gourd, snake gourd, bonnet pepper, melon, teasel gourd, agathi, breadfruit, Indian sorrel, drumstick, spleen amaranth and winged bean, and their wild relatives was collected from both A&N group of islands. The wild/weedy species belonged to

the genera *Solanum* L., *Momordica* L., *Cucumis* L., *Amaranthus* L., *Trichosanthes* L., *Artocarpus* Forst., *Spondias* L., *Abelmoschus* Medik. and *Canavalia* DC. (Table 3).

Accessions IC539833 and IC539855 of spleen amaranth, from Malacca Island in Nicobar were distinct for pigmentation and growth form, when compared to the mainland types. Accessions IC541382, IC541417 and IC541445 of livid amaranth, collected from Andaman Islands were robust with magenta red leaves. Chinese spinach accessions were green, but robust. Sweet gourd found rare in Andamans, had larger fruits (up to 700 g/fruit) and is a potential vegetable, tender fruits of which, gathered

Table 3 Vegetables and their wild relatives

Crop	Botanical name	No. of accessions
Okra	<i>Abelmoschus esculentus</i> (L.) Moench	6
Ranbhendi	<i>Abelmoschus manihot</i> (L.) Medik.	1
Livid amaranth	<i>Amaranthus blitum</i> L.	3
Spleen amaranth	<i>Amaranthus dubius</i> C. Mart. ex Thell.	4
Chinese spinach	<i>Amaranthus tricolor</i> L.	22
Pig-weed	<i>Amaranthus viridis</i> L.	2
Breadfruit	<i>Artocarpus altilis</i> (Parkinson) Fosberg	1
Malabar spinach	<i>Basella alba</i> L.	8
Ash gourd	<i>Benincasa hispida</i> (Thunb.) Cogn.	8
..	<i>Canavalia cathartica</i> Thouars	1
Jack bean	<i>Canavalia ensiformis</i> (L.) DC.	1
Ivy gourd	<i>Coccinia grandis</i> (L.) J. Voigt	1
..	<i>Cucumis callosus</i> (Royle) Cogn.	3
Weedy melon	<i>Cucumis melo</i> L. ssp. <i>agrestis</i> (Naudin) Pangalo	1
Melon	<i>Cucumis melo</i> L. ssp. <i>melo</i>	2
Cucumber	<i>Cucumis sativus</i> L.	9
Pumpkin	<i>Cucurbita moschata</i> (Duchesne ex Lam.) Duchesne ex Poir.	12
Indian sorrel	<i>Hibiscus sabdariffa</i> L.	1
Water-spinach	<i>Ipomoea aquatica</i> Forssk.	2
Field bean	<i>Lablab purpureus</i> (L.) Sw.	9
Bottle gourd	<i>Lagenaria siceraria</i> (Molina) Standley	10
Ridge gourd	<i>Luffa acutangula</i> (L.) Roxb.	6
Sponge gourd	<i>Luffa aegyptiaca</i> Mill.	9
Tomato	<i>Lycopersicon esculentum</i> Mill.	14
Bitter gourd	<i>Momordica charantia</i> L.	7
Small bitter gourd	<i>Momordica charantia</i> L. var. <i>muricata</i> (Willd.) Chakrav.	5
Sweet gourd	<i>Momordica cochinchinensis</i> (Lour.) Spreng.	3
Teasel gourd	<i>Momordica subangulata</i> Bl. ssp. <i>renigera</i> (G. Don) de Wilde	1
Drumstick	<i>Moringa oleifera</i> Lam.	2
Winged bean	<i>Psophocarpus tetragonolobus</i> (L.) DC.	4
Agathi	<i>Sesbania grandiflora</i> (L.) Pers.	1
Poison-berry	<i>Solanum anguivi</i> Lam.	3
Bitter-apple	<i>Solanum incanum</i> L.	4
Brinjal	<i>Solanum melongena</i> L.	8
Black nightshade	<i>Solanum nigrum</i> L.	2
Devil's fig	<i>Solanum torvum</i> Sw.	1
Tropical soda-apple	<i>Solanum viarum</i> Dunal	1
Amada	<i>Spondias dulcis</i> Sol. ex Parkinson	1
Snake gourd	<i>Trichosanthes anguina</i> L.	4
Indrayal	<i>Trichosanthes tricuspidata</i> Lour.	2

from the wild are sold in the market. Cultivated forms of small bitter gourd, *Momordica charantia* var. *muricata* was collected from Andaman Islands. Their

fruits, which are small, dark green and highly bitter, esteemed for flavour were found sold at a premium prize in the market. *Cucumis callosus*, a wild relative

of melon was collected. It resembles melon morphologically. Among perennial vegetables, variability for fruit size, colour and bearing season was observed in drumstick. The breadfruit which was found growing in many of the areas in Car Nicobar was introduced from Kerala and the Nicobari people use the fruits and relish them. Visit to the market places indicated that under-utilised vegetables like jack bean, winged bean, Malabar spinach and *parsag* (*Corchorus capsularis*) are cultivated for own consumption and surplus sold in the market.

Spices and their wild relatives

A total of 54 accessions including green chilli, giant ginger, *Garcinia cowa*, turmeric, bird chilli, nutmeg, *Vanilla andamanica*, mango ginger, *Zanthoxylum rhetsa*, ginger, *Zingiber spectabilis*, *Z. odoriferum*, zedoary, *Curcuma manga* var. *rubrinervia*, coriander, *Garcinia dhanikariensis*, *G. speciosa*, black pepper, *Piper sarmentosum*, curry leaf and *Knema andamanica* were collected (Table 4).

In green chilli, a unique accession (IC541402) with no pungency named ‘*inippumilagai*’ and a highly pungent type (IC541403) named ‘*Hindustan lavang*’ were collected. Species of *Myristica* L. have wider distribution followed by *Garcinia* L. and *Piper* L.. Both *Myristica* and *Garcinia* were found to occur in evergreen to semi-evergreen forests in slightly higher moist situations. In *Myristica*, diversity in fruit, seed and mace characters were observed. In the case of *Vanilla* Sw., the only rare and endangered species endemic to the islands, *V. andamanica* with large fragrant flowers, greenish white sepal, purple labellum having white patches, had isolated occurrence in rare pockets. This species thrives better in slightly higher elevations in Mount Harriet. A very bold type of cultivated ginger (IC405668) with comparatively less fibre content was collected. This collection retained its boldness in *ex situ* condition also in the mainland. Giant ginger from Munak, which was 2.5–3 m tall, with long pinnately compound radicle leaves, each pinna having a length of 1.0 m and breadth of 10–12 cm. The rhizomes were similar to that of ginger, but less pungent. The rhizome of this was reported as being used by the Onge tribes in Andamans to tranquillise honeybees while collecting honey. They chewed and spat juice on the hives, to ward off the bees.

Table 4 Spices and their wild relatives

Crop	Botanical name	No. of accessions
Chilli	<i>Capsicum annum</i> L.	9
Bonnet pepper	<i>Capsicum chinense</i> Jacq.	2
Bird-chilli	<i>Capsicum frutescens</i> L.	3
Coriander	<i>Coriandrum sativum</i> L.	1
Mango-ginger	<i>Curcuma amada</i> Roxb.	3
Turmeric	<i>Curcuma longa</i> L.	4
..	<i>Curcuma manga</i> Val. var. <i>rubrinervia</i> Val.	1
Zedoary	<i>Curcuma zedoaria</i> (Christm.) Roscoe	1
Cowa	<i>Garcinia cowa</i> Roxb.	4
..	<i>Garcinia dhanikariensis</i> S.K.Srivastava	1
..	<i>Garcinia speciosa</i> Wall.	1
Giant ginger	<i>Hornstedtia fenlzii</i> (Kurz) K. Schum	5
..	<i>Knema andamanica</i> (Warb.) de Wilde	1
Curry-leaf	<i>Murraya koenigii</i> (L.) Spreng	1
Nutmeg	<i>Myristica fragrans</i> Houtt.	3
Black pepper	<i>Piper nigrum</i> L.	1
..	<i>Piper sarmentosum</i> Roxb.	1
..	<i>Vanilla andamanica</i> Rolfe	3
Atitejani	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	3
..	<i>Zanthoxylum ovalifolium</i> Wight	1
..	<i>Zingiber odoriferum</i> Bl.	1
Ginger	<i>Zingiber officinale</i> Roscoe	2
..	<i>Zingiber spectabilis</i> Griff.	1

Tubers and their wild relatives

A total of 44 accessions of tuber crops and their wild relatives were collected (Table 5).

There was significant presence of *Dioscorea vexans* in the vicinity of Port Blair, growing wild. *D. vexans* is an endemic species with large number of fibrous roots and scanty tubers. It showed excellent growth characteristics, with profuse flowering and seed set. Capsules were collected and subsequently seedlings could be raised from them. Towards the Chidiya Tapu area, plants of *Ipomoea aquatica* were growing in marshy patches along the coast. These

Table 5 Tubers and their wild relatives

Crop	Botanical name	No. of accessions
..	<i>Amorphophallus onchophyllus</i> Prain ex Hk.f.	1
Elephant foot yam	<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson var. <i>campanulatus</i> (Decne.) Sivad.	1
..	<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson var. <i>paeoniifolius</i>	1
..	<i>Amorphophallus rex</i> Prain ex Hk.f.	1
Taro	<i>Colocasia esculenta</i> (L.) Schott	6
Greater yam	<i>Dioscorea alata</i> L.	11
Air-potato	<i>Dioscorea bulbifera</i> L.	2
Lesser yam	<i>Dioscorea esculenta</i> (Lour.) Burkill	1
..	<i>Dioscorea glabra</i> Roxb.	2
..	<i>Dioscorea oppositifolia</i> L.	1
Bhusa, Kanta alu	<i>Dioscorea pentaphylla</i> L.	2
..	<i>Dioscorea vexans</i> Prain et Burkill	9
Sweet-potato	<i>Ipomoea batatas</i> (L.) Lam.	3
Fiji arrow-root	<i>Tacca leontopetaloides</i> (L.) Kuntze	2
Blue taro	<i>Xanthosoma violaceum</i> Schott	1

were short forms with narrow leaves and blue flowers, as against white flowers normally found. Cocoyam (*Xanthosoma sagittifolium*) was found growing wild in the South Andaman, particularly in areas close to Port Blair. Yams and aroids were seen rarely. Purple petiole coloured wild accession of *Colocasia esculenta* was collected from the marshy area near the rice fields in Jolly Buoy Island. Nicobari Alu (*Tacca leontopetaloides*) is another tuber crop often cultivated by the Shompen tribals. This was available only in Great Nicobar. In the Perkha village, sweet potato is grown under partial shade on the fringes of coconut groves. Similarly, cassava was also found in homestead gardens. Sweet potato, taro, blue taro, various species of *Dioscorea* L. and *Alocasia* Neck are grown and used by them traditionally. Cassava as a crop had been introduced to Car Nicobar from Kerala recently. Some varieties of tuber crops might have come from Minicoy Islands (Lakshadweep) in Arabian Sea because some of the Nicobaris had migrated from these islands also. The yam cultivars, greater yam and lesser yam, had distinct shape and are expected to be valuable since they are clones evolved through geographical isolation from the mainland, selected and established for endemic specificity. In lesser yam, female clones were reported only from Andaman & Nicobar Islands

by the Botanical Survey of India (BSI). Hence, the present collection in this species (only male clones available presently in mainland) would help in the genetic improvement of this crop.

Banana and its wild relatives

These islands in general have good variability with respect to commercial banana clones. Visits to the forests of south Andaman revealed the presence of unique forms of wild *Musa acuminata* Colla and *M. balbisiana* Colla, whose subspecies status requires to be ascertained through further characterisation. *M. balbisiana*, *M. balbisiana* var. *andamanica* Singh, Sreekumar, Sharma & Bandhyopadhyaya, *M. acuminata* and *M. textilis* Nee are reported from South, Middle and North Andaman and Nicobar group of islands, both with and without seeds (Singh 2006). *Musa acuminata* has been the major species under the genus *Musa* L., seen on larger areas where currently deforestation is going on at an alarming rate. A total of 38 accessions including 8 of *Musa acuminata*, 21 of *M. balbisiana*, 9 of *Musa* hybrids including a distinct cultivated clone of Nicobari origin with AAB genome and an unique accession of *M. balbisiana* var. *andamanica* was collected.

Other fruits and their wild relatives

Wide variability was observed in fruit crops like “bael” (*Aegle marmelos*), pummelo (*Citrus grandis*), acid lime (*Citrus aurantiifolia*) and “jamun” (*Syzygium cumini*). In all 81 accessions was collected (Table 6).

Variability in fruit shape and flesh colour was observed in pummelo. A unique accession in pummelo, with fresh fruit weight of 2–3 kg, egg shaped with 1–2 seeds per segment, was collected from Belapur village of Andaman Islands. A wild relative of sapota, *Manilkara hexandra* with smaller fruits, taste of sapota, a very big tree spotted near the sea shore may be useful as salt tolerant root stock for sapota. Nicobari mangosteen (*Garcinia hombroniana*), fruits of which are eaten by Nicobaris is considered to be a progenitor of cultivated mangosteen. There is good scope for selection of large fruited *bael* adapted to high rainfall tropical climate as at present, *bael* is cultivated in the arid central and north-western India and those planted in temple premises, in the west coastal and ghats region of mainland are small fruited, shy bearing with large canopy, retained for their medicinal and religious significance. Heavy bearing tamarind trees with long fruits and high pulp content were spotted and collected from two places in North Andamans. The giant pandanus (*Pandanus leram* var. *andamanensis*, IC405588) with branches, height of 8–10 m and edible fruits was located in the interior of littoral forest of Rutland Island.

Coconut and other plantation crops

A total of 47 accessions, including 41 of coconut (*Cocos nucifera* L.), 2 of arecanut (*Areca catechu* L.) and 1 each of other plantation crops like cashew (*Anacardium occidentale* L.), palmyra palm (*Borassus flabellifer* L.) and Australian pine (*Casuarina equisetifolia* L.), and the wild *Areca triandra* Roxb. was collected. In respect of coconut wide variability was observed. Both vegetative and floral characters of the mother palms were recorded and seed nuts were collected from these. Palms were without bole, slight bole to boled. The crown shape varied from semi-circular to circular. The shape of fruits varied from round, oval, oblong with pointed base and oblong. The range of variation noticed for nut characters including

colour, shape and size was remarkable. Most of the palms were tall, had yellowish brown nuts. Other nut colours observed were green, brown, yellow, greenish-yellow, light brown, greenish-brown and orange. The size of nuts ranged from small, medium to large. The tender nut water was sweet in accessions Carbin Brown Tall (IC425776), Burmanella Green Tall (IC425779) and Kodiaghat Brown Tall (IC425783). Tender nut water was more in accessions Burmanella Green Tall (IC425779), Harminder Bay Tall (IC425787), Harminder Bay Giant (IC425790) and Panighat Giant (IC405691). Accessions with thick husk were observed in Panighat Green Tall (IC405683), Chunnabatta Brown Tall (IC405687), Kurmadera Brown Tall (IC405690) and with thin husk in Pokkadera Brown Tall (IC405684 and IC371798). Pokkadera Brown Tall (IC405684) and Panighat Giant (IC405691) had more copra content. Unique accessions were Nicobar Orange (IC425795) which was dwarf with semi-circular crown and orange fruits; Erthinabad Tall (IC425778) which had slight bole, sweet tender nut water and good meat, brown coloured, oblong fruits; and Malaca Giant (IC425797) with large green fruits. In other plantation crops, very limited variability was seen.

Sugarcane and its wild relatives

In the South Andaman, only cultivated forms of sugarcane (*Saccharum officinarum* L.) were present, which are possibly early introductions from the mainland by the settlers. Parkinson (1923) reported the presence of *Erianthus bengalense* (Retz.) C. E. Hubb. et R. E. Vaughan ex R. R. Stewart in the Haddo area in Port Blair. Haddo is now part of the capital city and this species is now nowhere traceable. Areas around Port Blair, Chidiya Tapu, Mount Harriet, Tirur and Wandoor were surveyed. But none of the wild species of *Saccharum* or related genera were present here. *Erianthus arundinaceus* (Retz.) Jesw. was present deep inside the forest close to Phoolthala along the banks of a fresh water stream, locally known as Ganna Nalla by the settlers from Bengal. These were tall and thick clones reaching over 4 m in height. Beyond Phoolthala no *Erianthus* or *Saccharum* could be located up to Rangath. Beyond Rangath, an isolated colony of *Erianthus arundinaceus* was located close to Betapur. This colony was found growing among *Calamus* sp. and

Table 6 Other fruits and their wild relatives

Crop	Botanical name	No. of accessions
Bael	<i>Aegle marmelos</i> (L.) Correa	7
..	<i>Aporusa villosa</i> (Lindl.) Baill	1
Chaplash	<i>Artocarpus chama</i> Buch.-Ham	1
..	<i>Artocarpus gomezianus</i> Wall. ex Trecul ssp. <i>zeylanicus</i> Jarrett	2
Bilimbi	<i>Averrhoa bilimbi</i> L.	1
Burmese-grape	<i>Baccaurea ramiflora</i> Lour.	3
Papaya	<i>Carica papaya</i> L.	1
Acid-lime	<i>Citrus aurantiifolia</i> (Christm.) Swingle	4
Pummelo	<i>Citrus grandis</i> Osbeck	7
Lemon	<i>Citrus limon</i> (L.) Burm. f.	1
Velvet-apple	<i>Diospyros blancoi</i> A. DC.	1
Mountain persimmon	<i>Diospyros montana</i> Roxb.	1
..	<i>Diospyros pyrrocarpa</i> Miq.	1
..	<i>Elaeagnus conferta</i> Roxb.	1
..	<i>Elaeocarpus macrocerus</i> (Turcz.) Merr.	1
Wood apple	<i>Feronia limonia</i> (L.) Swingle	1
Seashore mangosteen	<i>Garcinia hombroniana</i> Pierre	2
Mangosteen	<i>Garcinia mangostana</i> L.	3
Ban-am	<i>Mangifera andamanica</i> King	5
Ban-am	<i>Mangifera camptosperma</i> Pierre	3
Ban-am	<i>Mangifera griffithii</i> Hk.f.	2
Mango	<i>Mangifera indica</i> L.	4
Ban-am	<i>Mangifera sylvatica</i> Roxb.	1
Khirmi	<i>Manilkara hexandra</i> (Roxb.) Dubard	1
Bakul	<i>Mimusops elengi</i> L.	1
Rambutan	<i>Nephelium lappaceum</i> L.	2
Keora	<i>Pandanus leram</i> Jones ex Fontana var. <i>andamanensium</i> (Kurz) B.C.Stone	1
Screw-pine	<i>Pandanus tectorius</i> Soland. ex Parkinson	1
Passionfruit	<i>Passiflora edulis</i> Sims	3
Indian gooseberry	<i>Phyllanthus emblica</i> L.	1
Pomegranate	<i>Punica granatum</i> L.	1
Watery rose-apple	<i>Syzygium aqueum</i> (Burm.f.) Alston	1
Jamun	<i>Syzygium cumini</i> (L.) Skeels	3
Jawa apple	<i>Syzygium samarangense</i> (Bl.) Merr. et Perry	4
Indian almond	<i>Terminalia catappa</i> L.	4
Jojoba	<i>Ziziphus jujuba</i> Lam.	1
Ber	<i>Ziziphus mauritiana</i> Lam.	2
Jackal-jujube	<i>Ziziphus oenoplia</i> (L.) Mill.	1

other forest vegetation along the banks of a stream at CFO Nalla. The wild sugarcane (*S. spontaneum* L.) had been reported from the Mus area in Car-Nicobar (Kurz 1876). Scientists of the Botanical Survey of

India, Port Blair also recorded this species from the elevated places closer to seashore in Mus in 1976. Now the species has almost disappeared from the area following the construction of the Mus Jetty. *S.*

spontaneum was also absent in the forest areas in the island. A single colony of *S. spontaneum* was located in the IAF airfield, which also was about to be cleared for the construction of the helipad. *S. spontaneum* could not be located in Katchal and Camorta islands. In view of the reports of the presence of vast grasslands in some of the northern group of Nicobar Islands like Teresa, Nancowry and Katchal (Nair 1979) exploration of these islands has to be seriously considered for the collection of *S. spontaneum*. Cogon-grass (*Imperata cylindrica* (L.) Raeusch.) was abundantly distributed in the island. In general, the distribution of *Saccharum* and related grasses in the islands was poor. Nine accessions including 4 of *Erianthus arundinaceus*, 3 of *Imperata cylindrica* and 1 each of *Saccharum spontaneum* and sugarcane (*S. officinarum*) were collected. They represent new geographical variability, hitherto not represented in the *Saccharum* germplasm collections (Nair and Senthil Kumar 2006).

Medicinal and aromatic plants

Variability within a species was limited in these plants. Seventy-four accessions including six of sacred basil (*Ocimum tenuiflorum* L.), 5 of crab's eye (*Abrus precatorius* L.), 4 each of gray-nicker [*Caesalpinia bonduc* (L.) Roxb.] and periwinkle [*Catharanthus roseus* (L.) G. Don], 3 each of butter-fly pea (*Clitoria ternatea* L.), spiral ginger [*Costus speciosus* (Koen.) Sm.], glory-lily (*Gloriosa superba* L.), cowitch [*Mucuna pruriens* (L.) DC.] and gulancha [*Tinospora cordifolia* (Willd.) Hk.f. & Thom.], 2 each of keli-kadam [*Adena cordifolia* (Bl.) Engl.], creat [*Andrographis paniculata* (Burm.f.) Wall. ex Nees], fever-nut (*Caesalpinia crista* L.), poison-bulb (*Crinum asiaticum* L.), ban-nimbu [*Glycosmis mauritiana* (Lam.) Tanaka], khatavangi (*Mucuna monosperma* DC. ex Wt.), field mint (*Mentha arvensis* L.) and *Nervilia aragoana* Gaud. and 1 each of sweet-flag (*Acorus calamus* L.), Indian penny-wort [*Centella asiatica* (L.) Urb.], thorn-apple (*Datura metel* L.), bringraj [*Eclipta prostrata* (L.) L.], sweet basil (*Ocimum basilicum* L.), false ashok [*Polyalthia longifolia* (Sonner.) Thw.], *Strychnos andamensis* A.W.Hill, *Tinospora glabra* (Burm.f.) Merr., Indian ipecacuanha [*Tylophora indica* (Burm.f.) Merr.] and vetiver [*Vetiveria zizanioides* (L.) Nash] were collected. Among the two

commonly occurring wild species of *Piper*, 12 accessions of betel-vine (*P. betle* L.) and 2 of long-pepper (*P. longum* L.) were collected. Locals chew the wild betel-leaf like the people of the mainland.

Ornamentals

Orchid wealth of these islands is remarkable. Among them, 2 accessions of *Dendrolobium umbellatum* (L.) Benth. and 1 each of *Dendrobium secundum* (Bl.) Lindl., *D.indragiriense* Schltr., *D. formosum* Roxb., *Eria bractescens* Lindl., Mankand (*Eulophia nuda* Lindl.), *Luisia zeylanica* Lindl. and *Papilionanthe teres* (Roxb.) Schltr. were collected. In the case of other wild ornamentals, one accession each of *Gardenia tubifera* Wall., *Sterculia parviflora* Roxb., Burmese fish-tail palm (*Caryota mitis* Lour.) and yellow champak (*Michelia champaca* L.) were collected.

Oilseeds

A total of 31 accessions of oilseeds mostly tree-borne were collected including 16 of purging nut (*Jatropha curcas* L.), seven of pongam [*Pongamia pinnata* (L.) Pierre], 3 of neem (*Azadirachta indica* A. Juss.), two each of castor (*Ricinus communis* L.) and sesame (*Sesamum indicum* L.), and 1 of groundnut (*Arachis hypogaea* L.).

Other economically useful plants

Ten accessions of other economically useful plants with fibre or green manure value were collected. They were 4 of white jute (*Corchorus capsularis* L.), 2 of tree cotton (*Gossypium arboreum* L.), and 1 each of Jew's mallow (*Corchorus olitorius* L.), cotton (*Gossypium herbaceum* L.), white mulberry (*Morus alba* L.) and sesban [*Sesbania sesban* (L.) Merr.].

Discussion

Major crops collected during these missions are coconut, banana, taro, greater yam, betel leaf, long pepper, sugarcane, rice, chilli, cowpea, black gram, green gram, horse gram, nutmeg, betel leaf, bitter gourd, ash gourd, snake gourd, small bitter gourd, sponge gourd, okra, brinjal, pumpkin, field bean,

winged bean, cucumber, bottle gourd, ginger, Indian jujube, passion fruit, Java apple and Chinese spinach. Among the wild relatives of crop plants collected, *Dioscorea vexans*, *Solanum incanum*, *Trichosanthes tricuspidata*, *Vanilla anadamanica*, *Vigna marina*, *V. pilosa*, wild relatives of mango (*Mangifera andamanica*, *M. camptosperma*, *M. griffithii*), banana (*Musa acuminata*, *M. balbisiana* and *M. balbisiana* var. *andamanica*) ginger (*Zingiber spectabile*, *Z. odoriferum*) and sugarcane (*Erianthus arundinaceus*, *Saccharum spontaneum*) are important. North Andaman, Middle Andaman, South Andaman and Little Andaman, Car-Nicobar, Battimal, Chowra, Tillanchong, Teresa, Camorta, Katchal, Nancowrie, Trinket, Little Nicobar and Great Nicobar were covered in these missions. All these places are inhabited with little or no agriculture. The un-inhabited islands were not covered. As indigenous landraces are absent, there is not much scope for collection of variability in seed bearing field crops. Limited variability in tuber crops and plantation crops exist which are partly taken care of by CARI. Attention needs to be focussed on collection of tropical fruits like rambutan, longan, durian and mangosteen which are native of Malayan Archipelago, in which we do not have good representation in the mainland. Similarly, concerted efforts are to be made for the collection of wild relatives belonging to the genera *Mangifera*, *Garcinia*, *Nephelium*, *Citrus* and *Syzygium* which may serve as rootstocks and as materials for crop improvement. The *in situ* conservation of the wild relatives of crops is well taken care of. The Andaman & Nicobar group of islands have a very recent agricultural history. Andaman's native tribes are hunter-gatherers, sustaining on wild boar, marine food and practically do not have cultivation. The Nicobar tribes cultivate coconut, banana and tuber crops. Even though the natural biodiversity of these islands is rich, agro-biodiversity is limited. The reason being limited agro-ecosystem variation, very recent agricultural history dating back after the second settlement in 1858 and non-agrarian life style of tribals. The present variability in cultivated crops except coconut is mainly introductions from mainland brought by settlers and to a small extent through migrants and travellers from Myanmar and Indonesian islands. Diversity in cultivated crops is presently maintained in home gardens by settlers from Tamil Nadu, Kerala, Jharkhand (especially Ranchi), Andhra

Pradesh and Tamil refugees from Sri Lanka and Bengali refugees from Bangladesh (erstwhile East Pakistan). The horticulture crops being cultivated in the Islands, apart from coconut includes fruits, vegetables, spices, flowers, arecanut, cashew nut and oil palm. A wide range of indigenous wild medicinal and aromatic plants is found in the A&N Islands. The productivity of most of the horticultural crops is low, mainly due to inadequate awareness of hi-tech interventions and primitive methods of cultivation being practiced by the local population. Paddy, the main food crop, is mostly cultivated during *kharif* in Andaman group of islands, whereas coconut and arecanut are the cash crops of Nicobar group of islands. Pulses, oilseeds and vegetables are grown, followed by paddy during *rabi* season. Different kinds of fruits such as mango, sapota, orange, banana, papaya, pineapple and root crops are grown on hilly land owned by farmers. Spices, viz., black pepper, clove, nutmeg and cinnamon are grown under multi-tier cropping system. Rubber, red oil palm and cashew are grown on a limited scale. Most of the rice cultivars are either extant varieties brought by settlers from mainland or improved varieties popularised by CARI and the Department of Agriculture (Government of A&N Islands) and are not landraces (Srivastava et al. 2000). Tuberous vegetables like cassava, greater yam, taro and cocoyam are cultivated in home gardens in Nicobar by the tribals. The Bengali settlers in Diglipur (North Andaman) cultivate a variety of vegetable crops for commercial supply. They seldom keep seeds for crop raising and depend on improved seeds supplied by private seed companies from Kolkatta. Chinese spinach (*Amaranthus tricolor*), Uchie (*Momordica charantia* var. *muricata*) and field bean (*Lablab purpureus* var. *purpureus*) are the exceptions. The A&N Islands are rich in species diversity, but the genetic variability in cultivated crops is limited. As these island ecosystems are very fragile, further agricultural development of these islands needs to be approached with caution. A better option may be the conversion of the presently non-profitable arable land to orchards of rambutan, mangosteen, durian, pickling mango and longan which in addition to bringing in additional remuneration will also serve ecosystem functions. For achieving this, accessions of these exotic crops are to be introduced from adjoining Thailand, Malaysia and Indonesia after proper quarantine.

There is need to assess the impact of tsunami that swept these islands on 24 December 2004 on agricultural biodiversity as some landraces/clones would have been lost and some new genotypes of existing/new crops would have been brought to these islands from the centre of origin of this tsunami.

Acknowledgements The financial support received for this study, which was carried out under the NATP-PB, implemented by PIU, NATP, ICAR, New Delhi is acknowledged. The authors are thankful to Dr. S. K. Sharma (Director, NBPGR), Dr. B. S. Dhillon (Mission Leader, NATP-PB and former Director, NBPGR) and Dr. Mahendra Singh (former Head, Germplasm Evaluation Division, NBPGR), for extending the facilities to execute the exploration and collection missions to these islands. The authors also express their sincere gratitude to Shri M. A. Suryanarayana (Senior Scientist & CCPI, CARI) and to the two research associates of the NATP-PB Project at this station, Dr. Lakshmi Narayanan and Shri Cherian Varghese for their valuable assistance.

References

- Balakrishnan NP, Ellis JL (1996) Andaman and Nicobar Islands. In: Hajra PK, Sharma BD, Sanjappa M, Sastry ARK (eds), Flora of India: introductory. Volume. Part 1. Botanical Survey of India, Calcutta, pp 523–538
- Hajra PK, Rao PSN (1999) Flora of Great Nicobar Island. Botanical Survey of India, Calcutta, p 525
- Hajra PK, Rao PSN, Mudgal V (1999) Flora of Andaman-Nicobar Islands, vol I. Botanical Survey of India, Calcutta, p 487
- Kurz S (1876) A sketch of the vegetation of the Nicobar Islands. J Asiat Soc Bengal 45(3):105–164
- Nair NG (1979) A study on the grasslands of Car Nicobar Island. Indian J For 2:254–260
- Nair NV, Senthil Kumar R (2006) *Saccharum* germplasm collection in the Andaman-Nicobar Islands, India. Plant Genet Resour Newsl 146:28–32
- Parkinson CE (1923) A forest flora of the Andaman Islands. Government Central Press, Simla, India, p 325
- Singh DB (2006) Genetic diversity in banana. Indian Hortic 51(5):cover 2&3
- Srivastava U, Malik SS, Dhillon BS (2000) Plant diversity of Andaman & Nicobar group of islands and their role in eco-development of the region. Indian J Plant Genet Resour 13(2):109–115

Balakrishnan NP, Ellis JL (1996) Andaman and Nicobar Islands. In: Hajra PK, Sharma BD, Sanjappa M, Sastry