

Diversity and Ecology of Tree Species on Netaji Subash Chandra Bose Island (Ross Island), Andaman Islands, India

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ABSTRACT

This study documents the diversity, structure, and ecological characteristics of tree species on Netaji Subash Chandra Bose Island, Andaman Islands, India. A total of 23 tree species, representing 17 genera and 11 families, were recorded from 20 m × 20 m quadrats. The tree flora is dominated by dicotyledonous species, with only two monocotyledonous species; the genus *Ficus* is particularly well represented, with seven species, while the remaining 16 genera are monospecific. Climatic observations during the study period indicate deviations from long-term records, including reduced rainfall coinciding with slightly increased mean temperature, which may affect the ecological balance of the island's tropical evergreen forests. Sediment properties showed persistently acidic pH and marked seasonal variation in nutrients: nitrogen, phosphorus, and potassium reached minimum levels during the monsoon, likely due to leaching, and peaked in the post-monsoon months when accumulated litter and biomass decomposed, consistent with trends in organic carbon. Phytosociological analysis revealed that *Casuarina equisetifolia* and *Cocos nucifera* attained the highest Importance Value Index (IVI), reflecting their ecological dominance, while *Cocos nucifera*, *Azadirachta indica*, *Casuarina equisetifolia*, and *Terminalia catappa* showed the highest Total Importance Values (TIV), indicating multiple uses to local communities. Shannon diversity (H') for tree species was 3.46 and Gleason species richness (SR) was 3.98, indicating relatively high diversity and richness for a small island, although lower than values reported for larger Andaman islands. Notably, seedlings and saplings of the recorded tree species were absent, probably due to low light under a dense canopy combined with heavy browsing by spotted deer. The tree population is dominated by long-lived individuals, and opportunities for further forest expansion are limited by topography and shoreline erosion. These findings highlight the need for integrated conservation and shoreline protection measures to maintain the ecological integrity of Netaji Subash Chandra Bose Island's forests.

Keywords: tropical evergreen forest; phytosociology; species diversity; coastal erosion; regeneration; Andaman and Nicobar Islands

INTRODUCTION

The Andaman and Nicobar archipelago comprises more than 319 islands in the Bay of Bengal, with a total area of approximately 8,293 km². The islands lie between 6°40' and 13°45' N and 92°15' and 94°10' E in the southeastern Bay of Bengal, forming a north-south oriented chain. The archipelago is located about 1,126 km from the Coromandel coast of mainland India and 515 km from the Tenasserim coast of Myanmar; the northernmost Landfall Island is about 289 km from Cape Negrais in Myanmar, and the southern tip at Pygmalion Point (Campbell Bay, Great Nicobar) lies only about 145 km from Sumatra. Port Blair, the capital, is 1,255 km from Kolkata and 1,190 km from Chennai.

The Andaman and Nicobar Islands constitute one of the most isolated regions of India, being separated from the mainland and neighbouring countries by extensive stretches of open sea in all directions. The Andaman Sea separates these islands from the coasts of Myanmar and the Malay Peninsula, while the Ten Degree Channel separates the Andaman and Nicobar groups.

Vegetation plays a key role in terrestrial ecosystems as the main source of primary production and as the principal energy reservoir. It captures solar energy and thereby directly or indirectly supports the vast majority of energy requirements of human and animal components of the ecosystem. Various vegetation attributes have been used to

classify plant communities in space, including life form, growth form, floristic composition, dominance, and the presence of diagnostic species. Whittaker (1962) provided a comprehensive review of community classification and vegetation structure, while Dansereau (1975) and Mueller-Dombois and Ellenberg (1974) outlined the concept and methods of vegetation ecology, including structure, dynamics, and environment–vegetation relationships.

The vegetation of the Andaman and Nicobar Islands has been described as predominantly tropical evergreen, with associated semi-evergreen and deciduous formations. Dagar and Singh (1999) classified vegetation into littoral and inland categories, largely based on proximity to the sea and soil salinity, whereas Hajra et al. (2002) recognized evergreen and deciduous forest types. Despite some divergence in classification, there is broad agreement that tropical evergreen forest is the principal forest type in the islands. Recent assessments indicate that approximately 81–82% of the Andaman and Nicobar Islands remain under forest cover, with very dense and moderately dense forests predominating, consistent with the dominance of evergreen and semi-evergreen formations.

Floral diversity of the Andaman and Nicobar Islands has been widely studied, with estimates of about 3,500–3,600 plant species and approximately 2,000 angiosperm taxa, and angiosperm endemism approaching 14%, underscoring the conservation importance of these islands. Nevertheless, most studies have focused on broad-scale floristics, mangroves, or select groups, and there is comparatively little detailed information on vegetation ecology of individual small islands such as Nataji Subash Chandra Bose Island, including relationships between vegetation patterns and local environmental conditions.

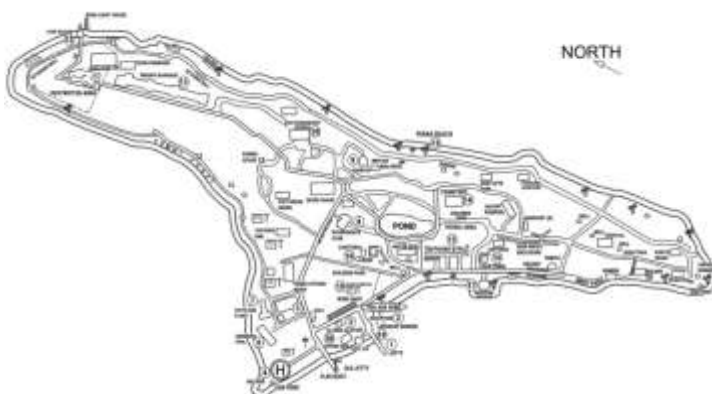
Nataji Subash Chandra Bose Island, located near Port Blair, is of particular interest because of its small size, steep topography, historical human use, and current exposure to coastal erosion. However, baseline information on its forest composition, structure, and ecological condition is limited. Understanding forest processes on such islands is fundamental for assessing impacts of disturbance, climate variability, and sea-level rise, and for planning conservation and rehabilitation.

The present study on the diversity and ecology of tree species on Nataji Subash Chandra Bose Island, Andaman Islands, was undertaken with the following objectives:

1. To characterize the environmental features (climate and soil) of Nataji Subash Chandra Bose Island.
2. To quantify seasonal variation in key environmental parameters.
3. To document the diversity, composition, and structure of tree species on the island.
4. To examine relationships between environmental conditions and vegetation patterns, with particular reference to regeneration and conservation issues.

METHODS

Study area



NSC Bose Island (Ross Island)

Nataji Subash Chandra Bose Island, named after the marine surveyor Sir Daniel Ross, is situated at the mouth of Port Blair harbour and flanks both the northern and southern approaches to the harbour, which is named after Lieutenant Archibald Blair. The island covers approximately 0.6 km², with a length of about three-quarters of a mile and a maximum width of less than half a mile. The western side is low-lying, whereas the terrain rises to around 200 feet on the northeastern side. The island acts as a natural breakwater for Aberdeen during the northeast monsoon and is located roughly 8,000 m from Aberdeen jetty on the eastern seaboard. Coral reefs fringe the island and extend up to about 200 m from the shore.

Environmental data

Monthly rainfall, wind speed, and air temperature data for the study period were obtained from the Meteorological Department at Port Blair. Sediment (soil) samples were collected from representative sites across the island for analysis of pH and nutrients. Sediment pH was measured using a portable pH meter (Takemura, Japan). Sediment nitrogen, phosphorus, potassium, and organic carbon were analysed using standard procedures described by Black (1965) and Jackson (1973), and organic carbon was determined following El Wakeel and Riley (1956).

Vegetation sampling

Vegetation sampling followed plot-based methods for biodiversity characterization at the landscape level (Indian Institute of Remote Sensing, 2004). Randomly located 20 m × 20 m quadrats were established across the forested parts of the island. Within each quadrat, all woody individuals were measured for circumference at breast height (CBH). Individuals with CBH greater than 30 cm were considered trees; those with CBH between 17 and 30 cm were classified as saplings, and individuals with CBH less than 17 cm as seedlings. For the present analysis, emphasis is placed on the tree layer. Data from all quadrats were pooled for further analysis.

Species identification

All woody plants encountered were recorded using their botanical and local (vernacular) names where available. Voucher specimens were collected with appropriate field notes (plot number, habit, habitat, flower colour) and preserved according to standard herbarium procedures. Taxonomic identification was carried out using the flora and reference works of Dagar and Singh (1999; Vols. I–II) and Hajra et al. (2002), and nomenclature was verified with the Botanical Survey of India (BSI), Sri Vijaya Puram.

Phytosociological analysis

For each species within each quadrat, the number of individuals was recorded. Phytosociological parameters were computed following standard methods. Frequency, density, abundance, relative frequency, relative density, relative dominance, and Importance Value Index (IVI) were calculated using the following formulae:

- Frequency (%) = (Number of quadrats in which a species occurs / Total number of quadrats studied) × 100
- Density = Total number of individuals of a species / Total number of quadrats studied
- Abundance = Total number of individuals of a species in all quadrats / Number of quadrats in which the species occurs
- Relative frequency (%) = (Frequency of a species / Sum of frequencies of all species) × 100
- Relative density (%) = (Density of a species / Total density of all species) × 100
- Relative dominance (%) = (Basal area of a species / Total basal area of all species) × 100
- Importance Value Index (IVI) = Relative frequency + Relative density + Relative dominance

Economic valuation (Total Importance Value)

The Total Importance Value (TIV) of each species was estimated based on its direct and indirect uses to local communities, following Belal and Springuel (1996). Primary uses considered included forage, medicinal uses, human food, fuelwood, timber, and charcoal. Secondary direct uses included oil and fibre, mat making, ropes and baskets, and leather tanning. Indirect uses included shade, hedges, soil stabilization, and nitrogen fixation. Each use category was scored on a 0–10 scale, and TIV was calculated as:

$$\text{TIV} = [(U_1 + U_2 + \dots + U_n) / (\text{Number of use categories} \times \text{maximum score})] \times 100$$

where U represents the score for each specific use category.

2.7 Species diversity and richness

Species diversity was quantified using the Shannon–Weaver index (Shannon and Weaver, 1949):

$$H' = - \sum P_i \log_2 P_i$$

where H' is the diversity index (bits per individual) and P_i is the proportion of individuals belonging to the i -th species.

Species richness (SR) was estimated using the Gleason (1922) index:

$$\text{SR} = (S - 1) / \ln N$$

Where S is the number of species in the sample and N is the total number of individuals of all species in the sample.

RESULTS

Environmental characteristics

Monthly rainfall exhibited a pronounced seasonal pattern, peaking at 818 mm in June and declining to a minimum of 15 mm in March, with no rainfall recorded in January and February; the total annual rainfall during the study period was 3,773.9 mm. Wind speed varied from 8.3 m s⁻¹ in March to a maximum of 22.8 m s⁻¹ in July, with generally higher velocities observed between June and September, coinciding with the southwest monsoon. Air temperature remained relatively uniform, ranging from 29.1 °C in December to 33.3 °C in April, with an annual mean of 30.47 °C. Sediment pH was consistently acidic throughout the year (5.4–6.2). Soil nitrogen content remained above 1% for most of the period, reaching a maximum of 1.8% in December and a minimum of 0.8% in March. Phosphorus levels ranged from 18.9 kg ha⁻¹ in February to 24.2 kg ha⁻¹ in December, while potassium varied between 130 kg ha⁻¹ in May and 183 kg ha⁻¹ in December. Organic carbon content fluctuated from a low of 1.69% in September to a high of 2.52% in November.

Tree species composition

A total of 23 tree species belonging to 17 genera and 11 families were recorded on Nataji Subash Chandra Bose Island (Table 1). The flora is dominated by dicotyledonous species, with only two monocotyledonous species (*Pandanus tectorius*, *Cocos nucifera*). The genus *Ficus* is particularly well represented, with seven species, while each of the remaining 16 genera is monospecific.

Table 1. Tree species recorded on Nataji Subash Chandra Bose Island, Andaman Islands.

S.No	Family	Species	Local name
1	Anacardiaceae	<i>Mangifera indica</i> L.	Mango
2	Anacardiaceae	<i>Buchanania platyneura</i> Kurz	Chironji
3	Malvaceae	<i>Bombax insigne</i> Wall.	Andaman didu
4	Bignoniaceae	<i>Oroxylum indicum</i> (L.) Kurz	Trumpet tree
5	Casuarinaceae	<i>Casuarina equisetifolia</i> Forst.	Casuarina
6	Combretaceae	<i>Terminalia catappa</i> L.	Indian almond
7	Fabaceae	<i>Cassia fistula</i> L.	Golden shower
8	Fabaceae	<i>Tamarindus indica</i> L.	Tamarind
9	Fabaceae	<i>Pterocarpus dalbergioides</i> Roxb.	Padauk
10	Fabaceae	<i>Pithecellobium dulce</i> Benth.	Madras thorn
11	Moraceae	<i>Artocarpus heterophyllus</i> Lam.	Kathal
12	Moraceae	<i>Ficus callosa</i> Willd.	Hard fig
13	Moraceae	<i>Ficus glaberrima</i> Bl.	–
14	Moraceae	<i>Ficus glomerata</i> Roxb.	Cluster fig
15	Moraceae	<i>Ficus benghalensis</i> L.	Banyan
16	Moraceae	<i>Ficus nervosa</i> Roxb.	Neer aal (Tamil)
17	Moraceae	<i>Ficus retusa</i> L.	Indian laurel
18	Moraceae	<i>Ficus rumphii</i> Bl.	Matiyal (Nicobarese)
19	Meliaceae	<i>Azadirachta indica</i> A. Juss	Neem
20	Nyctaginaceae	<i>Pisonia umbellifera</i> (Forst.) Seem.	Birdlime tree
21	Pandanaceae	<i>Pandanus tectorius</i> Sol. ex Park.	Screw pine
22	Arecaceae	<i>Cocos nucifera</i> L.	Coconut
23	Arecaceae	<i>Livistona chinensis</i> R.Br.	Fan palm

3.3 Phytosociological attributes

Among the 23 species, *Casuarina equisetifolia* attained the greatest mean height (13.2 m), closely followed by *Bombax insigne* (13.0 m), whereas *Azadirachta indica* had the lowest mean height (4.6 m). *Pterocarpus dalbergioides* exhibited the highest CBH, reflecting its large stature and timber value.

Table 2. Phytosociological attributes of tree species on Nataji Subash Chandra Bose Island

Species	Height (m)	CBH (cm)	Frequency	Abundance	Density
<i>Mangifera indica</i> L.	6.3	126	0.5	0.8	0.5
<i>Buchanania platyneura</i> Kurz	8.1	174	0.4	3	1.2
<i>Bombax insigne</i> Wall	13	184	0.2	6	0.6
<i>Oroxylum indicum</i> (L.) Vent	8.6	169	0.4	1	0.4
<i>Casuarina equisetifolia</i> L.	13.2	30	0.7	5.71	7

<i>Termanalia catappa</i> L.	9.6	238	0.2	2	0.2
<i>Cassia fistula</i> L.	8.3	156	0.3	2.67	0.6
<i>Pithecellobium dulce</i> (Roxb.) Benth	8.2	93	0.2	2	0.2
<i>Pterocarpus dalbergioides</i> Roxb.	11.6	272	0.1	4	0.1
<i>Tamarindus indica</i> L.	7.5	148	0.4	1	0.4
<i>Artocarpus heterophyllus</i> Lamk.	8.9	174	0.3	2.67	0.6
<i>Ficus callosa</i> Willd	8.9	66	0.3	2.67	6
<i>F. glaberrima</i> Bl.	10.3	235	0.2	2	0.2
<i>F. glomerata</i> Roxb.	8.1	225	0.3	1.33	0.3
<i>F. indica</i> L.	10.4	228	0.4	2	0.8
<i>F. nervosa</i> Rath	9.8	162	0.2	2	0.2
<i>F. retusa</i> L.	10.5	198	0.2	4	0.4
<i>F. rumphii</i> Bl.	6.9	148	0.6	0.67	0.6
<i>Azadirachta indica</i> Juss	4.6	83	0.8	1.5	2.4
<i>Pisonia umbellifera</i> (Forst.) Seem.	6.8	174	0.2	4	0.4
<i>Pandanus tectorius</i> Soland ex Park	6.3	142	0.5	2.4	1.5
<i>Cocos nucifera</i> L.	11.2	122	0.8	3.5	5.6
<i>Livistonia chinensis</i> R.Br.	6.2	148	0.2	2	0.2

Table 3. Relative frequency (RF), relative dominance (RD), relative density (RDen), Importance Value Index (IVI), and Total Importance Value (TIV) of tree species on Nataji Subash Chandra Bose Island.

Table -3. IVI and TIV recorded for the trees of the Ross island

Species	Relative Frequency	Relative Dominance	Relative Density	IVI	TIV
<i>Mangifera indica</i> L.	5.95	1.36	1067	8.95	16
<i>Buchanania platyneura</i> Kurz	4.76	5.09	3.95	13.8	7
<i>Bombax insigne</i> Wall	2.38	10.18	1.97	14.62	6
<i>Oroxylum indicum</i> (L.) Vent	4.76	107	1.32	7.78	8

<i>Casuarina equisetifolia</i> L.	8.33	9.69	23.03	41.62	24
<i>Termanalia catappa</i> L.	2.38	3.39	0.66	6.43	20
<i>Cassia fistula</i> L.	3.57	4.53	1.97	10.07	16
<i>Pithecellobium dulce</i> (Roxb.) Benth	2.38	3.39	0.66	6.43	18
<i>Pterocarpus dalbergioides</i> Roxb.	1.19	6.79	0.33	8.31	12
<i>Tamarindus indica</i> L.	4.46	1.7	1.32	7.78	14
<i>Artocarpus heterophyllus</i> Lamk.	3.57	4.53	1.97	10.07	16
<i>Ficus callosa</i> Willd	3.57	4.53	19.74	27.84	6
<i>F. glaberrima</i> Bl.	2.38	3.39	0.66	6.43	6
<i>F. glomerata</i> Roxb.	3.57	0.02	0.99	4.58	6
<i>F. indica</i> L.	4.76	3.39	2.63	10.78	6
<i>F. nervosa</i> Rath	2.38	3.39	0.66	6.43	6
<i>F. retusa</i> L.	2.38	6.79	1.32	10.49	6
<i>F. rumphii</i> Bl.	7.14	1.14	1.97	10.25	6
<i>Azadirachta indica</i> Juss	9.57	2.55	7.89	19.96	24
<i>Pisonia umbellifera</i> (Forst.) Seem.	2.38	6.79	1.32	10.49	12
<i>Pandanus tectorius</i> Soland ex Park	5.95	4.07	4.93	14.95	5
<i>Cocos nucifera</i> L.	9.52	5.94	18.42	33.58	37
<i>Livistonia chinensis</i> R.Br.	2.38	3.39	0.66	6.43	14

Casuarina equisetifolia and *Cocos nucifera* recorded the highest IVI values, indicating ecological dominance, while *Cocos nucifera*, *Azadirachta indica*, *Casuarina equisetifolia*, and *Terminalia catappa* had the highest TIV scores, reflecting their multiple uses to local communities.

Diversity and richness

Shannon diversity (H') for tree species on Nataji Subash Chandra Bose Island was 3.46, and species richness (SR) estimated using the Gleason index was 3.98. Comparable studies from Baratang and other Andaman islands have reported higher Shannon values (approximately 3.9–4.0) and greater tree richness, reflecting the larger area and more extensive forest tracts on those islands. Nevertheless, the values recorded for Nataji Subash Chandra Bose Island indicate relatively high tree diversity and considerable richness for a small coastal island.

DISCUSSION

Environmental context and climate trends

The climatic regime of Nataji Subash Chandra Bose Island is tropical, but sea breezes and substantial rainfall during most months moderate temperatures and impart a quasi-temperate ambience. Rainfall during the study period (3,773.9 mm) exceeded the average annual rainfall of about 3,000 mm reported previously for the Andaman Islands, and rainfall occurred in 10 months of the year, consistent with the classification of the forests as tropical evergreen.

Comparison with long-term rainfall data suggests temporal variability and possible decline in annual rainfall over recent decades. Annual rainfall was reported as 4,300 mm in 1961, declined to a minimum of 1,550 mm in 1979, rose to 3,000 mm in 1992, and was 3,773.9 mm during the present study period. Although rainfall fluctuates considerably, it has not reached the earlier maximum of 4,300 mm. Wind speed patterns, with higher values during June–September, are consistent with previous observations for the Andaman group. The annual mean temperature of 30.47 °C is about 0.5 °C higher than earlier averages reported for 1949–1992, indicating a modest warming trend, although the seasonal pattern of temperature remains broadly similar.

Soil pH remained acidic across the study period, with slightly higher values at the end of the monsoon, suggesting reduced acidity when decomposition of accumulated litter is most active. Nutrients (N, P, K) reached minimum values during the monsoon months, likely due to leaching during intense rainfall, and peaked in the post-monsoon months (October–December), when decomposing debris and biomass release nutrients, as reflected by increased organic carbon content. These patterns align with previous accounts of Andaman soils and tropical evergreen forest dynamics.

Vegetation structure and composition

The evergreen character of the forest on Nataji Subash Chandra Bose Island is well expressed, and tree density is comparatively high throughout much of the island. Vegetation can be broadly classified into littoral and inland types. No mangrove species were recorded, likely because steep rocky shores dominate much of the coastline; the lower western side is sandy and supports *Ficus* species, *Pandanus tectorius*, and *Azadirachta indica*.

Phytosociological observations indicate that most trees are mature and structurally well developed, with height and CBH values consistent with long-established stands. High IVI values for *Casuarina equisetifolia* and *Cocos nucifera* reflect their ecological dominance along coastal and near-coastal zones, while the prominence of *Azadirachta indica* and *Terminalia catappa* in TIV scores underscores their importance for fuelwood, timber, shade, and other uses.

4.3 Diversity, richness, and regeneration

The diversity and richness indices ($H' = 3.46$, $SR = 3.98$) indicate relatively high tree diversity for a small island but lower values than those reported for larger Andaman islands such as Baratang and others with extensive continuous forest. This pattern is consistent with species–area relationships and the influence of habitat heterogeneity on tree diversity.

A striking feature of the Nataji Subash Chandra Bose Island forest is the apparent lack of seedlings and saplings of the recorded tree species. The absence of regeneration may be linked to low light availability under a dense canopy, which limits establishment of shade-intolerant species, and to heavy browsing pressure by a high population of spotted deer on the island, which feed on seedlings, saplings, shrubs, and herbs. Such regeneration failure, if persistent, could lead to gradual decline in tree populations as mature individuals die without replacement.

Conservation and management implications

Overall, the tree population on Nataji Subash Chandra Bose Island is dominated by long-lived individuals, and opportunities for further forest expansion are limited by steep topography and shoreline configuration. In addition, the northern margin of the island is undergoing active sea erosion, and tree falls due to wave action have already been observed. These physical constraints, combined with lack of regeneration and changes in climatic variables, pose significant challenges for the long-term persistence of the island's forest.

Given the ecological and conservation importance of the Andaman and Nicobar Islands, there is a need for integrated management measures on Nataji Subash Chandra Bose Island. Potential actions include control of deer populations or establishment of exclosures to facilitate tree regeneration, shoreline protection and erosion control in critical sectors, and monitoring of climate and forest dynamics. Protection of remaining forest cover and maintenance of structural and compositional diversity are essential to preserve the island's ecological integrity and the ecosystem services it provides.

Conclusions

Nataji Subash Chandra Bose Island supports a comparatively diverse assemblage of tree species for its small size, with 23 species across 17 genera and 11 families and a strong representation of *Ficus* and other evergreen taxa. The forest is structurally mature and dominated by long-lived trees, but regeneration is notably absent, likely due to low light under a closed canopy and intense deer browsing. Climatic and edaphic conditions—high rainfall, acidic soils, and seasonal nutrient fluctuations—are consistent with tropical evergreen forest, but deviations from long-term rainfall and temperature patterns suggest emerging climatic changes. High IVI and TIV values for a few key species (*Casuarina equisetifolia*, *Cocos nucifera*, *Azadirachta indica*, *Terminalia catappa*) highlight their ecological and socio-economic importance. However, limited scope for forest expansion, active shoreline erosion, and regeneration failure indicate that the forest is vulnerable. Targeted conservation and management interventions are therefore required to safeguard the forest structure, species diversity, and ecological functions of Nataji Subash Chandra Bose Island.

References

- Anonymous (1992). UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change, Pilot Project of Mangrove and Coral Reefs.
- Balakrishnan L (1988). Buttress on trees of Andaman and Nicobar Islands. *Journal of Andaman Science Association* 1:124–127.
- Balakrishnan NP (1973). New or little-known plants from Great Nicobar Island. *Bulletin of the Botanical Survey of India* 24:55–56.
- Balakrishnan NP (1989). Andaman Islands vegetation and floristics. In: Saldanha CJ (ed) *Andaman, Nicobar and Lakshadweep: An Environmental Impact Assessment*. Oxford & IBH Publishing Co., New Delhi, pp 55–68.
- Balakrishnan NP, Rao MKV (1983). Dwindling plant species of Andaman and Nicobar Islands: an assessment of threatened plants of India. In: Jain SK, Rao AR (eds) *An Assessment of Threatened Plants of India*. Botanical Survey of India, Howrah, pp 186–201.
- Belal AE, Springuel I (1996). Economic value of plant diversity in arid environments. *Nature & Resources* 32:33–39.
- Black CA (1965). *Methods of Soil Analysis, Part I and II*. American Society of Agronomy, Madison, Wisconsin, USA.
- Chandrashekara UM, Ramakrishnan PS (2009). Tree species diversity and population structure across major forest types of Andaman Islands, India. *Journal of Tropical Ecology* 23:101–115.
- Congdon RA, Herbohn JL (1993). Ecosystem dynamics of disturbed and undisturbed sites in north Queensland wet tropical rain forest. *Journal of Tropical Ecology* 9:349–363.
- Dagar JC, Singh NT (1999). *Plant Resources of the Andaman and Nicobar Islands, Vols I and II*. Bishen Singh Mahendra Pal Singh, Dehradun.
- Dansereau P (1975). *Biogeography: An Ecological Perspective*. Ronald Press, New York.

- Deb P, et al. (2017). Diversity and phytosociological attributes of trees of Baratang Island, Andaman and Nicobar Islands, India. *International Journal of Conservation Science* 54:45–60.
- El Wakeel SK, Riley JP (1956). The determination of organic carbon in marine muds. *Journal du Conseil Permanent International pour l'Exploration de la Mer* 22:180–183.
- Forest Survey of India (2019). *India State of Forest Report 2019, Volume II: Andaman & Nicobar Islands*. Forest Survey of India, Dehradun.
- Gleason HA (1922). On the relation between species and area. *Ecology* 3:158–162.
- Hajra PK, Rao PSN, Mudgal V (2002). *Flora of Andaman and Nicobar Islands, Vol. I: Ranunculaceae to Combretaceae*. Botanical Survey of India, Kolkata.
- Indian Institute of Remote Sensing (2004). *Biodiversity Characterization at Landscape Level Using Satellite Remote Sensing and GIS: Manual*. Department of Biotechnology and Department of Space, Dehradun.
- Jackson ML (1973). *Soil Chemical Analysis*. Prentice-Hall of India, New Delhi.
- Mueller-Dombois D, Ellenberg H (1974). *Aims and Methods of Vegetation Ecology*. John Wiley & Sons, New York.
- Rao MKV (1986). A preliminary report on the angiosperms of Andaman and Nicobar Islands. *Journal of Economic and Taxonomic Botany* 8:107–184.
- Rao PSN (1996). Phytogeography of Andaman and Nicobar Islands. *Malayan Nature Journal* 50:57–59.
- Rao PSN, Nayar MP (2024). Coastal and marine plant diversity of Andaman and Nicobar Islands. *Nelumbo* 66:1–20.
- Shannon CE, Weaver W (1949). *The Mathematical Theory of Communication*. University of Illinois Press, Urbana.
- Singh JS, Gajja BL (1987). Climate of the Andaman Islands. In: Sobti RC (ed) *Geography of Andaman and Nicobar Islands*. Publication Division, Ministry of Information and Broadcasting, New Delhi.
- Singh RS, Mongia AD (1985). Soils of the Andaman and Nicobar Islands. *Journal of the Indian Society of Soil Science* 33:456–462.
- Sreekumar PV, Rao PSN (1992). Additions to the flora of Andaman and Nicobar Islands. *Journal of Andaman Science Association* 8:85–86.
- Sreekumar PV, Ray LN, Padhye PM (1996). Economically important vascular plants occurring wild in Bay Islands. *Journal of Economic and Taxonomic Botany* 20:407–421.
- Srinivasan MS (1986). Geology of Andaman and Nicobar Islands. *Journal of Andaman Science Association* 2:1–12.
- Whittaker RH (1962). Classification of natural communities. *Botanical Review* 28:1–239.