

Logistics Planning for Plant Genetic Resources Collecting from Nicobar Islands of India

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The Nicobar group of Islands forming a part of Sundaland biodiversity hotspot were explored for plant genetic resources during three consecutive years, 2017, 2018 and 2019. Out of the total 22 Islands in Nicobar district 12 are inhabited. Considering the remoteness, communication and transport problems, hurdles in getting clearance from forest and tribal welfare departments, impenetrable forest, unpredictable sea voyage conditions, unavailability of camping sites, scare of dangerous reptiles and many such issues, these explorations were really challenging. Also, equally rewarding as over 370 germplasm collections belonging to 180 species of mostly crop wild relatives including several endemics (not available in the genebanks in mainland) could be collected and conserved in the Long Term Storage/established in the Field Gene Banks. The planning and implementation of exploration missions to Nicobar was an entirely different experience for us than that followed in mainland. Hence, various aspects of logistics while undertaking an exploration in Nicobar Islands is dealt in detail in this narrative in order to serve as a guide to future explorers. Based on observations and experience gained during these trips spanning over 48 working days, future strategies for conservation and utilization are also briefly outlined.

Key Words: Agrobiodiversity, Andaman & Nicobar, Crop wild relatives, Germplasm, Sundaland biodiversity hotspot

Introduction

The Nicobar group of Islands of India is endowed with rich plant diversity and endemism; however, less studied and least explored by plant genetic resources (PGR) collectors mainly due to its remoteness causing difficulties in access. It is a part of Sundaland biodiversity hotspot in continuation with Sumatra (Indonesia). During the summer seasons of 2017, 2018 and 2019, the ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi in collaboration with ICAR-Central Island Agriculture Research Institute (ICAR-CIARI), Port Blair and ICAR-Indian Institute of Spices Research (ICAR-IISR), Kozhikode undertook explorations to these islands (Fig. 1) stretching over 48 working days. This narrative deals with various aspects of PGR exploration and collection in the Nicobar Islands, as experienced by the authors, with emphasis on logistics and future plan of action, serving as a guideline for future explorers to the region.

The Nicobar division/district comprised of 22 islands with a total land area of 1841 Km². The Ten Degree Channel separates Andaman group of islands from Nicobar group and plays a major role in the geographical isolation of the flora. The Great Nicobar Biosphere Reserve (GNBR) including Little Nicobar and Kondul, the Nancowry group of islands (Bampuka, Champin, Chowra, Hithui, Kamorta, Katchal, Nancowrie, Teresa, Tillangchong and Trinket) and Car Nicobar are the three major divisions in Nicobar. The Nicobar group of islands is reported as peaks of a submarine mountain range standing above sea level extending from ArakanYoma ranges in Myanmar (continuity of Mizoram-Nagaland hill ranges) to Mettawai Island in Sumatra. Mount Thullier near Campbell Bay of about 670m is the highest peak in Nicobar. Five perennial rivers, namely, Galathea, Dogmar, Amrit Kaur, Jubilee and Alexandra with their tributaries constitute the drainage system in Great Nicobar, while other islands

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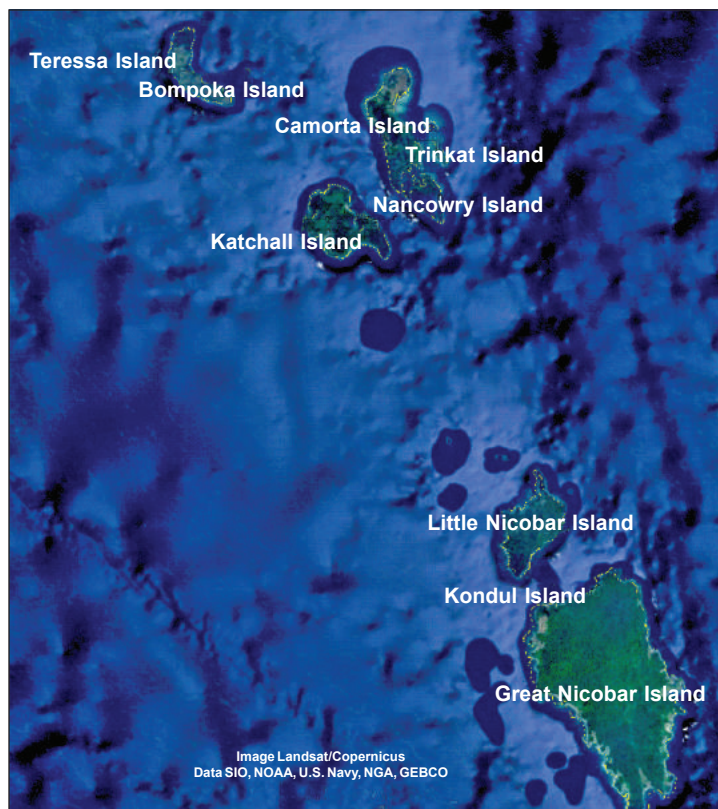


Fig. 1. Location map of explored islands in Nicobar

in Nicobar do not have major rivers except streams and forest *nallahs*. Car Nicobar is mostly plain land, while all other islands have rugged terrain. Car Nicobar has the highest density of population (140/km²).

Historical Perspective

The first definite reference to the Nicobar Islands is found in great Tanjore Inscription of Chola kings (around 1050 CE), who with their strong navy had contacts with these islands have described them in the inscription as '*Nakkavaram*' which means the land of naked people (GOI, 1908). In the 16th century, these islands attracted attention of Christian missionaries. In 1750, the Danish took possession of these islands and established their headquarters in Kamorta Island. In 1869, after negotiations with the Danish government, the British took possession of the islands.

The British made the Nicobar Islands a part of A&N Islands under Chief Commissioner of A&N Islands, Port Blair, and a government agent was put up at Car Nicobar to maintain law and order between natives and the Indian traders. Car Nicobar was selected as the seat of agent as it was more populated than the

other islands and the attitude of the British was non-interference in the life of people. The contact with the mainland grew over the years with the occupation of the Islands by the British. Many traders arrived especially from Sumatra (Indonesia) and also from Minicoy and Lakshadweep islands for coconut and betel nuts. Currency was not in use in Nicobar as they followed the barter system, exchanging coconuts to buy things.

The Second World War and the consequent Japanese occupation of Car Nicobar and other Islands during 1942 to 1945 brought many changes in the history of these islands. Many coconut trees were cut down and the Nicobarese were forced to work as labour for construction of roads around the island, runways and jetties. After independence from British, the Indian government has enacted the Protection of Aboriginal Tribes Regulation Act in 1956 to protect the interests of native people of Andaman and Nicobar Islands from exploitation under which entry to the tribal area of Nicobar Islands is restricted.

Demographic Profile

The native population consists mostly of two ethnic groups, the Nicobarese and the aboriginal Shompens, one of the least known particularly vulnerable tribal groups (PVTGs) in the Andaman and Nicobar Islands. As per the 2011 Census, Nicobarese population numbers around 30,000 and literacy rate for the entire Nicobar district is about 84 per cent. Vast majority of them have embraced Christianity, and pastors are treated with great respect. A small fraction of Nicobarese mainly at Kamorta follows Islam. Shompen population could be between 200 and 300 as per the demographic database of Anthropological Survey of India (AnSI).

Linguistic and Cultural Milieu

People in Nicobar Islands speak different languages. Car Nicobar people speak Nicobarese (part of the Austro-Asiatic language family). For centuries in the past they had no script; however in 1912, George Whitehead who lived some years in the Nicobar Islands as agent and missionary has evolved a script. Nicobarese can be taken to be the *lingua franca* of most of these islands.

Nicobarese people have good health. It is commonly said that the visitors to these islands get struck by the welcome sight of muscular bodies, the glow of health and the happiness on most faces. People of Nicobar are known to possess considerable practical skills and all men have been known to have some basic carpentry skill. They make good canoes of varying size from very small (which can carry 2 or 3 persons) to bigger ones which can easily accommodate about 40 persons. It is also reported that they use no nails for joining their outrigger.

Nicobarese are not much interested in money and in general are content with what they have. However, unlike other aboriginal tribes of A&N, they handle cash but wage earning for labour is less and voluntary labour donation or exchange is in vogue. There is no title deed for cultivated lands of Nicobarese, which is community-owned and inherited by families.

The Tsunami in 2004 had played havoc with their lives. Loss of human life was very high. The pain of bereavement still haunts the survivors. Monuments adorned with marble plaques with names of dear departed engraved, erected at entry points or prominent places in all Nicobari villages, stand a grim reminder to the loss (Fig. 2). Countless have been orphaned; however, nobody is rendered homeless and every orphan child is adopted by one family or the other.

Nicobarese are not hostile, mostly reserved and shy in socializing, in general, and often friendly and helpful. Generally, they don't greet strangers unless introduced by captain (village chieftain). A smile or a raised hand may be taken as reciprocation of greetings. Shaking hands and offering food/ Nicobarese delicacies may be taken as goodwill of the community. If we need any help, we have to clearly ask for nonpaid services and even for food and other requirements. Those Nicobarese, who are exposed to public contact extend hospitality and offer tea, tender coconuts etc. They do not generally express their emotions, and communication with outsiders is very less. They are considered very sensitive people and liable to get hurt easily and feel deeply. Thus, it is said that the greatest of tact, consideration, understanding as well as sympathy and patience are required for dealing with the Nicobarese, and without these qualities anybody wanting to work amongst these people must never ever hope to succeed.

Gender Mainstreaming

Men treat women with great respect; domestic violence is not heard off and women enjoy privileges in the society. Occasionally women hold the elected post of captaincy. There are quite a few Nicobari women in the Government services as doctors, nurses, teachers, police personnel, forest staff etc. However, unlike other Mongolian societies, women do not engage in any business like running petty shops and are confined to homes as agriculturists and home makers.

Agricultural Systems and Practices

The Nicobari system of crop cultivation is basically of sustenance agriculture. After the Tsunami, people moved from the traditional huts (Fig. 3) to Govt. provided Tsunami shelters which are in upper terrain away from sea coast. Agro-ecosystems are of three types – coconut monocrop in the coastal plains, *tuhets*, and backyard gardens in and around shelters. The coconut plantations are mostly monocrop with an occasional jackfruit, bread fruit or mango trees. Occasionally coconuts are planted near settlements. Ownership of bearing coconut tree is given to individuals and nobody encroaches on neighbour's property even for a fallen coconut. *Tuhet* is the traditional agro-ecosystem jointly managed by extended family members. The labour is contributed by members and harvest also shared between member families. Men do only a few limited activities like fencing and generally women tend to the crops. Agronomical practices are bare minimum in *tuhets*. No scientific practices of spacing, digging or earthing up are followed. An assorted mix of various crops like taro, cocoyam, giant taro, potato yam, greater yam, lesser yam, sweet potato, sugarcane, vegetable banana, fruit banana, pineapple, tobacco etc. are planted. Soil fertility is maintained by adding crop residues and pig dung. So far, no improved varieties have reached Nicobar Islands. We could not come across any rice cultivation except in Great Nicobar by settlers. *Tuhets* are protected from domestic pigs by meticulously built, beautifully designed wooden fences (Fig. 4). This zig-zag fence is an icon of the islands, especially in Teressa. Poles and logs of regular length are cut and placed in perfect geometric designs of waist height by tying with cordage fibre. Peculiar triangular wooden log tree guards are also seen in Little Nicobar to protect the individual plants from pigs (Fig. 5). Backyard gardens in and around shelters are common across Nicobar. An assorted mix of various vegetables and fruit trees is raised in and around the

dwellings. Ornamentals like various types of crotons, shoe flower, bougainvillea, jasmine, marigold, and many other annuals and shrubs are maintained in the vicinity of shelters. Trailing a betel vine to overhead water tank is a common practice in almost all Tsunami shelters. Nicobarese use only very few agricultural implements such as axe, crowbar and cutting knife. Even though State Agriculture Department is encouraging mechanized scientific agriculture, adoption is very low. Coconut climber is the only machine widely accepted.

Using *Imperata cylindrica* for thatching houses and giving fire to grasslands for promoting abundant fresh growth were common practices. However, after Tsunami, almost every dwelling is now roofed with tin sheets and there is no use for grasses either as thatching material or as fodder, as Nicobarese do not rear cattle. However, the annual ritual of lighting fire to the grasslands still continues. The ecological impact of this practice is worth studying.

Nicobarese live as a natural component of the predominantly forest ecosystem. There are no industries, hotels, tourism, public houses or anything of that sort. Due to strategic reasons, from 1960 to 1980, under the Great Nicobar Southern Frontier Rehabilitation Scheme of Govt. of India, 330 odd ex-servicemen families were allotted between 11-15 acres of cultivable, cleared forest land. Few makeshift shops and eateries at Kamorta and Campbell Bay by settler communities cater to floating populations arriving in ships mostly for Govt. work. Concrete constructions and double storey buildings are very few and restricted to Government buildings and defence enclaves. Roof-top rain water harvesting for drinking purpose is often practiced among Nicobari households.

Crop, Species and Genetic Diversity

Good diversity in greater yam and taro was observed in *tuhet* agro-ecosystem. Even though species diversity is high in *tuhets*, genetic diversity is less, probably because of less population density and recent agricultural history (except coconut). Species diversity comprises lime, lemon, citron, cotton, ginger, turmeric, lemon grass, *Alpinia nigra*, pineapple, bullock heart, soursop and banana. Altogether poor genetic variability was observed, probably due to people not keen in selecting, and whatever observed by us, are primarily due to natural selection. In riverine forests and marshy lowland forests, arecanuts are planted; however, no agronomic

care or scientific cultivation is practiced, it becoming self-sown thereafter.

The colonial history of the islands especially under Danish and British rule helped to augment genetic resources of crops like citrus. It was informed that seafarers from Minicoy (Lakshadweep) also brought some crops, especially in Kamorta.

Food Sources and Culinary Traditions

Rice supplied through public distribution system, few tubers, fish, banana and coconut constitute the major intake. Bread fruit, sweet potato, giant taro, greater yam, cocoyam and taro are the important carbohydrate source. Consumption of cultivated vegetables is very less in Nicobar society. Wild gathered fruits and vegetables form a regular part of their diet, which includes *Gnetum gnemon*, *Champereia manillana*, *Cissus repens*, *Gymnema latifolium* (all leafy vegetables), *Mangifera nicobarica*, *Artocarpus chama*, *Pandanus leram* (all fruits) and *Cycas zeylanica* (starch).

Every household rears pigs and chickens. Nicobari fowl is an indigenous breed with high population diversity. However, egg-laying hens are not generally slaughtered, as they are intended for maintaining higher flock size. Milking cows are seldom seen in Nicobari households. Goats were also spotted in very less numbers, even though Teresa Island is known for a unique breed of goat. Aromatic herbs like lemon grass, *Pandanus amaryllifolius*, *Ocimum tenuiflorus*, *Eryngium foetidum*, *Alpinia nigra*, *Kaempferia galanga*, ginger, turmeric, etc. are grown in almost all home gardens, which are well protected by fencing with used fish net, tin roofing sheets etc.

In fact, *Pandanus leram*, growing abundantly in the littoral forests and coastal strands, is an important food item for the Nicobarese. It used to be the staple food before free rations started. Now Nicobarese depend on rice and *dal* supplied by the Department of Tribal Welfare. During scarcity of food due to disruption of sea transport, people dig out various wild yam species like *Dioscorea glabra* (vern. *kokila*) and *D. piscatorum* (*okkav*) from the wild and eat the cooked tubers with fish and coconut. *Dioscorea piscatorum* is in early domestication phase. Wild stands are dug out and planted near home gardens for easy harvest (Pradheep *et al.*, 2019a).

We were fortunate to witness various stages of *Pandanus* meal preparation. Mature bunches are harvested from the forest by men and transported to

habitation. Women take care of the processing. Individual fruits are separated, washed and steam cooked before extraction of pulp from the mesocarp of the fruit. The fruit pulp is scraped and separated from fibre manually. The mealy mass /dough is mixed with grated coconut, salt and cooked as steamed cakes, which formed staple food for Nicobarese till few decades back.

As whole Great Nicobar and Little Nicobar Islands are protected as Biosphere Reserve and human activities confined to only a small tract from Campbell Bay to down south up to Sastry Nagar, this wild food source is protected. However, *Pandanus* is worth studying for their natural populations for genetic diversity and clonal selection of superior trees, further promote it as a crop in Nicobari gardens. Nutritional evaluation of the product, preparation of value-added products, promoting as health food etc., and linking this ethnic food tradition with ecotourism would offer greater income avenues for the tribals. This tree can be acclimatized elsewhere in mainland (Sundarbans and West Coast) also as food resource, also holding promise as a good source of leaf fibre for mat weaving – *kewda Pandanus*. Bigger the leaf size, more the benefit to the weaving industry.

Soil, Climate and Forests

Soils are primarily of sand stone, silt stone and clay beds. Alluvial soils predominate in river beds, silt sands in river mouth and tidal swamps and calcareous soils in beach forests. Forest soils are rich in humus, and are mildly to moderately acidic and heavily leached. *Areca* swamps and *Myristica* swamps are seen in Little Nicobar. Soils of coral origin are found in parts of Kamorta and Katchal islands.

Climate is warm tropical and humid throughout the year. Temperature ranges between 25 to 30°C. March-May is the summer period, even though 5-6 rainy days are expected during this period also. There is no winter even though it is mildly cool in December-February. Average relative humidity is 80 per cent. An average annual rainfall of 300cm is received, almost well distributed with South-West monsoon contributing the major share.

Forests can be broadly classified into mangrove forest, beach forest, littoral forest, riverine forest and tropical evergreen forest. According to Porwal *et al.* (2012), mixed mangroves (>89%) and littoral beach forests (86.3%) in Great Nicobar and Little Nicobar

were either submerged or severely damaged by Tsunami (Fig. 6). Stretches of grasslands dominated by *Imperata cylindrical* are found in Teresa (Fig.7), Kamorta and Champin islands. Vegetation also varies in different forest ecosystems; however, majority of the crop wild relative (CWR) species are found in the tropical evergreen forests (Fig. 8). *Vigna glabrescens* is found in grasslands of Teresa Island.

Logistics Planning

Consulting flora, herbarium and other associated resources

Agro-biodiversity in Nicobar is largely centered on CWR and useful economic plants with cultivation and domestication potential. Nevertheless, scope for collecting variability in few crops like jack fruit, citrus, mango, banana, coconut, arecanut, greater yam and taro does exist (Abraham *et al.*, 2008). For planning areas to be explored and target taxa, floristic accounts (Thothathri, 1960; Chakraborty, 1970; Thothathri *et al.*, 1973; Dagar and Singh, 1999; Pandey and Diwakar, 2008), botanical memoirs of explorers, relevant floras of A&N (Hajra *et al.*, 1999; Sinha, 1999) and adjoining Malesia (<http://portal.cybertaxonomy.org/flora-malesiana/node/1>) may be consulted. Herbarium consultation at Botanical Survey of India, Kolkata and Port Blair and online herbarium collections (at Leiden herbarium) from nearby islands of Indonesia (Sumatra, Java) would help in field identification of species of interest, besides their collection sites. Accordingly, a checklist of expected economically important species and tentative itinerary may be prepared.

Nicobar has three entry points from Port Blair by voyage/passenger ships: Campbell Bay in Great Nicobar, Kamorta in Nancowrie and Car Nicobar port. From Port Blair it takes about 24 h to reach Kamorta, 36 h to reach Campbell Bay and 24 h to reach Car Nicobar. Ship schedule is published in local dailies and also available in A&N Administration website 3-7 days in advance and tickets can be booked in advance. However, there is no online booking facility available for ships. In general, one can expect sailing of 1-2 ships to Campbell Bay (via Kamorta) and 2-3 to Kamorta in a week. Three classes, Bunk (Lower), Cabin and Deluxe accommodations are available with berth facilities in all. For booking ship tickets a valid pass for entering restricted area is necessary for any destination in Nicobar other than Campbell Bay.

Getting Forest Department Permission and Tribal Area Landing Permit

For entering into any protected area and collecting any biological material, a researcher must obtain a valid permission from the A&N Forest Department. The team leader has to apply in writing specifying list of species to be collected, period of time to be spent in the forest, forest ranges and divisions to be covered along with personal details of the team members. After scrutiny of the proposal, the A&N Forest Department will ask the team leader to make a brief presentation of the research proposal before the Research Advisory Committee (RAC) of the Department, usually at their Headquarters in Haddo, Port Blair. Upon recommendations of RAC of the A&N Forest Department, Principal Chief Conservator of Forests (PCCF) will issue a permit to the team for a specific period with detailed instructions on do's and don'ts. However, this permission for collection of germplasm does not entitle the applicant to visit Biological Park, and similar kinds, for which special permission from PCCF Wildlife (Chief Wildlife Warden) is required.

Further, in order to land at any of the ports in Nicobar other than Campbell Bay and also to visit Nicobari tribal areas, a pass for entering restricted areas, i.e. Tribal Area Landing Permit (TALP) is required to be issued from the Deputy Commissioner headquartered at Port Blair or Car Nicobar. It is also possible to get TALP issued at Campbell Bay, Kamorta and Car Nicobar by Sub-Divisional Magistrate (SDM) or Assistant Commissioner but the process is too cumbersome and time consuming. Moreover, for booking ship tickets it is mandatory to show the TALP. Hence, it is advisable to file the papers at the Deputy Commissioner's office at Port Blair well in advance after forest entry permit is obtained and itinerary is finalized. All team members have to apply individually in prescribed format through online portal (including getting attestation from gazetted officer working in A&N) and after police verification, photo-affixed pass for restricted areas entry is issued which contains all details like areas permitted, period of stay permitted along with instructions regarding do's and don'ts which the pass holder is to strictly comply with. Upon disembarkment from the ship, the pass holder is bound to report to the nearest police outpost with the pass and identity card and to appraise the police officer about halt details of the team. Sufficient number of photocopies of entry permits and Identity cards needs

to be kept by the pass holders to be deposited at police stations and forest check posts.

Liaisoning with Line Departments

For any PGR related explorations in A&N Islands, Director, ICAR-CIARI, Port Blair is the nodal person capable of providing necessary logistic support. Right from transit accommodation at CIARI guest house to local transport, hiring vehicles, *dungies* (country boat) etc. support and guidance from CIARI is required. The Directorate of Agriculture, Port Blair has their staff and offices and farms located in almost all inhabited islands. Logistic support from Forest Department, especially range officer is also crucial in almost all remote localities. Upon arrival at a port, the exploration team should meet and discuss with the concerned officials of Agriculture and Forest Departments for finalizing sites to be visited, transportation, accommodation, arranging local guides etc. A&N Public Works Department has guesthouses at Campbell Bay, Kamorta, Teressa, Katchal, Chowra and Car Nicobar. Rooms can be booked in advance on behalf of the team by line department officials. The SDMs at Campbell Bay, Kamorta and Car Nicobar are the designated officials for allotment of A&N Public Work Department guesthouse accommodation and the Special Relief Officer (SRO) for the other islands.

Inter-island and Road Transport

Passenger ships ply at regular intervals connecting Port Blair with Campbell Bay, Kamorta and Car Nicobar and other important jetties in Nicobar. Kamorta Jetty is the transit point for passenger boats to Nancowrie group of islands like Teressa, Katchal, Champin, Trinket and Hithui. Schedule of passenger boats are decided by Directorate of Shipping Service, A&N administration and can be known one week in advance from the jetty/port office. Just like taxis are hired for road journey, nearby islands in Nancowrie can be reached through hired *dungies* (motorized country boats) (Fig. 9). For exploration purpose to connect various destinations *dungies* can be hired. Well-built jetties are in place at most of the inhabited island destinations like Afra Bay, Hithui, Teressa, Katchal and Champin. However, at destinations like Kondul, Macachua, Pilobao, Pilopanja, Pilomilo and Kuiuino, no proper landing facilities are available. Hence, the *dungies* will have to be anchored in waist-deep water. In such cases, either one has to wade through shallow waters or transfer to the *oddies*

(single seated locally designed push boats) one by one to reach the shore (Fig. 10).

Good roads with asphalt (tar) top connecting diagonal points in the islands are laid out in Great Nicobar and single long roads in Kamorta, Katchal and Teressa. Campbell Bay has a fairly good network of roads and the North-South Road extending about 60 km connects Campbell Bay with Indira Point. Incidentally, this road had collapsed in Tsunami of 2004 and now construction has been completed up to 37th km, i.e. near Galathea Wild Life Sanctuary, the southernmost tip of India. Limited private taxis and auto rickshaws are available for hire at Kamorta, Campbell Bay and Katchal. At Teressa and Champin Islands, there is an option to hire motor bikes. However, Munak and Hithui Islands have no roads and trekking is the only option. In all the forest tracts like Dering, Mount Thullier, etc. no vehicular traffic is possible and trekking is the only option (Fig. 11). Table 1 provides information on the major trekking areas in various parts of Nicobar.

Efficient Management of Time

Sunrise and sunset in A&N Islands are at least two hours earlier than the mainland (barring eastern and north-east India), hence day starts early. Offices in the Nicobar Islands appear to have an extended lunch break. Regular electricity supply is available only at Kamorta and Campbell Bay guesthouses and at the remaining places diesel powered generator will run for only limited hours in the evening. Hence, planning of activities so as to use maximum day light is very important in Nicobar Islands. As the solar and lunar forces affect sea wave movements (Fig. 12), which in turn will affect smooth sailing of *dungies*, it is always advisable to start sailing early in the morning hours, preferably by 4-5 AM. Seasonal winds are also a deciding factor for calm sea. In certain periods of the year, landing at sea shore destinations is very difficult and risky. Hence, the exploration trip has to be planned preferably during January-April, and one should follow advice of port officials/ boat crew rather than taking own decisions regarding sailing and landing destinations.

Arrival at Island Port/Village

Upon disembarking, the team members are bound to report to the police station in person, enter details of visit in the register and deposit a photocopy of the permit. At Kamorta Jetty, police verify the documents before permitting entry in to the island and there is no need

for further verification in the police station. In other islands, non-tribal visitor is bound to report in person at the police outpost upon arrival (Fig. 13). Also, it is advised to inform Tribal Council Chairperson/Secretary for various group of Islands (located at Campbell Bay, Kamorta etc.) the purpose of collection team, so that they would instruct the respective captains of villages well in advance to cooperate with the team and provide essential support. Explorers should keep sufficient money with them avoiding last minute withdrawal option, as currently there are only one or two ATMs available, that too only at Kamorta, Campbell Bay and Malacca.

As the administrative hierarchy is very strong in Nicobari tribal society, the captain (elected chieftain) of the village has to be consulted before venturing into any action in his/her territory. In the absence of 1st captain next one (2nd and 3rd captain) in the order has to be consulted for any activities like collection or engaging people or anything like that. For requirements like temporary accommodations and food in places where no APWD guest houses are available, the captain usually makes arrangements. The unoccupied Tsunami shelters were provided in a few occasions for our stay. In Macachua and Afra Bay, as the police outpost is spacious, police officials usually provide halting facility, upon prior intimation. In Nicobar, the police force is very friendly and they maintain good rapport with Nicobari youth. Often youth assemble at the station for a game of volley ball and also share meals with the police. Criminal offences are seldom heard in Nicobari society and the rare cases are that of poaching, often involving Myanmarese and Thai nationals illegally entering in to Indian Territory. In Galathea WLS, only a camp shed is made by Forest Department, which is to be shared with their staff (Fig. 14). Therefore, while planning for exploration in Galathea WLS, Afra Bay and Little Nicobar where no regular lodging facilities are available, it is advisable to carry light weight sleeping bags.

Many Nicobari field staff are presently employed in Agriculture and Forest departments. It is always advisable to have a Nicobari guide from the department along with the team who will help to build rapport and also act as your interpreter with local population. Majority of the Nicobari men understand and speak Hindi. Getting the service of a good guide, preferably a field staff of the Forest Department, is important in successful collection of economic plants. The A&N Forest Department's labour staff mostly are 'Ranchi' tribals, Karens and



Fig. 2. A memorial for the dear departed in Tsunami



Fig. 3. A traditional Nicobari dwelling



Fig. 4. Zigzag fenced tuhet garden



Fig. 5. Tree guard for protection from domestic pigs



Fig. 6. Tsunami devastated inland forest



Fig. 7. Grasslands of Teressa



Fig. 8. A distant view of virgin evergreen forests in Great Nicobar



Fig. 9. Exploration team availing hired dungies for inter-island travel

Table 1. Sites explored by our team in Nicobar Islands

	Exploration sites	Island	Days (No.)	Halt
1	Dering forest	Kamorta	1	APWD, Kamorta
2	19 th km (in E-W Road) to Kopperheat	Great Nicobar	2	APWD, Camp bell Bay
3	Pilopanja to Macachua	Little Nicobar	1	Macachua
4	Laful to Mt. Thullier	Great Nicobar	2	APWD, Campbell Bay
5	Navy Dera to Mt. Thullier	Great Nicobar	2	APWD, Campbell Bay
6	Trinket Island walk	Trinket	1	APWD Kamorta
7	Galathea mouth point to Indira point	Great Nicobar	1	APWD, Campbell Bay
8	E-Wall to Jetty point	Katchal	1	APWD, Katchal
9	Vikas Nagar to Pilpilow	Kamorta	1	APWD, Kamorta

Nicobarese. Commonly called ‘Ranchis’, the descendants of Chottanagpur tribes, Uraon and Khadia brought by colonial administrators, have good knowledge of flora and fauna. Karens, the settlers from Myanmar origin are also equally good in their knowledge of ground realities of their forest beat.

Sea Security - Lifeboat, Coast Guard

Getting into and stepping out of the *dungies* needs to be managed carefully to avoid falling into the deep water. It is preferable that the team members know swimming. It is mandatory to keep life guards for every individual passenger and the team leader should ensure personal safety gear availability and also to hire only fit-to-sail *dungies* from service providers. Both at Kamorta and Campbell Bay jetties, Indian Coast Guard boats do keep surveillance and the team leader should be ready with all relevant documents and identity cards for verification by the Coast Guard officials. All *dungies* sail with Indian flag mast on small poles (Fig. 9).

Dungie travel from Campbell Bay to Macachua in Little Nicobar takes around 6.5 h in normal sea weather. Hired *dungies* have no seating arrangements and people have to sit for the whole time with cramped legs and those with sea sickness will often have bouts of vomiting. It is advisable to store sufficient drinking water, oral rehydration solution and lime juice, sugar and salt for rehydration. Exposure to open sun in no-roof *dungies* makes things worse. Umbrellas, hats, clothes etc. for covering whole body may be kept handy while embarking in *dungies*. Camera, mobile phones and other electronic gadgets should be kept covered safely as the sea water often splashes inside the boat. Toilet

services are not available once the *dungie* set sail till it reaches shore. At Campbell Bay and Kamorta, shops selling groceries, bakery items, vegetables and banana are available, which may be bought and stored for use at camping sites. Every member has to carry their own ration at Little Nicobar and forest areas of Great Nicobar as there are no shops there.

Mudflats, estuaries, fresh water streams joining sea, river mouths and swamps are highly prone to crocodile attack. Forest Department has placed signage at most of the known localities warning visitors of crocodile attack (Fig. 15). One has to be very careful and cautious while venturing for collection in crocodile infested areas. Stepping in to sea water in Little Nicobar during evening and wee hours may invite crocodile attack.

Clothing, Protective Gear and First Aid

Water swells during high tides in the rivers and crossing the river and embarking the *dungies* may be risky during dusk; invariably, valuable papers and currency notes need to be properly packed in water-proof envelopes. Getting into the *dungies*, transferring to *oddies* and travelling through open sea may expose travelers to lashing sea waves. So, it is always advisable to wear shorts as often due to rough weather, one may have to disembark from boat in to knee-deep or may be waist-high water. However, after reaching the shore, before venturing in to the forest, one has to wear full pants, socks and hunter shoes to avoid many dangers like slippery path, pit viper bite, leech bite, etc. Ready-to-use powder salt in cloth bag may be always kept handy in the pocket to periodically wipe off blood sucking leeches. Leeches are serious problem in rainy season.

Since ring worm infection is a common problem in Great Nicobar, broad spectrum anti-microbial medicine (such as candid cream) needs to be kept handy. Pin worm infection through fruits and salad vegetables are also a common problem. Tick bite may occur in forests, especially in the areas where wild boars are common, which may linger for days together causing itching and skin infection. Mosquito and sand fly bites are extremely high in Great Nicobar, hence mosquito repellent creams, anti-allergic drugs, full body covering clothes, mosquito nets, etc. need to be carried during the trip (Fig. 16). In Little Nicobar, safe drinking water availability is a problem; therefore, it is advised to carry alum/germicide tablets/water-purification tablets to purify raw water. Weil's disease spread by rats is very high in A&N, and one has to be very careful in stepping into stagnant pools, ditches while negotiating marshy areas.

Even though January-March is considered summer season in Nicobar, cyclonic spells of rain may occur and, as trekking in narrow forest path with opened umbrella will be difficult, it is desirable to wear rain coat and cap. All clothes and collected germplasm should be properly packed in water proof polybags before placing in *dungies*. As sharp corals may injure the feet, it is not advised to set bare foot in to water while disembarking from *dungies/oddies*.

A strong but light weight wooden walking stick of about 6 feet height will be ideal for negotiating steep climb and narrow paths through the ridges of gorges. Local guides can help in selecting good material for walking stick. Leaning forward, in order to keep feet straight below the centre of gravity, would ease uphill movement. One is expected to cover maximum area on foot and on an average 10-15 km may have to be covered in a day. Descending down the steep slopes may cause muscular pain and necessary painkiller sprays and muscle relaxants may be kept in the first aid box. Due to remoteness of the sites in Great Nicobar and Little Nicobar, first aid kit comprising of all essential medicine may be carried. Due to non-availability of power supply and limited hours of generator running, it is essential to carry torch, candle and such lighting arrangements. As it gets dark by 4 pm in evergreen dense forests, it is always advisable to wear a head light or carry handy night vision devices. No woollens are required during any time of the year. Carrying threads and ropes is also advised for tying and packing.

Even though Campbell Bay and Kamorta are with mobile network now, most of the interior areas and forest tracts are not in network range. However, all police stations have wireless communication through which emergency messages can be sent and received. BSNL is the only service provider in these islands, and internet connections are available in Government Department Offices at Campbell Bay and Kamorta.

It is very important to respect local customs and traditions. Nicobarese usually do not tolerate encroaching in to their property without proper permission. Any movement in the village has to be with the permission of senior most available village captain. Pig is one of the most precious resources of Nicobarese and pigs and chickens are omnipresent near habitations. One should be very careful not to hit or kill any animals. The penalty for such mishaps imposed by the village council is said to be hefty, often calculating the benefits accrued, had the animal been alive, for 2-3 generations.

Apart from Nicobarese, an aboriginal tribe, 'Shompens' inhabit the interior forests of Great Nicobar. Exploration activity is not permitted in Shompen territory, for which special permission from the District Administration and the Tribal Welfare Department is required, which is very difficult, if not impossible. Shompen men occasionally come out of the forest and their outside visit is mainly restricted for procuring the provisions supplied through public distribution system from Campbell Bay. Explorers may encounter Shompen men, especially in East-West Road (here exploration up to 20 km length from Campbell Bay is permissible), and are advised neither to give lift to them in the vehicle nor share food or even interact with them. Also, explorers should strictly refrain from photography or videography in the area as it is an offense inviting fine or imprisonment or both.

Exploration and Collection

Post-harvest processing of germplasm

General guidelines on how to sample, collect germplasm from farm and forest areas and process them for *ex situ* conservation are available in literature like Guarino *et al.* (1995) and NBPGR (2014). However, unlike exploration in mainland, arrangements for handling collected germplasm need to be planned carefully for two reasons. Collected germplasm is mostly vegetative propagules, live cuttings or pulled out seedlings as it is a compromise of what is available at the time

of visit. Secondly, the time required for reaching the laboratory or planting in field may be lengthy and is often unpredictable due to uncertainty in transportation to Port Blair Airport. Hence, the collected vegetative propagules need to be processed properly to ensure extended viability. Desiccation-free storage is the most important aspect combined with fungus-free environment. The collected cuttings/ seedlings may be sprinkled with water and stored in an improvised vasculum. Extra-large transparent polybags of 45×15 cm or bigger may be used for this purpose. After sprinkling water, the mouth of the polybag may be closed with a rubber band and kept away from hot sun areas (Fig. 17). Upon reaching campsite, the surplus foliage may be trimmed to reduce transpiration loss and dressed twigs given a drenching with 0.2% Mancozeb. The fungicide may be brought as convenient 2g packets for use in 10 L water. The basal part of the cuttings may be dipped in rooting hormone as per requirement and wrapped with small quantity of 1:3 moist vermiculate-perlite mixture and again stored in closed medium sachet, keeping the mouth of the sachet open for 1-2 hours during night to prevent fungal infection. Roots of the pulled-out seedlings should also be covered with the above mixture, wrapped with a cotton cloth and then to be kept inside a transparent polythene cover to prevent transpiration loss. If the exploration trip extends for a long period, the live plants have to be taken out of the cover and monitored periodically to salvage the infected, if any. Extra-large poly bags can also be prepared as ready-to-use mist chamber for planting the vegetative propagules during transit. Lemon grass, curry leaf, wild *Mangifera* seedlings, *Garcinia* seedlings, wild banana seedlings, *Alpinia* suckers were all preserved by us like this up to six weeks. Seeds with recalcitrant/intermediate storage behavior like wild *Artocarpus*, *Citrus*, etc. also need a coating of vermiculate-perlite mixture and wrapping in polybags with provision for aeration. Orthodox seeds need to be threshed, and extracted seeds are to be packed in aerated cloth bags and spread on the floor to prevent fungal growth. Monkey menace is very high in Great Nicobar Island and explorers should be very careful while keeping the fresh fruits/seeds outside for drying. Wet samples may be labeled with aluminum foil and paper tags may be restricted for dry seed packets only. In case where both seeds and vegetative propagules are equally viable (e.g. *Amorphophallus*), collectors can prefer seeds in order to reduce the bulkiness.

Finally, the collected germplasm needs to be neatly packed for transportation in the ship. Weight reduction by trimming off undesirable parts and removing soil, and moisture-proof packing are very important for safe shipping of 36-40 hours. All plant materials are to be packed by sorting and keeping dry seeds, vegetative propagules, delicate materials etc. carefully in separate bags, all in decently looking zip lock bags. Carrying heavy luggage through negotiating narrow ladder while embarking is a cumbersome process; therefore, it is advised to divide the weight accordingly. Poorly packed and shabby looking luggage and gunny bags may warrant ship crew to put them into luggage cabin, which is an open space, not air-conditioned and exposed to wind. After embarking the ship and settling in one's cabin, the bag containing perishable vegetative materials may be kept open to prevent possible mould growth and decay.

In each forest range after completion of the collection, the permit holder should submit a list of live materials collected and approximate sample size to facilitate the Range Officer to issue a Transit Permit (TP). The TP is a must for transferring any germplasm within A&N and also from the island to mainland. At the airport, luggage screening counter also one is supposed to produce the TP in case asked by forest officials. In addition to the TP it is always advisable to keep an authorization certificate issued by Director, ICAR-CIARI or Director of Agriculture, stating that the material transported is of no commercial value/ not for commercial purpose and is meant for research/ conservation. Placing a perishable commodity 'fragile' label is important for live materials when sent as unaccompanied luggage. It is also possible to send neatly packed live specimens through speed post and private air cargo. At Kamorta and Campbell Bay, Postal Department has speed post offices. Air cargo courier services are available at Port Blair. From remote islands, it is possible to send small samples free of cost by helicopter service to Port Blair for which one has to contact SRO. From Port Blair, the agent can send the seeds to mainland through courier/speed post, thus saving transportation time for perishable germplasm.

Herbarium processing

Collecting and preserving herbarium specimens of first-time collections are very important for authentication. As carrying FAA (Formalin Acetic Alcohol) and such preservative liquids are not permissible by air,

cumbersome process of pressing between blotter sheets (or more practically old newspapers) and occasionally pressing the semi-dried specimens within blotters using an electric iron is the only viable alternative.

Other Considerations

Return flights to mainland may be booked only after reaching Port Blair as return journey to Port Blair from remote destinations cannot be planned well in advance. For many reasons, ship schedule change at short notice or tickets may exhaust in quick time leading to disruption of travel plan. Even though helicopter services are available connecting Port Blair to various islands in Nicobar, it may not be feasible for an explorer due to obvious reasons. Only four passengers are permitted in helicopter and maximum luggage permitted is five kg per person. Also, patients waiting for airlifting and A&N administration officials on Govt. duty are given preference. Further, fares are very high for non-islanders.

Upon completion of the trip and arrival at headquarters, a report needs to be submitted to the Forest Department with details of collections made, photographs, new findings, observations and any such information which would strengthen the research and development wing of the Forest Department. The Forest Department must be acknowledged in all publications. It is very important to maintain rapport with few influential people in the community, preferably captains so that some precious germplasm, which were not physiologically mature at the time of exploration, can be procured at a later time/season through locals and delivered to mainland through speed post.

Future Line of Work

By and large, forests in Great Nicobar and Little Nicobar are dense and undisturbed. Unexplored and underexplored diversity rich pockets in Great Nicobar like Mount Thullier needs special permission and facilitation from Departments of Environment & Forests, and Tribal Welfare, as reaching the top, making collections and returning to Navy Dera shore the same day is not possible. Managing day long trekking to reach the top and then returning besides time required for collection of samples needs to be kept in mind. It may take around 8 hours to reach the top and scaling down the same day is not possible. At present the Department doesn't permit overnight stay in the forest due to administrative issues. Same is the case with Laful (on north-eastern side) and Kopenheat (on western side) of Great Nicobar. Out of

the five perennial rivers in Great Nicobar, we could only explore in part Galathea riverine forests, the other accessible areas also need to be explored for CWR.

ICAR-Central Island Agriculture Research Institute (ICAR-CIARI), Port Blair maintains a good collection of coconut germplasm of islands partnering with ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), Kasaragod, whereas, all the remaining crops and their wild relatives need suitable *ex-situ* regeneration in near natural habitat. In this regard, one of the Agriculture Department farms at Katchal or Kamorta are ideal maintenance site for representative economic species of Sundaland Biodiversity hotspot, from connectivity point of view. While implementing the proposed conversion of Katchal rubber plantation to natural forest, the forest department may consider developing a demonstration plot of tree species, CWR, wild economic species under the technical support of ICAR-CIARI and ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR).

Updating of Nicobar flora through publishing new reports of distribution is currently underway (e.g. Pradheep *et al.*, 2019b, 2020), which will also help in updating CWR database of India. A detailed documentation of all ethno-botanically important species used by native tribals needs to be undertaken, although interacting with Shompens may be difficult due to Govt. restrictions. The sustainable forest management plans adopted by Nicobarese in Great Nicobar and Little Nicobar also need proper documentation.

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Fig. 10. Transferring into oddie boat to reach shore



Fig. 11. A view of forest trekking path



Fig. 12. Anchoring near muddy shore during low tide



Fig. 13. Reporting at Nicobari police outpost



Fig. 14. The only camping site at Galathea WLS



Fig. 15. Signage by Forest Dept. in crocodile prone areas



Fig. 16. Night halt at camp site



Fig. 17. Processing collected seedlings

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