TECHNICAL REPORT

EFFECT OF FLOOD ON FLORA, FAUNA AND LIVELIHOOD IN THE ISLANDS OF ALAPPUZHA DISTRICT

>Scheme: Documentation of Specialized Ecosystem and Developing Sustainable Models of Biodiversity Conservation

SUBMITTED TO
KERALA STATE BIODIVERSITY BOARD,
THIRUVANATHAPURAM

SUBMITTED BY
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EFFECT OF FLOOD ON FLORA, FAUNA AND LIVELIHOOD IN THE ISLANDS OF ALAPPUZHA DISTRICT

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Effect of Flood on Flora, Fauna and Livelihood in the Islands of Alappuzha District

Under Sanctioned title: Inventory and Evaluation of Spread Ecology of Mangrove Flora in the Islands of Alappuzha District

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Team of Experts with Relevant Background

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1. INTRODUCTION

Vegetation is the most valuable gift that nature has provided human beings to meet the basic life requirements. It also plays a crucial role in sustainable management of the biosphere by maintaining the stability of biodiversity at its different levels of organization. The floristic wealth of a particular region is significant as it is considered an indicator in deciding the status of its ecological health. In this context, floristic studies are very much essential not only to understand the status of biodiversity but also to safeguard the ecological stability of an area by implementing stringent measures to conserve (Mathew, 2015). Due to the anthropogenic pressures, mangrove forest areas declining at an alarming rate. Nevertheless, efforts were taken up by the Forest Departments and other agencies to restore, develop and conserve forest resources for sustainable use and management. It is expected that the present investigation on species diversity, ecology and restoration feasibility study in the mangroves of Alappuzha Islands will provide valuable information for sustainable management and conservation of plant resources.

The word 'mangrove' be used to describe the habitat as well as the species of trees and shrubs that grown in the intertidal regions of the world. Mangrove ecosystems are found all over the world in tropics and subtropics along the land-sea interface, bays, estuaries, lagoons, backwaters and in rivers reaching upstream up where the water still remain saline. The specific regions where these plants occur are termed as 'mangrove ecosystems'. The development and structure of mangrove forests result from an interaction of many physical factors and environmental variables.

The mangroves comprise evergreen trees and herbs, adopted to thrive in shallow, muddy, salt and brackish waters. Generally, plants in mangrove ecosystem are categorized as Exclusive species referred as strict, 'obligate' or 'true mangroves' that are limited to the mangrove environment and 'non-exclusive' species referred as semi or 'mangrove associate' that are distributed in other habitats also. The canals, creeks and the estuarine environment provide home for a wide variety of aquatic fauna and the arid zone forms the nesting grounds for aquatic birds. Mangroves constitute the breeding and nursery grounds for the larvae and juveniles of commercially important species of prawns, shrimps, fishes and molluscs.

1.1 Extent of mangrove forest

The total mangrove area of the world has been assessed to be approximately 18.15 million hectares. India's mangrove wetlands range from 6,81,000 ha to 5,00,000 ha. Naskar and Mandal (1999) stated that, India has a total area of 4461 sq.km of mangroves; India is the fourth largest mangrove area in the world with 0.14% of country's total geographical area. The extent of mangrove of Kerala is 2502 ha out of which 1189 ha belongs to the state and 1313 ha is under private ownership, but various studies showed

that the vegetation of mangroves in Kerala covers only 1095 ha, early study reported that out of the total 1671 ha of mangroves in Kerala, 1470 ha are with private ownership (Mohanan, 1999). In 2009, Space Application Centre (ISRO) Ahemadabad published a recent data on the distribution of mangroves in Kerala. According to that data, mangroves in India has only 2.66% of the world's mangroves, covering an estimated area of 4,827 sq. km. Kerala along the west coast of India has a coastline of 590 km and presently the mangrove area is estimated to be about 17 sq. km, of which 36% is either completely degraded or is degrading.

1.2. Mangrove ecosystem

Mangroves occur in swamps and spread in patches and as forest in saline intertidal zones. They are seen in the intertidal brackish wetlands in estuaries and backwaters of tropical and sub-tropical regions of the world. The mangroves protect erosion and provide shelter for fishes and crustaceans. The ecosystems consist of trees and other plant species, living organisms and human beings in the nearby areas.

There are 3 biotic components in the mangrove ecosystem:

1. The mangrove flora, comprising of both true- mangroves (halophytes) and their associates.
2. The animal component consist mostly of the aquatic, amphibian and resident or migrant life forms, both brackish and fresh water species (prawns, shrimps, mussels, crabs, fishes, bivalves and numerous invertebrates and micro forms).
3. The human population comprising of people of traditional lifestyles (fisherman) and urban people seeking modern lifestyles and opportunistic livelihood.

1.3. Importance of mangrove ecosystem

It is true that a large body of the documented literature expresses the view that mangroves serve as '*nature's nursery'* for a variety of marine fishes and other animals of food value to man. Many saline fishes and shrimp species are believed to migrate to the mangroves, where they swarm their fingerlings and young ones. These unique plant communities occur in a habitat created by the confluence of rivers, backwaters and sea. By virtue of the prolific aerial and underground rhizomorphs they form a very effective soil binding geotextile. This provides incredibly sound anchorage which enables the plants to withstand the waves. As the abode of rich biodiversity including birds and insects their role in the sustainability of seafood species and shoreline stability, economic standing and the survival of selected communities and in the context of the predicted scenarios of global warming and sea level rise, conservation of mangrove vegetation is very important. Mangrove forests perform multiple ecological functions such as production of woody trees; provision of habitat, food, and spawning grounds for fin-fish and shellfish; provision of habitat for birds and other valuable fauna; protection of coastlines and accretion of sediment to form new land. Mangrove areas

have high biological productivity, associated with heavy leaf production, leaf fall and rapid decomposition to form detritus. The mangrove ecosystem is dynamic, changing in both location and composition, and has great resilience with the ability to restore itself after heavy damage, as long as seed sources and water flow are maintained. There are also many economic benefits from mangrove resources; like as a source of firewood, self replenishing areas of fishery resources, for collecting honey and for tourism.

1.4. Need and significance of the study

Most of the low lying areas in Alappuzha District experienced severe floods especially the islands viz., Pathiramanal, Pallippuram and Perumbalam. The basic cause of flood is the incidence of heavy monsoonal rainfall and the resultant large concentration of run-off, which exceeds river systems. Besides that, the heavy floods, landslides, soil erosion, depletion of slit and sand etc also affected the biodiversity, especially the riverine area. Elevation of water level, eutrophication, mangrove deforestation, stream narrowing, loss of stream ecosystem services, invasion of weeds are some of the factors that may lead to near extinction of a good number of endemic coastal plants species. In this context, effect of flood on flora, fauna and livelihood in the islands of Alapuuzha District is the need of the hour. The impact of plant diversity on environmental and climatic dimensions are adequately represented by way of floristic and vegetation analysis and of the influence of anthropogenic activities, which address the needs and opportunities for eco-restoration and conservation of the plants and animal species, especially of the RET category with special reference to the islands biodiversity in order to achieve the above mentioned objective and also to formulate suitable proposal for conservation of plant resources of the concerned study area, there is an urgent need to document precise information regarding the floristic composition, ecological status and spread biology of the plant species of coastal area.

Some other significant factors about the study area

- Vembanad Lake is the largest wetland (Ramsor site) in India
- The mangroves in the Vemband lake are the brooding site of numerous indigenous/ endemic fishes, crustaceans and several animals.
- These mangrove patches are the migratory sites for several birds, butterflies.
- Vembanad Lake bounds are the repository of numerous endemic plants.
- Flood and landslides happened in 2018, caused much havoc in biodiversity to these islands.
- Fast invasion of weeds to this precious area have been also noticed.
- Indigenous people of in and around the bounds of Vembanad Lake are dependent to the lake via., their belief, culture, myth and livelihood. Any disturbance to this unique ecosystem may lead to the extinction of the rich diversity of endemic species and the indigenous people.

Considering the above mentioned significant aspects of the study area, it is expected that the present floristic enumeration would bring out the importance of conservation priorities to be implemented to safeguard this highly fragile ecological region. It is also expected that the data generated would provide a guide line for future conservation studies.

1.5. Objectives of the study

The major objectives of the present study are:

- To assess the flora and fauna in the Mangroves of Pathiramanal, Pallippuram and Perumbalam islands of Alappuzha District.
- To assess the invasion of weed plants in the riparine zones
- To assess the consequence of flood on vegetation dynamics, floristic and faunal diversity and the livelihood of associated people.

1.6. Study Area

Three islands in the Vembanad Lake viz., Perumbalam, Pallipuram and Pathiramanal were selected for the study.

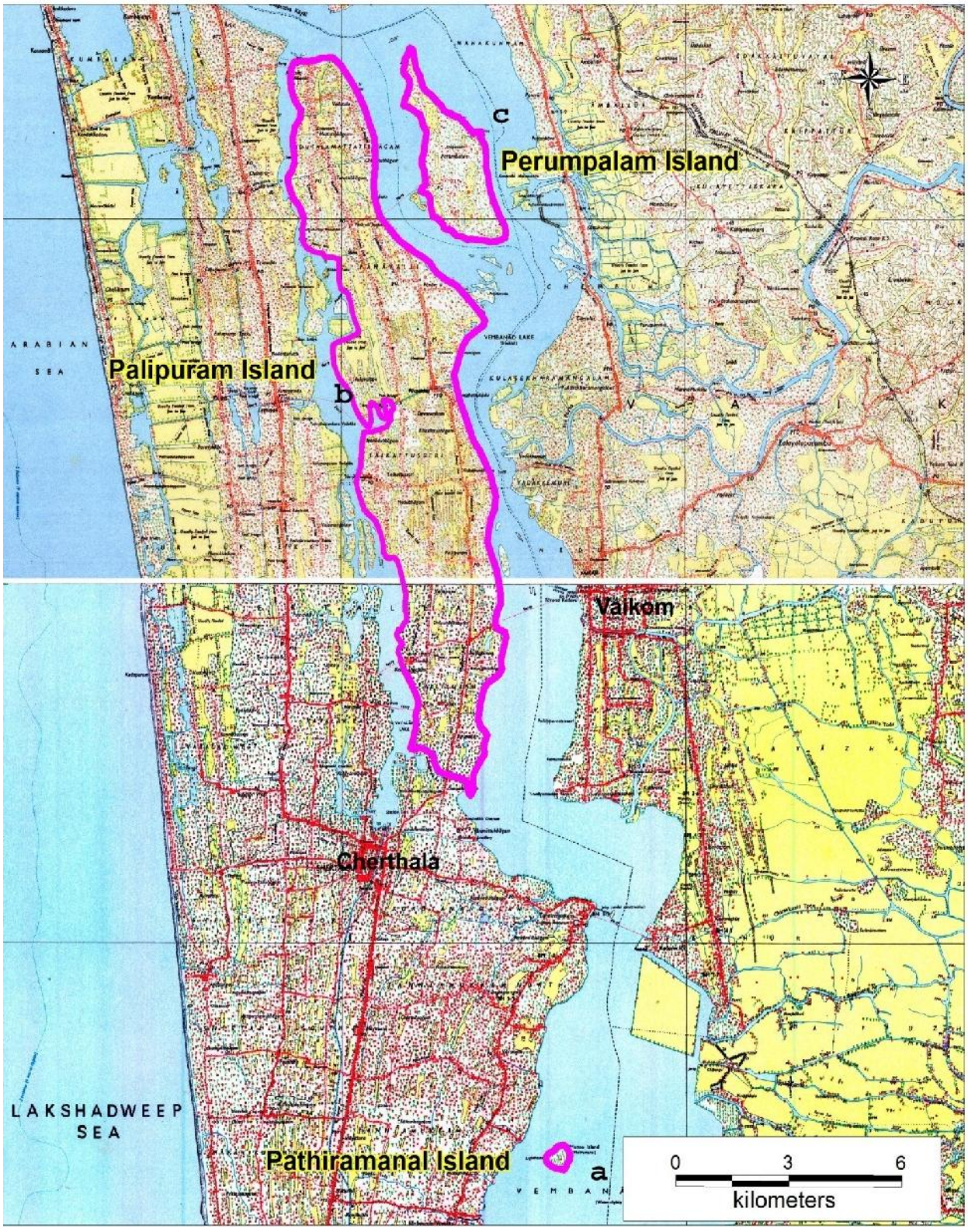

Fig. 1. Study area marked in map

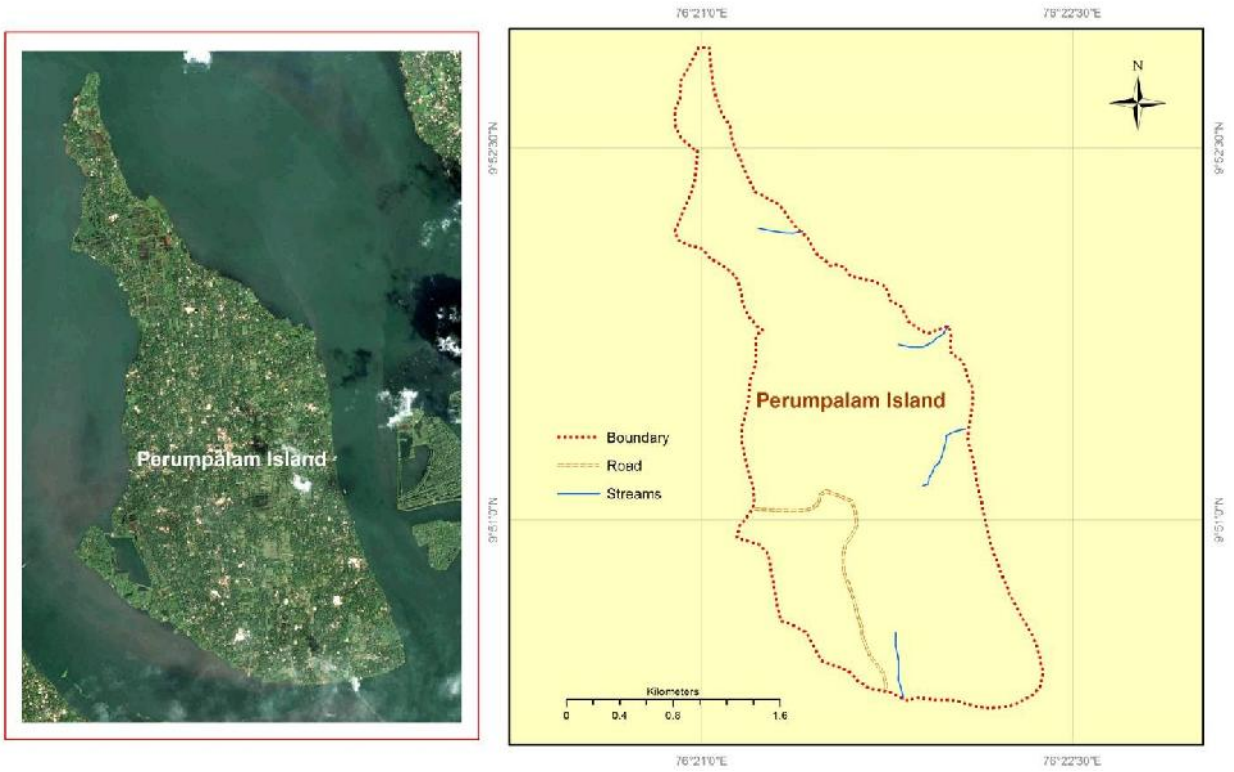

Fig. 2.: Map of Perumbalam Island

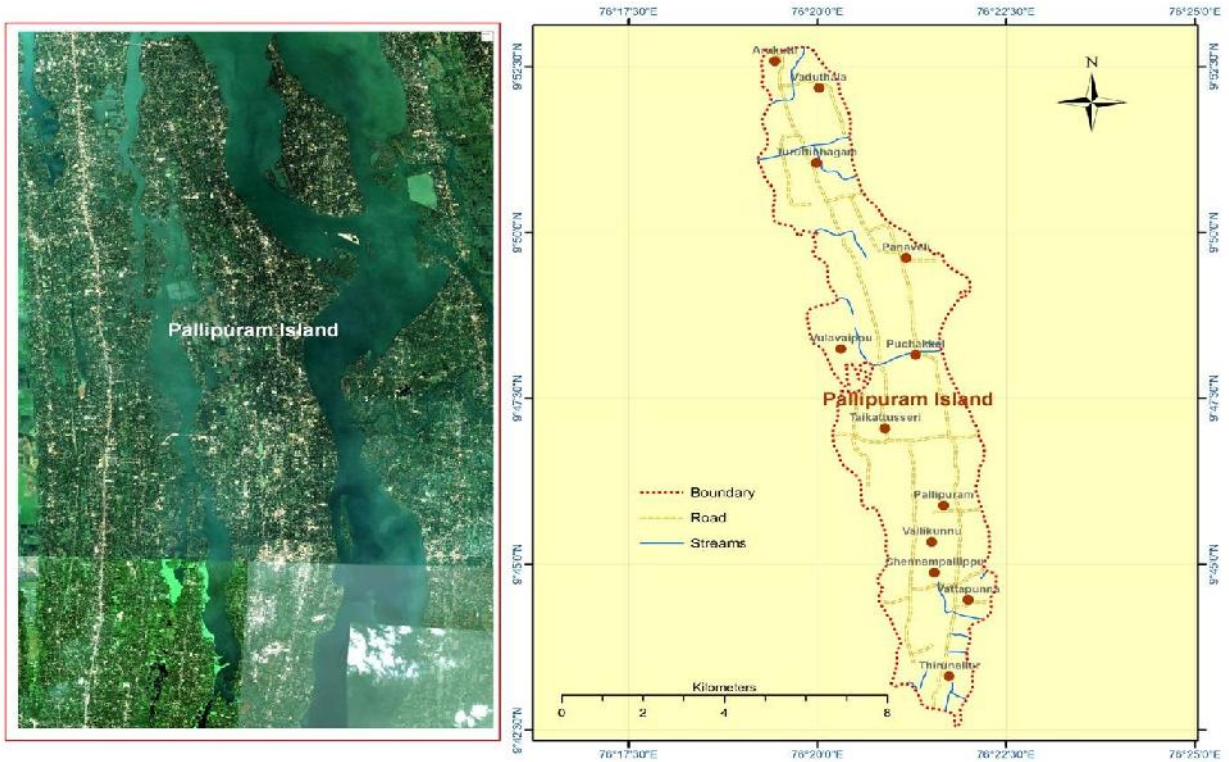

Fig. 3. Map of Pallipuram Island

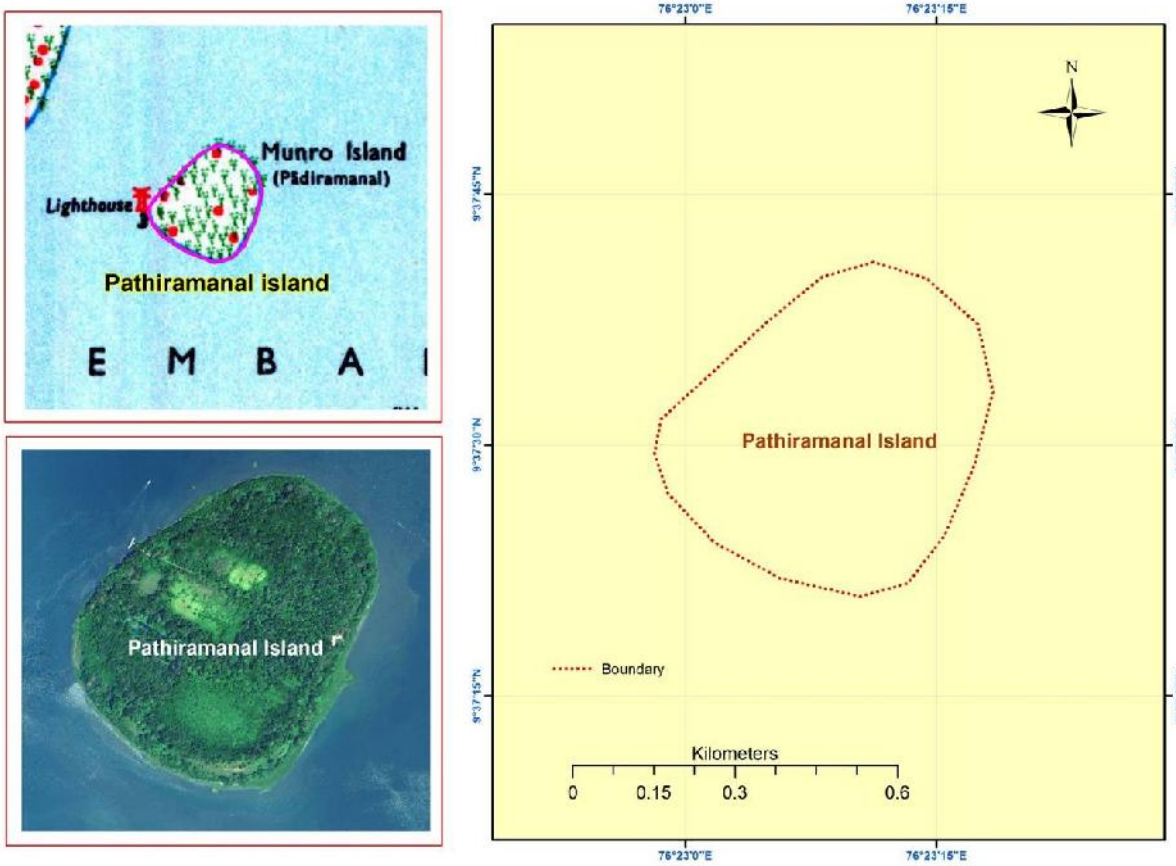

Fig. 4.: Map of Pathiramanal island

Plate 1. (a-h): Images of Perumbalam Island

Plate 2. (a-h). : Images of Pallipuram Island

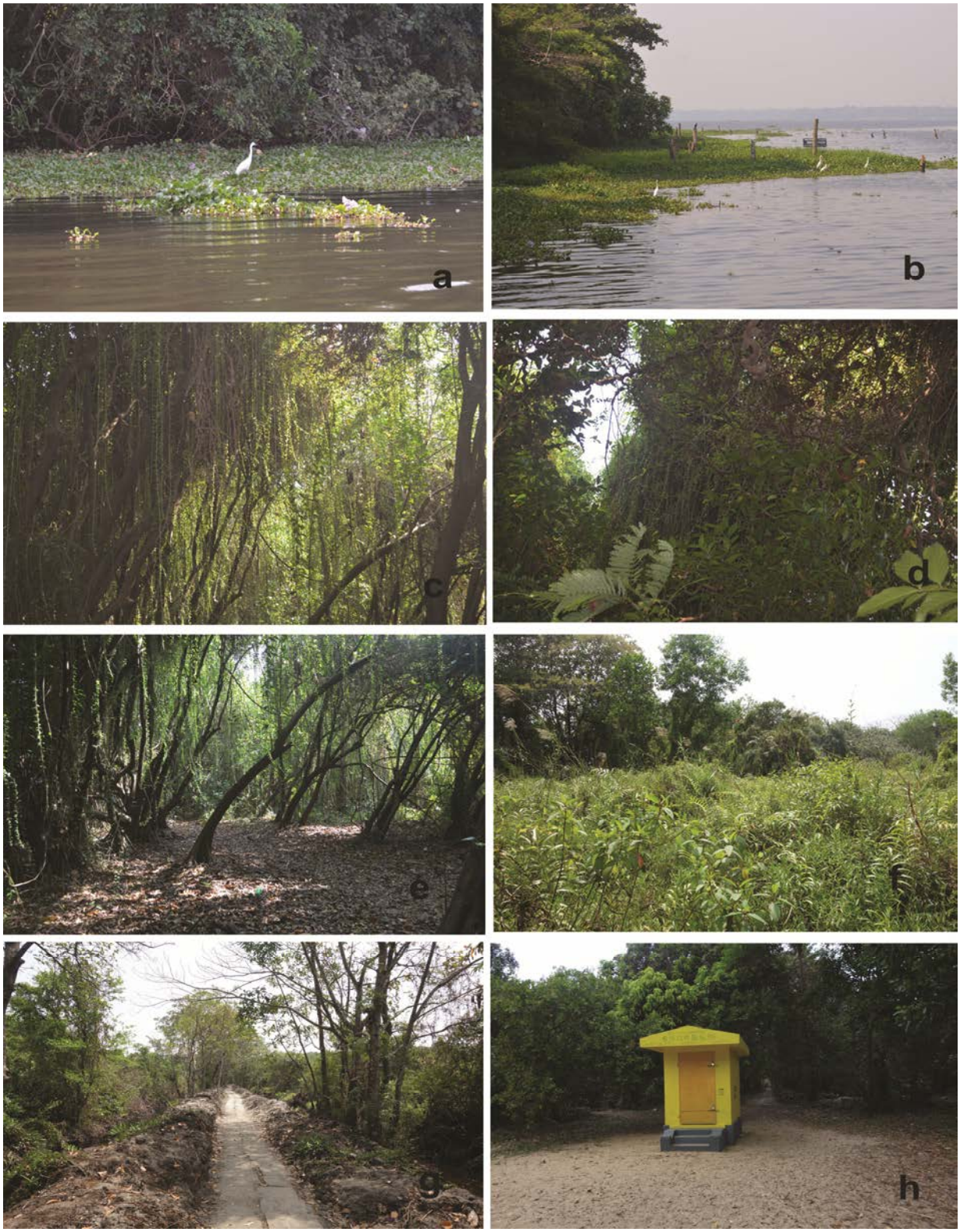

Plate 3. (a-g): Images of Pathiramanal Island

2. METHODOLOGY

2.1. Methods employed for investigation of flora & fauna

Collection trips of duration 1- 5 days were conducted at regular intervals during 2018-2019 to different habitats of islands. The specimens were collected in polythene bags to prevent desiccation. The field data with respect to habit, habitat, phenology, colour and morphology, of the collected specimens were noted in the field book. Phenological details were noted during subsequent visits. Photographs were taken using Canon EOS 500D, Coolpix S 210 and Canon Power Shot SX 260 HS. Two specimens of each species were collected from different locations to study the range of variations. Field data including height, colour and nature of bark, colour of latex/exudates, presence of buttress, odour and colour of vegetative and floral parts were recorded in the field book. Separate collections were made for both male and females. The collected specimens were preserved using 70% methylated alcohol/ 5% solution of formaldehyde by wet method (Fosberg & Sachet, 1965). The herbarium specimens were prepared as per the standard specifications (Fosberg & Sachet, 1965; Bridson & Forman, 1991). The collected specimens were brought to lab, critically analyzed using WILD M3Z Leica Stereo 19 microscope and described. The specimens were provisionally identified by using pertinent literatures and cross-compared with authentic herbarium specimens of the Kerala Forest Research Institute (KFRI), Calicut University (CALI), Jawaharlal Nehru Tropical Botanical Garden (TBGT) and CMS College, Kottayam. Selected specimens were compared with protologues. Type specimens were also consulted in few required cases. Animals including fishes were also collected and analyzed with conventional tools.

2.2. Spread ecology of mangroves

For accurate analysis, distribution patterns of mangroves in each zonations were studied using species area method and quadrat analysis with in each locations (Michael, 1998) 50 quadrats each of 10 x 10 m size were taken on the basis of data obtained. Density, frequency, basal area and their relative values and importance value index (IVI) of mangrove species were calculated by following standard Phytosociological methods (Curtis and Mclntosh, 1951). Girth of trees exceeding 15cm diameter at breast height (dbh, at 1.37m above the ground) was measured. In order to determine the quantitative relationship between the plant species, the subsequent parameters were determined. For getting exact idea about the distribution of mangroves, we calculated and interpreted the abundance of the mangroves of each island.

Plate 4. (a-c): Field study

2.3. Spread ecology of weeds

Distribution patterns of weeds in each zonations were studied using species area method and quadrate analysis within each locations (Michael, 1998). 20 quadrates in each habitat of 10 x 40 m size were taken on the basis of data obtained. A total of 100 quadrates (20 x 5 habitats) were estimated. Density, frequency, basal area and their relative values and importance value index (IVI) of plant species were calculated by following standard Phytosociological methods (Curtis and Mclntosh, 1951). The IVI for the species was determined as the sum of the relative frequency, relative density and relative dominance (Curtis, 1959).

Plate *5* (a-e): Field study

2.4. Assessment of conservation status

Endemics: Endemism and species richness are provided since these data have much significance in global prioritization for conservation efforts. A checklist of endemic plants and animals from the study area was prepared based on the earlier works (Rao, 1972; Ramachandran et al., 2010, Nair 1980a, 1980b; Sasidharan, 2013; and online repositories). The Status analysis of each specimen was done by cross comparison with the authentic herbarium specimens/pertinent literatures. Relevant information on distribution aspects (Asiatic, Indian, South Indian, Peninsular Indian, Western Ghats and southern Western Ghats) of endemic species were gathered from pertinent literature.

2.5. Assessment of effect of flood in flora, fauna and livelihood

Soil analysis: Changes in the soil analyzed by P^H assessment. 10 samples from each islands were collected and assessed through general protocol.

Semi structured interview: Effect of flood in the islands were assessed by a series of interview. During the field trips, interviews were conducted with old men, fishermen and women in the islands using a semi structured interview schedule (Annex.1). The information collected from them were cross checked with prior data inscripted.

Cross checking of secondary data: An earnest attempt made by cross compared the collected data with secondary data such as Sunil & Sivadasan (2009), SES (2013) etc.

3. REVIEW OF EARLIER WORKS

A brief review of literature with special reference to earlier works on flora, fauna, rarity and endemism and studies on invasive plants are presented below under appropriate heads.

3.1. Flora

`The oldest literary record about plant species in India is found in the ancient Sanskrit literature viz., *Rig Veda* and other three *Vedas* dating from around 3000 BC. The great Rishi, *Valmiki* recorded the uses of medicinal plants in his epic *Ramayana*. The excavations made in the Indus Valley have revealed indications regarding the uses of medicinal plants like Black pepper, Cinnamon, Turmeric and Cardamom. The medicinal properties of plants have also been mentioned in the writings of *Susrutha* dating back to 500 BC. There are innumerable citations by Hiuen Tsang (629 AD), Masudi of Baghad (890-956 AD), Abul Feda (1273-1331 AD) about the plant wealth of India. Marco Polo (1298 AD) mentioned about ginger plant (*Quilon Ginger)* that was cultivated in Malabar (Malhothra, 2000). The European countries particularly Spain, UK, and Portugal showed keen interest in the plant wealth of India, especially from southern part of Western Ghats. *Coloquis dos Simples* (a checklist of medicinal plants of India) written by Garcia de Orta (1565) is considered as the first published Botanical work on the plants of Western Ghats. Realizing the importance of spices and medicinal plants of Malabar region, Hendrich Adrian Van Rheede (1636-1691), the then Dutch admiral of Malabar, took special interest to collect and document the plant wealth of Malabar area. He took strenuous effort to document the indigenous uses of plants with the help of local traditional vaidyans viz., Itti Achuthen, Appu Bhat, Ranga Bhat and Vinayaka Panditt. A detailed descriptions of 781 plants species with sketches, habit, habitat, medicinal and other uses were published in 12 volumes during 1678-1693.

Icones Plantarum Indiae Orientalis published in six volumes during the period 1838-1853, Illustrations of Indian Botany published in the year 1840 and the work in collaboration with Walker-Arnott (1834) viz., Prodromus Florae Peninsulae Indiae Orientalis are some important classical works on the flora of Peninsular India by Wight (1838-1853, 1840, 1834). The classical works of Beddome (1868-74, 1869-74) on angiosperm flora of India are: 'Icons Plantarum Indiae Orientalis' published during the period 1868-1874 and 'The Flora Sylvatica for Southern India' during the period 1869- 1874. The work of Roxburgh (1820, 1824), Flora Indica was a landmark towards the compilation of the flora of India. The seven volume work, 'The Flora of British India' by Hooker (1872-1897) dealt with the flora of erstwhile British India. It is followed by 'The Flora of the Presidency of Bombay' by Cooke (1901-1908) and 'The Flora of the Presidency of Madras' by Gamble (1915-1936). The work of Gamble (1915-1936) is considered as the best

among the regional floras. Meanwhile, the first comprehensive work on 582 indigenous trees of Travancore entitled The Forest Trees of Travancore, was published by Bourdillon (1908). Subsequent floristic works were done by Rao (1914), Lushington (1915), Fischer (1921) and Fyson(1932). The works of Burkil (1965) entitled 'The Chapters on the History of Botany in India' and that of Joseph (1977) on 'Floristic studies in India-with special reference to Southern Circle of Botanical Survey of India' are the compilation of the contributions of various botanists. Many studies were undertaken on the regional floras by the initiative of Botanical Survey of India primarily with the objective of preparing a complete and comprehensive flora of India. The Flora of Tamil Nadu, India. Vol. I-III (Nair & Henry, 1983; Henry et al., 1987, 1989) was published as part of aforementioned project. Subsequent works on regional floras of Kerala either completed or being completed are: Floristic studies of Idukki District (Vivekananthan, 1981); The Flora of Calicut (Manilal & Sivarajan, 1982); Flora of Quilon District (Mohanan, 1984); Studies on the Flora of Kasaragod Division, Cannanore District (Ansari, 1985); Flora of Palghat (Subramanian et al., 1987); Flora of Silent Valley (Manilal, 1988); Flora of Cannanore (Ramachandran & Nair, 1988); Flora of Kottayam District (Antony, 1989); Flora of Malappuram District excluding Nilambur Forests (Babu, 1990); Flora of Palghat (Vajrevelu, l990); Observations on the Aquatic Angiosperms of Malabar (Joseph, 1991); Flora of Pathanamthitta District (Anil Kumar, 1993); Flora of Thiruvananthapuram (Mohanan & Henry, 1994); Flora of Thenmala Forest Division (Subramaniyan, 1995); Flowering Plants of Thrissur Forests (Sasidharan & Sivarajan, 1996); Flora of Nilambur (Sivarajan & Mathew, 1996); Shenduruny Wildlife Sanctuary (Sasidharan, 1997); Epiphytic Flora in the Tropical Ecosystem of Western Ghats (Muktesh, 1998); Periyar Tiger Reserve (Sasidharan, 1998); Chinnar Wildlife Sanctuary (Sasidharan, 1999); Floristic Studies in Vellarimala (Pradeep, 2000); Studies on Flowering Plants Diversity of Alappuzha District, Kerala (Sunil &Sivadasan, 2000), The flora of protected areas such as Agasthyamala (Mohanan & Sivadasan, 2002); Parambikulam Wildlife Sanctuary (Sasidharan, 2002); Flowering Plants of Kerala (Sasidharan, 2004); Floristic Study of Wayanad District with special emphasis on conservation of rare and threatened Flowering Plants (Narayanan, 2009); Riverine flora of Pamba River Basin (George, 2013) and Flowering plants of Kerala (Sasidharan, 2013).

Endemic taxa are essentially restricted to a specified geographical area. Tropical forests show a high degree of species richness and endemism (Orians & Groom, 2005). Endemic plant species in India has been estimated as 33% with *ca.* 140 endemic genera but no endemic families (Sheeba & Narasimhan, 2013.). Out of 150 important botanical sites identified for conservation action by the World Conservation Monitoring Center (WCMC), five locations are in India including the Western Ghats (IUCN, 1987). The high percentage of endemism in the Western Ghats resembles oceanic islands (Subramanyam & Nayar, 1974). The species richness in the Western Ghats is due to varied latitudinal and altitudinal gradients with varied rainfall and temperature. These geographical peculiarities also favour a high degree of endemism. As

Nayar (1996) rightly point out endemic species in peninsular region are paleoendemics that are found in hills of Peninsular India. Rarity is also considered as another natural phenomenon that arises by physical, chemical, biological and anthropogenic intrusions. Many studies were done by earlier researchers to assess the rare and endemic angiosperms (Cooke, 1901 – 1908; Chatterjee, 1939, Chatterjee, 1940; Wherry, 1944; Henry et al., 1978; Rao, 1972, 1979; Jain & Sastry, 1980, 1982, 1984; Nayar, 1980, 1982; Bhaskar, 1981; Abraham & Mehrotra, 1982; Ahmedullah & Nayar, 1987; Nayar & Sastry, 1987, 1988, 1990; Vajravelu, 1987, 1988; Binojkumar & Balakrishnan, 1991; Ramesh et al., 1991; Bhattacharyya & Kumar, 1992; Sarkar, 1995; Nayar, 1996; Ramesh & Pascal, 1997; Ahmedullah, 2000; Gopalan & Henry, 2000; Sasidharan, 2004; Joshi & Janarthanam, 2004; Nayar et al., 2006; Krishnan & Davidar, 2007; Mitra & Mukherjee, 2007; Ramachandran et al., 2010. In a resent investigation, Sasidharan (2013) documented 5091 taxa of flowering plants from Kerala of which 1709 are listed under endemic category and 493 under rare and endangered category. Narayanan (2009) had enumerated 2034 plants from Wayanad District. Among them 596 plants are endemics (29 %) and 138 are facing various threats.

Three genera of native gymnosperms were enlisted from Kerala part of Western Ghats. Of which, only one, Gentum is pointed from Wayanad District.

3.1.1. Studies on mangrove flora

Studies on ecology of mangrove ecosystems and review reports of mangroves in Indian subcontinent appeared from time to time by different authors - Gamble, Champion and Seth, (1968); Krishna Murthy et al. (1981) are the pioneer study in field.

The occurrence of *Acanthus ilicifolius, Avicennia alba, Rhizophora sp.* and *Bruguiera sp.* in small numbers was reported by Kurien (1980). Ramachandran et al. (1986) after very detailed survey along the entire Kerala coast reported 39 mangroves and mangrove associated species. Ramachandran et al. (1985, 1986) observed that mangroves of Kerala were degraded and grew in isolated patches. According to Banerjee et al. (1989) there are 32 species under 24 genera of 19 families are reported from Kerala. However, Basha (1991) has reported only 27 species under 21 genera of 17 families. According to authentic records about 70,000 ha of mangroves once fringed the backwaters of Kerala which now has become reduced to a few isolated patches consisting of a few species (Basha, 1992). Sunil and Sivadasan (2002) conducted study on the mangroves of Central Kerala. In Cochin, mangrove Islands are increasingly threatened by the population pressure and aquaculture operations (Thomas and Fernandes, 1994). Formerly, thriving shrimp production of Cochin back waters has fallen almost too nil as the after effects of extensive mangrove clearance (Mastaller, 1996). The flora is now restricted to small isolated strands along the banks of estuaries and back waters (Joy and Ammini, 1998). The total area of mangroves now existed in Kerala is estimated to be 1671 hectors (Suma, 2000). Suma and Joy (2002) conducted ecological studies on

mangrove and associated flora in the Vypeen block of Kerala. Suma (2005) studied on the diversity of mangroves in Ernakulam district. Status analysis of Mangroves in Thekkumbad, Kannur, Kerala by Sreeja and Khaleel (2010), phytosociological analysis of Mangroves at Kannur district, Kerala conducted by Vidyasagaran et al (2011), the distribution and abundance of mangrove vegetation and associated flora in Kumabalam Island conducted by Arun and Shaji (2013) and plant diversity and structural dynamics of mangroves in the southwest coast of kerala, india by Vijayan et al. (2014) are significant study in the ecology and biodiversity of mangroves of Kerala.

Restoration of mangroves was being carried out in the tropical and subtropical estuaries throughout the world (Field, 1996; Qureshi, 1996; Snedaker and Biber, 1996; Soemodihardjo et al., 1996; Untawale, 1996). Restoration of mangroves started in Indonesia in the early 1960's (Soemodihardjo et al., 1996) and an area of about 38,923 ha of mangroves were restored till 1992. Macnae, (1968) planted *Rhizophora apiculata* in the newly accreted soils in Sri Lanka for better stabilization of the area and to facilitate the trapping of sediments. Mangrove forest restoration in Andhra Pradesh, India by Ramasubramanian and Ravishankar (2013) is significant movement in India. Mangrove restoration efforts by Pokkudan in Northern Kerala, Mathrubhumi seeds and Forest Department of Kerala are highly appreciable.

3.2. Fauna

The Zoological Survey of India (ZSI) has published faunal series on the States of Orissa (1987), West Bengal (1992), Meghalaya (1995), Delhi (1997), Gujarat (2000), Sikkim (2003), Manipur (2004), Nagaland (2006), Arunachal Pradesh (2006), Mizoram (2007), Goa (2008), Tamil Nadu (2009), Meghalaya (2012), Andaman & Nicobar Islands (2012), Uttarakhand (2012). In addition there are also some independent checklists for mammals, birds, reptiles, amphibians and fishes from Kerala, and this compilation is a natural extension at integrating all of them.

3.3. Invasive plants

It is only in the last three or four decades that the focus of conservation in India has broadened to include not only species, but unique habitats and ecosystems. Invasive plant species in Indian protected areas have received relatively little attention. Only few studies were undertaken on the protected areas in India for which published information on invasive alien plants is available. Of which, most of the studies were concentrated only on *Lantana camera*, *Chromolaena odorata* and *Prosopis juliflora*. Studies in Kalakad Mundanturai Tiger Reserve (Chandrasekaran & Swamy, 2010); Protected forests of Anamalais (Joshi *et al.*, 2009); Greater Nicobar Biosphere Reserve (Babu & Leighton, 2004); North-eastern India (Gogoi, 2001); Achanakmar- Amarkantak Biosphere Reserve (Sahu & Singh, 2008; Shukla *et al.*, 2009); Mudumalai National Park (Mahajan & Azeez, 2001; Ramaswami & Sukumar 2011); Biligiri Rangaswamy

Temple Tiger Reserve (Murali & Setty, 2001; Sundaram & Hiremath, 2012; Bandipur National Park (Puyravaud *et al.,* 1995; Prasad,2009; 2010; 2012); Melghat Tiger Reserve (Sawarkar,1984); Tadoba-Andhari Tiger Reserve (Giradkar & Yeragi, 2008); Kumbalgarh Wildlife Sanctuary (Waite *et al.,* 2009); Ranthambore National Park (Dayal, 2007); Corbett Tiger Reserve (Babu *et al.*, 2009; Love *et al.*, 2009); Rajaji National Park (Rishi, 2009; Kimothi & Dasari, 2010; Kimothi et al., 2010); Valley of Flowers National Park (Saberwal *et al.,* 2000; Kala & Shrivastava, 2004); Mukurti National Park (Zarri *et al.,*2006; Srinivasan *et al.,*2007; Srinivasan, 2011); Kaziranga National Park (Vattakkavan *et al.*, 2005; Lahkar *et al.*, 2011); Orang National Park (Lahkar *et al.*, 2011); Pabitora Wildlife Sanctuary (Lahkar *et al.*, 2011); Manas National Park (Lahkar *et al.,* 2011); Jaldapara Wildlife Sanctuary (Lahkar e*t al.*,2011); Garumara Wildlife Sanctuary (Lahkar *et al.*,2011); Gulf of Mannar Marine Biosphere Reserve (Bagla, 2008; Chandrasekaran *et al.*, 2008; Namboothri & Shankar 2010) were published and are considered as the relevant studies on the invasive plants species in India. Besides that, a comprehensive list of invasive species in India has been prepared by Reddy (2008). The Ministry of Environment and Forests, Govt.of India has also collected information on invasive species in India (www.apfisn.net). Sankaran & Suresh (2013) have given comprehensive information on invasive plants in the forests of Asia - Pacific.

In Kerala, only few studies on invasive plants in protected areas were carried out (Abraham & Abraham, 2005; Sajeev *et al.,* 2012; Sankaran *et al.*, 2001; Sankaran and Srinivasan, 2001 and Chandrashekara, 1999). In addition to that, Handbook on Invasive plants of Kerala (Sankaran *et al.*, 2012) has been prepared.

Many studies on plant invasion have been undertaken by earlier researchers. However, a perusal of these literatures revealed that no in-depth studies on inventory and evaluation of spread ecology of the weeds in northern Kerala were conducted with special reference to these regions. It is expected that the present investigation in the islands of Alappuzha District will provide additional information for conservation measures to be employed to protect the indigenous biodiversity.

4. RESULTS & DISCUSSION

The floristic, faunal and phytosociological studies conducted in three islands of Vembanad Lake viz., Perumbalam, Pallipuram and Pathiramanal of Alappuzha District were subjected to systematic treatment and reasoning. The results emerged from the analysis are described here.

4.1. Species composition in each island

A detailed survey was conducted to enumerate the species composition and also to identify the general status of the plants and animals of these three islands. The results obtained from the survey during the year 2018 are presented here. A comprehensive checklist with due emphasis on dominant families, endemism, threatened plants etc are given in separate sections.

4.1.1. Floristic analysis

Floristic elements of the islands were collected and identified by taxonomical methods. Plants in the islands were categorized and examined as flowering plants, pteridophytes and gymnosperms. 421 Angiosperms, 14 Pteridophytes and 1 Gymnosperm were enumerated from the study area. Categorization of floristic elements presented below.

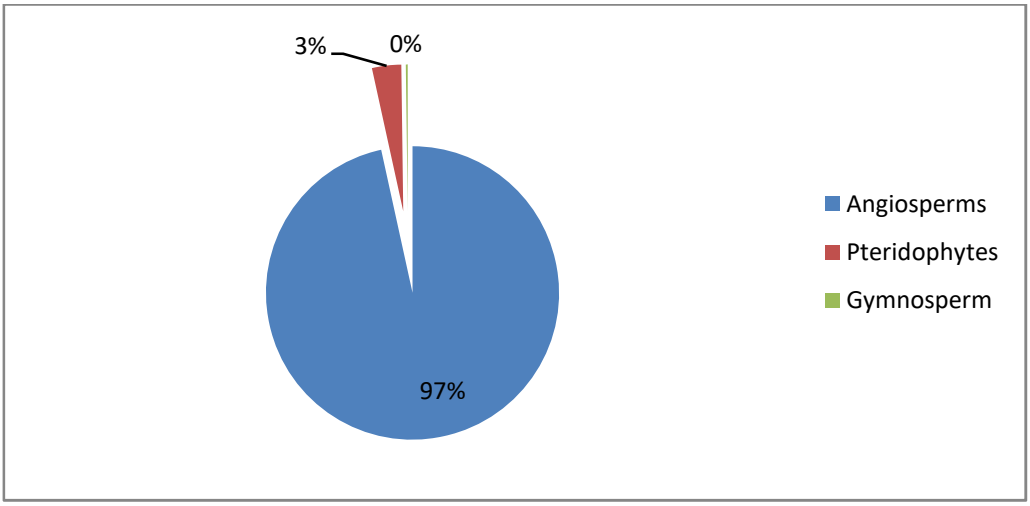

Fig.5. Categorization of floristic elements in the islands

4.1.1.1. Angiosperms

The floristic analysis resulted in the documentation of 421 flowering plants belonging to 384 genera of 116 families. 23 elements of which are endemic too. As revealed from the habit wise analysis of the

collected specimens, majority of the species fall under herbs (51%) followed by trees (18%), shrubs (17 %) and climbers (14%).

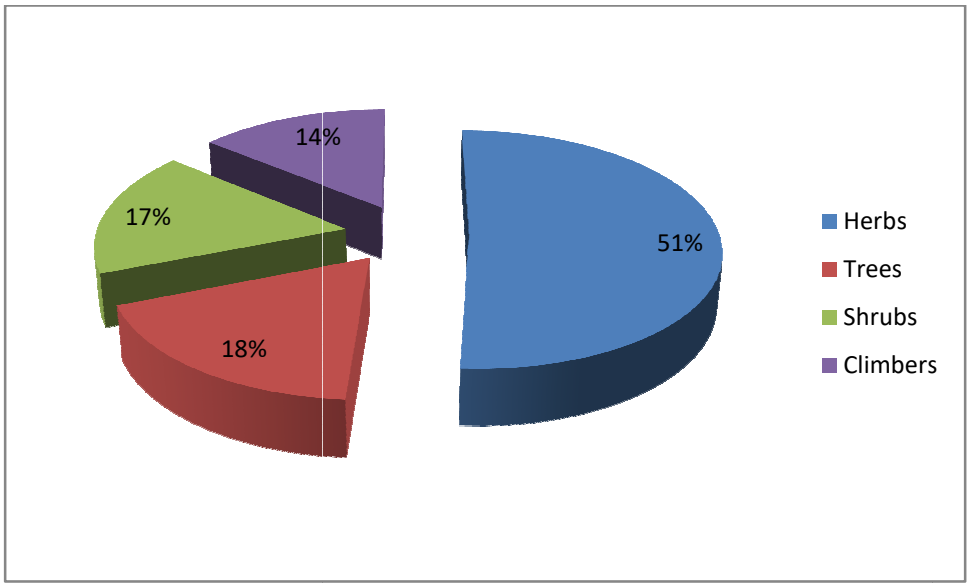

Fig. 6 : Habit wise categorization of angiosperms in the islands of Alappuzha

As revealed from the study, Perumbalam Island has 402 species coming under 362 genera. In the same manner, Pallipuram Islands holds 321 species of 299 genera. In Pathiramanal Island, its number is reduced to 157 species under 141 genera.

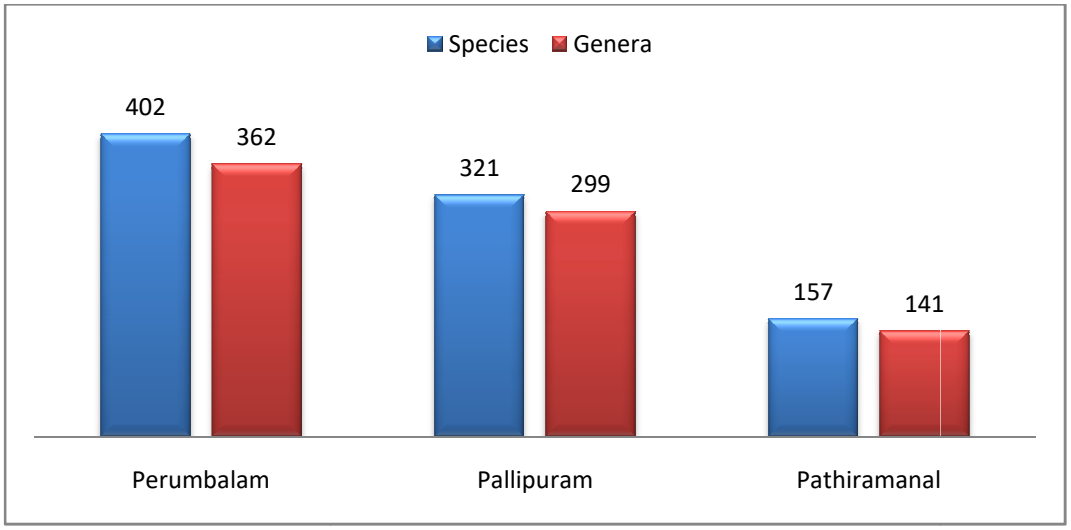

Fig.7. Bar diagram shows the wealth of angiosperms in each islands

Fabaceae, with 27 taxa is the largest family followed by Poaceae (25 species), Euphorbiaceae (21 species), Asteraceae (19 species), Convolvulaceae (18 species), Rubiaceae (18 species), Cyperacaceae (14 species), Moraceae (11 species), Acanthaceae (11 species), Scrophulariaceae (11 species). These dominant families constitute 39.42% of the total number of species.

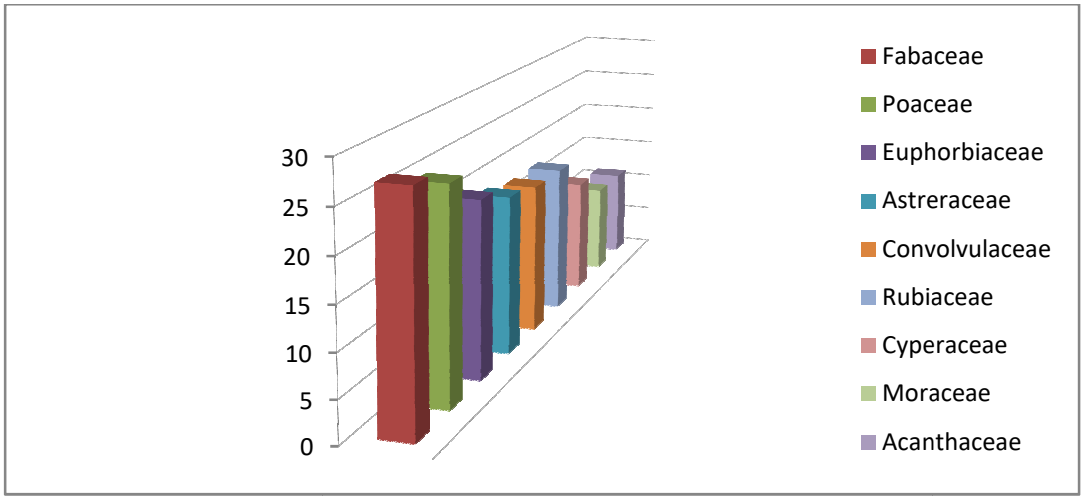

Fig. 8. Dominant families in the study area

4.1.1.1.1.. Non indigenous taxa of the study area

The flora of India as a whole has been enriched by the intrusive elements from other parts of Asia, Europe, tropical Africa, tropical America and Australia (Mani, 1974). Out of 421 plants identified from the study area, 171 plant taxa are non indigenous including naturalized plants, alien/invasive plants, transformers and weeds. The non indigenous taxa of these islands flora exhibit a trend of affinity of Pantropical elements (49 spp.) > Tropical elements (39 spp.) > Paleotropic elements (21 spp.) > African elements (17 spp.) > American elements (15 spp.) > Australasia (11 spp.) > Orientals/Asia (8 spp.) > Cosmopolitan (6 spp.) > European (5 spp.). Most of the African- American species located in the study area are fast spreading weeds. *Commelina benghalensis, Centotheca lappacea, Synedrella nodiflora* and *Spermacoce articularis* are examples of African elements. *Alternanthera brasiliana, Centrosema molle* and *Eleutheranthera ruderalis* are American elements. *Lantana camara, Solanum americanum, Mikania cordata, Mimosa diplotricha* and *Chromolaena odorata* are fast spreading aggressive weeds observed in the study area.

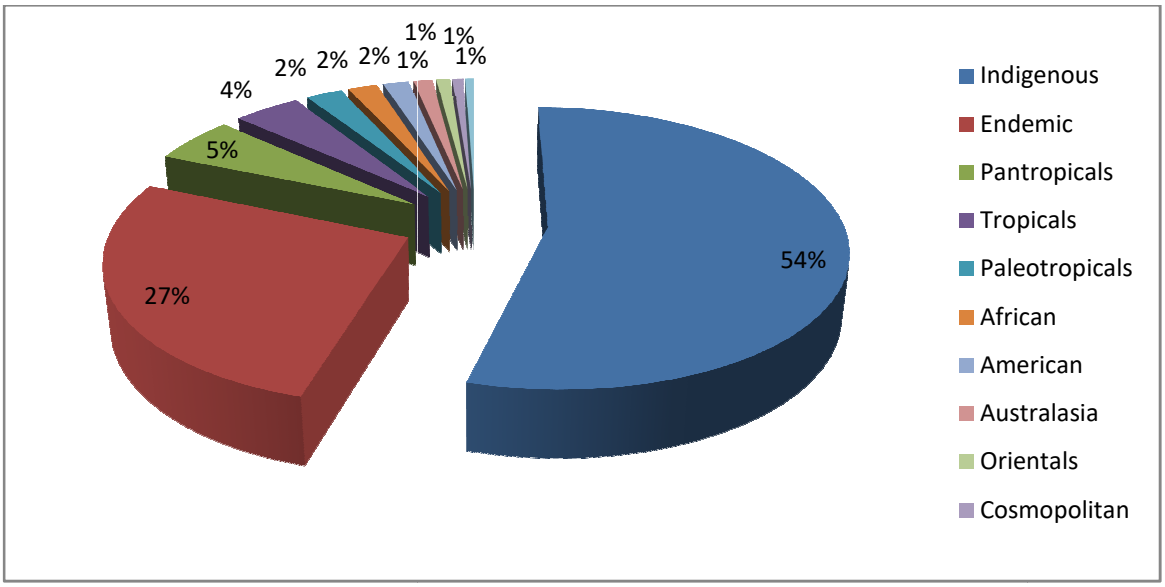

Fig.5. Phytogeographic affinities of the flora of Islands of Alappuzha

4.1.1.2. Non flowering plants

14 Pteridophytes coming under 13 genera of 7 seven families were enumerated from the study area. All of these elements were enumerated from Perumbalam and Pallipuram Islands. In Pathiramanal Island its number reduced to 13. And in the case of Gymnosperm, Gentum (only one genus) is enumerated from the sacred grove forests of Perumbalam Island.

Table 1. PLANTS

A. FLOWERING PLANTS

Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1	*Acanthus ilicifolius* L.	Acanthaceae	√	√	√	
2	*Andrographis echioides* (L.) Nees		√	√		
3	*Asystasia gangetica* (L.) Anders. ssp. *gangetica* Hook. f.		√	√		
4	*Dipteracanthus prostrates* (Poir.) Nees		√	√		E
5	*Hygrophila ringens* (L.) Steud		√	√	√	
6	*Justicia betonica* L.var. *betonica* Hook. f.		√	√		
7	*Lepidagathis incurva* Buch.-Ham. ex D.Don var. *incurva* Manilal & Sivar.		√	√		
8	*Phaulopsis imbricata* (Forssk.) Sweet.		√			
9	*Ruellia tuberosa* L.		√	√		
10	*Rungia parviflora* (Retz.) Nees		√			
11	*Rungia pectinata* (L.) Nees		√	√		
12	*Trianthema portulacastrum* L.	Aizoaceae	√	√	√	
13	*Limnocharis flava* (L.) Buch.	Alismataceae	√	√		
14	*Achyranthes aspera* L.*var. aspera* Hook. f.	Amaranthaceae	√	√	√	
15	*Aerva lanata* (L.) Juss.		√	√	√	
16	*Alternanthera brasiliana* (L.) Kuntze		√	√		
17	*Alternanthera philoxeroides* (Mart.) Grisb.		√	√	√	
18	*Alternanthera sessilis* (L.) R.Br. ex DC.		√	√	√	
19	*Amaranthus spinosus* L.		√		√	
20	*Amaranthus viridis* L.		√	√		
21	*Cyathula prostrata* (L.) Blume		√	√	√	
22	*Hymenocallis littoralis* (Jacq.) Salisb.	Amaryllidaceae	√		√	
23	*Scadoxus multiflorus* (Martyn) Raf.		√	√		
24	*Holigarna arnottiana* Hook.f.	Anacardiaceae	√	√	√	E
25	*Lannea coromandelica* (Houtt.) Merr		√	√	√	
26	*Mangifera indica* L.		√	√		
27	*Spondias pinnata* (L. f.) Kurz		√	√		
28	*Annona glabra* L.	Annonaceae	√	√	√	
29	*Polyalthia longifolia* (Sonner.) Thw.		√			

30	*Uvaria narum* (Dunal) Wall. ex Hook.f. & Thoms		√	√		
31	*Centella asiatica* (L.) Urb.	Apiaceae	√	√	√	
32	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	√	√	√	
33	*Anodendron paniculatum* (Roxb.) A. DC.		√			
34	*Cerbera odollam* Gaertn.		√	√	√	
35	*Chonemorpha fragrans* (Moon) Alston		√	√		
36	*Ichnocarpus frutescens* (L.) W.T.Aiton		√	√	√	
37	*Parsonsia indoora* (Lour.) M. R. & S. M. Almeida		√	√	√	
38	*Strophanthus wightianus* Wall. ex Wight		√			E
39	*Tabernaemontana alternifolia* L.		√	√	√	E
40	*Aponogeton natans* (L.) Engl. & Krause	Aponogetonaceae	√	√		
41	*Caladium bicolor* (Ait. ex Dryand.) Vent.	Araceae	√	√	√	
42	*Colocasia esculenta* (L.) Schott		√	√	√	
43	*Lagenandra ovata* (L.) Thw.				√	
44	*Pistia stratiotes* L.		√	√	√	
45	*Pothos scandens* L		√	√	√	
46	*Areca catechu* L	Arecaceae	√	√		
47	*Borassus flabellifer* L. (Introduced)		√	√		
48	*Caryota urens* L.		√			
49	*Cocos nucifera* L.		√	√	√	
50	*Aristolochia indica* L.	Aristalochiaceae	√			
51	*Calotropis gigantea* (L.) R. Br.	Asclepiadaceae	√	√	√	
52	*Gymnema sylvestre* (Retz.) R.Br. ex Sm.		√			
53	*Tylophora indica* (Burm. f.) Merr.		√	√		
54	var. *indica* Manilal & Sivar		√	√		
55	*Tylophora tetrapetala* var.*tetrapetala* Sasidh. & Sivar.		√	√	√	
56	*Wattakaka volubilis* (L. f.) Stapf		√	√	√	
57	*Chromolaena odorata* (L.) King & Robins.	Asteraceae	√	√	√	
58	*Crassocephalum crepidioides* (Benth.) S.Moore		√			

59	*Eclipta prostrata* (L.) L.		√	√	√	
60	*Elephantopus scaber* L.		√	√	√	
61	*Emilia sonchifolia* (L.) DC. ex DC.		√	√	√	
62	*Epaltes divaricata* (L.) Cass.		√			
63	*Grangea maderaspatana* (L.) Poir.		√	√		
64	*Mikania micrantha* Kunth		√	√	√	
65	*Sphaeranthus africanus* L.		√	√		
66	*Sphaeranthus indicus* L.		√		√	
67	*Spilanthes ciliata* HBK		√			
68	*Spilanthes radicans* Jacq.		√	√		
69	*Struchium sparganophorum* (L.) O. Ktze		√			
70	*Synedrella nodiflora* (L.) Gaertn.		√		√	
71	*Tridax procumbens* (L.) L.		√	√	√	
72	*Vernonia cinerea* (L.) Less.		√	√	√	
73	*Vernonia elliptica* DC.				√	
74	*Wedelia chinensis* (Osbeck) Merr.		√	√	√	
75	*Wedelia trilobata* (L.) A. S. Hitchc.		√	√		
76	*Avicennia officinalis* L.	Avicenniaceae	√	√	√	
77	*Impatiens diversifolia* B.Heyne ex Wight & Arn.	Balsaminaceae	√	√		E
78	*Ceiba pentandra* (L.) Gaertn.	Bombacaceae	√			
79	*Coldenia procumbens* L.	Boraginaceae	√	√		
80	*Heliotropium indicum* L		√		√	
81	*Burmannia coelestis* D.Don	Burmanniaceae	√	√		
82	*Rorippa indica* (L.) Hiern	Brassicaceae	√			
83	*Ananas comosus* (L.) Merr.	Bromeliaceae	√	√		
84	*Cabomba caroliniana* Gray	Cabombaceae	√	√		
85	*Sphenoclea zeylanica* Gaertn.	Campanulaceae	√	√		
86	*Cleome monophylla* L.	Capparaceae	√	√	√	
87	*Cleome viscosa* L.		√	√	√	
88	*Gynandropsis gynandra* (L.) Briq.		√	√		
89	*Polycarpon prostratum* (Forssk.) Asch. & Sehweinf.	Caryophyllaceae	√	√	√	

90	*Lophopetalum wightianum* Arn.	Celastraceae	√	√		
91	*Calophyllum inophyllum* L.	Clusiaceae	√	√	√	
92	*Garcinia gummi-gutta* (L.) Robs., var. *gummi-gutta* Mohanan		√	√		
93	*Calycopteris floribunda* Lam.	Combretaceae	√	√	√	
94	*Quisqualis indica* L.		√	√		
95	*Terminalia catappa* L.		√	√	√	
96	*Commelina benghalensis* L.	Commelinaceae	√	√	√	
97	*Commelina diffusa* Burm. f.		√	√		
98	*Cyanotis axillaris* (L.) D.Don ex Sweet		√	√	√	
99	*Murdannia crocea* (Griff.) Faden ssp.*ochracea* (Dalz.) Faden			√		
100	*Murdannia pauciflora* (Wight) Brueck.			√		
101	*Murdannia vaginata* (L.) Brueck		√			
102	*Connarus monocarpus* L.	Connaraceae	√		√	
103	*Rourea minor* (Gaertn.) Merr.		√	√		
104	*Aniseia martinicensis* (Jacq.) Choisy	Convolvulaceae	√	√	√	
105	*Cuscuta chinensis* Lam.		√	√		
106	*Erycibe paniculata* Roxb.		√			
107	*Evolvulus nummularius* (L.) L.		√	√	√	
108	*Hewittia malabarica* (L.) Suresh		√	√		
109	*Ipomoea aquatica* Forssk.		√	√		
110	*Ipomoea cairica* (L.) Sweet		√	√	√	
111	*Ipomoea carnea* Jack. ssp. *fistulosa* (Mart. ex Choisy) Austin		√	√		
112	*Ipomoea hederifolia* L.		√	√		
113	*Ipomoea marginata* (Desr.) Manitz, f. *marginata* Babu		√	√		
114	*Ipomoea pes-caprae* (L.) R. Br. ssp.*pes-caprae*; Gamble		√			
115	*Ipomoea obscura* (L.) Ker-Gawl.		√		√	
116	Ipomoea pes-tigridis L.		√	√		
117	*Merremia hederacea* (Burm. f.) Hall. f.		√	√		
118	*Merremia umbellata* (L.) Hall. f.		√	√	√	
119	*Merremia vitifolia* (Burm. f.) Hall. f.		√	√	√	

120	*Xenostegia tridentata* (L.) Austin & Staples		√	√		
121	*Aniseia martinicensis* (Jacq.) Choisy		√	√		
122	*Costus speciosus* (Koenig) J.E. Smith	Costaceae	√	√	√	
123	*Bryophyllum pinnatum* (Lam.) Kurz	Crassulaceae	√	√		
124	*Coccinia grandis* (L.) Voight	Cucurbitaceae	√	√		
125	*Diplocyclos palmatus* (L.) Jeffrey		√			
126	*Luffa cylindrica* (L.) Roem.		√	√		
127	*Mukia maderaspatana* (L.) Roem.		√	√		
128	*Bulbostylis barbata* ssp. *barbata* Gamble	Cyperaceae	√	√		
129	*Cyperus compactus* Retz.		√	√	√	
130	*Cyperus cyperinus* (Retz.) Sur.		√	√	√	
131	*Cyperus digitatus* Roxb.			√		
132	*Cyperus javanicus* Houtt.		√	√		
133	*Cyperus tenuispica* Steud.		√	√		
134	*Fimbristylis aestivalis* Vahl ssp.*aestivalis* Hook. f.		√	√		
135	*Fimbristylis microcarya* Muller		√		√	
136	*Fuirena ciliaris* (L.) Roxb.		√	√		
137	*Kyllinga brevifolia* Rottb. var. *brevifolia*; Hook. f.		√	√	√	
138	*Kyllinga nemoralis* (J. R & G. Forst.) Dandy ex Hutch. & Dalz.		√	√		
139	*Pycreus puncticulatus* (Vahl) Nees		√	√		
140	*Schoenoplectiella articulata* (L.) Lye		√		√	
141	*Tetracera akara* (Burm. f.) Merr.	Dilleniaceae	√		√	
142	*Dioscorea bulbifera* L.	Dioscoreaceae	√	√		
143	*Hopea parviflora* Bedd.	Dipterocarpacea e	√	√		E
144	*Vateria indica* L.		√	√		E
145	*Diospyros peregrina* (Gaertn.) Gurke	Ebenaceae	√			
146	*Elaeocarpus serratus* L. var.*serratus* Hook. f.	Elaeocarpaceae	√	√		
147	*Muntingia calabura* L		√	√	√	
148	*Eriocaulon heterolepis* Steud.	Eriocaulaceae	√			E
149	*Eriocaulon sexangulare* L.		√	√		
150	*Acalypha indica* L.	Euphorbiaceae	√	√		

151	*Acalypha malabarica* Muell.-Arg.		√	√		
152	*Aporosa cardiosperma* (Gaertn.) Merr.		√	√		
153	*Breynia retusa* (Dennst.) Alston		√	√	√	
154	*Briedelia stipularis* (L.) Blume		√	√	√	
155	*Croton bonplandianus* Baill.			√		
156	*Croton hirtus* L'Herit.					
157	*Drypetes sepiaria* (Wight & Arn.) Pax & Hoffm.		√			
158	*Euphorbia heterophylla* L.		√	√		
159	*Euphorbia hirta* L.		√	√	√	
160	*Euphorbia rosea* Retz.		√	√	√	
161	*Euphorbia thymifolia* L.		√	√		
162	*Excoecaria agallocha* L.		√	√	√	
163	*Glochidion zeylanicum* (Gaertn.) A.		√			
164	*Macaranga peltata* (Roxb.) Muell.-Arg		√	√	√	
165	*Micrococca mercurialis* (L.) Benth.		√	√		
166	*Microstachys chamaelea* (L.) Muell.-Arg		√	√	√	
167	*Phyllanthus amarus* Schum. & Thonn.		√	√		
168	*Phyllanthus urinaria* L.		√			
169	*Ricinus communis* L.		√	√	√	
170	*Tragia involucrata* L.		√			
171	*Cassia fistula* L.	Fabaceae –Sub Family: Caesalpiniaceae	√	√		
172	*Chamaecrista mimosoides* (L.) Greene		√			
173	*Senna alata* (L.) Roxb.		√	√	√	
174	*Senna occidentalis* (L.) Link		√	√		
175	*Senna tora* (L.) Roxb.		√	√	√	
176	*Tamarindus indica* L.		√			
177	*Mimosa diplotricha* C. Wight ex Sanvalle	Fabaceae: Subfamily: Mimosaceae	√	√	√	
178	*Mimosa pudica* L.		√	√		
179	*Racosperma auriculiforme* (Benth.) Pedley		√	√	√	
180	*Racosperma mangium* (Willd.) Pedley		√	√		
181	*Aeschynomene aspera* L.		√	√		
182	*Abrus precatorius* L.	Fabaceae: Sub.	√	√	√	

		Family : Papilionaceae				
183	*Alysicarpus vaginalis* (L.) DC. var. *vaginalis* Hook. f.		√	√		
184			√			
185	*Calopogonium mucunoides* Desv.		√			
186	*Canavalia cathartica* Thouars		√	√		
187	*Centrosema molle* Benth.		√	√	√	
188	*Crotalaria verrucosa* L.		√			
189	*Derris scandens* (Roxb.) Benth.		√	√	√	
190	*Derris trifoliata* Lour.		√	√	√	
191	*Desmodium biarticulatum* (L.) F.v. Muell.		√	√		
192	*Geissaspis cristata* Wight & Arn.		√	√		
193	*Gliricidia sepium* (Jacq.) Kunth ex Walp.		√	√		
194	*Indigofera longiracemosa* Boiv. ex Baill.		√			
195	*Mucuna gigantea* (Willd.) DC.				√	
196	*Stylosanthes fruticosa* (Retz.) Alston		√	√		
197	*Tephrosia maxima* (L.) Pers.		√	√		
198	*Vigna adenantha* (Meyer) Marechal		√			
199	*Hydnocarpus pentandra* (Buch.-Ham.) Oken	Flacourtiaceae	√	√	√	
200	*Flagellaria indica* L	Flagellariaceae			√	
201	*Salacia fruticosa* Wall.	Hippocrataceae	√		√	E
202	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	√	√		
203	*Ottelia alismoides* (L.) Pers.		√			
204	*Vallisneria natans* (Lour.) Hara		√	√		
205	*Curculigo orchioides* Gaertn.	Hypoxidaceae	√	√	√	
206	*Sarcostigma kleinii* Wight & Arn.	Icacinaceae	√	√	√	
207	*Anisomeles indica* (L.) Kuntze	Lamiaceae	√	√		
208	*Hyptis capitata* Jacq.		√	√		
209	*Hyptis suaveolens* (L.) Poit.		√	√		
210	*Leucas aspera* (Willd.) Link		√	√	√	
211	*Ocimum americanum* L.		√	√		
212	*Cinnamomum malabatrum* (Burm.f.) J.Presl	Lauraceae	√	√	√	E
213	*Litsea coriacea* (Heyne ex Meisner) Hook. f.		√			E

214	*Persea macrantha* (Nees) Kosterm.		√	√		
215	*Barringtonia racemosa* (L.) Spreng.	Lecythidaceae	√	√	√	
216	*Couroupita guianensis* Aublet		√	√		
217	*Leea indica* (Burm. f.) Merr.	Leeaceae	√	√	√	
218	*Lemna perpusilla*Torrey	Lemnaceae	√	√		
219	*Wolffia globosa* (Roxb.) Hartog & Plas		√	√		
220	*Utricularia aurea* Lour.	Lentibulariaceae	√	√		
221	*Asparagus racemosus* Willd.	Liliaceae	√	√	√	
222	*Gloriosa superba* L.		√	√	√	
223	*Lobelia alsinoides* Lam	Lobeliaceae	√	√		
224	*Strychnos minor* Dennst.	Loganiaceae	√			
225	*Strychnos nux-vomica* L.		√	√		
226	*Dendrophthoe falcata* (L.f.) Ettingsh.	Loranthaceae	√	√		
227	*Helicanthes elastica* (Desr.) Danser		√	√		
228	*Ammannia baccifera* L. ssp.*baccifera* Koehne	Lythraceae	√	√		
229	*Lawsonia inermis* L.		√	√		
230	*Rotala macrandra* Koehne		√			E
231	*Hibiscus hispidissimus* Griff	Malvaceae	√	√		
232	*Hibiscus rosa-sinensis* L.var. *rosa-sinensis* Hook. f.		√	√		
233	*Hibiscus rosa-sinensis* L. var. *schizopetalus* Dyer		√	√		
234	*Hibiscus sabdariffa* L.		√	√		
235	*Hibiscus surattensis* L.		√	√		
236	*Sida acuta* Burm. f.		√	√		
237	*Sida alnifolia* L.,		√	√		
238	*Sida cordifolia* L.		√	√		
239	*Sida rhomboidea* Roxb. ex Fleming		√	√		E
240	*Talipariti tiliaceum* (L.) Fryxell		√	√	√	
241	*Thespesia lampas* (Cav.) Dalz. & Gibs.		√	√	√	
242	*Urena lobata* L.		√	√	√	
243	*Indianthus virgatus* (Roxb.) Suksathan & Borchs.	Marantaceae	√			

244	*Melastoma malabathricum* L.	Melastomataceae	√	√	√	
245	*Memecylon randerianum* SM & MR Almeida				√	E
246	*Memecylon umbellatum* Burm.f.		√	√		
247	*Azadirachta indica* A.Juss.	Meliaceae	√	√		
248	*Swietenia macrophylla* King		√			
249	*Anamirta cocculus* (L.) Wight & Arn.	Menispermaceae	√	√	√	
250	*Cyclea peltata* (Lam.) Hook.f. & Thomson		√	√		
251	*Tiliacora acuminata* (Poir.) Miers ex Hook.f. & Thoms.		√	√	√	
252	*Nymphoides hydrophylla* (Lour.) O. Ktze.	Menyanthaceae	√	√		
253	*Nymphoides indica* (L.) O.Ktze.		√	√		
254	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	√	√		
255	*Mollugo pentaphylla* L		√	√		
256	*Artocarpus heterophyllus* Lam.	Moraceae	√	√	√	
257	*Artocarpus hirsutus* Lam		√	√		E
258	*Artocarpus incisus* (Thunb.) L.f.		√			
259	*Ficus drupacea* Thunb. var. *pubescens* (Roth) Corner		√	√		
260	*Ficus heterophylla* L.f.		√	√		
261	*Ficus hispida* L. f.		√	√	√	
262	*Ficus pumila* L.		√			
263	*Ficus racemosa* L.		√	√		
264	*Ficus religiosa* L.		√	√		
265	*Ficus tinctoria* G. Forst.ssp. *parasitica* (Koen. ex Willd.) Corner		√			
266	*Streblus asper* Lour.		√	√		
267	*Moringa pterygosperma* Gaertn.	Moringaceae	√	√		
268	*Musa x paradisiaca* L.	Musaceae	√	√		
269	*Ardisia littoralis* Andr.	Myrsinaceae	√		√	
270	*Psidium guajava* L.	Myrtaceae	√	√		
271	*Syzygium aqueum* (Burm.f.) Alston		√	√		
272	*Syzygium caryophyllatum* (L.) Alston		√	√	√	
273	*Syzygium cumini* (L.) Skeels		√	√		

274	*Syzygium malaccense* (L) Merr. & Perry		√	√		
275	*Syzygium zeylanicum* (L.) DC.		√	√		
276	*Boerhavia diffusa* L.	Nyctaginaceae	√	√	√	
277	*Nymphaea nouchali* Burm.f.	Nymphaceae	√			
278	*Nymphaea pubescens* Willd.		√	√		
279	*Nymphaea rubra* Roxb. ex Salisb.		√	√		
280	*Gomphia serrata* (Gaertn.) Kanis	Ochnaceae	√	√	√	
281	*Jasminum angustifolium* (L.) Willd.	Oleaceae	√			
282	*Myxopyrum smilacifolium* (Wall.) Blume		√	√		
283	*Olea dioica* Roxb		√	√	√	E
284	*Ludwigia adscendens* (L.) Hara	Onagraceae	√	√	√	
285	*Ludwigia hyssopifolia* (G. Don) Exell		√			
286	*Ludwigia octovalvis* (Jacq.) Raven			√	√	
287	*Cansjera rheedei* Gmel.	Opiliaceae	√			
288	*Acampe praemorsa* (Roxb.) Blatt. & McCann	Orchidaceae	√	√		
289	*Zeuxine longilabris* (Lindl.) Trimen		√	√	√	
290	*Biophytum reinwardtii* (Zucc.) Klotzsch	Oxalidaceae	√	√		
291	*Oxalis corniculata* L.		√	√	√	
292	*Pandanus odorifer* (Forssk.) Kuntze	Pandanaceae	√	√		
293	*Passiflora foetida* L. var.*foetida*; Gamble	Passifloraceae	√	√		
294	*Sesamum radiatum* Schum.	Pedaliaceae	√	√		
295	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Periplocaceae	√	√	√	
296	*Rivina humilis* L.	Phytalocaceae	√	√		
297	*Peperomia pellucida* (L.) Kunth	Piperaceae	√	√	√	
298	*Piper longum* L.		√	√	√	
299	*Xanthophyllum arnottianum* Wight	Polygalaceae	√	√	√	E
300	*Acroceras munroanum* (Balansa) Henrard	Poaceae	√	√		E
301	*Axonopus compressus* (Sw.) P. Beauv.		√	√	√	
302	*Bambusa bambos* (L.) Voss		√	√		
303	*Centotheca lappacea* (L.) Desv.		√	√	√	
304	*Cenchrus echinatus* L.		√		√	
305	*Chloris barbata* Sw.		√	√	√	
306	*Chrysopogon aciculatus* (Retz.) Trin.		√	√		

307	*Cynodon dactylon* (L.) Pers.		√	√	√	
308	*Dactyloctenium aegyptium* (L.) Willd.		√	√	√	
309	*Digitaria ciliaris* (Retz.) Koeler		√	√		
310	*Digitaria radicosa* (Pers.) Miq.		√	√	√	
311	*Diplachne fusca* (L.) P.Beauv. ex Roem. & Schult.		√	√		
312	*Echinochloa frumentacea* Link		√	√		
313	*Eleusine indica* (L.) Gaertn.		√	√		
314	*Ischaemum barbatum* Retz.		√	√		
315	*Ischaemum muticum* L.		√	√	√	
316	*Ischaemum timorense* Kunth			√	√	
317	*Oplismenus burmannii* (Retz.) P. Beauv.		√	√		
318	*Oplismenus composites* (L.) P. Beauv.		√			
319	*Panicum notatum* Retz.			√	√	
320	*Pennisetum pedicellatum*Trin.		√			
321	*Perotis indica* (L.) O. Ktze.		√			
322	*Phragmites kark***a** (Retz.) Trin. ex Steud.		√	√		
323	*Pseudoraphis spinescens* (R. Br.) Vickery		√			
324	*Sacciolepis interrupta* (Willd.) Stapf		√			
325	*Persicaria barbata* (L.) Hara	Polygonaceae	√	√	√	
326	*Persicaria glabra* (Willd.) Gomez,		√	√		
327	*Persicaria pulchra* (Blume) Sojak		√	√		
328	*Persicaria strigosa* (R. Br.) Nakai		√		√	
329	*Eichhornia crassipes* (Mart.) Solms.	Pontederiaceae	√			
330	*Monochoria vaginalis* (Burm. f.) Presl		√			
331	*Portulaca oleracea* L.	Portulaceae	√	√	√	
332	*Talinum portulacifolium* (Forssk.) Aschers & Schweinf		√	√	√	
333	*Potamogeton octandrus* Poir.	Potamogetonaceae	√			
334	*Naravelia zeylanica* (L.) DC	Ranunculaceae	√	√		
335	*Ziziphus oenoplia* (L.) Mill.	Rhamnaceae	√	√		
336	*Ziziphus rugosa* Lam.		√	√		
337	*Bruguiera cylindrica* (L.) Blume	Rhizophoraceae	√	√	√	

338	*Bruguiera gymnorrhiza* (L.) Savi.		√	√		
339	*Carallia brachiata* (Lour.) Merr.		√	√		
340	*Kandelia candel* (L.) Druce		√	√	√	
341	*Rhizophora apiculata* Blume		√			
342	*Rhizophora mucronata* Poir.			√		
343	*Canthium coromandelicum* (Burm. f.) Alston	Rubiaceae	√	√		
344	*Canthium rheedei* DC.			√		E
345	*Chassalia curviflora* var. *ophioxyloides* (Wall.) Deb & B.Krishna		√	√	√	
346	*Dentella repens* (L.) J. R. & G. Forst.		√	√		
347	*Ixora coccinea* L.		√	√	√	
348	*Ixora javanica* (Blume) DC.		√			
349	*Ixora malabarica* (Dennst.) Mabb.		√		√	E
350	*Mitracarpus hirtus* (L.) DC.		√			
351	*Morinda citrifolia* L.		√	√	√	
352	*Morinda umbellata* L.		√		√	
353	*Mussaenda frondosa* L.		√	√	√	E
354	*Oldenlandia auricularia* (L.) K. Schum.		√	√		
355	*Oldenlandia corymbosa* L.		√	√	√	
356	*Oldenlandia trinervia* Retz.		√			
357	*Pavetta indica* L.		√			
358	*Psilanthus travancorensis* (Wight & Arn.) Leroy		√	√		
359	*Spermacoce hispida* L.			√		
360	*Spermacoce ocymoides* Burm.f.		√			
361	*Acronychia pedunculata* (L.) Miq.	Rutaceae	√	√		
362	*Aegle marmelos* (L.) Correa		√			
363	*Glycosmis pentaphylla* (Retz.) DC.		√	√	√	
364	*Melicope lunu-ankenda* (Gaertn.) T.G. Hartley					
365	*Murraya koenigii* (L.) Spreng.		√			
366	*Cardiospermum halicacabum* L.	Sapindaceae	√	√	√	
367	*Schleichera oleosa* (Lour.) Merr.		√			

368	*Chrysophyllum cainito* L.	Sapotaceae	√	√		
369	*Isonandra lanceolata* Wight		√	√		
370	*Adenosma indianum* (Lour.) Merr.	Scrophulariaceae	√			
371	*Bacopa monnieri* (L.) Pennell		√	√	√	
372	*Limnophila aquatica* (Roxb.) Alston		√			
373	*Limnophila aromatica* (Lam.) Merr.		√	√		
374	*Limnophila repens* (Benth.) Benth.		√		√	
375	*Lindernia hyssopioide s*(L.) Haines		√	√		
376	*Lindernia rotundifolia* (L.) Mukerjee		√	√	√	
377	*Mecardonia procumbens* (Mill.) Small		√			
378	*Scoparia dulcis* L.		√	√	√	
379	*Torenia bicolor* Dalz.		√			E
380	*Torenia hirsuta* Willd.		√	√		E
381	*Ailanthus triphysa* (Dennst.) Alston	Simaroubaceae	√	√		
382	*Quassia indica* (Gaertn.) Nooteb.		√	√	√	
383	*Smilax zeylanica* L.	Smilacaceae	√			
384	*Capsicum annuum* L.	Solanaceae	√	√		
385	*Datura stramonium* L.		√			
386	*Physalis angulata* L.		√	√		
387	*Solanum americanum* Mill.		√			
388	*Solanum capsicoides* All.			√		
389	*Solanum torvum* Sw.		√		√	
390	*Sonneratia caseolaris* (L.) Engl.	Sonneratiaceae	√	√	√	
391	*Helicteres isora* L.	Sterculiaceae	√	√		
392	*Melochia corchorifolia* L.		√	√		
393	*Sterculia foetida* L.		√	√		
394	*Sterculia guttata* Roxb. ex G.Don			√		
395	*Sterculia villosa* Roxb.		√			
396	*Waltheria indica* L.		√	√		
397	*Symplocos cochinchinensis* (Lour.) Moore ssp. *laurina* (Retz.) Nooteb.	Symplocaceae	√			
398	*Corchorus aestuans* L.	Tiliaceae	√			
399	*Grewia nervosa* (Lour.) Panigrahi		√	√		
400	*Triumfetta rhomboidea* Jacq		√	√	√	

401	*Typha angustifolia* L.	Typhaceae	√			
402	*Trema orientalis* (L.) Blume	Ulmaceae	√	√		
403	*Laportea interrupta* (L.) Chew	Urticaceae	√	√		
404	*Pilea microphylla* (L.) Liebm.		√	√	√	
405	*Pouzolzia zeylanica* (L.) Benn.		√	√	√	
406	*Clerodendrum inerme* (L.) Gaertn.	Verbenaceae	√	√	√	
407	*Clerodendrum infortunatum* L.		√	√		
408	*Lantana camara* L.		√	√	√	
409	*Phyla nodiflora* (L.) Greene		√	√		
410	*Premna serratifolia* L.		√	√	√	
411	*Stachytarpheta jamaicensis* (L.) Vahl		√	√	√	
412	*Tectona grandis* L. f		√			
413	*Vitex pinnata* L.		√	√		
414	*Hybanthus enneaspermus* (L.) F.Muell.	Violaceae	√	√		
415	*Ampelocissus indica* (L.) Planch	Vitaceae	√	√		
416	*Cayratia pedata* (Lam.) A. Juss. ex Gagnep.		√		√	
417	*Cissus latifolia* Lam		√	√	√	
418	*Cissus trilobata* Lam.		√	√		
419	*Xyris pauciflora* Willd.	Xyridaceae	√			
420	*Curcuma aeruginosa* Roxb.	Zingiberaceae	√	√		
421	*Zingiber zerumbet* (L.) Roscoe ex Sm.		√	√	√	
TOTAL		F: 116	S: 402(G: 365)	S: 321(G:299)	S: 157 (G: 146)	E: 23

B. PTERIDOPHYTES

Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Adiantum capillus-veneris* L	Adiantacdeae	√	√	√	
2.	*Adiantum philippense* L.		√	√	√	
3.	*Stenochlaena palustris* (Burm.f.) Bedd.	Blechnaceae	√	√	√	
4.	*Lygodium japonicum* (Thunb.) Sw.	Lygodiaceae	√	√	√	
5.	*Marsilea minuta* L.	Marsileaceae	√	√	√	
6.	*Leptochilus decurrens* Blume	Polypodiaceae	√	√	√	
7.	*Drynaria quercifolia* (L.) J. Sm.		√	√	√	

8.	*Microsorum pteropus* Blume		√	√	√	
9.	*Pyrrosia piloselloides* (L.) M.G. Price		√	√	√	E
10.	*Acrostichum aureum* L.	Pteridaceae	√	√	√	
11.	*Parahemionitis cordata* (Roxb. ex. Hook & Grev.) Fraser – Jenkins		√	√	√	
12.	*Vittaria elongata* Sw.		√	√	√	
13.	*Azolla pinnata* R. Br.	Salviniaceae	√	√		
14.	*Salvinia molesta* D.Mitch		√	√	√	
TOTAL		**F: 7**	S: 14 (G: 13)	S: 14 (G: 13)	S: 13 (G: 12)	E: 1

C. GYMNOSPERM

Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Gnetum edule* (Willd.) Blume	**Gnetaceae**	√			E
TOTAL		**F: 1**	S: 1 (G: 1)			E:1

Plate 6. (a-h): Indigenous plants of the study area.. a. *Holigarna arnottiana* Hook. f., b. *Ardisia littoralis* Andr., c. *Abrus precatorius* L., d. *Zeuxine longilabris* (Lindl.) Benth. ex Hook. f., e. *Mucuna gigantea* (Willd.) DC., f. *Lagenandra ovata* (L.) Thw., g. *Ischaemum muticum* L., h. *Hygrophila ringens* (L.) Steud.

Plate 7. **a.** *Athyma selenophora* Kollar, **b.** *Euripus consimilis* Westwood, **c.** *Tajuria cippus* Fabricius, **d.** *Cyrestis thyodamas* Boisduval, **e.** *Eurema hecabe* Linnaeus, **f.** *Vindula erota* Fabriscus, **g.** *Celaenorrhinus leucocera* Kollar, **h.** *Yptima baldus* Fabricius

Plate 8: a, b. *Fejervarya keralensis* Dubois, **c.** *Hoplobatrachus tigerinus* Daudin,
d. *Polypedates leucomystax* Gravenhorst, **e.** *Rhacophorus malabaricus* Jerdon,
f. *Nyctibatrachus major* Boulenger, **g.** *Vestalis apicalis* Selys, **h.** *Brachythemis contaminata* Fabricius

4.1.2. Fauna

Animals of three islands were subjected to analysis and the result shown here in the Table.1. Mammals of 9 species (8 genera), Reptiles of 13 species (12 genera), Ambhibians of 22 species (15 genera), Odonata of 18 species (16 genera), Birds of 176 species (137 genera), Butterflies of 106 species (78 genera), Fishes of 72 species (56 genera), Shrimps and Prawns of 11 species (8 genera), Molluscs-Bivalves of 8 species (7 genera) and Mussels – Oyster – Gastropods of 18 species (13 genera).

Table.1. Faunal elements in the study area

ANIMALS **A. MAMMALS**						
Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Bos taurus* Linnaeus	Bovidae	√	√		
2.	*Capra aegagrus* Linnaeus		√	√		
3.	*Canis lupus* Linnaeus	Canidae	√	√		
4.	*Felis catus* Linnaeus	Felidae	√	√		
5.	*Rattus norvegicus* Berkenhout	Muridae	√	√	√	
6.	*Rattus rattus* Linnaeus		√	√	√	
7.	*Funambulus palmarum* Linnaeus	Sciuridae	√	√	√	
8.	*Paradoxurus hermaphrodites* Pallas	Viverridae	√	√	√	
9.	*Viverra civettina* Blyth		√	√	√	
TOTAL		F: 6	S:9 (G: 8)	S:9 (G: 8)	S:5 (G: 4)	
B. REPTILES **I. LIZARDS**						
Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Calotes calotes* Linnaeus	Agamidae	√	√	√	E
2.	*Calotes versicolor* Daudin		√	√	√	
3.	*Lampropholis guichenoti* A.M.C. Dumeril &Bibron	Scincidae	√	√	√	
4.	*Hemidactylus frenatus* Duméril &Bibron	Gekkonidae	√	√		
5.	*Varanus bengalensis*Daudin	Varanidae	√	√	√	
6.	*Sphenomorphus dussumieri* Duméril&Bibron	Sphenomorphidae	√	√	√	E

TOTAL		F: 5	S: 6 (G:5)	S: 6 (G:5)	S: 5 (G:4)	E: 2
II. SNAKES						
Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Ahaetulla nasuta* Lacepede	Colubridae			√	
2.	*Ptyas mucosa* Linnaeus		√	√	√	
3.	*Xenochrophis piscator* Schneider		√	√	√	
4.	*Dieurostus dussumieri* A.M.C. Dumeril, Bibron& A.H.A. Dumeril	Homalopsidae	√	√	√	
5.	*Hypnale hypnale* Merrem	Viperidae	√	√	√	E
TOTAL		F: 3	S: 4 (G:4)	S: 4 (G:4)	S: 5 (G:5)	E: 1
III.TESTUDINES (Tortoise)						
Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Indotestudo travancorica* Boulenger	Testudinidae			√	E
2.	*Melanochelys trijuga* Schweigger	Geomydidae	√	√	√	
TOTAL		F: 2	S: 1(G:1)	S: 1 (G:1)	S: 2 (G:2)	E: 1
C. ODONATA (FLIES)						
Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Vestalis apicalis* Selys	Calopterygidae	√	√	√	E
2.	*Vestalis gracilis* Rambur		√	√	√	
3.	*Heliocypha bisignata* Hagen	Chlorocyphidae	√	√	√	E
4.	*Libellago lineata* Burmeister			√	√	
5.	*Euphaea fraseri* Laidlaw	Euphaeidae	√	√	√	
6.	*Lestes elatus* Hagen	Lestidae	√	√	√	
7.	*Brachythemis contaminata* Fabricius	Libellulidae	√	√	√	
8.	*Cratilla lineate* Brauer		√	√	√	
9.	*Diplacodes trivialis* Rambur				√	
10	*Libellula luctuosa* Burmeister			√	√	

11	*Neurothemis fulvia* Drury		√		√	
12	*Neurothemis tullia* Drury		√	√	√	
13	*Orthetrum pruinosum* Burmeister				√	
14	*Trithemis aurora* Burmeister		√	√	√	
15	*Tholymis tillarga* Fabricius		√	√	√	
16	*Esme longistyla* Fraser	Platycnemidi dae	√	√	√	E
17	*Phylloneura westermanni* Hagen			√	√	E
18	*Protosticta gravelyi* Laidlaw		√		√	E
TOTAL		F: 6	S: 13 (G:11)	S: 14 (G:13)	S: 18 (G:16)	E: 5

D. AMPHIBIANS

Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Duttaphrynus melanostictus* Schneider	Bufonidae	√	√	√	
2.	*Fejervarya keralensis* Dubois	Dicroglossidae	√	√	√	E
3.	*Fejervarya rufescens* Jerdon				√	E
4.	*Ichthyophis tricolor* Annandale	Ichthyophiidae	√	√	√	E
5.	*Uperodon taprobanicus* Parker	Microhylidae	√		√	
6.	*Uperodon triangularis* Günther		√	√		E
7.	*Micrixalus fuscus* Boulenger	Micrixalidae	√	√		
8.	*Nyctibatrachus aliciae* Inger	Nyctibatrachidae	√			E
9.	*Nyctibatrachus major* Boulenger			√		E
10	*Indosylvirana aurantiaca* Boulenger	Ranidae	√	√	√	E
11	*Hydrophylax malabaricus* Tschudi			√	√	E
12	*Hylarana temporalis* Gunther				√	
13	*Indirana beddonii* Gunther	Ranixalidae			√	E
14	*Indirana brachytarsus* Gunther		√		√	E

15	*Indirana leithii* Boulenger				√	E
16	*Walkerana leptodactyla* Boulenger			√		E
17	*Polypedates leucomystax* Gravenhorst	Rhacophoridae	√		√	E
18	*Polypedates maculates* Gray			√		
19	*Polypedates pseudocruciger* Das & Ravichandran				√	
20	*Raorchestes flaviventris* Boulenger		√		√	E
21	*Raorchestes tinniens* Jerdon					E
22	*Rhacophorus malabaricus* Jerdon		√		√	E
TOTAL			S: 12 (G: 12)	S: 10 (G: 10)	S: 18 (G: 18)	E: 17

E. BIRDS

Sl. No	Scientific Name	Family	Perumabalam	Pallipuram	Pathiramanal	Status
1.	*Aquila fasciata* Vieillot	Accipitridae	√			
2.	*Aviceda jerdoni* Blyth		√	√	√	
3.	*Aviceda leuphotes* Dumont				√	
4.	*Butastur teesa* Franklin			√		
5.	*Circaetus gallicus* Gmelin		√		√	
6.	*Circus aeruginosus* Linnaeus			√		
7.	*Circus macrourus* S. G. Gmelin		√			
8.	*Circus pygargus* Linnaeus			√		
9.	*Elanus caeruleus* Desfontaines				√	
10.	*Haliaeetus humilis* Müller & Schlegel				√	
11.	*Hieraaetus pennatus* Gmelin				√	
12.	*Ictinaetus malaiensis* Temminck			√		
13.	*Lophotriorchis kienerii* G. de Sparre		√			
14.	*Nisaetus cirrhatus* Gmelin				√	
15.	*Nisaetus nipalensis* Hodgson			√		
16.	*Pernis ptilorhynchus*			√		

	Temminck					
17.	*Spilornis cheela* Latham				√	
18.	*Acrocephalus dumetorum* Blyth	Acrocephalidae			√	
19.	*Aegithina tiphia* Linnaeus	Aegithinidae			√	
20.	*Alcedo atthis* Linnaeus	Alcedininae			√	
21.	*Alcedo meninting* Horsfield		√			
22.	*Ceyx erithaca* Linnaeus			√		
23.	*Halcyon smyrnensis* Linnaeus				√	
24.	*Pelargopsis capensis* Linnaeus		√		√	
25.	*Apus nipalensis* Hodgson	Apodidae		√		
26.	*Cypsiurus balasiensis* J.E. Gray				√	
27.	*Hemiprocne coronata* Tickell			√		
28.	*Hirundapus giganteus* Temminck		√			
29.	*Tachymarptis melba* Linnaeus			√	√	
30.	*Ardeola grayii* Sykes	Ardeidea		√		
31.	*Bubulcus ibis* Linnaeus				√	
32.	*Butorides virescens* Linnaeus			√		
33.	*Gorsachius melanolophus* Raffles		√			
34.	*Artamus fuscus* Vieillot	Artamidae			√	
35.	*Anthracoceros coronatus* Bodda	Bucerotidae			√	E
36.	*Ocyceros griseus* Latham				√	E
37.	*Buceros bicornis* Linneaeus			√		
38.	*Caprimulgus indicus* Latham	Caprimulgidae			√	
39.	*Zoonavena sylvatica* Tickell		√		√	
40.	*Coracina javensis* Horsfield	Campephagidae			√	
41.	*Lalage melanoleuca* Blyth			√		
42.	*Pericrocotus cinnamomeus* Linnaeus				√	
43.	*Pericrocotus speciosus*			√		

	Latham					
44.	*Chloropsis aurifrons* Temminck	Chloropseidae			√	
45.	*Orthotomus sutorius* Pennant	Cisticolidae		√		
46.	*Prinia hodgsonii* Blyth		√			
47.	*Prinia inornata* Sykes		√			
48.	*Prinia socialis* Sykes				√	
49.	*Ducula badia* Raffles	Columnbidae		√		
50.	*Coracias benghalensis* Linnaeus	Coraciidae	√			
51.	*Corvus macrorhynchos* Wagler	Corvidea			√	
52.	*Corvuss plendens* Vieillot				√	
53.	*Dendrocitta leucogastra* Gould			√		E
54.	*Dendrocitta vagabunda* Latham		√		√	
55.	*Centropus sinensis* Stephens	Cuculidae	√			
56.	*Clamator jacobinus* Boddaert			√	√	
57.	*Eudynamys scolopaceus* Linnaeus				√	
58.	*Hierococcyx sparveioides* Vigors				√	
59.	*Hierococcyx varius* Vahl			√		
60.	*Surniculus dicruroides* Hodgson				√	E
61.	*Dicaeum agile* Tickell	Dicaeidae		√		
62.	*Dicaeum erythrorhynchos* Latham				√	
63.	*Dicaeum minullum* Swinhoe				√	
64.	*Dicrurus aeneus* Vieillot	Dicruridae			√	
65.	*Dicrurus leucophaeus* Vieillot			√		
66.	*Dicrurus paradiseus* Linnaeus		√			
67.	*Lonchura atricapilla* Vieillot	Estrildidae			√	
68.	*Lonchura kelaarti* Jerdon			√		
69.	*Lonchura punctulata* Linnaeus				√	
70.	*Lonchura striata*			√		

	Linnaeus					
71.	*Falco peregrinus* Sundevall	Falconidae			√	
72.	*Falco tinnunculus* Linnaeus				√	
73.	*Erythrina erythrina* Pallas	Fringillidae		√		
74.	*Cecropis daurica* Laxmann	Hirundinidae	√			
75.	*Irena puella* Latham	Irenidae			√	
76.	*Lanius cristatus* Linnaeus	Laniidae		√		
77.	*Lanius schach* Linnaeus				√	
78.	*Sterna aurantia* J.E. Gray	Laridae		√	√	
79.	*Argya striata* Dumont	Leiothrichidae	√		√	
80.	*Argya subrufa* Jerdon			√		
81.	*Pterorhinus delesserti* Jerdon			√	√	
82.	*Locustella naevia* Boddaert	Locstellidae		√		
83.	*Schoenicola platyurus* Jerdon	Locustellidae			√	
84.	*Psilopogon viridis* Boddaert	Megalaimidae			√	E
85.	*Merops leschenaultia* Vieillot	Meropidae			√	
86.	*Merops orientalis* Latham			√		
87.	*Nyctyornis athertoni* Jardine & Selby				√	
88.	*Anthus rufulus* Vieillot	Motacillidae			√	
89.	*Dendronanthus indicus* Gmelin			√		
90.	*Motacilla cinerea* Tunstall				√	
91.	*Motacilla maderaspatensis* Gmelin			√		
92.	*Copsychus saularis* Linnaeus	Muscicapidae	√			
93.	*Cyornis pallidipes* Jerdon		√		√	
94.	*Cyornis rubeculoides* Vigors					
95.	*Cyornis tickelliae* Blyth				√	
96.	*Eumyias albicaudatus* Jerdon		√	√	√	
97.	*Eumyias thalassinus*			√		

	Swainson					
98.	*Ficedula nigrorufa* Jerdon				√	
99.	*Ficedula ruficauda* Swainson				√	
100.	*Larvivora brunnea* Hodgson			√	√	
101.	*Monticola solitarius* Linnaeus			√		
102.	*Muscica padauurica* Pallas				√	
103.	*Muscica pamuttui* Layard				√	
104.	*Saxicola caprata* Linnaeus				√	
105.	*Sholicola major* Jerdon				√	
106.	*Arachnothera longirostra* Latham	Nectariniidae			√	
107.	*Cinnyrisa siaticus* Latham		√			
108.	*Cinnyris lotenius* Linnaeus			√	√	
109.	*Leptocoma zeylonica* Linnaeus			√	√	
110.	*Nectarinia minima* Sykes				√	
111.	*Oriolus chinensis* Linnaeus	Oriolidae		√		
112.	*Oriolus oriolus* Linnaeus			√		
113.	*Machlolophus xanthogenys* Vigors	Paridae			√	
114.	*Passer domesticus* Linnaeus	Passeridae				
115.	*Alcippe poioicephala* Jerdon	Pellorneidae	√			
116.	*Pellorneum ruficeps* Swainson		√			
117.	*Microcarbo niger* Vieillot	Phalacrocoracidae	√			
118.	*Galloperdix spadicea* Gmelin	Phasianidae			√	E
119.	*Gallus sonneratii* Temminck				√	E
120.	*Phylloscopus affinis* Tickell	Phylloscopidae		√		
121.	*Phylloscopus trochiloides* Sundevall				√	
122.	*Phylloscopus tytleri* Brooks			√		

123.	*Seicercus magnirostris* Blyth				√	
124.	*Seicercus occipitalis* Blyth			√		
125.	*Chrysocolaptes lucidus* Scopoli	Picidae	√			
126.	*Dinopium benghalense* Linnaeus				√	
127.	*Dryocopus martius* Linnaeus			√		
128.	*Hemicircus canente* Lesson				√	
129.	*Micropternus brachyurus* Vieillot			√		
130.	*Picumnus innominatus* Burton				√	
131.	*Psilopogon rubricapillus* Gmelin				√	
132.	*Picus chlorolophus* Vieillot			√		
133.	*Picus xanthopygaeus* Gray & Gray		√			
134.	*Yungipicus moluccensis* Gmelin				√	
135.	*Pitta brachyura* Linnaeus	Pittidae			√	
136.	*Ptyonoprogne concolor* Sykes				√	
137.	*Ploceus philippinus* Linnaeus	Ploceidae		√		
138.	*Loriculus vernalis* Sparrman	Psittaculidae		√		
139.	*Psittacula columboides* Vigors				√	E
140.	*Psittacula cyanocephala* Linnaeus		√			
141.	*Acritillas indica* Jerdon	Pycnonotidae		√		
142.	*Hypsipetes leucocephalus* Gmelin				√	
143.	*Pycnonotus cafer* Linnaeus		√			
144.	*Pycnonotus jocosus* Linnaeus		√			
145.	*Pycnonotus melanicterus* Gmelin			√		
146.	*Pycnonotus priocephalus* Jerdon				√	E
147.	*Amaurornis phoenicurus* Pennant	Rallidae	√			
148.	*Actitis hypoleucos*	Scolopacidae			√	

	Linnaeus					
149.	*Tringa glareola* Linnaeus		√			
150.	*Tringa ochropus* Linnaeus				√	
151.	*Sitta frontalis* Swainson	Sittidae		√		
152.	*Culicicapa ceylonensis* Swainson	Stenostiridae		√		
153.	*Hypothymis azurea* Boddaert				√	
154.	*Bubo nipalensis* Hodgson	Strigidae			√	
155.	*Glaucidium radiatum* Tickell			√		
156.	*Ketupa zeylonensis* Gmelin		√			
157.	*Ninox scutulata* Raffles				√	
158.	*Otus lettia* Hodgson			√		
159.	*Otus sunia* Hodgson		√			
160.	*Strix leptogrammica* Temminck				√	
161.	*Acridotheres fuscus* Wagler	Sturnidae	√			
162.	*Acridotheres tristis* Linnaeus			√		
163.	*Sturnia blythii* Jerdon				√	
164.	*Gracula religiosa* Linnaeus			√		
165.	*Sylvia curruca* Linnaeus	Sylviidae				
166.	*Dumetia hyperythra* Franklin	Timaliidae		√		
167.	*Pomatorhinus horsfieldii* Sykes				√	
168.	*Harpactes fasciatus* Pennant	Trongonidae		√		
169.	*Geokichla citrina* Latham	Turdidae			√	
170.	*Trochalopteron jerdoni* Blyth					E
171.	*Turdus merula* Linnaeus		√			
172.	*Turdus simillimus* Jerdon				√	
173.	*Hemipus picatus* Sykes	Vangidae		√		
174.	*Tephrodornis virgatus* Temminck			√		
175.	*Pteruthius rufiventer* Blyth	Vireonidae	√			
176.	*Zosterops palpebrosus*	Zosteropidae		√		

	Temminck					
TOTAL		F: 58	S:37 (G: 37)	S:63 (G: 58)	S:89 (G:78)	E: 10
F. BUTTERFLIES						
Sl. No	Scientific Name	Family				Status
1.	*Iambrix salsala* Moore	Hesperiidae				
2.	*Notocrypta curvifascia* Felder & Felder					
3.	*Psolos fuligo* Mabille					
4.	*Spialia galba* Fabricius					
5.	*Tagiades gana* Moore					
6.	*Tagiades litigiosa* Moschler					
7.	*Udaspes folus Cramer*					
8.	*Acytolepis puspa* Horsfield	Lycaeniidae				
9.	*Caleta caleta* Hewitson					
10.	*Castalius rosimon* Fabricius					
11.	*Catochrysops strabo* Fabricius					
12.	*Chilades lajus* Cramer					
13.	*Cigaritis vulcanus* Fabricius					
14.	*Creon cleobis* Godart					
15.	*Discolampa ethion* Westwood					
16.	*Jamides celeno* Cramer					
17.	*Lampides boeticus* Linneaus					
18.	*Loxura atymnus* Cramer					
19.	*Megisba malaya* Horsfield					
20.	*Neopithecops zalmora* Butler					
21.	*Rachana jalindra* Horsfield					
22.	*Rapala manea* Hewitson					
23.	*Rapala varuna* Hewitson					
24.	*Rathinda amor* Fabriscus					
25.	*Spalgis epius* Westwood					
26.	*Tajuria cippus* Fabricius					
27.	*Talicada nyseus* Guerin					
28.	*Tarucus ananda* de Niceville					
29.	*Zizin aotis* Fabricius					
30.	*Zizula hylax* Fabricius					
31.	*Acarea violae* Linneaus	Nymphalidae				
32.	*Ariadne ariadne* Linneaus					
33.	*Ariadne merione* Cramer					
34.	*Athyma nefte* Cramer					
35.	*Athyma selenophora* Kollar					
36.	*Charaxes bernardus* Fabricius					
37.	*Cirrochora thais* Fabricius					
38.	*Cupha erymanthis* Drury					
39.	*Cyrestis thyodamas* Boisduval					
40.	*Euripus consimilis* Westwood					
41.	*Euthalia aconthea* Cramer					
42.	*Euthalia lubentia* Cramer					

43.	*Hypolimnas bolina* Linneaus		
44.	*Hypolimnas missippus* Linneaus		
45.	*Idea malabarica* Moore		E
46.	*Junonia almana* Linneaus		
47.	*Junonia atlites* Linneaus		
48.	*Junonia iphita* Cramer		
49.	*Junonia lemonias* Linneaus		
50.	*Kallima horsfieldii* Kollar		
51.	*Kaniska canace* Linneaus		
52.	*Lethe europa* Fabricius		
53.	*Lethe drypetis* Hewitsin		
54.	*Lethe rohria* Fabricius		
55.	*Libythea myrrha* Godart		
56.	*Melanitis leda* Linnaeus		
57.	*Melanitis zitenius* Herbst		
58.	*Mouza procris* Cramer		
59.	*Neptis hylas* Linneaus		
60.	*Neptis jumbah* Moore		
61.	*Orsotrianea medus* Fabricius		
62.	*Polyura athamas* Drury		
63.	*Pantoporia hordonia* Stoll		
64.	*Parantica aglea* Stoll		
65.	*Parantica nilgiriensis* Moore		E
66.	*Parthenos sylvia* Cramer		
67.	*Phalanta phalanta* Drury		
68.	*Rhoana parysatis* Linneaus		
69.	*Tanaecia lepidea* Butler		
70.	*Tirumala limniaca* Cramer		
71.	*Tirumala septentrionis* Butler		
72.	*Vanessa cardui* Linneaus		
73.	*Vanessa indica* Herbst		
74.	*Vindula erota* Fabriscus		
75.	*Ypthima huebneri* Kirby		
76.	*Ypthima baldus* Fabricius		
77.	*Graphium Agamemnon* Linneaus	Papilionidae	
78.	*Graphium doson* C. & R. Felder		
79.	*Graphium sarpedon* Linnaeus		
80.	*Pachliopta aristolochiae* Fabricus		
81.	*Pachliopta hector* Linnaeus		
82.	*Pachilopta pandiyana* Moore		E
83.	*Papilio clytia* Linnaeus		
84.	*Papilio demoleus* Linnaeus		
85.	*Papilio dravidarum* Wood-Mason		E
86.	*Papilio liomedon* Moore		
87.	*Papilio papilio* Linnaeus		
88.	*Papilio paris* Linnaeus		
89.	*Papilio polymnestor* Cramer		E
90.	*Papilio polytes* Linnaeus		
91.	*Troides minos* Cramer		E

92.	*Appias indra* Moore	Pieridae	
93.	*Appias albino* Boisduval		
94.	*Appias lyncida* Cramer		
95.	*Catopsilia pomona* Fabricus		
96.	*Catopsilia pyranthe* Linnaeus		
97.	*Cepora nadina* Lucus		
98.	*Delias eucharis* Drury		
99.	*Eurema blanda* Boisduval		
100.	*Eurema brigitta* Cramer		
101.	*Eurema hecabe* Linnaeus		
102.	*Eurema laeta* Boisduval		
103.	*Hebomoia glaucippe* Linnaeus		
104.	*Leptosia nina* Fabricius		
105.	*Prioneris sita* C. Felder		
106.	*Abisara echerius* Stoll	Riodinidae	
		F: *5* S: 106 (G:78)	E: *5*

G. FISHES

Sl. No.	Scientific Name	Family	Status
1	*Parambassis dayi*	Ambassidae	E
2	*Parambassis thomassi*		E
3	*Anabas testudineus*	Anabantidae	
4	*Anguilla bengalensis*	Anguillidae	
5	*Anguilla bicolor*		
6	*Batasio travancoria*	Bagridae	E
7	*Hemibagrus menoda*		
8	*Horabagrus brachysoma*		E
9	*Mystus armatus*		
10	*Wallago attu*		
11	*Bhavania australis*	Balitoridae	
12	*Pampus argenteus*	Bramidae	
13	*Alepes kleinii*	*Carangidae*	
14	*Alepes djedaba*		
15	*Channa*	Channidae	E

	diplogramma		
16	*Channa marulius*		
17	*Channa orientalis*		
18	*Channa striatus*		
19	*Etroplus maculatus*	Cichlidae	
20	*Etroplus suratensis*		
21	*Oreochromis mossambica*		
22	*Clarias batrachus*	Clariidae	
23	*Clarias dussumieri*		E
24	*Clarias gariepinus*		
25	*Heteropneustes fossilis*		
26	*Anodontostoma chacunda*	Clupeidae	
27	*Esculosa thoracata*		
28	*Sardinella longiceps*		
29	*Lepidocephalus thermalis*	Cobitidae	
30	*Amblypharyngodon mola*	Cyprinidae	
31	*Barilius bakeri*		
32	*Barilius gatensis*		E
33	*Catla catla*		
34	*Cirrhinus mrigala*		
35	*Cyprinus carpio*		
36	*Danio aequipinnatus*		
37	*Danio malabaricus*		
38	*Garra ceylonensis*		
39	*Garra mullya*		
40	*Garra surendranathanii*		E
41	*Gonoproktopterus curmuca*		
42	*Labeo dussumieri*		
43	*Labeo fimbriatus*		
44	*Labeo rohita*		
45	*Puntius amphibious*		
46	*Puntius bimaculatus*		
47	*Puntius chola*		
48	*Puntius denisonii*		
49	*Puntius fasciatus*		E
50	*Puntius filamentosus*		E
51	*Puntius ticto*		
52	*Puntius vittatus*		
53	*Rasbora daniconius*		
54	*Salmostoma acinaces*		

55	*Salmostoma boopis*		E
56	*Systomus sarana*		
57	*Tor khudree*		
58	*Encrasicholina heteroloba*	Engraulidae	
59	*Stolephorus indicus*		
60	*Gerres filamentosus*	Gerreidae	
61	*Glossogobius giuris*		
62	*Hyporhamphus xanthopterus*	Hemiramphidae	E
63	*Xenentodon cancila*		
64	*Mastacembelus armatus*	Horobagridae	
65	*Mugil cephalus*	Mugilidae	
66	*Brachirus orientalis*	Nandidae	
67	*Mesonoemacheilus triangularis*	Nemacheilidae	E
68	*Nemipterus japonicus*	Nemipteridae	
69	*Pristolepis marginata*	Pristolepididae	E
70	*Rastrelliger kanagurta*	Scombridae	
71	*Scomberomorus commerson*		
72	*Ompok bimaculatus*	Siluridae	
Total		F : 24 (S: 72: G:56)	E: 14

H. SHRIMPS AND PRAWNS

Sl. No.	Scientific Name	Family	Status
1	*Metapenaeus affinis*	Penaeidae	
2	*Metapenaeus dobsoni*		
3	*Metapenaeus monoceros*		
4	*Parapenaeopsis stylifera*		
5	*Penaeus indicus*		
6	*Penaeus monodon*		
7	*Penaeus*		

	semisulcatus		
8	*Heterocarpus gibbosus*	Pandalidae	
9	*Macrobrachium rosenbergii*	Palaemonidae	
10	*Carinotetraodon travancorius*	Tetrodontidae	E
11	*Lepturacanthus savala*	Trichiuridae	
Total		F :5 (S: 11; G: 7)	E: 1

I. MOLLUSCS-BIVALVES

Sl. No.	Scientific Name	Family	Status
1	*Anadara inaequivalvis*	Arcidae	
2	*Tegillarca granosa*		
3	*Villorta cyprinoides*	Cyrenidae	E
4	*Donax scrotum*	Donacidae	
5	*Marcia opima*	Veneridae	
6	*Meretrix casta*		
7	*Meretrix meretrix*		
8	*Protapes gallus*		
Total		F: 4 (S: 8; G:7)	E: 1

J. MUSSELS – OYSTER - GASTROPODS

Sl. No.	Scientific Name	Family	Status
1	*Perna perna*	Mytilidae	
2	*Perna viridis*		
3	*Crassostrea madrasensis*	Ostreidae	
4	*Pinctada fucata*	Pteriidae	
5	*Babylonia spirata*	Babyloniidae	
6	*Babylonia zeylonica*		
7	*Bufonaria echinata*	Bursidae	
8	*Semicassis bisulcata*	Cassidae	

9	*Semicassis craticulata*		
10	*Indothais lacera*	Muricidae	
11	*Murex carbonnieri*		
12	*Cellana rota*	Nacellidae	
13	*Bullia tranquebarica*	Nassariidae	
14	*Bullia vittata*		
15	*Natica marochiensis*	Naticidae	
16	*Tibia curta*	Strombidae	
17	*Turritella attenuata*	Turritellidae	
18	*Turritella duplicata*		
	Turritella terebra		
Total		F: 12 (S: 18; G:13)	

*F: Family; S: Species; G: Genus; E: Endemic

4.2. Mangrove vegetation and its analysis

The mangrove plants collected during the field exploration trips to different islands were subjected to systematic taxonomic treatment and the identified plants are given below in two sub headings.

4.2.1. Mangrove plants

1. ***Rhizophora apiculata*** Blume

Synm : *Rhizophora candelaria* DC.
Rhizophora conjugata Arn.

Family : *Rhizophoraceae*

Local Name : *Kaya-kandel, Vallikandel*

Distribution: India & Malesia; Kerala: All Kerala except Pathinamthitta, Idukki, Palakkad, Malappuram and Wayanad.

Description: Evergreen trees, to 5 m high; trunk and lower branches supported by numerous profusely looping stilt roots and prop roots corky, lenticellate; bark brown, fissured; branchlets terete, glabrous, reddish-brown or greyish-white, with conspicuous circular, scaly, brown stipular scar. Leaves simple, opposite, decussate, clustered towards the apex; stipules interpetiolar, 9 x 1.5 cm, pale red; petiole 20-30 mm long, stout, grooved above, pale green, glabrous; lamina 13-17 x 4-7 cm, elliptic, oblong, oblanceolate or ovate-lanceolate, base cuneate, apex apiculate, margin entire, glabrous, coriaceous, dark, green above, pale green beneath; lateral nerves 10-15 pairs, slender, pinnate, secondary laterals present, obscure; intercostae reticulate, faint. Flowers bisexual, greenish-white, 2.2 x 1.5 cm, sessile, in axillary unbranched 2 flowered cymes; peduncle to 5 mm long, glabrous; bracts small, connate; bracteoles 2, connate, cupular, 5 mm across, dark brown, surface wrinkled and cracked, enclosing the base of the calyx; calyx externally fissured, brownish-yellow outside and yellowish-white and glabrous within; lobes 4, 1.5 x 0.7 cm, ovate-oblong, acute, fleshy, persistent; petals 4, free, 9 x 2.5 mm, narrow-lanceolate, acute, white, thin, flat, glabrous, persistent; stamens 11 or 12, free, sessile, inserted on the margin of the receptacular disc; anthers 8 mm long, multilocellate; pistil conoid, slightly angled; ovary half inferior, inserted within and fused with the calyx cup, 2-celled, ovules 2 in each cell, pendulous, style short, stigma bifid. Fruit a drupe, 2-4 cm long, conical, pericarp brown, thick, leathery, calyx lobes reflexed; seed one; hypocotyl 50 x 1.8 cm, piercing the apex of the fruit, cylindric, thick towards the radicle tip, tip blunt, straight with a slight curvature at plumular end; cotyledonary collar protruded and exposed on maturity .

2. ***Rhizophora mucronata*** Poir.

Synm. : *Rhizophora mangle* Roxb.

Rhizophora candelaria Wight

Family : Rhizophoraceae

Local Name : *Panachikandal, Pranthan kandal, Pikandal.*

Distribution: Paleotropics; Kerala: All Kerala except Pathinamthitta, Idukki, Palakkad and Wayanad.

Description: Evergreen trees, to 6 m high; branches horizontal; trunk and lower branches supported by numerous profusely looping stilt-roots and prop roots, lenticellate, bark brown, longitudinally fissured; branchlets, terete, brownish-green, glabrous, with prominent, rough, thick, brown layer of stipular scar, prominent. Leaves simple, opposite decussate, stipulate, clustered at the shoot apex; stipules 2, interpetiolar, 6 x 1.2 cm, pale green with pinkish tinge, overlapping the apical bud, subcylindric; petiole 25-35 mm long, stout, glabrous, grooved above, pale green; lamina 12.5-14.5 x 5.5-8.5 cm, elliptic-ovate, base cuneate, apex mucronate, glabrous, coriaceous, green above, pale green beneath with numerous black dots; lateral ve, yellowish-white, 2.5 x 1.5 cm, in axillary dichotomously or trichotomously branched or unbranched 2-4 flowered cymes; peduncle 3-5 cm long, terete, glabrous, pendulous; bracts small, cupular; pedicel 5 mm long; bracteole 2, connate to form a dilated cupular part enclosing the base of the calyx tube; calyx yellowish-white, calyx tube smooth, enclosing the base of the pistil, lobes 4, 1.2 x 0.6 cm, ovate, acute, thick, fleshy, glabrous; petals 4, 1 x 0.2 cm, white, lanceolate, densely hairy along the ma ins 8-9 pairs, pinnate, slender, inconspicuous, secondary laterals also present, intercostae reticulate. Flowers bisexualrgins, hairs white, uniseriate; stamens 8, free, inserted on the margin of the receptacular disc; filaments 2 mm long, terete, anthers basifixed, multilocellate; pistil conoid; ovary half inferior, inserted within and fused with the calyx cup, ovules 2 in each cell, pendulous; style short; stigma bifid. Fruit a drupe, 5-7 cm long, ovoid or conoid, pericarp brown, thick, leathery, glabrous, calyx lobes reflexed, brown; seed one, hypocotyl 50 x 1.8 cm, cylindric, slightly curved, tapering towards the radicle end, surface rough warty, green; cotyledonary collar protruded and exposed on maturity.

3. ***Avicennia officinalis*** L.

Synm. : *Avicennia tomentosa* Jacq.

Family : Avicenniaceae

Local Name : *Madaipattai, Orei, Oora, Uppatti*

Distribution: Tropics ; Kerala : All Kerala except Pathinamthitta, Idukki, Palakkad and Wayanad.

Description: Evergreen trees, to 8 m high; much branched with occasional stilt roots; pneumatophores numerous, straight, cylindrical, often forked with blunt tips; bark smooth, brownish-grey; branchlets terete, glabrous, pale brown, nodes swollen. Leaves simple, opposite, decussate, estipulate; petiole 10-18 mm long, stout, with a basal groove; lamina 3-10 x 2.5-5 cm, ovate, elliptic-obovate; base cuneate; apex obtuse; margin entire, glabrous above, silvery white tomentose beneath, coriaceous; lateral nerves

Plate 9 (a-h). : True mangroves of study area. **a,b,c.** *Sonneratia caseolaris* (L.) Engl., **d, e.** *Avicennia officinalis* L., **f,g,h.** *Bruguiera gymnorrhiza* (L.) Savi.

Plate 10 (a-f): True mangroves of the study area. **a.** *Bruguiera sexangula* (Lour.) Poir.**, b,c.** *Kandelia candel* (L.) Druce, **d,** *Rhizophora mucronata* Poir. e,**f.** *Rhizophora apiculata* Blume

7-10 pairs, parallel, obscure; intercostae reticulate, obscure. Flowers bisexual, yellow, 1 x 1.5 cm, sessile, in terminal or axillary compound spikes, arranged in dense capitate units; peduncle upto 25 cm long, terete, silvery tomentose; bracts 3 x 3 mm, triangular, convex, green, black tipped with fringed margin, pubescent; bracteoles 2, similar to the bract, slightly smaller, bracts and bracteoles persistent; calyx brownish-green, sepals slightly united at base; lobes 5, to 5 x 4 mm, triangular, tip acute, pubescent, persistent; corolla yellow, glabrous within, densely pubescent side, thick, fleshy; tube to 4 mm long,

Plate 11 (a-o): Mangrove associates of the study area. a. *Calophyllum inophyllum*, b. *Acrostichum aureum*, c, *Excoecaria agallocha*, d. *Acanthus ilicifolius*, e. *Oldenlandia trinerva,* f. *Tylophora tetrapetala,* g. *Annona glabra, h. Ipomoea aquatica,* i. *Flagellaria indica,* j. *Cerbera odollam*, k. *Barringtonia racemosa*, l.*Pyrrossia piloselloides*, m. *Parsonsia inodora*, n, *Quassia indica*, o. *Derris trifoliata*

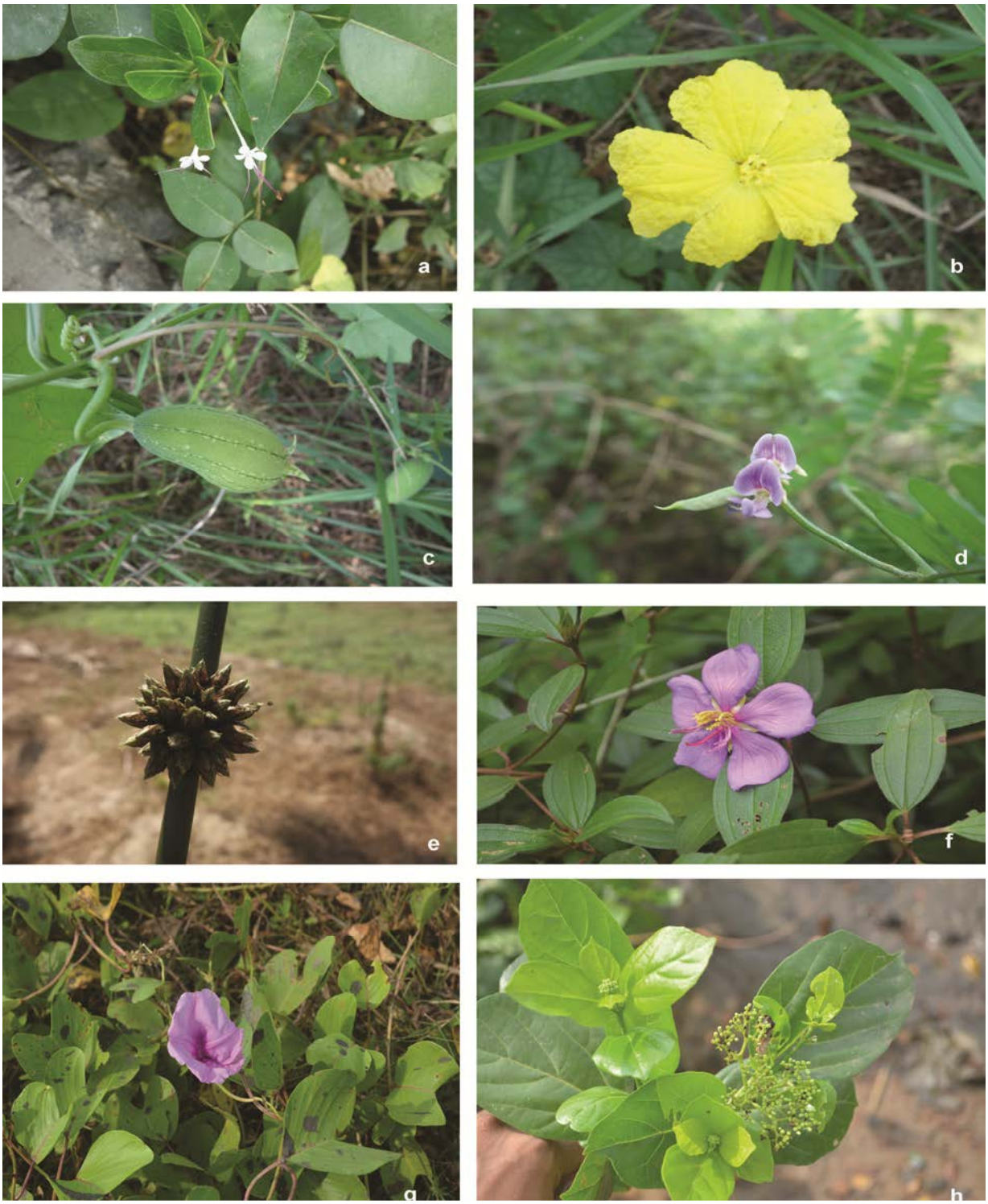

Plate 12(a-h): Mangrove associates of the study area. **a.** *Clerodendrum inerme,* **b,c.** *Luffa cylindrica,* **d.** *Abrus precatorius,* **e.** *Schoenoplectiella articulata,* **f.** *Melastoma malabathricum,* **g.** *Ipomoea pes-caprae,* **h**. *Premna serratifolia*

lobes 4, to 6 x 5 mm, elliptic, unequal; stamens 4, filaments 3 mm long, flask shaped, slightly oblique, pubescent; ovary superior, imperfectly unilocular; ovules 4, pendulous, attached to the tip of central 4-winged axis; style 3 mm long, solid, gradually tapering; stigma unequally 2-lobed. Fruit a capsule 5 x 3.5 cm, mango-shaped, yellowish-green, flattened, apex acute with persistent stylar beak, pericarp thick, coriaceous, silvery tomentose; seed one.

4. ***Bruguiera gymnorrhiza*** (L.) Savi.

Synm. : *Rhizophora gymnorrhiza* L.
Bruguiera rheedei Blume
Bruguiera conjugata Merr.

Family : Rhizophoraceae

Local Name : *Kandel, Karakandel*

Distribution: Asia, Africa; Kerala : Thrissur, Ernakulam, Kottayam, Alappuzha, Kollam and Thiruvanthapuram

Description: Evergreen trees, to 6 m high; bole occasionally buttressed, underground roots producing numerous knee roots; bark greyish to black, roughly fissured, lenticellate; branchlets terete, glabrous, reddish-green, with conspicuous, narrow brown stipular scar encircling the node. Leaves simple, opposite, decussate, stipulate; stipules interpetiolar, 3.5-5 cm long, reddish; petiole 20-45 mm long, terete, stout, grooved above, reddish, glabrous; lamina 6-17 x 3-7.5 cm, elliptic, elliptic-oblong or ovate-lanceolate, base cuneate, apex acute, coriaceous, glabrous, reddish-green above, pale green beneath; lateral nerves 9-12 pairs, parallel, slender, looped near the margin, secondary laterals present, obscure, intercostae reticulate, obscure. Flowers bisexual, reddish-pink, 2.5-3.5 x 2.4 cm, solitary, axillary, drooping; pedicels 1.5-2.5 cm long, curved, bright red; calyx tube campanulate, red or dark pink, glabrous, enclosing the ovary; lobes 12-16, to 2 cm long, narrow, thick, fleshy, glabrous, persistent; petals 12-16, 1.1-1.3 cm long, free, shortly stalked, brown, deeply bilobed with a bristle in the sinus of the lobes; bristle not exceeding the petal lobes; lobes equal, more or less round with 2-4 cilia on each, basal margin of the petals with dense stiff hairs, stamens slightly unequal in length; filaments 5-6 mm long, anthers 4-5 mm long, basifixed, mucronate, lobes slightly unequal; ovary half inferior, inserted within and fused with the calyx cup, 2-4-celled, ovules 2, in each cell, pendulous, style 1.5 cm long, filiform, terete; stigma 3-4 fid. Fruit a drupe 2-2.5 cm long, reddish-green, conoid with persistent erect calyx lobes; seed one; hypocotyl 10-25 cm x 1.2 cm, cylindric, with a blunt tip, surface slightly ridged, green with brownish tinge.

5. ***Bruguiera gymnorrhiza*** **(L.) Savi.**

Synm. : *Rhizophora gymnorrhiza* L.

Bruguiera rheedei Blume

Bruguiera conjugata

Local Name : *Kandel, Karakandel*

Family : Rhizophoraceae

Distribution: Asia Africa; Kerala : Thrissur, Ernakulam, Kottayam, Alappuzha, Kollam and Thiruvanthapuram

Description: Evergreen trees, to 6 m high; bole occasionally buttressed, underground roots producing numerous knee roots; bark greyish to black, roughly fissured, lenticellate; branchlets terete, glabrous, reddish-green, with conspicuous, narrow brown stipular scar encircling the node. Leaves simple, opposite, decussate, stipulate; stipules interpetiolar, 3.5-5 cm long, reddish; petiole 20-45 mm long, terete, stout, grooved above, reddish, glabrous; lamina 6-17 x 3-7.5 cm, elliptic, elliptic-oblong or ovate-lanceolate, base cuneate, apex acute, coriaceous, glabrous, reddish-green above, pale green beneath; lateral nerves 9-12 pairs, parallel, slender, looped near the margin, secondary laterals present, obscure, intercostae reticulate, obscure. Flowers bisexual, reddish-pink, 2.5-3.5 x 2.4 cm, solitary, axillary, drooping; pedicels 1.5-2.5 cm long, curved, bright red; calyx tube campanulate, red or dark pink, glabrous, enclosing the ovary; lobes 12-16, to 2 cm long, narrow, thick, fleshy, glabrous, persistent; petals 12-16, 1.1-1.3 cm long, free, shortly stalked, brown, deeply bilobed with a bristle in the sinus of the lobes; bristle not exceeding the petal lobes; lobes equal, more or less round with 2-4 cilia on each, basal margin of the petals with dense stiff hairs, stamens slightly unequal in length; filaments 5-6 mm long, anthers 4-5 mm long, basifixed, mucronate, lobes slightly unequal; ovary half inferior, inserted within and fused with the calyx cup, 2-4-celled, ovules 2, in each cell, pendulous, style 1.5 cm long, filiform, terete; stigma 3-4 fid. Fruit a drupe 2-2.5 cm long, reddish-green, conoid with persistent erect calyx lobes; seed one; hypocotyl 10-25 cm x 1.2 cm, cylindric, with a blunt tip, surface slightly ridged, green with brownish tinge.

6. ***Kandelia candel*** (L.) Druce

Synm. : *Rhizophora candel* L.

Kandelia rheedei

Local Name : *Kandel, Karakandel*

Family : Rhizophoraceae

Distribution: Asia Africa; Kerala : Thrissur, Ernakulam, Kottayam, Alappuzha, Kollam and Thiruvanthapuram

Description: Evergreen trees, to 6 m high; bole buttressed; bark dark brown, smooth; branchlets, terete, glabrous, reddish-brown; stipular scar narrow, thin, brown layered; leaf scar round, prominent.

Leaves simple, opposite, decussate, stipulate, clustered at the shoot apex; stipules 2.5 cm long, pale green; petiole 15-20 mm long, stout, glabrous; lamina 8.5-12 x 3-4.5 cm, oblong or lanceolate, base cuneate, apex emarginate, margin entire, glabrous, coriaceous, shiny-green above and pale green beneath; lateral nerves 7-9 pairs, pinnate, slender, obscure, intercostae obscure. Flowers bisexual, white, 2.2 x 3.3 cm, in axillary dichotomously branched 4-flowered cymes; peduncle 4.4 cm long, terete, glabrous; bracts minute, cupular, at each node on peduncle; pedicel 3 mm long, terete, glabrous; bracteoles 2, connate to form a cup enclosing the calyx base, glabrous; calyx white, tube cupular, smooth, glabrous, enclosing the ovary; lobes 5, 1.5 cm long, linear, thick, fleshy, glabrous, persistent; petals 5, free, 5 mm long, white, deeply bilobed, lobes equal with 3-6 cilia at apex, glabrous; stamens many, free, inserted on the rim of calyx cup, filaments unequal, 0.7-1.2 cm long, terete, anthers basifixed, bilobed; ovary half inferior, inserted and fused with the calyx cup, single celled, ovules 6, pendulous, attached to the tip of central axis; style filiform, terete; stigma minutely 3-lobed. Fruit a drupe, 1.5-2 cm long, ovoid-conical; calyx lobes reflexed; peduncle elongating; seed one; hypocotyl 40 x 1.5 cm, spindle shaped, slightly curved with pointed radicle, surface smooth, green; cotyledonary collar protruded and exposed on maturity.

7. *Sonneratia caseolaris* (L.) Engl.

Synm. : *Rhizophora caseolaris* L.
Sonneratia acida L.f.

Family : Sonneratiaceae

Local Name : *Blatti, Chakkarakandal, Puzhamunja, Thirala*

Distribution: Austral-Asia; Kerala : Kasargod, Kannur, Kozhikod, Ernakulam, Kottayam, Alappuzha, Kollam and Thiruvanthapuram

Description : Evergreen trees, to 8 m high; pneumatophores 1 m long and 6 cm diameter, straight, stout, corky, conical, brownish grey or orange-coloured, outer thin layer flaky; bark brown, cracked; branchlets pendulous; angled, greenish-brown, glabrous; nodes swollen with 2 lateral pair of circular glands. Leaves simple, opposite-decussate, estipulate; petiole 5-10 mm long, stout, red, glabrous; lamina 4-11 x 3.5-6.5 cm, broadly ovate or broadly elliptic, base cuneate, apex mucronate, emarginate or obtuse, glabrous, coriaceous, thick, slightly fleshy, green; lateral veins 10-15 pairs, parallel, looped near the margin forming intramarginal nerve, slender, obscure, intercostae reticulate, obscure. Flowers bisexual, pink, 6 x 5-7 cm, terminal, solitary; bracts rudimentary, in conspicuous; pedicel 5-10 mm long, quadrangular, glabrous; calyx green outside, white within, calyx cup 1.8 x 2 cm, smooth, glabrous, enclosing the basal portion of the pistil; lobes 6, 2 x 1 cm, oblong, elliptic, acute, greenish outside, purplish-white within, thick, coriaceous, glabrous, persistent; petals 6, 2 x 0.2 cm, free, purple to violet

red, acuminate, apex wrinkled and coiled, membranous, glabrous, cauducous; stamens many, free, inflexed in bud, inserted in several rows on the terminal raised rim of the calyx cup, conspicuous, cauducous; filaments upto 4.2 cm long, reddish below, white above, thread like, anthers reniform, medifixed, bilobed; ovary 1 cm across, globose, white, many celled, ovules many in each cell; style coiled in bud, to 6 cm, white, terete; stigma capitate. Fruit a drupe, 7 cm across, globose, slightly flattened, calyx lobes horizontal, pericarp smooth, glabrous; seeds many, embedded in the fleshy pulp of the placenta, angular with rough surface.

4.2.2. Mangrove associate plants

Table 3. Mangrove associates in islands of Alappuzha

Sl. No	Name of the plant	Common name	Family	Distribution
1	*Annona glabra* L.	Kattathi, Kattu-aatha Kadalatha	Annonaceae	Tropics
2	*Calophyllum inophyllum* L.	Punna, Surampunna	Clussiaceae	Paleotropics
3	*Premna serratifolia* L.	Appel, Munja, Kozhichedi	Verbanaceae	Indo-Malesia
4	*Clerodendrum inerme* (L.) Gaertn.	Nironchi	Verbanaceae	Austral-Asia
5	*Thespesia populnea* (L.) Soland. ex Correa	Pooparutthi, Poovarasu	Malvaceae	Pantropics
6	*Talipariti tiliaceum* (L.) Fryxell	Poopparuthi, Thalipparuthi, Velipparuthi	Malvaceae	Pantropics
7	*Cerbera odollam* Gaertn.	Othallam	Apocynaceae	Indo-Malesia
8	*Tylophora tetrapetala* (Dennst.) Suresh var. *tetrapetala*; Sasidh. & Sivar.	Parparam	Asclepiadaceae	Indo-Malesia
9	*Morinda citrifolia* L.	Manjanathi	Rubiaceae	Austral-Asia

10	*Lannea coromandelica* (Houtt.) Merr.	Karasu, Karayam, Kalayam	Anacradiaceae	Austral- Asia
11	*Ipomoea alba* L.	Mandavalli	Convolvulaceae	Tropics
12	*Cayratia trifolia* (L.) Domin	Chorivalli, Kattuperanda	Vitaceae	Austral-Asia
13	*Derris trifoliata* Lour.	Kammattivalli, Ponumvalli	Fabaceae	Paleotropics
14	*Cyperus javanicus* Houtt.	Flat sedge	Cyperaceae	Pantropical
15	*Acrostichum aureum* L.	Coarse Swamp Fern	Pteridaceae	Tropics
16	*Acanthus ilicifolius* L.	Chakkaramullu	Acanthaceae	Austral-Asia
17	*Racosperma auriculiforme* (Benth.) Pedley.	Acacia	Fabaceae	Tropics
18	*Bacopa monnieri* (L.) Pennell	Brahmi	Scrophulariaceae	Paleotropics
19	*Excoecaria agallocha* L.	Kannampotti	Euphorbiaceae	Paleotropics

4.2.3. Phytogeographic affinities of the mangroves of Islands of Alappuzha

The flora of India as a whole has been enriched by the intrusive elements from other parts of Asia, Europe, tropical Africa, tropical America and Australia (MANI, 1974). Of 26 taxa as identified from the study area as mangrove plants and its associates, all of them are non indigenous including naturalized plants, alien/invasive plants, transformers and weeds. The mangrove flora of Vembanadu Lake Islands exhibit a trend of affinity of Austral Asian elements (7 spp.) > Tropical elements (5 spp.) > Paleotropic elements (4 spp.) = Indo-Malesian elements (4 spp.) > Pantropics elements (3 spp.) > Afro-Asian (3 spp.).

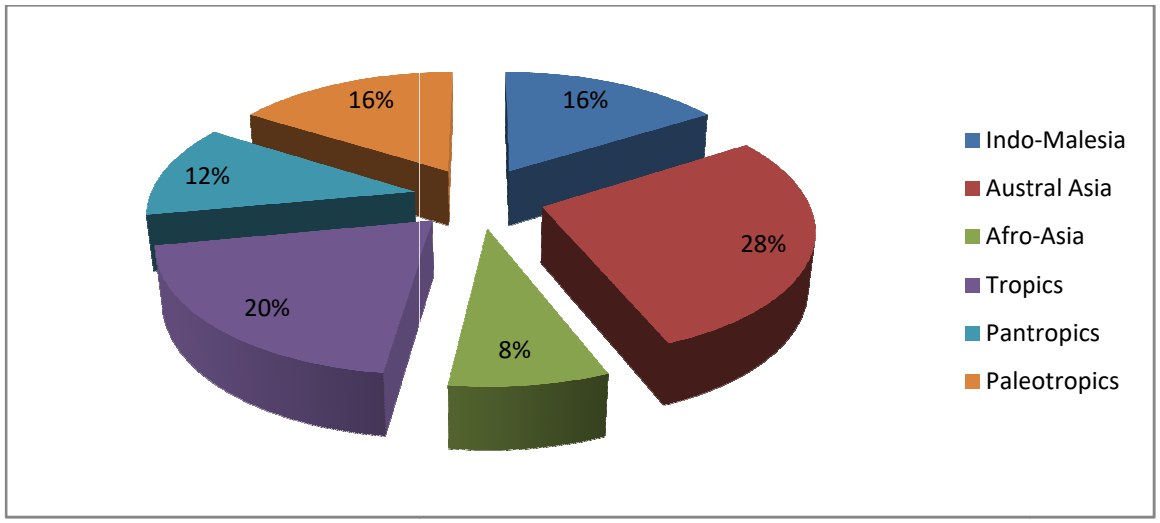

Fig. 6. Graphical representation of the phytogeographic affinities of the mangroves of Islands of Alappuzha

4.2.4. Abundance of mangroves and its associates

Six species of true mangroves viz., *Rhizophora mucronata* Poir., *Avicennia officinalis* L., *Bruguiera cylindrica* (L.) Blume., *Bruguiera gymnorrhiza* (L.) Savi., *Sonneratia caseolaris* (L.) Engl. and *Kandelia candel* (L.) Druce were enumerated from the Perumbalam Island. Same manner, Pallipuram island holds six species of mangroves viz., *Rhizophora apiculata* Blume *Avicennia officinalis* L., *Bruguiera cylindrica* (L.) Blume., *Bruguiera gymnorrhiza* (L.) Savi., *Sonneratia caseolaris* (L.) Engl. and *Kandelia candel* (L.) Druce . In the case of Pathiramanal Island, only 4 species of true mangroves were identified viz., *Avicennia officinalis* L., *Bruguiera cylindrica* (L.) Blume., *Sonneratia caseolaris* (L.) Engl. and *Kandelia candel* (L.) Druce. Besides that, 19 mangrove associates were also enlisted from there. Here we calculated the abundance of the mangroves and its associates.

In perumbalam island, 5200 m^2 mangrove forests were noted. This means 129.35 cent land (5200/40.46) mangroves are there. As revealed from the study 13307 (SD ±1889) mangroves and its associates were enumerated from there (including seedlings). Of which, 2220 true mangroves were included.

In Pallipuram Island, 18000 m^2 mangrove forests were noted. This means 445 cent land (18000/40.46) mangroves are there. By quadrate analysis, the abundance of the mangroves and its associates calculated as 45610 (SD ±2365). Among them, 7665 individuals were true mangroves.

Such a way, the abundance of the mangroves and its associates of Pathiramanal Island is enumerated as 23000 (SD ±1667). 12500 m^2 mangrove forests were noted in the Pathiramanal Island. This means 296 cent land (18000/40.46) mangroves are there. This area holds 3426 true mangroves.

Phytosociological analysis of Mangroves and its associates in Perumbalam Island by Quadrate Method

Number of Quadrate studied = 10
Size of the each Quadrate = 10m x10 m

5200 m^2 mangrove forests were noted in the Perumbalam Island. This means 129.35 cent land (5200/40.46) mangroves are there.

Table : 7: Abundance of Mangroves and associates of Perumbalam Island

Sl. No	Name of the Species	Qdt - 1	Qdt - 2	Qdt - 3	Qdt -4	Qdt - 5	Qdt - 6	Qdt - 7	Qdt -8	Qdt -9	Qdt-10	Total	Abun-dance in 10 ^{m2}	Abundance in total Mangroves	
1	*Rhizophora mucronata* Poir.	0	0	0	0	2	1	0	0	0	1	4	1.0	129	2200
2	*Avicennia officinalis* L.	1	3	5	1	1	2	0	5	8	9	35	3.8	497	
3	*Bruguiera cylindrica* (L.) Blume.	1	1	1	3	5	4	2	5	7	6	35	3.5	451	
4	*Bruguiera gymnorrhiza* (L.) Savi.	0	0	0	0	2	1	4	3	5	3	18	3.0	387	
5	*Sonneratia caseolaris* (L.) Engl.	2	0	0	0	0	2	1	5	3	5	18	3.0	387	
6	*Kandelia candel* (L.) Druce	2	1	0	0	0	2	1	6	2	5	19	2.71	349	
7	*Excoecaria agallocha* L.	3	0	2	1	3	2	1	5	1	2	20	2.2	284	
8	*Derris trifoliata* Lour.	2	0	4	0	1	3	1	4	6	0	21	3	387	
9	*Acrostichum aureum*	20	30	15	10	40	24	20	20	5	1	185	18.5	2386	
10	*Acanthus ilicifolius* L.	10	0	20	15	9	20	25	10	25	20	154	17.11	2207	
11	*Cerbera odollam* Gaertn.	1	2	5	0	1	4	12	10	25	14	74	8.22	1060	
12	*Taliparíti tiliaceum* (L.) Fryxell.	5	8	1	3	4	6	8	10	13	12	70	7.00	903	
13	*Thespesia populnea* (L.) Soland. ex Correa	1	2	0	0	2	1	4	3	8	10	31	3.87	501	
14	*Morinda citrifolia* L.	1	0	3	2	0	5	4	3	4	3	25	3.12	402	
15	*Clerodendrum inerme* (L.) Gaertn.	0	1	3	15	0	20	20	10	10	6	85	10.62	1369	
16	*Calophyllum inophyllum* L.	2	1	0	2	5	1	0	3	5	2	21	2.62	338	
17	*Lannea coromandelica* (Houtt.) Merr.	3	5	2	5	8	12	5	5	5	6	56	5.60	722	
18	*Premna serratifolia* L.	0	0	1	2	4	6	3	5	8	5	34	4.25	548	
	Total											**905**		**13307**	

18000 m^2 mangrove forests were noted in the Pallipuram Island. This means 445 cent land (18000/40.46) mangroves are there.

Table : 8: Abundance of Mangroves and associates of Pallipuram Island

Sl. No	Name of the Species	Qdt - 1	Qdt - 2	Qdt - 3	Qdt -4	Qdt - 5	Qdt - 6	Qdt - 7	Qdt -8	Qdt -9	Qdt-10	Total	Abun-dance in 10 ^{m2}	Abundance in total Mangroves	
1	*Rhizophora apiculata* Blume	0	1	0	2	2	1	0	0	0	1	7	1.0	623	
2	*Avicennia officinalis* L.	0	2	8	2	1	6	1	2	4	3	29	3.2	1424	
3	*Bruguiera cylindrica* (L.) Blume.	2	1	1	2	4	1	2	3	5	7	28	2.8	1246	**7655**
4	*Bruguiera gymnorrhiza* (L.) Savi.	0	0	0	6	2	0	2	3	5	3	21	3.0	1557	
5	*Sonneratia caseolaris* (L.) Engl.	1	5	2	0	0	4	6	5	3	4	30	3.0	1668	
6	*Kandelia candel* (L.) Druce	4	1	3	0	1	2	1	6	2	3	23	2.71	1137	
7	*Excoecaria agallocha* L.	10	2	2	1	2	2	1	5	1	1	27	2.7	1201	
8	*Derris trifoliata* Lour.	2	6	5	3	1	3	1	4	6	5	36	3.6	1602	
9	*Acrostichum aureum*	26	30	15	10	40	24	20	20	5	1	191	19.1	8499	
10	*Acanthus ilicifolius* L.	7	2	20	15	9	20	25	10	25	26	159	15.9	7075	
11	*Cerbera odollam* Gaertn.	6	2	5	9	1	4	12	10	24	8	81	8.1	3604	
12	*Talipariti tiliaceum* (L.) Fryxell.	9	8	1	3	4	8	8	10	13	10	74	7.4	3293	
13	*Thespesia populnea* (L.) Soland. ex Correa	3	2	6	2	2	1	4	3	8	9	40	4.0	1780	
14	*Morinda citrifolia* L.	0	0	3	2	1	5	4	3	2	1	21	2.6	1157	
15	*Clerodendrum inerme* (L.) Gaertn.	6	2	3	15	7	14	20	10	10	4	91	9.1	4049	
16	*Calophyllum inophyllum* L.	2	1	9	2	5	3	0	3	5	5	35	3.5	1557	
17	*Lannea coromandelica* (Houtt.) Merr.	4	5	2	5	8	10	5	5	5	9	58	5.8	2581	
18	*Premna serratifolia* L.	1	3	1	2	4	6	3	5	6	4	35	3.5	1557	
	Total											**986**		**45610**	

12500 m^2 mangrove forests were noted in the Pathiramanal Island. This means 296 cent land (18000/40.46) mangroves are there.

Table : 9: Abundance of Mangroves and associates of Pathiramanal Island

Sl. No	Name of the Species	Qdt - 1	Qdt - 2	Qdt - 3	Qdt -4	Qdt - 5	Qdt - 6	Qdt - 7	Qdt -8	Qdt -9	Qdt-10	Total	Abun-dance in 10 ^{m2}	Abundance in total Mangroves	
2	*Avicennia officinalis* L.	0	0	3	2	1	5	1	2	4	3	21	2.62	777	
3	*Bruguiera cylindrica* (L.) Blume.	1	1	1	2	4	1	2	3	5	7	27	2.7	799	3426
5	*Sonneratia caseolaris* (L.) Engl.	5	5	2	0	0	4	6	5	3	4	34	4.25	1258	
6	*Kandelia candel* (L.) Druce	1	1	3	0	1	2	1	2	2	3	18	2	592	
7	*Excoecaria agallocha* L.	4	0	2	1	2	2	1	3	1	1	17	1.8	559	
8	*Derris trifoliata* Lour.	1	2	4	3	1	2	1	4	5	1	24	2.4	710	
9	*Acrostichum aureum*	15	21	15	10	40	24	20	20	25	10	200	20.0	5920	
10	*Acanthus ilicifolius* L.	17	20	10	15	9	20	25	10	21	11	158	15.8	4676	
11	*Cerbera odollam* Gaertn.	0	2	1	9	1	4	1	1	2	8	29	3.22	953	
12	*Taliparíti tiliaceum* (L.) Fryxell.	7	2	3	2	4	8	8	6	4	3	47	4.7	1391	
13	*Thespesia populnea* (L.) Soland. ex Correa	0	2	3	2	2	1	4	3	8	5	30	3.0	888	
14	*Morinda citrifolia* L.	0	0	1	0	1	0	4	3	2	1	12	2	592	
15	*Clerodendrum inerme* (L.) Gaertn.	0	0	0	10	7	7	0	3	1	5	33	5.5	1628	
16	*Calophyllum inophyllum* L.	0	1	5	2	5	3	0	3	2	3	24	3	888	
17	*Lannea coromandelica* (Houtt.) Merr.	0	0	2	0	1	3	2	5	5	4	22	2.75	814	
18	*Premna serratifolia* L.	1	0	1	2	4	0	3	1	1	2	15	1.87	555	
	Total											**711**		**23000**	

4.3. Weed invasion in the study area

A survey was conducted to enumerate the species composition and also to identify the general status of the weed invasion in the islands. The results obtained from the survey during the year 2018 are presented here.

4.3.1. Invasive weeds

Seven noxious weeds were spotted in the study area viz., *Chromolaena odorata, Lantana camara, Camonea vitifolia, Sphagneticola trilobata, Mikania scandens, Mimosa diplotricha and Ipomoea carnea* Jack. ssp. *fistulosa* (Mart. ex Choisy) Austin.

4.3.1.1. *Chromolaena odorata* (L.) R.M.King & H.Rob.

Synm. *Chromolaena barranquillensis* ; *Chromolaena odorata* f. *odorata* ; *Chromolaena odorata* f. *squarrosa* ; *Chrysocoma maculata*; *Chrysocoma volubilis* ; *Chrysocoma volubilis* ; *Eupatorium affine*; *Eupatorium atriplicifolium* ; *Eupatorium barranquillense*; *Eupatorium brachiatum* ; *Eupatorium conyzoides* ; *Eupatorium conyzoides* var. *incanum* ; *Eupatorium conyzoides* var. *phyllocephalum* ; *Eupatorium conyzoides* var. *scaberulum* ; *Eupatorium conyzoides* var. *tambillense* ; *Eupatorium dichotomum*; *Eupatorium divergens* ; *Eupatorium floribundum* ; *Eupatorium graciliflorum*; *Eupatorium klattii*; *Eupatorium odoratum*; *Eupatorium odoratum* var. *brachiatum* ; *Eupatorium odoratum* var. *cubense*; *Eupatorium odoratum* var. *mallotophyllum*; *Eupatorium odoratum* var. *pauciflorum*; *Eupatorium sabeanum* ; *Eupatorium stigmatosum* ; *Osmia atriplicifolia* ; *Osmia conyzoides* ; *Osmia divergens*; *Osmia floribunda* ; *Osmia graciliflora*; *Osmia odorata* .

Common Name: Siam weed, Christmas bush, devil weed, camphor grass, common floss flower, communist green and triffid. Communist pacha (Malayalam)

Family: Asteraceae

Distribution: *Chromolaena odorata* is native to the Caribbean and Latin America. It has been introduced to tropical Asia, west Africa, and parts of Australia. **Kerala:** All Kerala

Description: Herbs, dense tangled bushes to 1.5-3.0 m in height. The older stems are brown and woody near the base; tips and young shoots are green and succulent. The root system is fibrous and does not penetrate beyond 20-30cm in most soils. stems terete, pubescent; leaves opposite, flaccid-membranous, velvety-pubescent, deltoid-ovate, acute, 3-nerved, very coarsely toothed, each margin with 1-5 teeth, or entire in youngest leaves; base obtuse or subtruncate but shortly decurrent; petiole slender, 1-1.5cm long; blade mostly 5-12cm long, 3-6cm wide, capitula in sub-corymbose axillary and terminal clusters; peduncles 1-3cm long, bracteate; bracts slender, 10-12mm long; involucre of about 4-5 series of bracts, pale with green nerves, acute, the lowest ones about 2mm long, upper ones 8-9mm long, all acute, distally ciliate, flat, appressed except the extreme divergent tip; florets

all alike (disc-florets), pale purple to dull off-white, the styles extending about 4mm beyond the apex of the involucre, spreading radiately; receptacle very narrow; florets about 20-30 or a few more, 10-12mm long; ovarian portion 4mm long; corolla slender trumpet form; pappus of dull white hairs 5mm long; achenes glabrous. The seeds of Siam weed are small (3-5mm long, ~1mm wide, and weigh about 2.5mg seed-1. **Impacts:** *Chromolaena odorata* can be considered as a very serious weed in all types of plants species in the humid areas of the Palaeotropics. *C. odorata* is a typical pioneer species of secondary forest succession with a strong heliophilic character and vigorous vegetative development. lnitially C. odorata spreads by seed, but after establishment it may also reproduce vegetatively from lateral branches; regrowth occurs after slashing and burning. It flowers at the end of the rainy season and after flowering the leaves fall and the stems die back. The ripe seeds are wind dispersed, although adherence to the fur of animals, clothes and machinery, and the contamination of planting material are also important mechanisms for seed dispersal over large distances. C. odorata may easily invade open spaces. In heavily disturbed environments, it competes effectively with other plants and crops, and may become the dominant species.

4.3.1.2. *Lantana camara* L.

Synm. : *Camara vulgaris*; *Lantana camara* f. *albiflora* ; *Lantana camara* f. *caffertyi*; *Lantana camara* f. *camara ; Lantana camara* f. *nana* ; *Lantana camara* f. *rubelloflavescens* ; *Lantana camara* var. *camara*; *Lantana camara* var. *nana* ; *Lantana coccinea* ; *Lantana coccinea* ; *Lantana glandulodissima* ;*Lantana glandulosissima* f. *aculeatissima* ; *Lantana glandulosissima* f. *parvifolia* ; *Lantana glandulosissima* var. *grandis* ; *Lantana mexicana* ; *Lantana polyacantha* ; *Lantana scabrida* ; *Lantana spinosa* ; *Lantana spinosa* ; *Lantana tiliaefolia*; *Lantana tiliaefolia* var. *glandulosa* ; *Lantana tiliaefolia* var. *scabra* ; *Lantana urticifolia* subsp. *urticifolia.*

Common Name: Big-sage , wild-sage, red-sage, white-sage and tickberry. Kongini, Aripoo (Mal.)

Family: ***Verbenaceae***

Distribution: Native of Central and South America; it has been introduced and now it has a cosmopolitan range. **Kerala:** All Kerala

Description: Deciduous shrub, to 2 m (6 ft) ormore, with stems square, covered with bristly hairs when green, often armed as well with scattered small prickles. Leaves opposite, simple, with petioles to 2 cm (0.8 in) long; blades oval, rough hairy, to 15 cm (6 in) long and 6 cm (2.4 in) wide, with margins blunt-toothed and blade bases broad, squared off (truncate); leaves strongly aromatic. Flowers small, multicolored, in stalked, dense, flat-topped clusters to 4 cm (1.5 in) across; corolla a narrow tube with 4 short spreading lobes; flowers in a single cluster may be white to pink or

lavender, yellow to orange or red, changing color over time. Fruit a round, fleshy, 2-seeded drupe, about 5 mm (0.2 in) wide, green turning purple then blue-black.

Plate 13. *Chromolaena odorata* (L.) R.M.King & H.Rob.

Impacts: Its infestations alter the structural and floral composition of native communities. As the density of *Lantana camara* in forest increases, allelopathic interactions increase and hence there is decline in species richness. Due to its prolific nature of flowering and dispersal, the species tends to alter the structure of the terrestrial ecosystem by gregarious presence. The species forms dense thickets and tends to eliminate the native species. *L. camara* become the understorey species in

disturbed native forest thus dominating the flora, causing disruption in succession and loss in biodiversity. *L. camara* often causes a reduction in yield or impedes harvesting in plantations. Also, species has potential to contaminate the gene pool of the rare plant species. Allelopathy characteristics of species enable it to survive secondary succession and become monospecific thickets. Fire regimes are altered immensely by the presence of the *Lantana camara* in natural systems. The species burns readily in hot and dry conditions. Its occurrence on forest margins are seen as major threat to community, as a result of increased in roads of fire into the land.

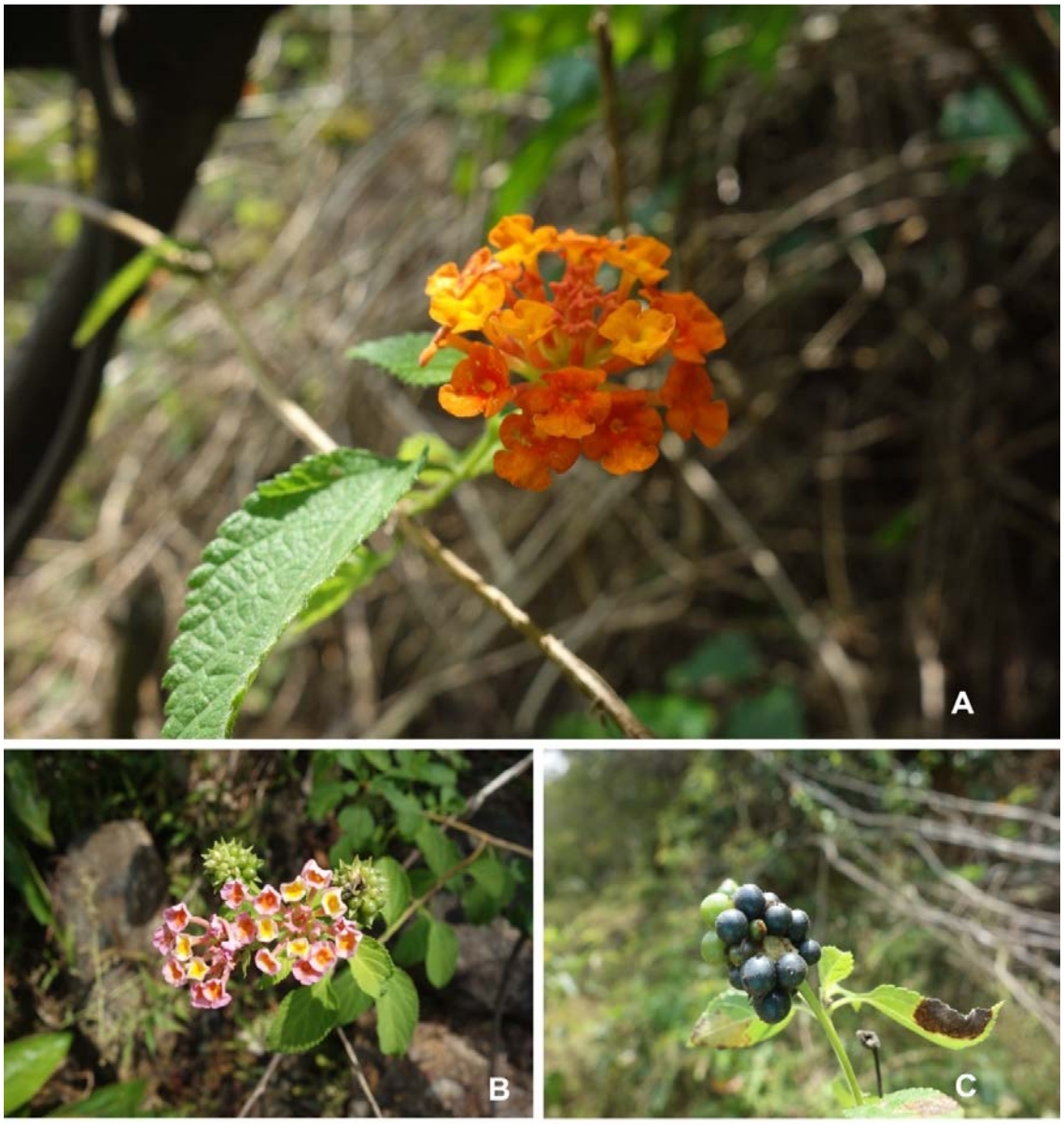

Plate 14. *Lantana camara* L.

4.3.1.3. ***Camonea vitifolia*** (Burm.f.) A.R.Simões & Staples

Synm. : *Convolvulus angularis*; *Convolvulus vitifolius* ; *Ipomoea vitifolia* ; *Ipomoea vitifolia* var. *angularis* ; *Merremia vitifolia; Tirtalia vitifolia.*

Local Name : Grape-leaf Wood Rose

Family: *Convolvulaceae*

Distribution: E. Asia - China, India, Sri Lanka, Nepal, Bangladesh, Myanmar, Thailand, Laos, Vietnam, Malaysia, Indonesia, Philippines. **Kerala:** All Kerala .

Description: Twinning or prostrate herb. The stems are purplish when old, and grow to 4 m long. Leaf blade is circular in outline, 5-18 by 5-16 cm, cordate at the base, palmately 5-7-lobed. Flower-buds narrow-ovoid, acute. Flower tube is funnel shaped -6 cm long, glabrous, bright yellow, paler towards the base. Pedicel 1–1.6 cm, thicker distally. Sepals oblong or ovate-oblong, 1.4–1.8 cm, enlarged in fruit, ± leathery, ± shiny, pitted adaxially, pellucid glandular, apex obtuse or ± acute; outer 2 hirsute abaxially; inner ones glabrous. Corolla yellow, paler in tube, funnelform, 2.5–5.5 cm, glabrous outside; limb ± 5-angled. Stamens ca. 1.1 cm; anthers spirally twisted. Ovary glabrous. Capsule straw colored, ± globose, ca. 1.2 cm, papery. Seeds black-brown, trigonous-ovoid, ca. 7 mm, gla-brous.

Impacts: Found all over the open forests, thickets, and hedges, in teak-forests, along edges of secondary forests, on river-banks and waysides. *Camonea vitifolia* become the understorey species in disturbed native forest thus dominating the flora, causing disruption in succession and loss in indigenous phytodiversity.

4.3.1.4. *Sphagneticola trilobata* (L.) Pruski

Synm. : *Acmella brasiliensis* ; *A. spilanthoides* ; *Aster strigosus* ; *Buphthalmum heterophyllum*; *B. procumbens* ; *B. repens* ; *B. strigosum* ; *Polymnia carnosa* (Rich.) Poir.; *P. carnosa* var. *carnosa* ; *P. crenata* ; *Seruneum paludosum* ; *S. trilobatum* ; *Silphium trilobatum* ; *Sphagneticola ulei* ; *Stenmodontia carnosa* ; *S. trilobata* ; *Thelechitonia trilobata* ; *Verbesina carnosa* ; *V. carnosa* var. *aspera* ; *V. carnosa* var. *carnosa; Verbesina carnosa* var. *triloba* ; *V. tridentata* ; *Wedelia brasiliensis* ; *W. brasiliensis* var. *brasiliensis; W. carnosa* ; *W. carnosa* ; *W. carnosa* var. *carnosa; W. carnosa* var. *glabella* ; *W. carnosa* var. *triloba* ; *W. carnosa* var. *triloba* ; *W. crenata* ; *W. paludicola*; *W. paludosa* ; *W. paludosa* var. *paludosa; W. paludosa* var. *vialis* ; *W. pedunculata*; *W. pedunculata* ; *W. tannensis* ; *W. triloba* ; *W. trilobata*; *W. trilobata* ; *W. trilobata* var. *hirtella* ; *W. trilobata* var. *pilosissima*; *Wollastonia trilobata*

Local Name: Bay Biscayne creeping-oxeye,Singapore daisy, creeping-oxeye, trailing daisy, and wedelia.

Family : Asteraceae

Distribution: Native of Tropical America, but now grows throughout the Neotropics. Kerala: All over.

Description: Perennial herbs, prostrate, diffuse, rooting at nodes; stems glabrous or pubescent. Leaves 3-10 x 3-7 cm, elliptic-obovate, usually with 3 angular lobes with toothed margins, acute at apex, basally cuneate, glabrous to sparingly pubescent; petiole short, upto 5 mm. Heads radiate, 2-2.5 cm across, solitary on ebracteate 4-15 cm long peduncles. Involucre green; bracts lanceolate, 1-1.5 cm long, ciliate; inner narrower. Ray florets 5-8; corolla bright yellow, 1.5-2.0 x 0.5-0.7 cm, 3-4 denticulate; tube short. Ovary trigonous; stigma bilobed. Pappus connate into a spathiform, fimbriate cup at the apex, devoid of awns. Disc florets many; corolla yellow; tube 5-8 mm long, 5-lobed; lobes deltoid, densely pubescent within. Anthers black, syngenecious. Style branches flattened and marginally pubescent. Achenes blackish, warty, 4-6 mm long, crowned by the persistent pappus cup.

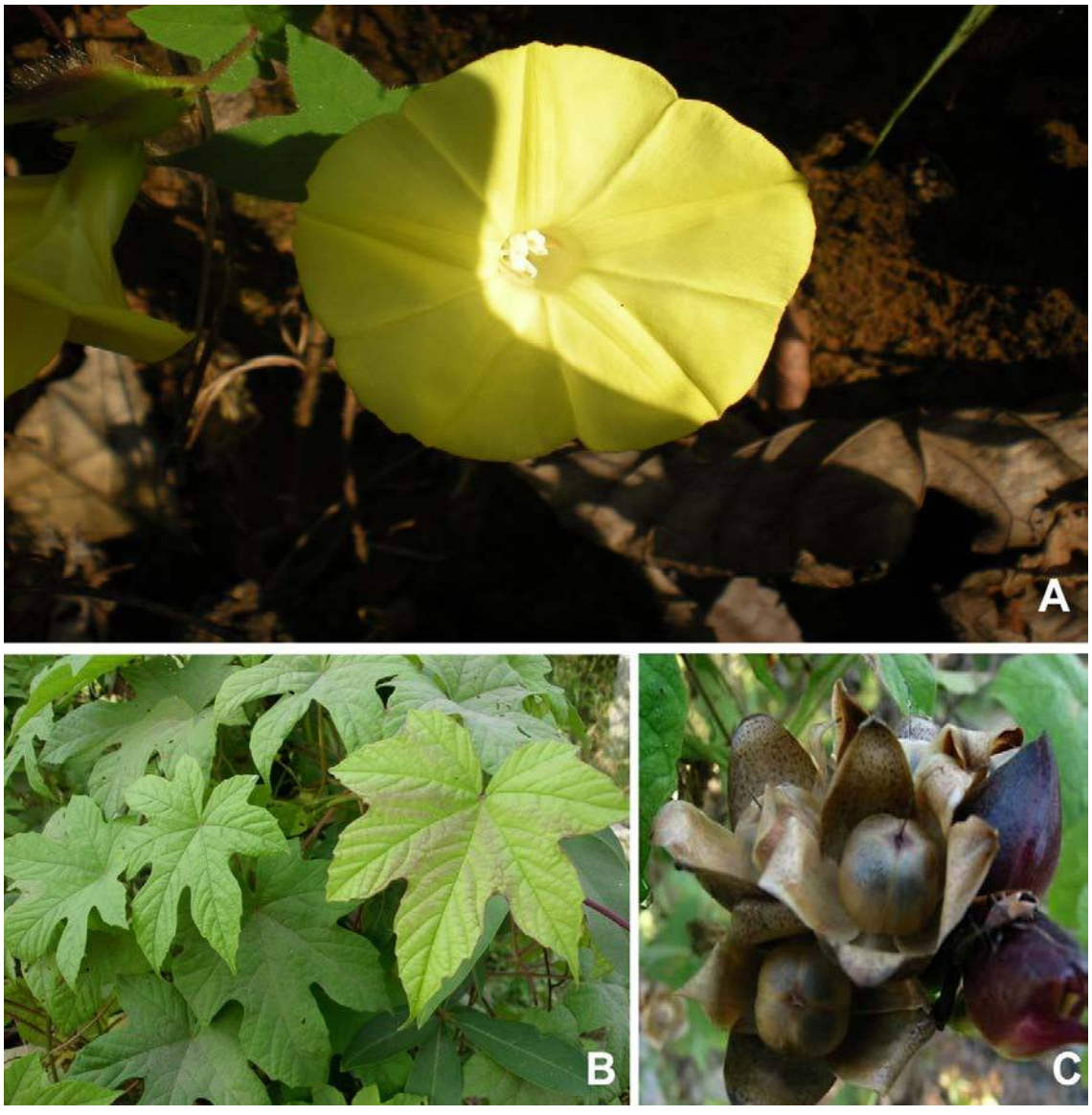

Plate 15. *Camonea vitifolia* (Burm.f.) A.R.Simões & Staples

Impacts: *Sphagneticola* is one of the most significant dominant invasive plant species. The presence of invasive plant species such as *S. trilobata* in the terrestrial ecosystem poses a major threat to the biodiversity of a given community and ecosystem functions. S. trilobata was found to prevent regeneration of co-occurring species and damage riverbanks and wastelands. This could have been attributed to the allelopathic effect of S. trilobata leachates and residues that caused substantial reduction in germination and growth rate of native plants. One of the reasons *S. trilobata* is more aggressive and dominant in the invaded region is because of the lack of natural enemies which are capable of controlling its population growth.

Plate 16. *Sphagneticola trilobata* (L.) Pruski

4.3.1.5. *Mikania scandens* Willd.

Synm. : *Eupatorium orinocense* var. *bataefolium* ; *E. scandens*; *Mikania angulosa* ; *M. bataefolia* ; *M. menisperma* ; *M. menispermea* ; *M. mikanoides* ; *M. pubescens*; *M. scandens* var. *pubescens* ; *M. scandens* var. *scandens*; *Willoughbya scandens* ; *W. scandens* var. *normalis* ; *W. scandens* var. *pubescens*

Local Name: Mikenia, Bittervine, Chinese Creeper, Climbing Hempweed. Vayara (Mal.)

Family: Asteraceae

Distribution: Native to the eastern and central United States and it is spread all over pantropical.

Kerala: All Kerala .

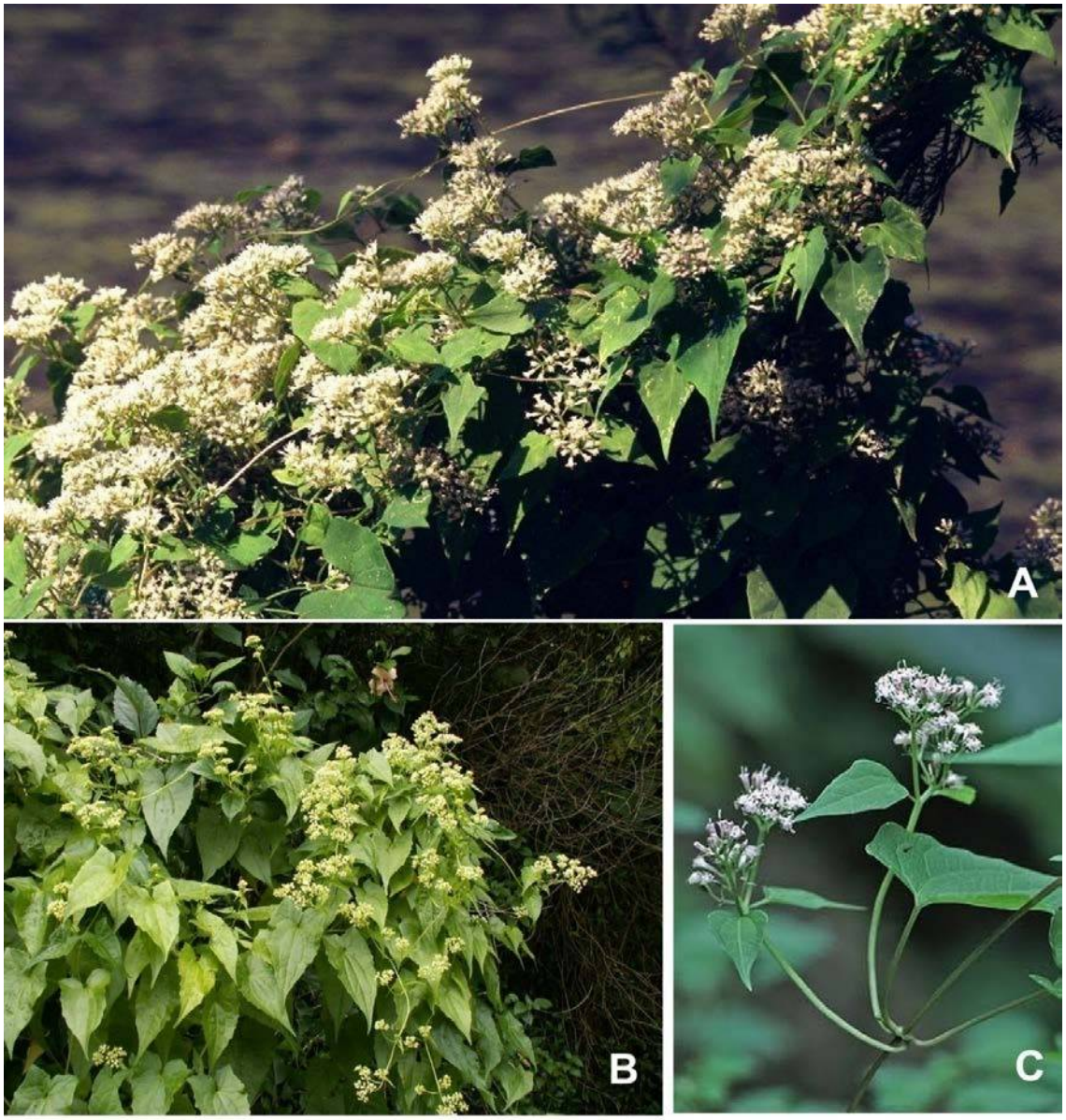

Plate 17. *Mikania scandens* Willd.

Description: Climbers, stem glandular-hispid. Leaves simple, opposite, 5-8 x 4-6 cm, ovate, apex acute, base cordate, crenate, glabrate; petiole 2-4 cm long. Heads 5 mm long, in axillary panicles; bracts biseriate, outer 2 smaller, inner 3-5, 4 x 1.5 mm, ovate, obtuse. Flowers 3-5, similar, bisexual; corolla 3 mm long, tubular, lobes 5, glandular, white; anthers linear. Achenes 2 mm long, 5-ribbed, black, glabrous; pappus 4 mm long, many, hispid.

Impacts: Its rapid spread is a threat to natural environments, where it kills or reduces growth of preferred species, severely impacting on biodiversity and production. Large numbers of wind-dispersed seeds and ability to propagate vegetatively from stem fragments facilitate rapid invasion. Management of M. micrantha is difficult.

Plate 18. *Mimosa diplotricha* C. Wright

4.3.1.6. *Mimosa diplotricha* C. Wright

Synm. : *Mimosa invisa*; *Morongia pilosa*; *Schrankia brachycarpa*; *Schrankia pilosa*

Local Name: Giant sensitive plant

Family: Fabaceae, Mimosaceae

Distribution: Native to t Native of Tropical America; a weed in India. Kerala: All Kerala

Description: Rambling shrubs, stem pubescent, prickles short, in 4-rows. Leaves to 10 cm long; pinnae opposite, to 5 cm long; leaflets to 35 pairs, to 5 x 1 mm, oblong, truncate at base, glabrous; rachis prickled. Head to 1.5 cm across, in terminal racemes, peduncled. Flowers many, 3 mm long, pink; stamens 10, filaments 6 mm long. Pods 2-5 cm long, bristly, black when mature.

Impacts: It has the ability to climb over and smother other plants and can shade out light-demanding species, preventing the natural regeneration of other plants, and it constitutes a wildland fire hazard when dry. Due to its prolific nature of flowering and dispersal, the species tends to alter the structure of the terrestrial ecosystem by gregarious presence. The species forms dense thickets and tends to eliminate the native species. There are no potential enemies and the seeds spread through winds are another threat to the indigenous flora.

4.3.1. 7. *Ipomoea carnea* Jack. ssp. *fistulosa* (Mart. ex Choisy) Austin

Synm. *: Ipomoea fistulosa* Mart. ex Choisy; *Ipomoea crassicaulis* (Benth.) Robins.; *Batatas crassicaulis* Benth

Local Name: Neyveli katta (Mal.); Bush Morning Glory ,Shrub Ipomoea

Family: Convolvulaceae

Distribution: Native of America; now Pantropical

Description: Erect to subscandent shrubs; stems fistulose at maturity, tomentose. Leaves ovate-lanceate, 4-14 by 2.5-9 cm, base cordate, apex gradually acuminate, lateral veins 8-10 pairs, prominent. Cymes many-flowered, axillary or subterminal; peduncle c. 10 cm long; calyx lobes subequal; corolla pale pink, c. 9 cm long. Capsule ovoid. Seeds pubescent.

Impacts: Due to its prolific nature of flowering and dispersal, the species tends to alter the structure of the terrestrial ecosystem by gregarious presence. The species forms dense thickets and tends to eliminate the native species. There are no potential enemies and the seeds spread through winds are another threat to the indigenous flora.

4.3.2. Aquatic and semi aquatic weeds

Some aggressive aquatic weeds viz., *Colocasia esculenta, Cabomba caroliniana, Eichhornia crassipes* and *Pistia stratiotes* were also shows invasive nature in islands. Native biota was highly affected by them.

4.3.3. Likely invasive species (L.IAS)

These plants are non-native, having biological potential for rapid or widespread dispersal and naturalized in the islands. These plants also have invasion history in other protected areas.

However, there is no major invasion in the study area noticed. Plants species such as *Urena lobata, Hygrophila ringens, Microstachys chamaelea, Stachytarpheta jamaicensis, Persicaria glabra, Ludwigia peruviana, L. hyssopifolia, Cleome viscosa, Tridax procumbens, Achyranthes aspera, Ipomoea hederifolia, Mimosa pudica, Aerva lanata* and *Evolvulus alsinoides* are the invasive species with potential to be a noxious weed, identified from the islands.

4.3.4. Spread ecology and phytosociology of the noxious weeds in the study area

The data collected for the present study were analyzed to throw light on the answers to the specific questions raised in the study. As based on the criterion we have used, 7 invasive alien plants species were enumerated. An earnest attempt is made to study the spread ecology of these weeds of the entire region. The details emerged from the study are presented below.

Table 4: Spread ecology of Invasive weeds in Perumbalam Islands

Quadrate No	CO	LC	CV	ST	MS	MD	IC	
1	5		2					
2				20	4			
3		2					4	
4		5						
5	5		3				2	
6	3							
7					4			
8			4				6	
9				25				
10							7	
11	2							
12		2			3	1		
13							3	
14	7						2	
15				15				
16	6							
17		2	7				3	
18					2		1	
19		6	1	20		1		
20	4		3			20	3	
Total	32	17	20	80	13	22	31	215
Abundance	4.57	2.82	3.33	16	2.6	5.5	4.52	
Standard Deviation	2.32	1.75	1.89	8.36	1.38	4.46	2.29	
Density	1.6	0.85	1	4	0.65	1.1	1.55	
Relative Density	1.73	0.9	1.08	4.33	0.7	1.19	1.43	
Frequency	30	25	30	20	20	15	29	
Relative Frequency	8.86	6.32	7.59	5.06	5.06	3.79	8.32	
Relative Dominance	0.53	0.36	0.18	0.74	0.12	0.2	0.0002	

RIVI	3.7	2.52	2.95	3.37	1.96	1.72	1.21	

Table 5: Spread ecology of Invasive weeds in Pallipuram Island

Quadrate No	CO	LC	CV	ST	MS	MD	IC	
1	20	6						
2	5	14		8				
3		2	5	5	2	6		
4	15	6	2	14	6		22	
5	7		3	18	2		10	
6			8			14	14	
7	11	18		14	4			
8		16	4		5			
9	26	9		10		21	5	
10	1		4		16			
11	7	11		6			9	
12		14	4		9			
13	29	12		16			3	
14	12		8		2		9	
15			21	15		9	4	
16	26	9			7			
17		2			16	15		
18	14		25		2		4	
19		13	1	18			7	
20	6	9	3	2		3	11	
Total	179	141	88	126	71	68	98	771
Abundance	13.76	10.07	7.33	11.45	6.45	11.33	8.9	
Standard Deviation	9.86	6.26	6.89	7.12	5.04	6.59	6.06	
Density	8.95	7.05	4.4	6.3	3.55	3.4	4.9	
Relative Density	6.28	4.95	3.08	4.42	2.49	1.83	3.44	
Frequency	65	70	60	55	55	30	55	
Relative Frequency	4.51	4.86	4.16	3.81	3.81	1.25	3.81	
Relative Dominance	0.942	0.74	0.46	0.66	0.37	0.0003	0.51	
RIVI	3.91	3.51	2.56	2.96	2.22	1.02	2.58	

Table 6: Spread ecology of Invasive weeds species in Pathiramanal Island

Quadrate No	CO	LC	CV	ST	MS	MD	IC	
1	60	18	21		18	2		
2	425	60				6		
3	68	42	15			14		
4	12	18	15					
5	4	19	12		17			

6	45	23	12	9				
7		10	19					
8	250	23	8					
9	120	6	15			5		
10	4	18	6					
11	600	51	19	11	60	240		
12	468	45	21		56	300		
13		19	14					
14	125				11			
15	10	7	37					
16	220	14				25		
17	46	8			10			
18	140	9	24			4		
19	85	11	20	13		7		
20	75	15	11		18	45		
Total	2757	416	269	33	190	648		4313
Abundance	153.16	21.89	13.5	11	27.14	64.8		
Standard Deviation	172.53	16.15	54.45	4.09	17.9	82.58		
Density	137.85	20.8	13.45	1.65	9.5	32.4		
Relative Density	36.76	5.54	3.58	0.44	2.53	8.64		
Frequency	80	85	85	15	35	50		
Relative Frequency	6.87	6.1	6.1	1.14	2.67	3.81		
Relative Dominance	0.036	0.005	0.0035	0.0004	0.002	0.008		
RIVI	14.55	3.88	3.22	0.526	5.2	3.81	0.	

4.3.4.1. Spread ecology of weeds

Chromolaena odorata is widely acknowledged as a major economic and ecological burden to many tropical and subtropical regions of the world including India. In Perumbalam and Pallipuram regions this noxious weed is spreading at an alarming rate. The research revealed the decrease of species diversity in the invaded habitats. Another noteworthy feature observed is that, *Chromolaena odorata* infested plantation area is less reproductive in the case of native plants and teaks. As denoted by Ambika and Jayachandran (1980), *C. odorata* produces a variety of allelochemicals, including flavonoids, terpenoids, and alkaloids to Suppress the crops. Lowland Vayals are also prone to the invasion. When compared to other habitats, mangroive swamps are less invaded.

Lantana camara L. a notorious global invader, has spread rapidly in many of the 60 regions of the world and is listed among the world's one hundred worst invasive species (Lowe et al., 2000). Morphological and ecological characteristics that have contributed to its successful spread in Tropical countries. These include prolific flowering and production of fleshy fruit throughout the

year features that are particularly important as frugivorous birds are important dispersal vectors. Endozoochory (i.e. the dispersal of seeds after passage through the vertebrate gut) has been shown to increase seed germination rates and vigor (Jordaan et al., 2011).In three islands, L. camera is naturalized. However, modest invasion noticed there.

Camonea vitifolia was not an aggressive weed until the last two decades. But, these plants acclimatized in Indian forest especially the Western Ghats and proliferate at an alarming rate. *C. vitifolia* grows particularly well on forest margins and rapidly colonises forest gaps created by dead trees and tree falls. It can even cause death of shrubs and small trees. Roots emerges out from each node of the plant and will spread over the thickets and gaps. The research revealed that, *C. vitifolia* is a destructive weed even in swamps. The lowland Vayals also provide habitat for them. Urgent preventive measures should be adopted to conserve the local flora.

Sphagneticola trilobata was able to adapt to different environments. The mean phenotypic plasticity index of *S. trilobata* was higher than that of other invasive plant species. As revealed from the study *S. trilobata* spread all over the habitat except sacred groves. It denoted that, this species is highly adapted for these habitats and may spread over shades also. It having a greater biomass and higher rates of transpiration compared to the indigenous vegetation it also reduces water run-off in water catchments.

The spread of *Mikania scandens* suppresses indigenous vegetation through physical smothering and allelopathy. *M. Scandens* forms a higher plant biomass than the indigenous vegetation on swampecosystems. Another noteworthy result observed in the study that, *M. scandens* is slowly invaded into the mangrove forest also. *Mikania scandens* threatens the habitats of animal taxa too.

Mimosa diplotricha is a fast-growing, sprawling annual although behaves as a short-lived perennial shrubby leguminous vine. This plant forms dense, tangled clumps up to 2 m high. It produces enormous seeds and these seeds remain dormant for up to several years. There are no potential enemies to *Mimosa diplotricha* and their seeds spread through winds and easily grow everywhere.

Ipomoea carnea ssp. *fistulosa* is a pantropical weed, was able to adapt to different environments. In different habitat of the islands it spreads its distribution at an alarming rate. When compared to other islands, no such invasion of *Ipomoea carnea* in Pathiramanal Island. However, urgent preventive measures should be adopted to conserve the local flora.

4.4. Livelihood of indigenous people

The details of the population of Perumbalam Island : Total members: 10125 (Male - 4891, Female - 5234). About 20 % male and 6 % of female were engaged in fishing and allied jobs for livelihood. Hunting of fishes, crabs, mollusks, valves and prawns used to meet their livelihood requirements. In Pallipuram islands, only 15 % of male and 3 % of female were subjected to fishing and allied jobs. In pathiramanal Island no inhabitants are there.

4.5. Effect of flood in flora, fauna and livelihood

Flood in 2018 made much havoc in Kerala. The impact of flood in islands of Alappuzha is subjected to investigation. Results revealed from the study are enlisted here.

- **Soil P^H**

The soil P^H became more acidic and its level fall down to 3. This soil conditions does not favors the germination of seeds and growth of immature plants. Therefore, growth of mangroves seedlings highly declined.

- **Invasion of weeds**

Seven noxious weeds were spotted in the study area viz., *Chromolaena odorata, Lantana camara, Camonea vitifolia, Sphagneticola trilobata, Mikania scandens, Mimosa diplotricha and Ipomoea carnea* Jack. ssp. *fistulosa* (Mart. ex Choisy) Austin. Besides, numerous likely invasive species are growing at an alarming rate. The aquatic weeds like *Colocasia esculenta, Cabomba caroliniana, Eichhornia crassipes* and *Pistia stratiotes* were also shows fast invasion.

- **Invasion of aquatic organisms**

Aquatic organisms like Jellyfish population increased even in the small ditches of swamps. Its population threatening other species and creating havoc for fishing operations. The invasive fishes like African Catfish, Redbelly, Cattla etc . makes the serious problem in the indigenous biodiversity.

- **Declining of fish population**

As revealed from the long term investigation and questionnaire survey, the population of indigenous fishes likes Etroplus, Kayal Prawns, Valves, Gastropods etc. facing a serious declination.

- **Loss of vegetation**

Flood caused the destruction of plants even the mangrove vegetation. Numerous plants fallen down. Besides that, plant diseases such as yellowing and various insect diseases were also noticed.

Plate 18. Indigenous people engaged in labour

Plate 19. (a-f). Biodiversity loss: a, b. Plastic accumulation, **c.** Invasive water animal (Jellyfish), **d.** Spreading of plant diseases, **e,f.** Fallen trees.

- **Plastic accumulation**

Kilos of plastics and bottles were accumulated in Pathiramanal Island. It will affect this biodiversity rich area.

4.6. Recommendations

4.6.1. Mangrove restoration

Mangroves play a significant role in controlling coastal erosion and improving water quality of the area. It protects the coastlines from cyclones and tsunami. Mangroves are known to provide shelter, act as nursery grounds and are also habitats for economically important fishes, prawns, crabs and molluscs. But environmental pollution caused the degradation of mangrove habitats and there by its natural regeneration. In order to overcome the issue of reduction in mangrove cover, attempts were made by the government and non-governmental organizations to restore the mangrove wherever possible.

Aspects to be paid attention to

1. Identification of appropriate sites for mangrove cultivation (soil stability, flooding regime, elevation, extent of pollution)
2. Selection of species/species assemblages suitable for the soil and hydrological conditions of the site
3. Quality of the planting material
4. Adoption of an appropriate planting technique
5. Reduction of predator pressure
6. After-care practices
7. Mechanisms to obtain local community participation and support for restoration

4.6.2. Methods to control of Invasive Alien Species

The following methods are proposed to control and prevent the invasion and the expansion of the weed plants.

4.6.2.1. Prevention of spread

For preventive measures which have already established in some areas and immediate eradication is difficult, efforts should be focused on preventing their spread by:

1) Restricting the movement of soil and plant parts from infested areas to un-infested areas and

2) Removing the weeds manually or mechanically (cutting or pulling) before flowering and fruiting and burning them at the site.

3) Integrated weed management

4). Introduction of eco-friendly pathogens or insects which is harmful to these weeds

5). Application of biological herbicide

5). Application of herbicide

4.6.2.2. Habitat restoration

Manual/mechanical control may be difficult, costly and unsustainable for exotic weeds which have established in large areas. In such cases, systematic restoration strategies should be taken up. To achieve this, remove the weeds manually or mechanically (pulling along with roots/tubers) in small areas at a time and subsequently plant the area with fast growing native species. Assisted regeneration may also be attempted in such areas.

4.6.2.3. Silviculture Practices

Introduction of saplings in open areas of the swamps and ensure facilities for its growth. It will help to reduce the radius of the open areas and such a way we can prevent the expansion of weeds.

4.6.3. Plastic removal

Accumulated plastic in the islands should be collected and recycled. For the same, self help groups, NGO s etc. can be participate.

REFERNCES

Abraham, M. & C.T. Abraham (2005). Biology Of Mile - A Minute Weed (*Mikania Micrantha* H. B.K.), An Alien Invasive Weed in Kerala. *Indian Journal of Weed Science* **37**(1/2):153-154.

Abraham, Z. & B. N. Mehrotra (1982). Some Observations of Endemic Species and Rare Plants of The Montane Flora of The Nilgiris, South India. *J. Econ. Tax. Bot.* 3: 863-867.

Ahmedullah, M. (2000). Endemism In The Indian Flora. *In*: Singh, N. P., D. K. Singh, P. K. Hajra & B. D. Sharma (Ed.), *Flora of India, Introductory Volume* 1. Part 2. Botanical Survey of India, Calcutta. 246 – 265.

Ahmedullah, M. & M. P. Nayar (1987). *Endemic Plants of the Indian Region.* I. *Peninsular India.* Botanical Survey of India, Calcutta. 262 P.

Ambika, S.R. & Jayachandra (1980). Suppression of Plantation Crops by Eupatorium Weed. *Curr. Sci.* **49**:874-875.

Anilkumar, N. (1994). Flora of Pathanamthitta District. *PhD Thesis.* University Of Calicut, Malappuram.

Ansari, R. (1985). Studies on The Vascular Flora of Kasaragod Division, Cannanore District, Kerala State. *PhD Thesis*. University Of Madras.

Antony, V. T. (1989). Systematic Studies on The Flora of Kottayam District, Kerala. *Ph.D Thesis.* Bharathiyar University, Coimbatore.

Babu, A. (1990). Flora Of Malappuram District (Excluding Nilambur Forest Division) Parts - I & Ii. *PhD Thesis.* University of Calicut.

Babu, S. & D.P. Leighton (2004). The Shompen of Greater Nicobar Island (India) – Between"Development" and Disappearance. *Policy Matter* **13**:198–211.

Babu, S., Love, A. & C.R. Babu (2009). Ecological Restoration Of Lantana-Invaded Landscapes In Corbett Tiger Reserve, India. *Ecol Restor.* **27**:468–478.

Bagla, P. (2008). Seaweed Invader Elicits Angst In India. *Science* **320**:1271–1271.

Bhaskar, V. (1981). The Genus Impatiens L. in South India: Endemism & Affinities. *Ind For.* 368-375.

Bhattacharyya, U. C. & K. D. Kumar (1992). Endemic Species of the Family Begoniaceae of India. *J. Econ. Tax. Bot.* 16(3): 565-269.

Binojkumar, M. S. & N. P. Balakrishnan (1991). Endemic, Rare, and Endangered Euphorbiaceae of Western Ghats India. Plants. *In*: *The Proceedings of the Symposium on Rare, Endangered and Endemic Plants of the Western Ghats*. Thiruvananthapuram.

Bourdillon, T. F. (1908). *The Forest Trees of Travancore.* Govt. Press, Trivandrum.

Bridson, D. M. & L. Forman (1991). *The Herbarium Handbook*. Royal Botanic Gardens, Kew.

Burkill, I. H. (1965). *Chapters on the History of Botany In India.* Govt. India Press, Delhi.

Champion,H.G. & S.K. Seth (1968). *Revised Survey of the Forest Types of India*. Manager of Publications, Govt. of India, New Delhi. 404 P.

Chandrasekaran, S. & P.S. Swamy (2010). Growth Patterns of *Chromolaena odorata* in Varied Ecosystemsat Kodayar in the Western Ghats, India. *Acta Oecol.* **36**:383–392.

Chandrasekaran, S., Nagendran, N.A. & D. Pandiaraja (2008). Bioinvasion of Kappaphycus Alvarezzi on Corals in the Gulf of Mannar, India. *Curr Sci.* **94**:1167–1172.

Chandrashekara, U.M. (2001). *Lantana camara* in Chinnar Wildlife Sactuary, Kerala, India. *In*: Sankaran, K.V., Murphy, S.T. & Evans, H.C. (Eds) *Alien Weeds in Moist Tropical Zones: Banes and Benefits*. Kfri/Cabi Bioscience, Kerala/Ascot. 56–63 pp.

Chandrasekaran, S. & P.S. Swamy (2010). Growth patterns of *Chromolaena odorata* in varied ecosystemsat Kodayar in the Western Ghats, India. *Acta Oecol.* **36**:383–392.

Chatterjee, D. (1940). Studies on the Endemic Flora of India And Burma. *J. Asiat. Soc. Bengal 5*: 19-67.

Chatterjee, S. (1939). Studies on the Endemic Flora of India and Burma. *J. Asiat Soc. Bengal (N.S.) Science. 5*: 19-67.

Clara Lewis, T. N. N. Jul 3, 2012, 04.02 am Ist (2012-07-03). 39 Sites in Western Ghats get World Heritage Status. *The Times of India.* Retrieved 2014-02-20.

Clout, M.N. & P.A. Williams (2009). *Invasive Species Management: A Handbook of Principles and Techniques*. Oxford University Press, New York. 309 p.

Cooke, T. (1901 – 1908). *The Flora of the Presidency of Bombay*, Vol. 1-3. Taylor & Francis, London.

Curtis, J.T. (1959). *The Vegetation of Wisconsin an Ordination of Plant Communities*. University Wisconsin Press, Madison. Wisconsin.

Dayal, V. (2007). Social Diversity and Ecological Complexity: How An Invasive Tree Could Affect Diverse Agents in the Land of the Tiger. *Environ Dev Econ.* **12**:1–19.

Dukes, J.S. & H.A. Mooney (2004). Disruption of Ecosystem Processes in Western North America by Invasive Species. *Rev Chil Hist Nat.* **77**: 411–437.

Fischer, C. E. C. (1921). A Survey of the Flora of the Anamalai Hills in the Coimbatore District, Madras Presidency. *Rec. Bot. Sur. India.* 9 : 1-218.

Fosberg, F. R. & M. M. Sachet (1965). *Manual For Tropical Herbaria* (Reg. Veg. 39). Iapt, Utrecht.

Fsi (2011). *Atlas Forest Type of India*. Forest Survey of India, Dehradun.

Fyson, P. F. (1932). *The Flora of The South Indian Hill Stations.* Vol. 1 & 2. Govt. Press, Madras.

Gadgil, M. & V.M. Meher-Homji (1990). Ecological Diversity *In :* Daniel, J.C. & J.S. Serrao (Ed.), *Conservation in Developing Countries: Problems And Prospects.* Proceedings of the Centenary Seminar of the Bombay Natural History Society. P.175-198. Bombay Natural History Society and Oxford University Press, Bombay.

Gamble, J.S. (1915 – 1936). *The Flora Of The Presidency of Madras.* Adlard & Son Ltd, London.

Garcia, De Orta (1565). *Coloquinos Dos Simples*. Goa.

George, K. V. (2013). *Riverine Flora of Pamba River Basin*. Dept. of Botany, CMS College, Kottayam.

Giradkar, P.G. & S.G. Yeragi (2008). Flora of Tadoba National Park. *Ind For.* **134**:263–269.

Gogoi, A.K. (2001). Status of *Mikania Micrantha* Infestation in Northeastern India: Management Options and Future Research Thrust. *In*: Sankaran, K.V., Murphy, S.T. & Evans, H.C. (Eds) *Alien Weeds in Moist Tropical Zones: Banes and Benefits*. KFRI/CABI Bioscience, Kerala/Ascot, 77–79 Pp.

Gopalan, R. & A. N. Henry (2000). *Endemic Plants of India. Camp for the Strict Endemics of Agasthiyamalai Hills, SW Ghats.* Bishen Singh Mahendra Pal Singh, Dehra Dun.

Grice, A.C. (2004). Weeds and the Monitoring of Biodiversity in Australian Rangelands. *Austral Ecology* **29**: 51-58.

Henry, A. N., Kumari, G. R. & G. Chitra (1987 & 1989). *Flora of Tamil Nadu, India.* Series 1 : Analysis, Vol. 2 & 3. Bot. Sur. Of India, Coimbatore.

Henry, A.N, K. Vivekananthan & N. C. Nair (1978). Rare And Threatened Flowering Plants of South India. *J. Bombay Nat. Hist. Soc.* 75 : 684 – 697.

Hooker, J. D. (1872 – 1897). *The Flora of British India.* 7 Vols. L. Reeve & Co., London.

IUCN (1987). *The Iucn Red List of Threatened Species*. Iucn, Gland.

IUCN (2003). *2003 Iucn Red List of Threatened Species*. http://www.iucnredlist.org.

IUCN (2006). *2006 Iucn Red List of Threatened Species*. http://www.iucnredlist.org.

IUCN (2011). *2011 Iucn Red List of Threatened Species*. http://www.iucnredlist.org.

IUCN (2012). *2012 Iucn Red List of Threatened Species*. http://www.iucnredlist.org.

Jain, S. K. & A. R. K. Sastry (1980). *Threatened Plants of India— A State-of-the-Art Report.* Bsi, Calcuttta.

Jain, S. K. & A. R. K. Sastry (1984). *The Indian Plant Red Data Book*. Botanical Survey of India, Calcutta. 779 P.

Jain, S.K. & A. R. K. Sastry (1982). Threatened Plants and Habitats — A Review of Work in India. *P1. Conserv. Bull. Posscef.* 2: 1-9.

Jordaan, L.A., Johnson, S.D. & C.T. Downs (2011). The Role of Avian Frugivores in Germination of Seeds of Fleshy-Fruited Invasive Alien Plants. *Biological Invasions* **13** : 1917-1930.

Joseph, J. (1977). Floristic Studies in India-With Special Reference to Southern Circle of Botanical Survey of India. *Bull. Bot. Surv.* India. 19: 109-111.

Joseph, K. T. (1991). Observation in the Aquatic Angiosperms of Malabar (North Kerala). *PhD Thesis.* Calicut University, Calicut.

Joshi, A.A., Mudappa, D. & T.R. Shankar Raman (2009). Brewing Trouble: Coffee Invasion in Relation to Edges and Forest Structure in Tropical Rainforest Fragments of the Western Ghats, India. *Biol Invasions* **11**:2387–2400.

Joshi, V. C. & M. K. Janarthanam (2004). The Diversity, Life-Form Type, Habitat Preference And Phenology of the Endemics in the Goa Region of the Western Ghats, India. *J. Biogeogr.* 31:1227 – 1237.

Kala, C.P. & R.J. Shrivastava (2004). Successional Changes in Himalayan Alpine Vegetation: Two Decades After Removal of Livestock Grazing. *Weed Technol.* **18**:1210–1212.

Keane, R.M. & M.J. Crawley (2002). Exotic Plant Invasions and the Enemy Release Hypothesis. *Trends Ecol. Evol.* **17**: 164 -170.

Kimothi, M.M., Anitha, D. & H.B. Vasistha (2010). Remote Sensing to Map the Invasive Weed, *Lantana Camara* in Forests. *Trop Ecol.* **51**:67–74.

Kimothi, M.M. & A. Dasari (2010). Methodology to Map the Spread of An Invasive Plant (*Lantana Camara* L.) in Forest Ecosystems Using Indian Remote Sensing Satellite Data. *Int J Remote Sens.* **31**:3273–3289.

Krishnan, R. M. & P. Davidar (2007). The Shrubs of the Western Ghats (South India): Floristics And Status. *J. Biogeogr.* 23: 783 – 789.

Kulmatiski, A., Beard, K.H. & J.M. Stark (2006). Soil History as a Primary Control on Plant Invasion in Abandoned Agricultural Fields. *J. Appl. Ecol.* **43**: 868–876.

Lahkar, B.P., Talukdar, B.K. &, P. Sarma (2011). Invasive Species in Grassland Habitat: An Ecological Threat to the Greater One-Horned Rhino (Rhinoceros Unicornis). *Pachyderm* **49**:33–39.

Love, A., Babu, S. & C.R. Babu (2009). Management of Lantana, An Invasive Alien Weed in Forest Ecosystems of India. *Curr Sci.* **97**:1421–1429.

Lowe, S., Browne, M., Boudjelas,S. & M. De Poorter (2000). *100 of The World's Worst Invasive Alien Species - A Selection From The Global Invasive Species Database.* The Invasive Species Specialist Group (Issg) A Specialist Group of The Species Survival Commission (Ssc) of the World Conservation Union (IUCN).

Lushington, A. W. (1915). *Vernacular List of Trees, Shrubs and Woody Climbers of The Madras Presidency.* Govt. Press, Madras.

Mack, R.N., Simberloff. D., Lonsdale, W.M., Evans. H., Clout. M. & F.A. Bazzazz (2000). Biotic Invasions: Causes, Epidemiology, Global Consequences, And Control. *Ecological Applications* **10**: 689–710.

Mahajan, M. & P.A. Azeez (2001). Distribution of Selected Exotic Weeds in Nilgiri Biosphere Reserve. *In:* Sankaran, K.V., Murphy, S.T. & Evans, H.C. (Eds) *Alien Weeds in Moist Tropical Zones: Banes and Benefits*. KFRI, India & CABI Bioscience, Uk, 46–55 pp.

Malhothra, K. S. (2000). Past, Present and Future Prospects of Spice Crops in India *in* Premsing Arya (Ed.), *Spice Crops of India:* 8-14. Kalyani Publishers, Delhi.

Mani, M. S. (1974). *Ecology and Biogeography in India.* Dr. W. Junk B.V. Publishers, The Hague, Netherlands. 793 p.

Manilal, K. S. & V. V. Sivarajan (1982). *Flora of Calicut.* Bishen Singh Mahendra Pal Singh, Dehra Dun. 387 p.

Manilal, K. S. (1988). *Flora of Silent Valley : Tropical Rain Forest of India*. Calicut University, Calicut. 398 p.

Mathew, J. (2015). Floristic and Ethnobotanical studies of Achankovil forest, Western Ghats, Kerala. *Ph.D thesis,* Submitted to Mahatma Gandhi University, Kerala 715 pp.

Michael, A.J. (1998).Determination of Stress from Slip Data: Faults and Folds. *Journal of Geophysical Research* **89**(11): 517- 526.

Mitchell, C.E. & A.G. Power (2003). Release of Invasive Plants From Fungal And Viral Pathogens. *Nature* **421**: 625 - 627.

Mitra, S. & S. K. Mukherjee (2007). Reassessment and Diversity of Endemic Angiospermic Genera Of India. *J. Econ. Taxon. Bot.* 31: 163 – 176.

Mohanan, C. N. (1984). Studies on the Flora of Quilon District, Kerala. *PhD Thesis.* Madras University, Madras.

Mohanan, C.N. (1999). Mangroves. In. Thampi, K.B., Nayar, N.M. &C.S. Kumar (eds.), The natural Resources of Kerala. WWF India, Thiruvananthapuram. 149-158 pp.

Mohanan, M. & A. N. Henry (1994). *Flora of Thiruvananthapuram*. Botanical Survey of India, Calcutta. 392 p.

Mohanan, N. & M. Sivadasan (2002). *Flora of Agasthyamala*. Bishen Singh Mahendra Pal Singh, Dehra Dun. 889 p.

Muktesh, Kumar (1998). *Studies on Epiphytic Flora in the Tropical Ecosystem of Western Ghats With Special Reference to Nilgiri Biosphere Reserve.* Kerala Forest Research Institute, Peechi.

Murali, K.S. & R.S. Setty (2001). Effect of Weeds *Lantana Camara* And *Chromolaena Odorata* Growth on the Species Diversity, Regeneration And Stem Density of Tree and Shrub Layer in Brt Sanctuary. *Curr Sci.* **80**:675–678.

Myers, N. (1988). Threatened Biotas: "Hot Spots" In Tropical Forests. *The Environmentalist.* 8: 187-208.

Myers, N. (2003). Biodiversity Hotspots Revisited. *Bioscience* **53** : 916-917.

Nair, M. P. (1996). *Hot Spots Of Endemic Plants of India, Nepal And Bhuttan*. Tropical Botanical Garden and Research Institute, Trivandrum. 252 P.

Nair, N. C. & A. N. Henry (1983). *Flora of Tamil Nadu, India.* Series 1 : Analysis. Vol. 1. Bot. Sur. of India, Coimbatore.

Namboothri, N. & Shankar, K. (2010). Corals or Coke: Between The Devil And The Deep Blue Sea. *Curr Conserv.* **4**:18–20.

Narayanan, M. K. R. (2009). Floristic Study of Wayanad District With Special Emphasis on Conservation of Rare and Threatened Flowering Plants. *PhD Thesis*. Calicut University, Calicut.

Naskar, K. & R. Mandal (2000). *Ecology and Biodiversity of Indian Mangroves*. Daya Publishing House, New Delhi. 783 p.

Nayar, M. P. & A. R. K. Sastry (1987). *Red Data Book of Indian Plants.* Vol. 1. BSI.

Nayar, M. P. & A. R. K. Sastry (1987-1990). *Red Data Book of Indian Plants,* Vo. 1-3. Bot. Survey of India, Calcutta.

Nayar, M. P. & A. R. K. Sastry (1988). *Red Data Book of Indian Plants.* Vol. 2. BSI.

Nayar, M. P. & A. R. K. Sastry (1990). *Red Data Book Of Indian Plants.* Vol. 3. BSI.

Nayar, M. P. (1980a). Endemic Flora of Peninsular India And Its Significance. *Bull Bot. Surv. India.* 22 : 12-23.

Nayar, M. P. (1980b). Endemism And Patterns of Distribution Of Endemic Genera (Angiosperms) In India. *J. Econ. Tax. Bot.* 1: 99-110.

Nayar, M. P. (1982). Endemic Flora of Peninsular India and its Significance. *Bull. Bot. Surv. India.* 19 (1-4): 145-155.

Nayar, M. P. (1996). *Hot Spots Of Endemic Plants of India, Nepal and Bhutan.* Tropical Botanical Garden And Research Institute, Thiruvananthapuram.

Nayar, T. S., A. Rasiya Beegam, N. Mohanan & G. Rajkumar (2006). *Flowering Plants Of Kerala- A Handbook.* TBGRI, Thiruvananthapuram. 1069 p.

Nayar, T.S., A. Rasiya Beegam & M. Sibi (2014). *Flowering Plants of the Western Ghats, India* (2 Volumes). Jawaharlal Nehru Tropical Botanic Garden And Research Institute, Palode, Thiruvananthapuram, Kerala, India. 1700 p.

Niu, H.-B., Liu, W.-X., Wan, F.-H. & B. Liu (2007). An Invasive Aster (*Ageratina Adenophora*) Invades and Dominates Forest Understories in China: Altered Soil Microbial Communities Facilitate The Invader and Inhibit Natives. *Plant Soil* **294**: 73–85.

Orians, G.H. & M. J. Groom (2005). Global Biodiversity: Patterns and Processes. *In*: Groom, M. J., G. K. Meffe & R. C. Carroll (Ed.), *Principles of Conservation Biology*. Sinauer Associates, Inc. Publ., Massachusetts. 27 – 60.

Pradeep, A. K. (2000). *Floristic Studies on Vellarimala on the Western Ghats of Kerala.* Department of Botany, University of Calicut, Calicut.

Prasad Ae (2012) Landscape-Scale Relationships Between the Exotic Invasive Shrub *Lantana Camara* and Native Plants in a Tropical Deciduous Forest in Southern India. *J Trop Ecol.* 28:55–64.

Prasad, A.E. (2009).Tree Community Change in a Tropical Dry Forest: The Role of Roads and Exotic Plant Invasion. *Environ Conserv.* **36**:201–207.

Prasad, A.E. (2010). Effects of an Exotic Plant Invasion on Native Understory Plants In A Tropical Dry Forest. *Conserv Biol.* **24**:747–757.

Puyravaud, J.P., Shridhar, D. & A. Gaulier (1995). Impact Of Fire on A Dry Deciduous Forest in the Bandipur National Park, Southern India – Preliminary Assessment And Implications For Management. *Curr Sci.* **68**:745–751.

Ramachandran, V. S. & V. J. Nair (1988). *Flora Of Cannanore.* Bot. Sur. of India. Calcutta. 599 P.

Ramachandran, V. S., A. Honey John & R. Rasi (2010). *Rare, Endemic and Threatened Flowering Plants of Nilgiris and its Conservation.* Proceedings Of The XX Annual Conference of IAAT. Coimbatore. Tamil Nadu. 194 P.

Ramaswami, G. & R. Sukumar (2011). Woody Plant Seedling Distribution Under Invasive *Lantana Camara* Thickets in a Dry-Forest Plot In Mudumalai, Southern India. *J Trop Ecol.* **27**:365–373.

Ramesh, B. R & J. P. Pascal (1997). *Atlas of Endemics of the Western Ghats (India).* French Institute, Pondichery. 403 P.

Ramesh, B. R. & J. P. Pascal (1991). Distribution of Endemic Arborescent Evergreen Species in the Western Ghats. *In*: Karunakaran, C. K. (Ed.), *The Proceedings Of The Symposium on Rare, Endangered and Endemic Plants of The Western Ghats.* Kerala Forest Department, Trivandrum. Pp. 20-29.

Rao, C. K. (1972). Angiosperm Genera Endemic to the Indian Floristic Region and Its Neighboring Areas. I. *Indian Forester* 98: 560 – 566.

Rao, C. K. (1979). Angiosperm Genera Endemic to the Indian Floristic Region and its Neighboring Areas Ii. Addition, Deletion And Correction. *Indian Forester* 105: 335 – 341.

Rao, M.R. (1914). *Flowering Plants of Travancore.* Govt. Press, Trivandrum. 200 P.

Reddy, C.S. (2008). Catalogue of Invasive Alien Flora of India. *Life Sci J.* 5:84–89.

Rheede, H. A. V. (1678-1703). *Hortus Indicus Malabaricus*, 12 Vol. Amsterdam.

Rishi, V. (2009). Wildlife Habitat Enrichment for Mitigating Human-Elephant Conflict By Biological Displacement Of Lantana. *Ind For.* **135:** 439–448.

Roxburg, William (1820 & 1824). *Flora Indica.* Mission Press, Serampore.

Saberwal, V., Rangarajan, M. & A. Kothari (2000). *People, Parks And Wildlife: Towards Coexistence*. Orient Longman, New Delhi.

Sahu, P.K. & J.S. Singh (2008). Structural Attributes of Lantana-Invaded Forest Plots in Achanakmar-Amarkantak Biosphere Reserve, Central India. *Curr Sci.* **94**:494–500.

Sajeev, T.V., Sankaran,K.V. & T.A. Suresh (2012). Are Alien Invasive Plants A Threat to Forests of Kerala? . *KFRI Occasional Papers 1.*, KFRI, Peechi. 28 p.

Sankaran, K.V. & T.A. Suresh (2013). *Invasive Alien Plants in the Forests of Asia And The Pacific.* Food And Agriculture Organization of the United Nations, Bankok. 211 p.

Sankaran, K.V. & M.A. Srinivasan (2001). Status of Mikania Infestation in the Western Ghats. *In*: Sankaran, K.V., Murphy, S.T., Evans, H.C. (Eds) *Alien Weeds in Moist Tropical Zones: Banes and Benefits*. Kfri/Cabi Bioscience, Kerala/Ascot. 67–76 pp.

Sankaran, K.V., Suresh, T.A. & T.V. Sajeev (2012). *Handbook on Invasive Plants of Kerala*. Kerala State Biodiversity Board, Thiruvanathapuram. 98 p.

Sarkar, A. K. (1995). Endemic Genera Of Angiosperms and Their Species in India. *In*: Gupta, S.K. (Ed.), *Higher Plants of Indian Subcontinent.* Vol. 1. (Indian J. Forest. Addit. Ser. Iv). Dehra Dun. pp. 235 – 257.

Sasidharan, N. & V. V. Sivarajan (1996). *Flowering Plants of Thrissur Forests.* Scientific Publishers, Jodphur. 579 p.

Sasidharan, N. (1997). *Studies on the Flora of Shenduruny Wildlife Sanctuary With Emphasis on Endemic Species.* Kerala Forest Research Institute, Peechi.

Sasidharan, N. (1999). *Study on the Flora of Chinnar Wildlife Sanctuary.* Kerala Forest Research Institute, Peechi.

Sasidharan, N. (2002). *Floristic Studies in Parambikulam Wildlife Sanctuary*. Kerala Forest Research Institute, Peechi.

Sasidharan, N. (2004). *Biodiversity Documentation of Kerala.* Part 6. *Flowering Plants*. Kerala Forest Research Institute, Thrissur. 702 p.

Sasidharan, N. (2013). *Flowering Plants of Kerala* (Cd) 2.0 . Kerala Forest Research Institute, Thrissur.

Sawarkar, V.B. (1984). *Lantana Camara* In Wildlife Habitats with Special Reference to The Melghat Tiger Reserve. *Cheetal* **26**:24–38.

Saxena. (1991). Biological Invasions In The Indian Subcontinent: Review of Invasion by Plants. *In*: Ramakrishnan, P.S. (Ed,). *Ecology Of Biological Invasion in the Tropics*. International Scientific Publication New Delhi. 21-34.

Sheeba J. I. & D. Narasimhan (2011). Endemic Genera of Angiosperms in India: A Review. *Rheedea* 21. 87- 105.

Shukla, A.N., Singh, K.P. & J.S. Singh (2009). Invasive Alien Species of Achanakmar-Amarkantak Biosphere Reserve, Central India. *Proc Natl Acad Sci Ind Sect B-Biol Sci.* **79**:384–392.

Sivarajan, V.V. & P. Mathew (1996). *Flora of Nilambur: Western Ghats, Kerala*. Bishen Singh Mahendra Pal Singh, Dehra Dun. 900 P.

Srinivasan, M.P. (2011). *The Ecology of Disturbance And Global Change in the Montane Grasslands of the Nilgiris, South India*. University of Kentucky Doctoral Dissertations, Lexington, 213 P.

Srinivasan, M.P., Shenoy, K. & S.K. Gleason (2007). Population Structure of Scotch Broom (*Cytisus Scoparius*) And Its Invasion Impacts on the Resident Plant Community in the Grasslands of Nilgiris, India. *Curr Sci.* 93:1108–1113.

Subramanian, K.N., N. Venkatasubramanian, & Nallarswamy (1987). *Flora of Palghat,* Bsmps, Dehra Dun.

Subramaniyan K. N. (1995). *Flora of Thenmala Division.* International Book Distributors, Dehra Dun. 516 p.

Subramanyam, K. & M. P. Nayar (1974). Vegetation and Phytogeography of the Western Ghats. *In*: Mani, M.S. (Ed.), *Ecology and Biogeography of India.* Dr. W. Junk Publishers, Hague. 23: 178 – 196.

Sundaram, B. & A.J. Hiremath (2012). *Lantana Camara* Invasion in a Heterogeneous Landscape: Patterns of Spread and Correlation With Changes in Native Vegetation. *Biol Invasion* **14**:1127–1141.

Sunil, C.N. & M. Sivadasan (2009). *Flora of Alappuzha District, Kerala, India*. Bishen Singh Mahendra Pal Singh, Dehra Dun. 949 P.

Vajravelu, E. (1987). Studies on The Endemic Species of Palghat District, Kerala. *J. Econ. Tax. Bot.* 9(1): 101-112.

Vajravelu, E. (1988). Collection of Rare and Little Known Plants From Southern States. *J. Econ. Tax. Bot.* 12(1): 55-70.

Vajravelu, E. (1990). *Flora Of Palghat District*. Bot. Sur. of India, Calcutta. 646 p.

Vattakkavan, J., Vasu, N.K. & S. Varma (2005). *Silent Stranglers. Eradication Of Mimosa In Kaziranga National Park, Assam*. Wildlife Trust of India, New Delhi.

Vivekananthan, K. (1981). Floristic Studies in Idukki District, Kerala. *Bull. Bot. Sum. India.* 23: 1-4.

Waite, T.A., Corey, S.J. & L.G. Campbell (2009). Satellite Sleuthing: Does Remotely Sensed Landcover Change Signal Ecological Degradation In A Protected Area?. *Divers Distrib.* **15**:299–309.

Wherry, E. T. (1944). A Classification of Endemic Plants. *Ecology* 25: 247-248.

Wight, R. & Walker-Arnott (1834). *Prodomus Florae Peninsulae Indiae Orientalis*. London.

Wight, R. (1838-1853). *Icones Plantarum Indiae Orientalis*, 6 Vol. Madras.

Wight, R. (1840). *Illustrations of Indian Botany.* Glasgow, London.

Yurkonis, K.A., Meiners, S.J. & B.E. Wachholder (2005). Invasion Impacts Diversity Through Altered Community Dynamics. *Journal of Ecology* **93**: 1053-1061.

Zarri, A.A., Rahmani, A.A. & M.J. Behan (2006). Habitat Modification by Scotch Broom *Cytisus Scoparius* Invasion of the Grasslands of Upper Nilgiris In India. *J Bombay Nat Hist Soc.* **103**:356–365.

വിവരശേഖരണ ഫാറം

2018 ലെ വെള്ളപൊക്കവുമായി അനുബന്ധിച്ച് ആലപ്പുഴയിലെ ദ്വീപുകളിലുണ്ടായ മാറ്റങ്ങളെക്കുറിച്ചുള്ള വിവരശേഖരണം

പേര് :

വിലാസം :

വയസ് :

ആൺ/പെൺ :

ഉപജീവനമാർഗ്ഗം :

എത്ര വർഷമായി ദ്വീപ് നിവാസിയാണ്? :

എത്ര വർഷമായി പ്രസ്തുത ജോലി ചെയ്യുന്നു? :

വെള്ളപൊക്കം വീടിനോ വസ്തുവകകൾക്കോ
കേടുപാടുകൾ വരുത്തിയോ? :

അക്കാലത്ത് ജോലിയിൽ നേരിട്ട
പ്രയാസങ്ങൾ ഏവ? :

വെള്ളപൊക്കം ദ്വീപിലെ സസ്യസമ്പത്തിനെ
ഏതുതരത്തിൽ ബാധിച്ചു? :

കണ്ടൽക്കാടുകൾക്ക് വെള്ളപ്പൊക്കത്തെ
തുടർന്ന് ശോഷണം സംഭവിച്ചിട്ടുണ്ടോ? :

വെള്ളത്തിന് രുചി, ഗന്ധം എന്നിവയിലെന്തെ
ങ്കിലും മാറ്റം തോന്നിയിട്ടുണ്ടോ? :

മത്സ്യലഭ്യതയിൽ വ്യതിയാനമുണ്ടായോ? :

മത്സ്യേതര വിഭവങ്ങളുടെ ലഭ്യതയെക്കുറിച്ച്? :

അന്യദേശമത്സ്യങ്ങളുടെ വരവ് ഉണ്ടായോ?
അവ തദ്ദേശവിഭവങ്ങളിൽ സ്വാധീനം
ചെലുത്തിയിട്ടുണ്ടോ? :

കളസസ്യങ്ങളുടെ വളർച്ചയിൽ പ്രകടമായ
മാറ്റം കാണുന്നുണ്ടോ? :

വിവരശേഖരണം നടത്തിയ
ആളുടെ പേരും ദിവസവും