

A Study of Plant diversity and indices of woody species (trees and lianas) of G. Ariyur Sacred Grove, Viluppuram District, Tamil Nadu, South India

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Abstract: Sacred groves are ecologically important with great heritage of genetic diversity of many local forest based plant species having medicinal, economic, cultural and religious values. The present study was aimed at documenting the wealth of plant diversity of a sacred grove. A survey was conducted to record density, species richness and diversity of woody species (trees and lianas) in the G. Ariyur sacred grove which is dedicated to Aiyanar with an area of 2.5 hectares and which is situated in Tirukkoyilur taluk of Viluppuram district, Tamil Nadu, South India. A total of 39 plant species representing 37 genera were recorded, belonging to 23 families. Of these, 32 (71%) species were trees and 7 (29%) species were lianas. The dominant families are: Mimosaceae (5 species), Caesalpiniaceae (4 species) and Rutaceae (4 species). Apocynaceae, Capparaceae, Fabaceae, Rhamnaceae, Rubiaceae, and Sapindaceae which were represented by two species each from the study site. Density, species richness and diversity of trees were recorded for the detailed study of plant diversity. The vegetation type indicates that this grove is considered to be an inland tropical dry evergreen forest.

Keywords: *G. Ariyur, sacred groves, plant biodiversity, conservation, cultural tradition.*

INTRODUCTION:

Ancient societies such as those of Greece, Rome, Asia and Africa had long practiced preserving patches of forests in their original state due to the belief that they were the abodes of gods and goddesses (Gadgil and Vartak, 1975). Sacred groves may be defined as patches of climax vegetation protected on religious grounds and buttressed by cultural mores. Fortunately, in many parts of the world, including India, there are many patches of pristine forests which have been preserved in their original state due to the prevalence of religious beliefs and social customs. These patches of forests are known as sacred groves and are considered to be the abode of ancestral deities and village gods. The names of the sacred groves vary from place to place in various

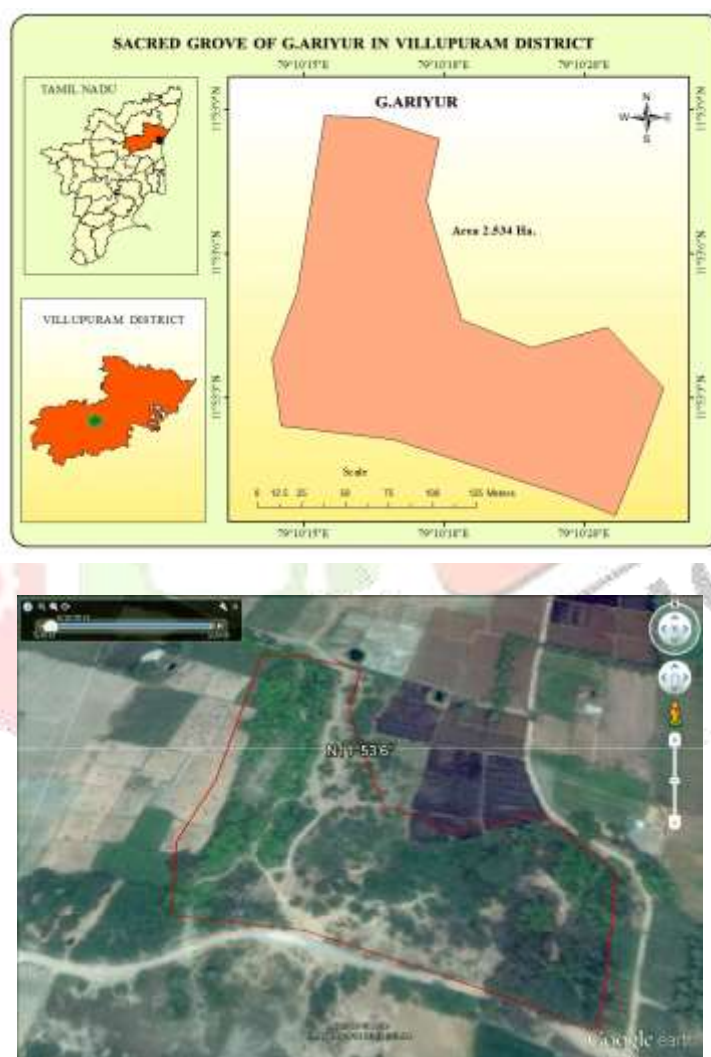
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regions of the country (Malhotra *et al.*, 2001). These groves are the repositories of varied biodiversity and thus play an important role in its conservation (Anthwal *et al.* 2006). The important role played by the sacred groves in preserving biodiversity has long been recognized (Khan *et al.*2008). Sacred groves are thus veritable natural museums of rare medicinal plants, balancers of the watershed, a gene bank of economic species and laboratory for environmentalists (Vartak and Kumbhojkar, 1984; Amirthalingam, 1998; Ramanujam, 2000; Sukumaran and Raj,2010). These sacred groves are kept in a state of good preservation as islands of native species of plants, animals, insects and micro-organisms. Hence it is necessary to make a detailed study of the G.Ariyur sacred grove and its plant diversity.

METHODOLOGY

Study Area

Plate 1: Base map and Google earth photo of G.Ariyur sacred grove



The present study was conducted in G.Ariyur sacred grove which has an inland tropical dry evergreen forest types which is situated in Tirukkoyilur taluk of Viluppuram district, Tamil Nadu, South India. The total area of the grove is 2.5 hectares. It lies between latitude $11^{\circ}53'3.54''N$ and longitude $79^{\circ}10'18.12''E$. In this grove, regular *poojas* are performed on Tuesdays, Fridays and Saturdays. Once in a year, during the month of *Masi* (February – March), a two days festival is conducted. Some of the devotees offer animal sacrifice for the

fulfilment of their wishes. The practice of offering terracotta statues and tributes for the development and maintenance of the temple is found to be common. Tonsure ceremony for the children is also conducted regularly. The grove is maintained by the people of the Udaiyar community. However, the priest is usually from the Manudaiyar community. Crops like sugarcane, cotton, corn, green gram are cultivated in the surrounding areas (Plate 1). An overview of the groves is given in plate -2.

METHODS

Floristic composition of the grove was analysed during the periodic field visits spread over different seasons. In this grove, the size one hectare plot was laid and data collected accordingly. The study plot was further divided into sub-grids of 10 x 10m size to facilitate the inventory. During inventory, all trees ≥ 10 cm girth at breast height (gbh) were measured at 1.5m from ground level and the lianas ≥ 1 cm diameter were measured at 1.3 m from the rooting point. Voucher specimens were collected for all the species, methodically processed and identified using regional floras (Gamble and Fischer, 1915–1935; Hooker, 1872–1897; Matthew, 1991) and confirmed with the herbarium repository in the Department of Plant Biology and Plant Biotechnology, Presidency College, Chennai. Following Diversity indices such as Shannon (H'), Simpson (D) and Fisher's alpha were calculated as per Magurran (2004). Species Importance Value Indices (IVI) was calculated as per Mori *et al.* (1983). A modified Family Importance Value (FIV) was calculated by summing up the relative diversity (number of species in the family/total number of species $\times 100$) and relative density of the individuals (Mori *et al.*, 1983) as it gives the relative contribution of the species to the stand structure.

RESULTS

Floristic analysis of G.Ariyur sacred grove

In this grove, there were 39 plant species representing 37 genera distributed in 23 families. Of these, 32 species were trees (71%) and 7 species were lianas (29%), (Table 2). The dominant families are: Mimosaceae (5 species), Caesalpiniaceae (4 Species) and Rutaceae (4 Species). Apocynaceae, Capparaceae, Fabaceae, Rhamnaceae, Rubiaceae, and Sapindaceae were represented with two species each. Alangiaceae, Anacardiaceae, Annonaceae, Arcaceae, Ebenaceae, Loganiaceae, Meliaceae, Moraceae, Moringaceae, Oleaceae, Santalaceae, Sapotaceae, Tiliaceae, Vitaceae had only one species in each of the families.

Diversity analysis

Shannon (H') index for tree and liana species was 0.7 and the Alpha index was 10.07. This shows that more dominant species with almost equal contributions among 475 individuals were available in the stand. The Simpson (1/D) index was 8.1 and the Berger-Parker dominance (1/d) index was 4.1 indicating a good diversity in the grove. Hill's number (H1) index for the tree and liana species was 66.1 (Table 1).

Table 1: Inventory of wood species comprising the G.Ariyur sacred grove

Variables	Number / Value (Number of individuals)
Species richness	39
Number of the Genera	37
Number of families	22
Number of tree species	32 (414)
Number of liana species	7 (61)
Density (ha ⁻¹)	475

Average tree girth	32.52
Average liana girth	6.69
Diversity indices	
Shannon J'	0.7
Alpha	10.068
Simpsons Diversity (1/D)	8.126
Berger-Parker dominance (1/d)	4.095
Hill's Number H1	66.154

Species richness

The grove has a stand density of 475 ha⁻¹. It was distinctly dominated by *Albizia amara*, *Prosopis juliflora*, *Azadirachta indica*, *Cascabela thevetia*, *Wrightia tinctoria*, *Ziziphus oenopolia*, *Diospyros montana* and *Crateva magna* (Table 2).

Table 2: Plant Phytosociology of woody species at Aiyanar grove in G.Ariyur

S.No	Botanical name	Count	Habit	BA	RBA	RD	RF	IVI
1	<i>Abrus precatorius</i> L.	5	L	0.0008	0.0087	1.0526	1.3699	2.4311
2	<i>Acacia leucophloea</i> (Roxb.) Willd.	2	T	0.0314	0.3585	0.4211	0.6849	1.4645
3	<i>Aegle marmelos</i> (L.) Correa	1	T	0.0145	0.166	0.2105	0.3425	0.719
4	<i>Alangium salviifolium</i> (L.f.) Wangerin	3	T	0.0287	0.3287	0.6316	1.0274	1.9877
5	<i>Albizia amara</i> (Roxb.) B.Boivin	116	T	0.9093	10.398	24.4211	15.753	50.572
6	<i>Annona squamosa</i> L.	1	T	0.0032	0.0371	0.2105	0.3425	0.5901
7	<i>Atalantia monophylla</i> DC.	4	T	0.0199	0.2272	0.8421	1.0274	2.0967
8	<i>Azadirachta indica</i> A.Juss.	48	T	0.4511	5.158	10.1053	11.986	27.25
9	<i>Benkara malabarica</i> (Lam.) Tirveng.	1	T	0.0123	0.1406	0.2105	0.3425	0.6936
10	<i>Borassus flabellifer</i> L.	5	T	0.3975	4.5453	1.0526	1.3699	6.9678
11	<i>Capparis zeylanica</i> L.	1	L	0.0003	0.0031	0.2105	0.3425	0.5561
12	<i>Cascabela thevetia</i> (L.) Lippold	33	T	0.1157	1.3229	6.9474	6.5068	14.777
13	<i>Cassia fistula</i> L.	2	T	0.0161	0.1838	0.4211	0.6849	1.2898
14	<i>Cassia roxburghii</i> DC.	1	T	0.0044	0.0507	0.2105	0.3425	0.6037
15	<i>Cissus quadrangularis</i> L.	11	L	0.0009	0.0108	2.3158	2.7397	5.0663
16	<i>Clausena dentata</i> (Willd.) M. Roem.	1	T	0.0056	0.0639	0.2105	0.3425	0.6169
17	<i>Crateva magna</i> (Lour.) DC.	12	T	0.079	0.9034	2.5263	4.1096	7.5393
18	<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	3	T	0.0111	0.1267	0.6316	0.6849	1.4432
19	<i>Diospyros montana</i> Roxb.	13	T	0.1462	1.672	2.7368	4.1096	8.5184

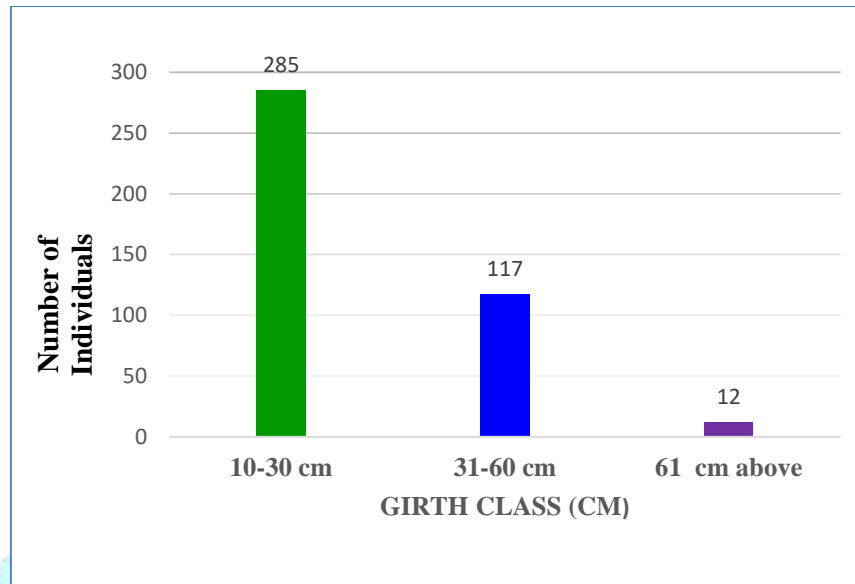
20	<i>Ficus religiosa</i> L.	1	T	1.8612	21.284	0.2105	0.3425	21.837
21	<i>Grewia orientalis</i> L.	11	L	0.0053	0.0602	2.3158	3.7671	6.1431
22	<i>Jasminum angustifolium</i> (L.) Willd.	7	L	0.003	0.0338	1.4737	2.3973	3.9048
23	<i>Lanea coromandelica</i> (Houtt.) Merr.	2	T	0.057	0.6523	0.4211	0.6849	1.7583
24	<i>Lepisanthes tetraphylla</i> (Vahl) Radlk.	7	T	0.0507	0.5793	1.4737	1.7123	3.7653
25	<i>Leucaena leucocephala</i> (Lam.) de Wit	1	T	0.0186	0.2124	0.2105	0.3425	0.7654
26	<i>Madhuca longifolia</i> (J.Koenig ex L.) J.F.Macbr.	2	T	0.1059	1.2107	0.4211	0.6849	2.3167
27	<i>Morinda pubescens</i> J.E.Smith	10	T	0.0567	0.648	2.1053	3.0822	5.8354
28	<i>Moringa oleifera</i> Lam.	1	T	0.0047	0.0533	0.2105	0.3425	0.6063
29	<i>Peltophorum pterocarpum</i> Auct. non K.Heyne	3	T	0.1032	1.1798	0.6316	1.0274	2.8388
30	<i>Pongamia pinnata</i> (L.) Pierre	10	T	0.0632	0.723	2.1053	2.3973	5.2255
31	<i>Prosopis juliflora</i> (Sw.) Dc.	98	T	0.5284	6.0427	20.6316	13.356	40.03
32	<i>Santalum album</i> L.	1	T	0.003	0.0346	0.2105	0.3425	0.5876
33	<i>Sapindus emarginatus</i> Vahl	3	T	0.0399	0.4557	0.6316	1.0274	2.1147
34	<i>Strychnos nux-vomica</i> L.	4	T	0.0644	0.7368	0.8421	1.3699	2.9488
35	<i>Tamarindus indica</i> L.	1	T	3.3411	38.207	0.2105	0.3425	38.76
36	<i>Toddalia asiatica</i> (L.) Lam.	11	L	0.0064	0.0728	2.3158	2.7397	5.1283
37	<i>Wrightia tinctoria</i> R.Br	19	T	0.1227	1.4031	4	3.4247	8.8277
38	<i>Ziziphus mauritiana</i> Lam.	5	T	0.0528	0.6034	1.0526	1.3699	3.0259
39	<i>Ziziphus oenopolia</i> (L.) Miller	15	L	0.009	0.1027	3.1579	5.137	8.3976
	Total	475		8.7449	100	100	100	300

L- Liana., T- Tree. BA=Basal Area, RBA = Relative Basal Area, RD=Relative Density, RF =Relative Frequency, IVI=Importance Value Index.

Girth class and stand density

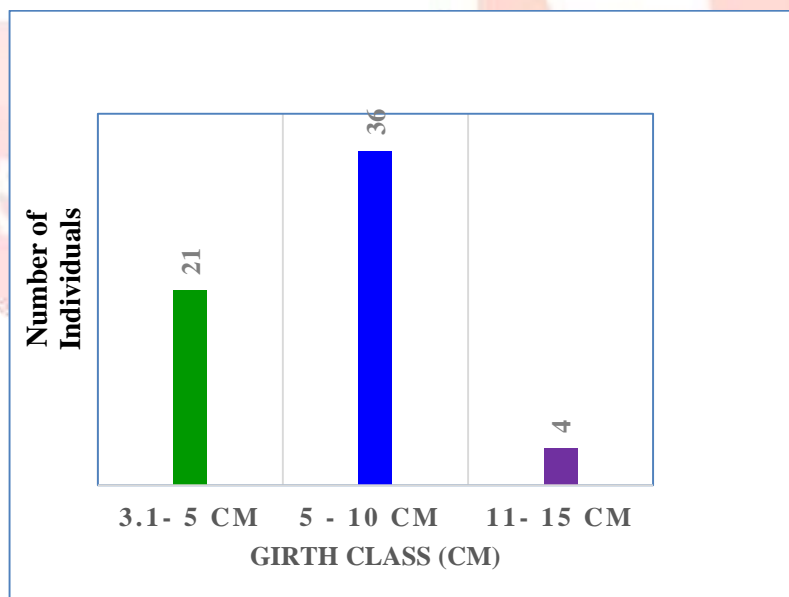
The largest GBH observed was that of *Ficus religiosa* (483.5cm), followed by *Tamarindus indica* (647.8 cm), *Madhuca longifolia* (112.3 cm), *Borassus flabellifer* (110.2 cm) and *Azadirachta indica* (85.6 cm). Tree species belonging to 10 to 30 cm gbh class percentage are represented by 285 individuals; 31 to 60 cm gbh represented by 117 individuals and above 61cm gbh by 12 individuals (Fig. 1).

Fig. 1: GBH of dominant trees in G.Ariyur sacred grove



As far as lianas are concerned, *Toddalia asiatica* had a maximum GBH (14.3 cm), followed by *Grewia orientalis* (13.4 cm) and *Ziziphus oenopolia* (12.4 cm). Liana species belonging to 5 to 10 cm gbh are represented by 36 individuals; 3.1 to 5 cm gbh are represented by 21 individuals; 11 to 15cm gbh are represented by 4 individuals (Fig. 2).

Fig. 2: GBH of dominant lianas in G.Ariyur sacred grove



Basal area of stand of woody species

The total basal area is $8.74 \text{ m}^2 \text{ ha}^{-1}$ in the study area. *Tamarindus indica* has the largest share in stand basal area ($3.3411 \text{ m}^2 \text{ ha}^{-1}$) followed by *Ficus religiosa* ($1.8612 \text{ m}^2 \text{ ha}^{-1}$), *Albizia amara* ($0.9093 \text{ m}^2 \text{ ha}^{-1}$), *Prosopis juliflora* ($0.5284 \text{ m}^2 \text{ ha}^{-1}$), and *Ziziphus oenopolia* ($0.0090 \text{ m}^2 \text{ ha}^{-1}$). The lowest basal area is represented by *Capparis zeylanica* ($0.0003 \text{ m}^2 \text{ ha}^{-1}$) (Table 2).

Importance value index

Dominant Importance Value Index (IVI) is maximum for *Albizia amara* (IVI = 50.572), followed by *Prosopis juliflora* (IVI = 40.03), *Tamarindus indica* (IVI = 38.76), *Azadirachta indica* (IVI = 27.25) and *Ficus religiosa* (IVI = 21.837.). The IVI is minimum for *Capparis zeylanica* (IVI = 0.5561) (Table 2).

Vegetation profile

Albizia amara, *Prosopis juliflora*, *Azadirachta indica*, *Cascabela thevetia* and *Wrightia tinctoria* are dominant and medium size trees. Tree species like *Tamarindus indica* and *Ficus religiosa* are present as the upper canopy trees in the grove. Slightly short trees such as *Prosopis juliflora*, *Albizia amara*, and *Cascabela thevetia* are sparsely distributed in the grove.

Disturbance analysis

The local community collects the fallen branches and other dead wood from the grove with no restrictions. Some areas within the groves have been cleared for raising commercial crops such as drumstick and banana. Unrestricted grazing is also being practiced in the grove which has resulted in the disappearance of some rare species. The grove has also become a refuge for drunkards and other anti-social elements.

DISCUSSION

The tropical dry evergreen forest (TDEF) sites scattered along the Coromandel coast of India are invariably protected as sacred forests in which different researches have been carried out on plant biodiversity by the researchers including Meher Homji, 1986; Ramujam and Kadamban (2001), Parthasarathy and Karthikeyan, 1997; Mani and Parthasarathy (2007), Parthasarathy, et.al., (2008), etc. However, there is no complete documentation and research on the social and biodiversity values till date. To fulfill this scientific gap, the present study has been carried out in ten inland sacred groves from Cuddalore and Villupuram districts of Tamil Nadu.

The present study has enumerated a total of 39 plant species representing 37 genera distributed in 23 families. Of these, 32 species are trees (71%) and 7 species are lianas (29%), (Table 2). The dominant families are: Mimosaceae (5 species), Caesalpiniaceae (4 Species) and Rutaceae (4 Species). This is closer to the value from India at comparable 1-ha scale.

The total basal area is $8.74 \text{ m}^2 \text{ ha}^{-1}$ in the study area. *Tamarindus indica* has the largest share in stand basal area ($3.3411 \text{ m}^2 \text{ ha}^{-1}$) followed by *Ficus religiosa* ($1.8612 \text{ m}^2 \text{ ha}^{-1}$), *Albizia amara* ($0.9093 \text{ m}^2 \text{ ha}^{-1}$), *Prosopis juliflora* ($0.5284 \text{ m}^2 \text{ ha}^{-1}$), and *Ziziphus oenopolia* ($0.0090 \text{ m}^2 \text{ ha}^{-1}$). The lowest basal area is represented by *Capparis zeylanica* ($0.0003 \text{ m}^2 \text{ ha}^{-1}$) (Table 2). This is closer to the tree diversity (stem $\geq 10 \text{ cm}$ gbh) ranged from a low value of 26.3 ± 6.7 with range from 18-37 species per hectare in TDEF, India (Vivek and Parthasarathy, 2015), Similarly, the mean stands 21 ± 5.5 with range from 12 - 33 species per ha from Cuddalore and Villupuram districts (Karthik et al. 2016) to a higher value of 51.2 ± 9.5 species per ha with range from 42-66 in the Southern Eastern Ghats (Rao et al., 2011) were recorded.

A total of 32 species belonging to 37 genera and 23 families enumerated on one ha. Scale recorded is significant (Table 2). There are 32 in woody species and 7 are lianas. The dominant families are: Mimosaceae (5 species), Caesalpiniaceae (4 Species) and Rutaceae (4 Species). Apocynaceae, Capparaceae, Fabaceae, Rhamnaceae, Rubiaceae, and Sapindaceae were represented with two species each. Alangiaceae, Anacardiaceae, Annonaceae, Arecaceae, Ebenaceae, Loganiaceae, Meliaceae, Moraceae, Moringaceae,

Oleaceae, Santalaceae, Sapotaceae, Tiliaceae, Vitaceae have only one species in each of the families which are reported in this grove.

As far as vegetation analysis is concerned, it indicates that the stand density of the grove ranging from 117 to 285 stems per hectare. It is far below the 1663 stems ha⁻¹ recorded for Shanmuganathapuram nearby (Mani and Parthasarathy 2007).

Based on the data, the patchy vegetation of the grove has a mixture of Bravi-deciduous and tropical dry evergreen trees forming an apparently two layered forest. *Albizia amara*, *Prosopis juliflora*, *Azadirachta indica*, *Cascabela thevetia* and *Wrightia tinctoria* are dominant and medium size trees. Tree species like *Tamarindus indica* and *Ficus religiosa* are present as the upper canopy trees in the grove. Slightly short trees such as *Prosopis juliflora*, *Albizia amara*, and *Cascabela thevetia* are sparsely distributed in the grove. Such as two layer structure is a special type of formation confined only to the south east coast of India and north east part of Sri Lanka (Rao and Meher-Homji 1993).

CONCLUSION

The analysis showed that the stand density and tree diversity of the grove is on the lower side when compared to the other inland tropical dry evergreen forest type groves of this area. It was revealed that tree diversity varied according to biogeography and habitat destruction. Another factor that played an important role in affecting the composition of the grove was anthropomorphic activities. The grove is also closely linked with the religious and cultural traditions of the local communities. The grove is also performing a very useful function in conserving the biodiversity and providing the natural habitat for plants and animals. However, this study has focused on a tropical dry evergreen forest as it is essential that this type of forest is preserved from species extinction. It is also to be noted that the sacred groves fulfil the function of repositories of genetic diversity of native trees.

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Plate – 2 Overview of the G. Ariyur Aiyandar Sacred Grove



Mud path leading to the site



The major deity and terracotta horses



Minor deities in the site



A major drinking water source inside the grove



A part of the grove cleared for banana plantation



Adjoining agricultural land with paddy cultivation